3 Shaking the World

Whereas Icelanders had long since familiarized themselves with the peculiarities of their homeland, in mainland Europe, volcanism was still quite an obscure concept. Indeed, it was not the obvious and dramatic consequences of a volcano that occupied the continent that summer but the protracted presence of a caustic mist. Chapter Three analyzes how contemporaries in Europe and beyond reacted physically, emotionally, and intellectually to the Laki haze and the numerous other unusual phenomena that characterized 1783.

History of Geology

Volcanoes: A Topic of Meteorology

In the mid-eighteenth century, geology was still a fledgling branch of the sciences. Volcano itself was a neologism; in the literature of that period, there is scant mention of the term *vulcanus*, but rather "fire-spitting mountain" or "earth fire."[1] The term "volcano" only emerged in the sixteenth and seventeenth centuries when Europeans started traveling to other parts of the world, such as the Canary Islands, the Moluccas, and Central and South America. Volcanoes were popular attractions with educated Europeans on their Grand Tours. The well-traveled elite soon realized that fire-spitting mountains were a recurrent worldwide phenomenon. The first mention of the noun "volcano" in the English language is in the Oxford English Dictionary of 1613. Spanish explorers of the time referred to these "mountains of fire" (*montañas de fuego*) as *vulcan* or *volcan*, amongst other names, referencing the Aeolian Islands north of Sicily in the Mediterranean. Historian of geology Kenneth Taylor states that Vulcano and Stromboli were often confused, so their names were used interchangeably for a long time. Until the seventeenth century, Etna was referred to as *Vulcanus mons*. The term volcanology was only coined in the nineteenth century.[2]

Today it seems obvious that volcanoes are a central part of geoscience; however, in the eighteenth century, the exploration of volcanoes and earthquakes was considered part of meteorology. The Greek adjective *meteoros* means "uncertain or inconstant." In the seventeenth century, the term *meteora* was used to denote "a class of 'phenomena which surprise us.'"[3] The phenomena included subsurface revolution events associated with volcanoes and earthquakes, thunderstorms, northern lights, comets, and shooting stars. In summary, *meteora* were natural occurrences that took

1 "Vulcanus" in Zedler 1747, vol. 51: 1239. "Feuer=speyende Berge" in Zedler 1734, vol. 9: 768.

2 Taylor 2016: 3; McCallam 2019: 4–6.

3 Taylor 2016: 4; note 5.

https://doi.org/10.1515/9783110731927-003

place at odd times and inspired awe. *Meteora* is also the title of Aristotle's treatise that dealt with the atmosphere, geology, and hydrology, among other topics.[4]

Kenneth TAYLOR argues that in antiquity, the Romans regarded Mount Etna and Vesuvius as local phenomena rather than expressions of the same underlying principle and made no effort to categorize them. The seemingly accidental nature of volcanoes was related to the notion of *meteora*.[5] But, of course, the awareness of volcanoes in antiquity extended far beyond just Mount Etna and Vesuvius. Aristotle's *Meteora* inspired Pliny the Elder's (23–79 CE) 37-volume *Naturalis historia*, in which he thought deeply about volcanic eruptions.[6] Other notable scholars who engaged with these ideas include Isidore of Seville (560–636) and Bede the Venerable (ca. 672–735).[7]

The knowledge produced about volcanoes from antiquity was known and discussed among scholars in the Middle Ages. During the thirteenth century, Aristotle's *Meteora* regained its allure. Important thinkers such as Thomas Aquinas, Albertus Magnus, and Thomas de Cantimpré made good use of the treatise's insights. In 1349, Konrad von Megenberg published the first German-language natural history encyclopedia; it became extremely popular and made Aristotelian knowledge accessible to a lay audience.[8] Knowledge from antiquity on volcanoes and the natural world did not disappear in the Middle Ages; instead, it was transferred.[9] The echoes of the ideas of antiquity struck a chord with those of a curious bent during the Enlightenment. The period's predisposition toward "novelties of nature" and faraway travels to the New World further sparked an interest in these mysterious fire-spitting mountains.[10]

In the eighteenth century, volcanoes were increasingly explored, researched, and discussed. Fieldwork and travels to Italy or Iceland stimulated debate among naturalists with a surge in interest between 1763 and 1792, a period of relative peace on the continent. This period, by happenstance, coincided with activity at Vesuvius and Etna and so offered an opportunity for naturalists to consolidate their theories on the causes of eruptions and the formation of the planet. Naturalists at the time leaned on other disciplines, such as chemistry, when considering the explosive reactions between gases, rocks, or metals and seawater, air, or fire, and later physics, when considering the role of electricity.[11] The discovery of Pompeii and Herculaneum in the eighteenth century – frozen in time by a pyroclastic density current from Vesuvius' eruption in 79 CE – served as a reminder of humanity's mortality. Geological timescales threaten human resilience and make huge events easy to forget. Volcanoes, at

4 TAYLOR 2016: 4.
5 TAYLOR 2016: 3–4.
6 Plinius 2013.
7 ROHR 2017: 49, 64–67.
8 Konrad von Megenberg 2003.
9 ROHR 2017: 49, 64–67.
10 TAYLOR 2016: 4.
11 MCCALLAM 2019: 1–3, 234.

least in contrast to earthquakes, leave a visual reminder in the landscape: "Generations pass, the smoking peak endures."[12]

Athanasius KIRCHER (1602–1680) was a German Jesuit who observed nature and volcanoes extensively. On a journey to Italy in 1638, he visited Mount Etna, Vesuvius, and an erupting Stromboli. Thus, he gained first-hand experience with volcanoes at a time when they were a rather exotic topic.[13] Prior to its 1628 eruption, Vesuvius had been considered extinct. KIRCHER speculated about the mechanisms of volcanic eruptions and assumed a connection between the different burning mountains around the world, which he famously depicted in a copperplate print published in his *Mundus Subterraneus*. KIRCHER considered volcanoes part of a "system of terrestrial operations" and imagined a subsurface network of chambers and passages linked to a central fire within the Earth.[14] The volcanoes depicted by KIRCHER were cone-shaped stratovolcanoes; the iconic image included in Figure 19 influenced the public perception of the appearance of volcanoes for centuries.

Beginning in the 1790s, a debate concerning the origin of basalt divided the scientific community. Two schools of thought existed, Neptunism and Plutonism. Neptunism, also called Diluvialism as it referenced the biblical Flood, was the assumption that all rocks, including basalt, derive from ocean sediments.[15] Abraham Gottlob WERNER (1749–1817) and his students taught Neptunism, which had, for a time, a proponent in Johann Wolfgang VON GOETHE (1749–1832). Plutonism, also called *Volcanism*, was a theory developed by Scottish geologist James HUTTON (1726–1797), which assumed that a central fire inside the planet created the Earth's crust through volcanic activity.[16] At the end of the eighteenth century, HUTTON suggested that geologists should consider volcanoes a central concept in geology.[17] This debate is explored in greater depth in the fourth chapter of this book.

Eighteenth-century geologists developed many theories as to why earthquakes and volcanoes occurred. The discipline of geology strove to identify the laws behind observations of nature. Volcanoes played a marginal role as they would only erupt at odd, irregular times, making it nearly impossible to determine the laws behind their existence. As TAYLOR points out, volcanoes needed to become ordinary to be integrated into the thought-world of early geology.[18]

12 MCCALLAM 2019: 233.

13 TAYLOR 2016: 6.

14 TAYLOR 2016: 46; PYLE 2017: 56.

15 RAPPAPORT 2007: 103, 111–114; MCCALLAM 2019: 234–235. Michael KEMPE (2003a, 2003b) has studied the Swiss polymath Johann Jakob SCHEUCHZER and the theory of the biblical Deluge; see also BOSCANI LEONI 2010.

16 PÁLSSON 2004: 175.

17 HUTTON 1788: 274; TAYLOR 2016: 1.

18 TAYLOR 2016: 1.

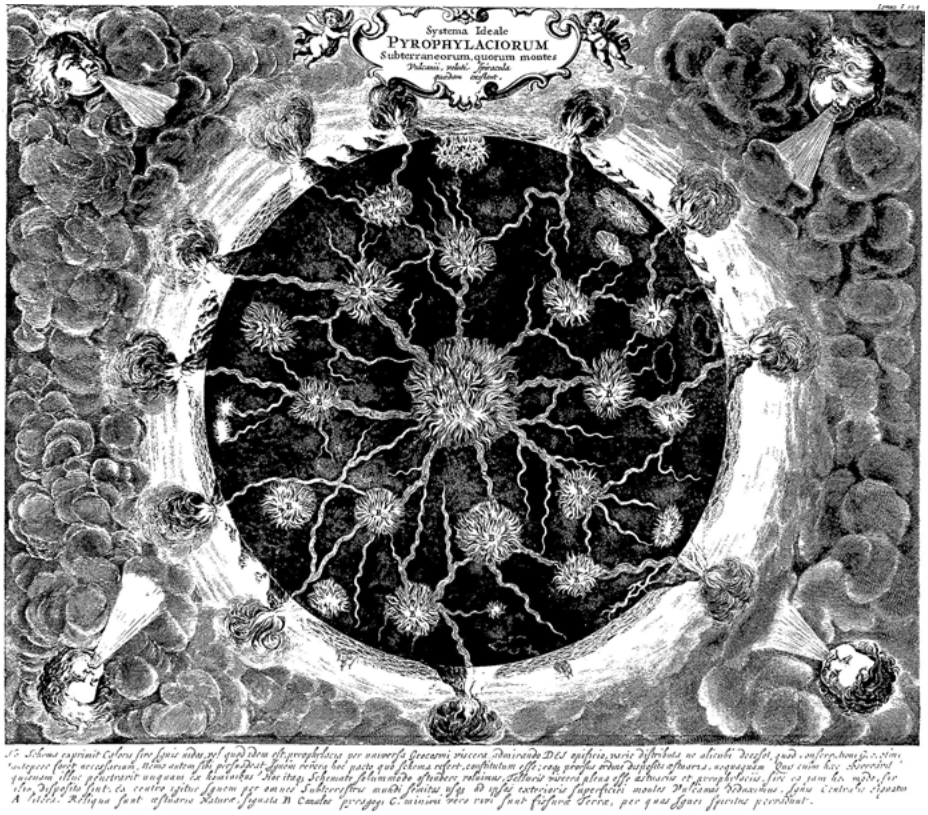

Figure 19: Athanasius KIRCHER, *Subterraneus Pyrophylaciorum*, 1665. This copperplate print shows the scheme of the Earth's fire canals, which KIRCHER believed connected all the volcanoes in the world.

Natural Sciences in the Late Eighteenth Century

"Nobody is so ignorant that they have never heard or read about fire-spitting mountains (volcanoes), even in the newspapers."[19] This statement by German philosopher Christoph Gottfried BARDILI (1761–1808) strongly suggests that volcanoes had a place within the collective consciousness in 1783. In the second half of the eighteenth century, volcanoes were considered sublime – terrifying and beautiful simultaneously.[20]

Today, the term "natural sciences," coined during the nineteenth century, is an umbrella term that encompasses the different fields of research that engage with facts and

19 BARDILI 1783: 9–10: "Niemand ist so unwissend, daß er nicht schon einmal etwas von feuerspeyenden Bergen (Vulkanen) gehört oder gelesen hätte, wäre es auch nur in den Zeitungen gewesen."
20 MCCALLAM 2019: 235.

natural processes. In the eighteenth century, the terms "science," "physics," "physical science" [*Naturlehre*], and "natural philosophy" were used synonymously.[21] Thus, natural scientists were referred to as scholars, naturalists, or natural philosophers.[22]

Toward the end of the seventeenth century, the sciences became increasingly institutionalized: universities, academies, and learned societies were founded. Local languages, such as German, replaced Latin as the language of science. In the second half of the eighteenth century, this process intensified in the German Territories and many centers of science arose.[23] The natural sciences underwent a transformative period that laid the foundation for the modern disciplines as we know them today. Many existing disciplines became more specialized. New knowledge led to the formation of new scientific fields. Throughout this differentiation process, knowledge production intensified.[24] The importance of this period cannot be overstated; the patterns of thought that emerged played a crucial role in the debates about the strange phenomena of the summer of 1783.

I will illustrate the rapidness of this change with examples from three scientific realms. The first is meteorology. By 1783, weather observers increasingly relied on scientific instruments to take measurements; these instruments had become more standardized, which made for more useful data.[25] The second is the invention of hot-air balloons; these aircraft offered a new perspective on the world and the chance to conduct weather observations at higher altitudes. Some of the first flights took scientific instruments onboard to take readings in previously inaccessible locations: the first step in airborne atmospheric research.[26] The third is research on electricity.[27] This will be expounded upon in a later subchapter on the public's engagement with lightning rods.

These examples were closely related to the advent of new technologies. A particular feature of the transformational period of the natural sciences in the second half of the eighteenth century was the concept of "public science." Naturalists were often able to demonstrate that their new technology was practicable and enlightened amateurs were interested in the spectacular and often surprising effects of scientific experiments.[28] Demonstrations took place at universities, learned societies, salons, shops, and even on the streets.[29] Science became increasingly experimental and empirical. It was more important than ever that scientific experiments were reproducible and that scientists were accountable. Although newspapers reported on new findings and discoveries, the sciences also

21 Steinle 2009: 54, 56; "Natur=Lehre, Natur=Kunde, Natur=Wissenschafft, Physick" in Zedler 1740, vol. 23: 1147–1167.

22 Stollberg-Rilinger 2011: 183.

23 Weigl 1987: 25; Hochadel 2003: 35.

24 D'Aprile, Siebers 2008: 74.

25 Golinski 1999.

26 De Syon 2002: 7–13; Lynn 2010; Thébaud-Sorger 2013.

27 Hochadel 2003.

28 Hochadel 2003: 17–19.

29 Weigl 1987: 25–26; Trischler, Bud 2018: 187.

had their own channels of communication in the shape of numerous journals and book publications.[30] These journals offered naturalists a new and direct way to engage with the public.[31] Unfortunately, they also highlighted the increasing gap between the knowledge of the educated and that of the "common people."[32]

Enlightened science in the eighteenth century had two foundational aims: the search for the truth and the glorification of God.[33] This was not perceived as a contradiction; it was possible to think about the natural cause of an extreme event and simultaneously believe that God could intervene.[34] Naturalists of the early modern period often viewed science as the search for divine truth; their God-given curiosity inspired their attempts to decipher creation. Although the search for natural laws was the primary focus, God remained the creator of those natural laws.[35] From a Christian perspective, research on volcanoes and what the findings implied was problematic: deep geological time, of which fieldwork produced more and more proof, stood in contrast to biblical chronology. Geologists began formulating ideas about the mechanisms behind volcanic eruptions and refuting the notion that they were God's punishment for human misbehavior.[36]

Understanding weather was crucial for agriculturally oriented societies in the premodern world; a successful harvest depended on it and so, throughout antiquity, the skies were carefully observed. Records of daily visual observations of the weather exist from as far back as the late Middle Ages.[37] In the following centuries, scientific instruments helped measure the weather empirically.[38] In 1592, Galileo Galilei invented the thermometer. In 1643, Evangelista Torricelli invented the barometer, which measures changes in atmospheric pressure and therefore changes in weather.[39] From the 1660s, the barometer was widely used in observatories and from around 1720, they were available to anyone who had the means to purchase one. Well-off households were likely to own a barometer during this time.[40] In 1714, Daniel Gabriel Fahrenheit invented the mercury thermometer; at the end of the eighteenth century, these devices, although not yet fully standardized, were widely available. For many years, this meant that if three different thermometers were stationed in one place, each could offer a different reading.[41] In the eighteenth century, scholars realized that to gain insights into long-term

30 Münch 1992: 496; Hochadel 2003: 28; Alt 2007: 12; Steinle 2009: 69; Behringer 2011: 203–204.
31 D'Aprile, Siebers 2008: 74.
32 Schmidt 1999: 227; Stollberg-Rilinger 2011: 186.
33 Hochadel 2003: 21, 33.
34 Reith 2011: 83.
35 Ruppel, Steinbrecher 2009: 14; Reith 2011: 92–93.
36 McCallam, 2019: 235–236.
37 Schmidt 1999: 37–38; Malberg 2007: 189–190.
38 Kington 1988: 3.
39 Cappel 1986: 15; Golinski 2007: 144–145; Behringer 2011: 25–26.
40 Weyer, Koch 2006b: 85; Golinski 2007: 121, 144–145.
41 Kington 1980: 8; Weyer, Koch 2006b: 81.

climatic trends, it was necessary to observe the weather from different locations with standardized equipment.[42] While long-term trends are crucial to historical climatology today, first-hand accounts of individual days are also invaluable: they draw attention to extraordinary weather events that might otherwise remain invisible. Weather observations were taken conscientiously throughout the eighteenth century, so a lot of data is available for this time.[43]

The Laki eruption and the unusual weather of 1783, which inspired Louis-Sébastien Mercier to deem the year an *annus mirabilis*, coincided with a period in which the Enlightenment had thoroughly captivated most of Europe's naturalists. Many institutions existed that were well-suited to engage with the unusual weather, such as meteorological networks, learned societies, and universities. Laypersons and naturalists alike looked skyward, recorded their observations, and published their findings.[44] Beyond the circles of academia, many well-heeled Europeans took an interest in the natural world; a great deal of them even purchased instruments and kept daily logs.[45] As well as non-standardized equipment, another problem existed insofar as scientists lacked a standardized vocabulary to describe the weather.[46]

The frenetic pace of discovery in the late Enlightenment and the whirlwind that this created left naturalists straddling two worlds, one of relative nescience and one of knowledge. They were only too keen to cast off the old world, but the limitations of this intermediary period meant that some discoveries lay just out of reach. A glorious sense of excitement in some left them keen to use any opportunity to produce knowledge but, consequently, left them equally as keen to pursue the next mystery. Never was there a clearer example of this culture than the dealings of those who were concerned with the sultry mist of 1783.

Historical Context

1783: The End of the American Revolution and "Ballomania" in Europe

In the 1760s, growing differences strained the relationship between Great Britain and its colonies in North America, which led to conflict. The American Revolutionary War began with open combat between British soldiers and the Massachusetts militia in

42 Cappel 1986: 15.

43 Münch 1992: 136–137.

44 Oppenheimer 2011: 277. The CHIMES project, based at the University of Bern and led by Stefan Brönnimann and Christian Rohr, as well as a conference on a global inventory of early instrumental measurements back to the 1760s, has produced the following studies: Brugnara et al. 2019; Brönnimann et al. 2019; L. Pfister et al. 2019.

45 Demaréé, Ogilvie 2001: 223.

46 Mauelshagen 2010: 45–46, 50.

1775. On 4 July 1776, the Thirteen Colonies declared independence as the United States of America.[47] The war, however, continued, with different European countries joining as co-belligerents on both sides.

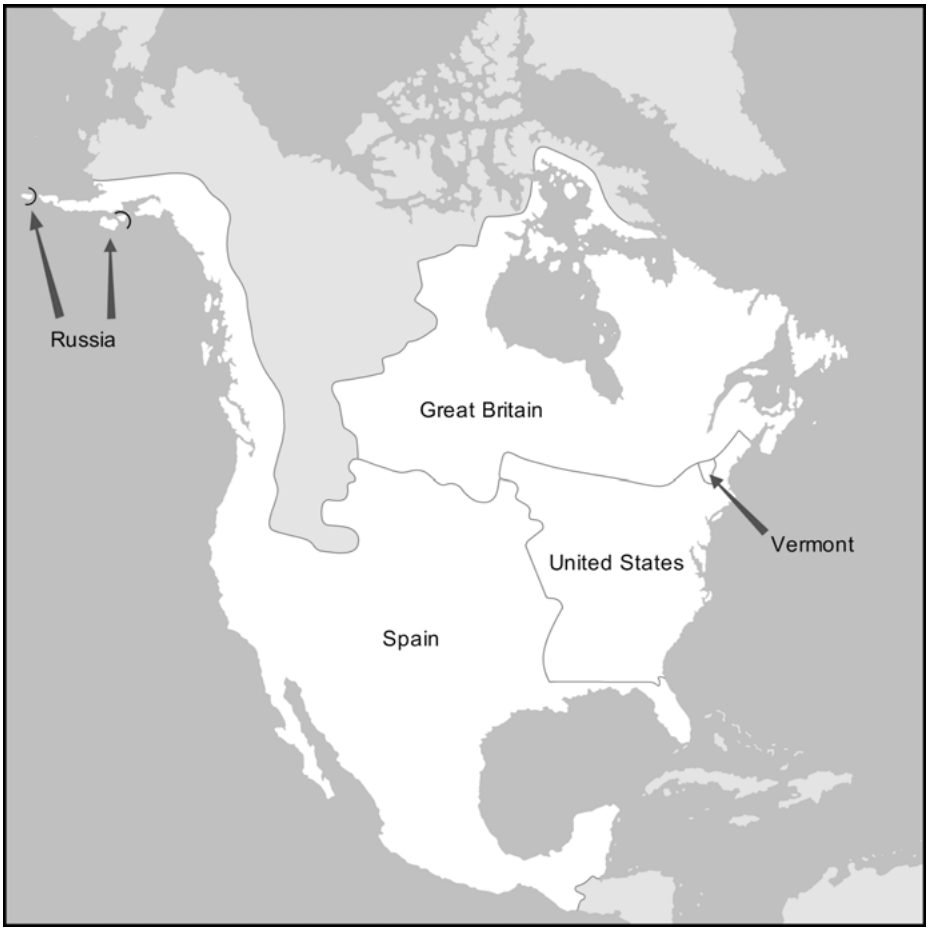

Figure 20: North America in 1784. This shows the claims non-native countries had in 1784, not necessarily the land they controlled.

Peace negotiations started in 1782. Four Americans, Benjamin Franklin (1706–1790), John Adams (1735–1826), John Jay (1745–1829), and Henry Laurens (1724–1792), were in Paris and had the authorization to negotiate a final peace treaty with Great Britain. On 3 February 1783, Great Britain acknowledged the independence of the United States of America and, soon after, on 15 April 1783, the Congress of the Confederation

47 Greene, Pole 2000; Black 2001; Fremont-Barnes, Arnold 2006; Ferling 2015.

ratified preliminary articles of peace. The Peace of Paris, a treaty between the United States and Great Britain, was signed on 3 September 1783; this formally ended the American Revolutionary War and granted the United States independence from Great Britain. Thus, the United States of America became a fully recognized and independent nation (Figure 20).[48] The US Congress of Confederation ratified the peace treaty on 14 January 1784. However, due to the severe winter in Europe (Figure 21) and North America, the ratified versions were not exchanged until 12 May 1784.[49]

Figure 21: Europe ca. 1783. The thick black line marks the borders of the Holy Roman Empire.

During this period, George III was the king of Great Britain and Ireland (reigned 1760–1820). Louis XVI was the king of France (reigned 1774–1792); the last king of France before the abolition of the monarchy during the French Revolution. Joseph II, the brother of Louis XVI's wife, Marie Antoinette, was the Holy Roman Emperor (reigned 1765–1790). Frederick the Great ruled the Kingdom of Prussia (reigned 1740–1786).

48 Franklin 2011: liv, lvi–lvii.

49 Hoffman 1986. For a detailed account of the adventurous journey undertaken by Josiah Harmer during the extraordinarily cold winter of 1784 to transport the ratified treaty from Annapolis, Maryland, to Paris, France, see Smith 1963.

Catherine the Great was the empress of Russia (reigned 1762–1796). Christian VII was the king of Denmark and Norway (reigned 1766–1808). William V, Prince of Orange, was the last *Stadtholder* of the Dutch Republic (1751–1795).[50] According to the newspapers, Europe's main concerns at the time were the threat of invasion by the "Turks" and outbreaks of the plague.[51]

1783 also saw a milestone in human invention: in France, pioneers of air travel – like the MONTGOLFIER brothers – created hot-air balloons that could take off from the ground, fly to the skies, and (ideally) land safely. The term "ballomania," coined by Sir Joseph BANKS (1743–1820), adequately describes the enthusiasm for these "aerostatic globes" or "flying machines."[52] On 4 June 1783, the brothers Joseph-Michel MONTGOLFIER (1740–1810) and Jacques-Étienne MONTGOLFIER (1745–1799) demonstrated their first hot-air balloon, called a *Montgolfière*, to the public in their hometown of Annonay. The flight was uncrewed and lasted about ten minutes. It reached an altitude of about 2,000 meters, covered two kilometers, and landed safely in a nearby vineyard. News of this invention would dominate the headlines and communications among scientists for months. These "flying globes" inspired other inventors and would-be-balloonists to join the race to the skies.[53]

French inventor Jacques CHARLES (1746–1823), the only true competitor of the MONTGOLFIER brothers, also worked on a balloon of his own design; *Le Globe* was filled with hydrogen and made from silk and rubber rather than paper, like the *Montgolfière*. Using hydrogen instead of hot air meant *Le Globe* could be much smaller.[54] On 27 August 1783, at Champ-de-Mars in Paris, *Le Globe* saw its first uncrewed ascent. Benjamin FRANKLIN was in the crowd of 50,000 onlookers. These demonstrations were both scientific experiments and a kind of public entertainment that helped raise funds for the next experiment.[55] *Le Globe* traveled 21 kilometers but was destroyed with pitchforks and rocks by terrified residents in the village where it landed.[56] The competitive nature of this duel for the skies mirrored the nature of the debate regarding the meteorological phenomena of that year.

50 KINDER, HILGERMANN 2004: 276–287.

51 Münchner Zeitung, 17 July 1783: 439–440. The plague is caused by a bacterium called *Yersinia pestis*. After the Black Death in the mid-fourteenth century, the plague became endemic and recurred regularly until the nineteenth century.

52 GILLESPIE 1984: 242, 262.

53 GILLESPIE 1984: 249; FRANKLIN 2011: 394–396; HOLMES 2009: 125–128.

54 Hydrogen, a flammable gas lighter than air, had been discovered by English chemists Henry CAVENDISH and Joseph PRIESTLEY in 1766; HOLMES 2009: 125–131.

55 Journal de Paris, 28 August 1783. In a letter dated 30 August 1783 to Joseph BANKS, Franklin detailed his experience of the demonstration on 27 August; FRANKLIN 2011: 544, 547–555. FRANKLIN (2011: lvii, 393) kept the Royal Society in London apprised of the demonstrations of the balloon experiments, about which he was very enthusiastic. He used this opportunity to reestablish his connection to the Society. See also GILLESPIE 1984: 250–252.

56 FRANKLIN 2011: 548–551; FRANKLIN 2014: lvii.

On 19 September 1783, the MONTGOLFIER brothers demonstrated another *Montgolfière* in the front courtyard of the Palace of Versailles. The spectators included Louis XVI and Marie Antoinette. This aircraft had animal passengers: a sheep, a rooster, and a duck. The flight lasted eight minutes, traveled a distance of three kilometers, and reached an altitude of 460 meters. The animals managed to survive the journey.[57] Based on this positive

Figure 22: The view from Benjamin FRANKLIN's terrace in Passy on 21 November 1783. FRANKLIN was a keen observer of hot-air balloons. He also witnessed the first untethered journey of a *Montgolfière* hot-air balloon with a crew. FRANKLIN himself observed the ascent from the launching stage at the Château de la Muette.

result, the next step in the development of air travel was sending a person.[58] Contemporary engravings depict many of the test flights; significantly, for this book, none of these numerous depictions feature a hazy sky or a blood-red sun (Figure 22).

On 1 December 1783, the first-ever crewed journey in a hydrogen-filled balloon, *La Charlière*, named after Jacques CHARLES, took place in Paris (Figure 23). Benjamin FRANKLIN was also present at this event.[59] Five days after the experiment, FRANKLIN

Figure 23: The ascent of *La Charlière* in the Jardin des Tuileries in Paris on 1 December 1783. An estimated 400,000 spectators were present.

57 A report about the MONTGOLFIER demonstration to the Royal Family at the Palace of Versailles can be found in a letter to Joseph BANKS from 8 October 1783, FRANKLIN 2014: 81–83.

58 HOLMES 2009: 127–131; "Procès-verbal of the Montgolfier Balloon experiment," FRANKLIN 2014: 210–212; Letter to Joseph BANKS from 22–25 November 1783, FRANKLIN 2014: 216–220.

summarized the atmosphere surrounding the event in a letter to Henry Laurens: "We think of nothing here at present but of Flying; the Ballons engross all Conversation."[60]

Several publications came out in and around 1783 that informed the interested reader about these "aerostatic balls."[61] Further hot-air balloon journeys followed in the next few years. Flying a hot-air or hydrogen balloon was a risky endeavor: fatal accidents were not uncommon. In 1785, the French aviator Jean-François Pilâtre de Rozier crashed and died during an attempt to cross the English Channel from France to England.[62]

Earthquakes in Lisbon and Calabria

Three decades previous, a momentous event incited debate about science and God: the Lisbon Earthquake, which occurred on 1 November, All Saints' Day, in 1755. This devastating earthquake had its epicenter in the Atlantic, 200 kilometers southwest of Portugal, along the Azores-Gibraltar Transform Fault.

Geologists rely on descriptions and damage reports to estimate the intensity of historical earthquakes. The intensity scale used varies from region to region. These include the Modified Mercalli Intensity Scale (MMI), used in the United States, and the European Macroseismic Scale (EMS-98). Whereas magnitude scales indicate how much energy is released during an earthquake, intensity scales consider the level of destruction. Both intensity scales mentioned above have divisions between I ("not felt") and XII ("almost all structures destroyed").[63] The 1755 All Saints' Day earthquake in Lisbon was possibly Europe's largest and most destructive earthquake in recorded history.[64] It is estimated to have reached an XI on the MMI/EMS-98 scale.[65]

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59 Rolt 1966: 29; Holmes 2009: 131–133; letter from Benjamin Franklin to Joseph Banks on 1 December 1783, Franklin 2014: 248–251.

60 Franklin 2014: 264. A similar report was printed in the Münchner Zeitung, 19 September 1783: 586. "War and people were quickly forgotten and one did not talk about anything else other than the flying balloon," an anonymous correspondent snarkily remarked. "Es ist abscheulich zu sagen, was die Luftkugel neulich hier für ein litterarisches Stiergeheze veranlasset hat. [. . .] Kaum war die Unterzeichnung dann in Paris bekannt geworden, als schon Krieg und Friden vergessen ward, und man sich von nichts mehr als dem fliegenden Ballon unterhielt. [. . .]."

61 For German translations of French books on the matter, see Murr 1784; Lütgendorf 1784; Ehrmann 1784.

62 Gillespie 1984: 249; Holmes 2009: 153–155. For a brief overview of ballooning and flying after 1800, see Holmes 2009: 159–162.

63 For more information on the Modified Mercalli Intensity Scale, see USGS, "The Modified Mercalli Intensity Scale." For more information on European Macroseismic Scale (EMS-98), see Grünthal 1998.

64 Kübler 2012: 14.

65 NOAA, Significant Earthquake Database, estimates that the Lisbon earthquake reached XI on the Modified Mercalli Intensity Scale. A recent study has suggested that the magnitude was not as large as

The earthquake and resulting tsunami affected several places in Portugal, Spain, and Morocco. The Portuguese capital of Lisbon was devastated. Between 30,000 and 70,000 people died during the earthquake and its fiery aftermath.[66] Furthermore, it was felt as far away as Finland and caused surface water waves (*seiches*) in Switzerland and Scotland.[67] Given the magnitude of the destruction, it was difficult for eyewitnesses to find words for the calamity. Often, they resorted to the tried and tested method of focusing on individuals' experiences, ordeals, and losses.[68]

The earthquake also had "intellectual aftershocks." It was interpreted as divine judgment as it destroyed almost all the churches in Lisbon, the conspicuous ruins of which left many feeling vulnerable.[69] The physical and intellectual consequences of this earthquake have been the subject of much scholarly attention. Many historians argue that the Lisbon earthquake profoundly influenced the European Enlightenment and fundamentally changed European culture and philosophy. The earthquake, and the death and destruction it left in its wake, led to a dialogue between French philosophers Voltaire (1694–1778) and Jean-Jacques Rousseau (1712–1778) on God's purported benevolence.[70]

German philosopher Immanuel Kant (1724–1804), residing in Königsberg, was fascinated by the reports he received from Lisbon; these reports prompted him to write three papers concerning earthquakes and volcanoes. Concerning volcanoes, Kant favored the hypotheses put forward by French naturalists Nicholas Lémery (1645–1715) and Georges-Louis Leclerc, Comte de Buffon (1707–1788), both of which suggested that subterraneous chemical reactions between sulfur and iron caused eruptions. This idea remained popular throughout the eighteenth century. It is unlikely that Kant ever experienced a significant earthquake himself. He had to rely on second-hand information gleaned from newspapers and other scientific publications for his writings.[71]

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previously believed and the hypocenter might have been located closer to or even on the Iberian Peninsula; Fonseca 2020.

66 Brown 1991: 23. Jelle Zeilinga de Boer and Donald T. Sanders (2005: 94) suggest the earthquake reached a magnitude of 8.5 on the Richter scale. The USGS suggests a magnitude of 8.7; USGS, "Historic Earthquakes: Lisbon, Portugal, 1755 November 01." Another study suggests a magnitude of 8.5 to 9.0; Gutscher, Baptista, Miranda 2006: 154.

67 Demarée et al. 2007: 356. According to this text, a *seiche* is "a standing wave caused by seismic or atmospheric disturbance in an enclosed or partially enclosed body of water." See also Demarée, Nordli 2007.

68 Weber 2015: 360–361.

69 Löffler 1999; Frömming 2005: 155; Reith 2011: 82.

70 Dynes 1999. At the same time, Matthias Georgi (2009: 22, 163–168) states that he was unable to find indications of this clear change that is often assumed for the Lisbon earthquake in the English newspapers of the 1750s, nor in sermons and newspaper articles from Germany.

71 Reinhardt, Oldroyd 1983: 251–252; see also Kant 1755; Kant 1756a; Kant 1756b. All three of these texts by Immanuel Kant have been fully or partially translated by Reinhard and Oldroyd (1983).

Three and a half months after the 1755 Lisbon earthquake, another occurred in Düren, a town in western Germany. It probably reached a Richter magnitude of 6.2 ± 0.2 and precipitated in damage worthy of VIII to IX on the MMI/EMS-98 scale, making it one of the strongest earthquakes recorded in Germany. It killed two people, damaged several buildings, triggered a landslide, and brought home the destructive potential of earthquakes for those in the western parts of the German Territories.[72]

Gaston Demarée and his colleagues describe the Lisbon earthquake "as a laboratory for new seismological concepts." Its consequences demonstrated the need for a better understanding of earthquakes and the hazards they pose.[73] Fatefully, a seismic sequence of five strong earthquakes that shook Calabria and Sicily some 30 years later would test the preparedness of Europe. Historian of science Deborah Coen highlights that the Calabrian earthquakes were the first to be described scientifically; *men of science* such as Scottish geologist Charles Lyell visited the affected regions in southern Italy, collected evidence, and documented the aftermath.[74]

The Calabrian earthquakes were caused by the subduction of the African tectonic plate under the Eurasian plate. The collision zone between the plates in southern Italy is called the Calabrian Arc. Stromboli and the Aeolian Islands show near-constant volcanic activity, and Mount Etna in Sicily is an active stratovolcano. These volcanoes are a product of the violent subduction of a tectonic plate. There were other tsunamigenic and deadly earthquakes in eastern Sicily in 1114, 1169, 1542, and 1693, and in the Messina Strait in December 1908.[75]

Some reports describe a "strange fog" that was visible before the first strong earthquake of the seismic sequence in Calabria (Figure 24), as early as 4 February 1783, which dispersed only to return for a few weeks over the summer.[76] An unknown author detailed his experience of the earthquake on 5 February 1783 (Figure 25) while on a ship in the Strait of Messina. Around noon, there was a terrible roar from the ocean and a loud noise permeated the air, which gave way to thick fog, similar to smoke, with a sulfuric smell. High waves added to the confusion, and the sailors feared that their ship would sink.[77] Given the nature of maritime weather, this "strange fog" could have simply coincided with the earthquake. Many Europeans

72 Kübler 2012: 64; 77. Meidow (1994) indicates an intensity of VIII to IX. Leydecker (2011: 48) states an intensity of VIII. A detailed analysis of the geology and the impact of the 1756 Düren earthquake, including an analysis of the question of whether it was related to the 1755 Lisbon earthquake, has been conducted by Kübler (2012).

73 Demarée et al. 2007: 354.

74 Coen 2014: 15–16.

75 D'Angelo, Saija 2002: 123, 133; Graziani, Maramai, Tinti 2006: 1053; Carcione, Kozák 2008: 668. For the 1908 Messina earthquake, also see Carzione, Kozák 2008: 670; Parrinello 2015: 21–120.

76 Kiessling 1988: 26; Hoff 1840, vol. 1: 108; Kleemann 2019a; Kleemann 2020.

77 Anonymous 1783: 3.

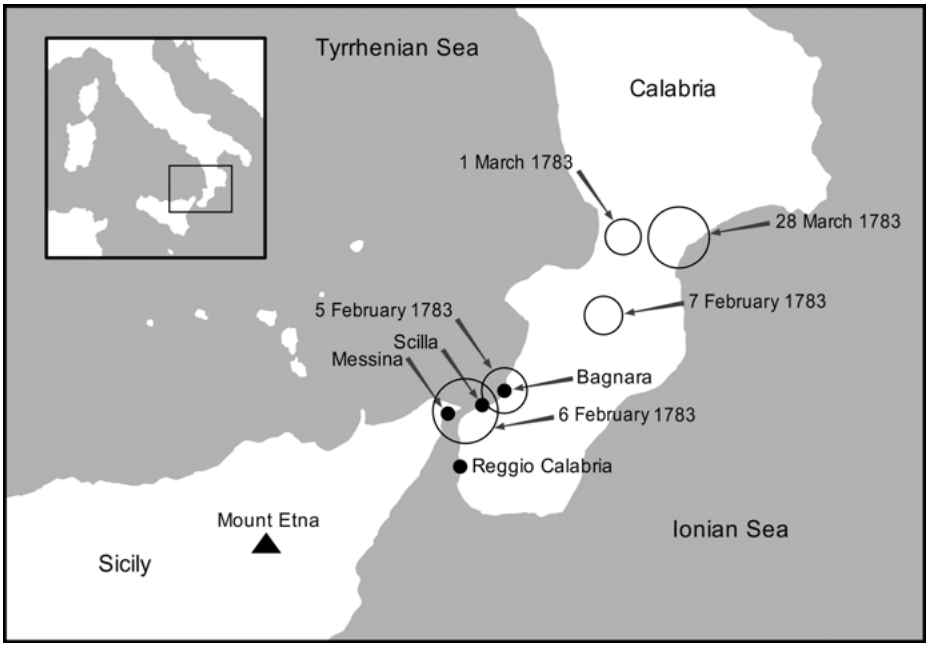

Figure 24: The locations of the five main earthquakes in Calabria in February and March 1783.

feared unusual fogs, as will become clear, believing them to be harbingers of misfortune. There had been a similar, ominous occurrence a mere two weeks before the All Saints' Day earthquake in Lisbon in 1755; a yellowish fog or smoke that was accompanied by a sulfuric smell appeared on 20 October 1755. An Icelandic eruption had caused this: Katla erupted from 17 October 1755 to February 1756 and released ash and gases that formed a haze, likely reaching Portugal just before the All Saints' Day earthquake.[78]

Figure 26 depicts the events of 5 February 1783. The tremors were probably severe enough to knock people off their feet. The artist portrays the wave-like ground movement that can occur during strong earthquakes. There are three different types of waves: the first to arrive are primary waves, which consist of push-and-pull movements. An up-and-down and side-to-side movement characterizes secondary waves. The third type of waves during strong earthquakes are surface waves, which can be subcategorized into Love waves, which travel sideways on a horizontal plane, or Rayleigh waves, which travel elliptically on a vertical plane (a reverse waveform).[79]

Furthermore, the print shows people falling as they try to run away; some are hit by the debris from collapsing buildings, while others are already trapped or buried

78 Demarée et al. 2007: 337, 345, 349.

79 Grotzinger, Jordan 2017: 342–352, 372–382.

Figure 25: The Strait of Messina as seen from the north when the earthquake struck. On the left is the coast of Calabria, on the right is the harbor of Messina; in the distance, to the right, Mount Etna erupts (it is uncertain whether it erupted in 1783). Buildings, city walls, and lighthouses collapse, fires spread, and a tsunami (visualized as a whirlpool) causes trouble for the ships in the Strait.

under the rubble. Many buildings appear destroyed or severely damaged. Trees reportedly shook so violently that their tips touched the ground, and some were uprooted entirely. The ferocity of the earthquake was such that it even dislodged heavy pavement.[80] The print, however, is not a first-hand account: the artist lived in aseismic Paris where they imagined the poor of Calabria running around and the wealthy, equally terrified, being taken away in their horse-drawn carriages. Several other artworks of the earthquake and its aftermath depict deep cracks in the ground. According to geophysicist Jan Kozák, these are noteworthy as they indicate a macroseismic intensity of more than X.[81] It can be inferred that the earthquake on 5 February 1783 reached XI on the Mercalli-Cancani-Sieberg (MCS) scale, a predecessor to the MMI scale, which correlates with a Richter magnitude of around 7.0. This figure is based

80 Dolomieu 1784; Jacques et al. 2001: 504.

81 Kozák, Čermák 2010: 146–147.

Figure 26: The earthquake of 5 February 1783. Hand-colored copper engraving, ca. 1790.

on the reported destruction of almost all the built structures as well as occurrences of landslides and rockslides.[82]

Terrified, many spent the night outside; in Scilla, thousands slept on the beach, a fatal mistake. A second large earthquake occurred shortly after midnight on 6 February 1783, most likely reaching a magnitude of at least 6.5 on the Richter scale and X or XI on the MCS scale. A resulting rockslide near Scilla caused a tsunami, which swept away 1,500 of those seeking refuge on the shore. Both earthquakes also dammed rivers and created 215 new lakes. Another strong earthquake occurred on 7 February 1783 at 1:10 p.m., with an approximate Richter magnitude of 6.5. The next followed on 1 March 1783 at 1:40 a.m. This fourth earthquake was perhaps the smallest of the seismic sequence, reaching a Richter magnitude of less than 6.0. The fifth and last large

82 Graziani, Maramai, Tinti 2006. A detailed description of the earthquakes and the damage they caused can also be found in Torcia (1783).

earthquake occurred on 28 March 1783 at 6:55 p.m. with a Richter magnitude of 6.5 or greater. As it was felt at a greater distance, geologists believe it occurred at a greater depth than the others. The aftershocks lasted from 1783 to 1785, with more than 300 between February and May 1783.[83]

Many people had lost their homes. Destroyed infrastructure, such as bridges and roads, made transportation difficult. As is often the case with earthquakes, the spread of fire and disease caused problems. Landslides triggered by the tremors caused olive groves and cultivated flats to cascade hundreds of meters into the valleys below them, thus disrupting agriculture.[84] In June 1783, Ferdinand IV, the king of Naples and also the king of Sicily (reigned 1759–1816), established the *cassa sacra*, a governmental body to administer expropriated Church estates to aid with reconstruction.[85]

At the time, there was widespread interest among naturalists and scholars in this seismic crisis. Intellectuals, scientists, Italians, and foreigners all contacted their friends and family members in Calabria to get information.[86] News traveled, albeit slowly, via newspapers to other parts of Europe detailing this dreadful event. As early as 6 March 1783, there is a reference to the destruction caused by the Calabrian earthquakes in the *Münchner Zeitung*. The lengthy report covers almost two entire pages and is based on a letter from Rome dated 15 February 1783. The "terrible earthquake" was said to have destroyed 320 of the 375 towns and villages in Lower Calabria. Furthermore, the report states that "several terrible maws opened up and are now releasing thick smoke and sulfuric steam."[87] Other German-language newspapers published similar reports; only the numbers of existing and destroyed villages varied. News of each earthquake of the seismic sequence reached the German Territories within roughly one month of the event.[88] Descriptions of the earthquakes and tsunami must have sounded truly fantastic and petrifying to the readers: "The force of the volcano which caused all this was one of incomprehensible violence, as even the ships on the ocean were thrown up in the air, and all the elements and creatures felt His power."[89]

83 Jacques et al. 2001: 504–506; D'Angelo, Sajia 2002: 126; Graziani, Maramai, Tinti 2006: 1054–1059.

84 Jacques et al. 2001: 503.

85 Das Wienerblättchen, 27 August 1783: 120.

86 Placanica 1985: 67.

87 Münchner Zeitung, 6 March 1783: 147–148: Report from Rome and Lower Calabria, 15 February 1783. "Im Messinesischen Grunde, und den umligenden Feldern ist die Erde an vilen Orten geborsten, und hat ungeheure Schlünde, aus denen diker Rauch, und Schwefeldampf emporquillt."

88 Hochfürstlich-Bambergische wochentliche Frag- und Anzeigenachrichten, 18 March 1783: 1–2 (News about the 5 February 1783 earthquake); Münchner Zeitung, 17 April 1783: 243–244. Giacomo Parrinello (2015: 219) states that the earthquakes flattened 182 towns and villages, 33 of which were later relocated.

89 Hochfürstlich-Bambergische wochentliche Frag- und Anzeigenachrichten, 15 April 1783: 2: Report from Italy, 24 March 1783. "Die Stärke des Vulkans welcher dies alles wirkte, muß von einer unbegreiflichen Gewalt gewesen seyn, weil sogar die Schiffe auf dem Meer in die Höhe geworfen worden, und also die Elementen und Kreaturen seine Wirkungen empfanden."

On 23 May 1783, William HAMILTON (1730–1803), the British ambassador based in Naples at the time, wrote to Joseph BANKS. His report, based on first-hand accounts of the affected region, is titled *An Account of the Earthquakes which happened in Italy, from February to May 1783*; it was read at the Royal Society on 3 July 1783 and published at the end of the same year.[90] To HAMILTON and others' surprise, the earthquake had not destroyed Reggio Calabria as they had expected. Indeed, it was in significantly better shape than Messina.[91] The *Hamburgischer Unpartheyischer Correspondent* published excerpts of HAMILTON's report on 30 July 1783. It is a terrifying account of the destructive power of earthquakes: "He [Hamilton] has also seen a house that had been thrown a quarter of an Italian mile from its initial location. A man and a woman had to lie under the rubble for four days until they were rescued." In addition, the report mentions that 40,000 people had been dug up from the rubble, but that 50,000 had perished.[92]

A study from 1935 by Guiseppe IMBÓ, director of the Catania Observatory, claimed that Mount Etna erupted on 17 February 1783 and that Stromboli erupted a few days later. Stromboli is a very active volcano: the term "Strombolian" is used to describe a volcano with near-constant activity. It is quite likely that Stromboli erupted around this time. However, as for Mount Etna, the Smithsonian Institution's Global Volcanism Program has only confirmed a VEI 2 eruption in March 1781 and a VEI 4 eruption in June 1787, but none in 1783.[93] Although contemporary newspapers shared stories about volcanic activity at Vesuvius, Stromboli, Vulcano, and Mount Etna, it remains unclear whether any of these volcanoes erupted. A point of certainty is that they did not affect the weather in any notable way.[94]

Nýey: A Burning "New Island"

On 1 May 1783, Jörgen MINDELBERG, the captain of a Danish fishing vessel called the *Boesand*, observed smoke rising from the sea southwest of the Reykjanes Peninsula. He noted this discovery in the ship's logbook at 3 a.m. On 3 May, the vessel returned to the area but found it impossible to inspect closely; within half a mile of the source

90 HAMILTON 1783.

91 JACQUES et al. 2001: 503.

92 Hamburgischer Unpartheyischer Correspondent, 30 July 1783. "Er hat auch ein Haus gesehen, das eine Italienische Viertelmeile weit von dem Platz, da es gestanden, geworfen worden. Ein Mann und eine Frau, die sich in dem Hause befanden, mußten 4 Tage unter dem Schutt liegen, ehe sie gerettet werden konnten." Michele TORCIA gave a detailed list of the towns and villages that lost people, he estimated the total to be 31,871 casualties; TORCIA 1783: 34–39.

93 IMBÓ 1935 (quoted after GRATTAN, BRAYSHAY, SADLER 1998: 26); Global Volcanism Program: Etna.

94 SIMKIN et al. 1981: 123; CAMUFFO, ENZI 1994: 32; CAMUFFO, ENZI 1995: 148. According to the "eruptive history" section of the Global Volcanism Program, Vesuvius was active from 18 August 1783 to 5 July 1784, VEI 3; Global Volcanism Program: Vesuvius. Stromboli and Vulcano were almost constantly producing magma.

of the smoke, the sulfuric smell became unbearable and MINDELBERG turned the ship around for fear his crew would faint from the stench.[95]

More famous were the reports by Danish fishermen aboard the *Torsken*. Captain Peder PEDERSEN and his assistant Gottfried SVENDBORG came across the burning island approximately 50 kilometers southwest of Reykjanes on 22 May 1783. Both wrote separate letters stating that the inhabitants of mainland Iceland had noticed smoke in the sea around Easter [20 April] without knowing the cause.[96] On 1 July 1783, an article was published in the Danish daily newspaper *Kjøbenhavns Adresse-Contoirs Efterretninger*, which stated that the island was surrounded by pumice, smoke, and fire, all of which was impeding sea travel in the area.[97] The *Königlich Privilegirte Zeitung* announced that the king of Denmark, Christian VII, had given the island the name *Ny-Oee*, which means "new island." In Icelandic, it was christened *Nýey*.[98]

A dramatic newspaper report detailed SVENDBORG's reaction upon discovering this island. When he first laid eyes on the smoldering outcrop, he feared that Iceland was lost.[99] However, upon circumnavigating the new island, SVENDBORG discovered it had a circumference of just one mile and reasoned that it could not be Iceland. He then had cause to travel further north, where he found the real Iceland the next day. He was relieved to find it intact, remarking on the welcome sight of the birds on the cliffs in their regular place. In a sign of things to come, a newspaper article remarked that this strange new island had emerged from the sea at the same time earthquakes had rocked Messina and Calabria.[100]

PEDERSEN and his crew were fishermen; they did not stick to the regimented sailing pattern of the merchants, who arrived in spring and departed in late summer or autumn. It seems that the fishermen left Iceland sometime in late May 1783, a few days before the earthquakes became stronger in the Síða region and the Laki eruption began. This explains why news of the new island reached Europe during the summer of 1783, but news of the Laki eruption only reached Europe in the autumn.

During the summer of 1783, Nýey received a lot of attention in the press; in particular, it fascinated naturalists and they speculated whether this newly emerging island might have produced the dry fog they were witnessing. This is unsurprising, given the

95 HALLDÓRSSON 2013: 20. "Before 1 May 1783" is also the time frame given for the eruption of Nýey by SIMKIN et al. (1981: 123).

96 HALLDÓRSSON 2013; STEINÞÓRSSON 1991: 136. These letters were sent to Professor HEINZE in Kiel and then they were translated from Danish into German; Hanauisches Magazin, no. 49 [first week of December 1783]: 449–450; DEMARÉE, OGILVIE 2016: 124; DEMARÉE, OGILVIE 2017.

97 Kjøbenhavns Adresse-Contoirs Efterretninger, 1 July 1783; World Data Center 1984: 12.

98 Königlich Privilegirte Zeitung, 12 July 1783: 688: Report from Copenhagen, 1 July 1783; WOOD 1992: 71; DEMARÉE, OGILVIE 2001: 230.

99 Hanauisches Magazin, no. 49 [first week of December 1783]: 450.

100 Hamburgischer Unpartheyischer Correspondent, 28 June 1783. A similar report can be found in the Berlinische Nachrichten, 10 July 1783.

temporal proximity of the appearance of the dry fog in Europe and the news about Nýey.[101]

In October 1783, prompted by further reports from the merchants who returned in early September, Christian VII ordered Magnús STEPHENSEN and Hans VON LEVETZOW to claim the island for Denmark.[102] This order was part of the grander expedition to inspect the extent of the damage caused by the Laki eruption in Iceland.[103] When they arrived in the spring of 1784, Nýey had vanished; it had succumbed to wave erosion.[104] Today, Nýey is a submarine crater, a submerged reef nine to 55 meters below sea level.[105]

Given what we know about other temporary volcanic islands that have emerged around Iceland in the past, it is unlikely that the Nýey eruption could have produced ejecta anywhere near the scale of that produced by the Laki eruption. Additionally, Nýey's eruptive activity took place in March, whereas the Laki haze only began in mid-June. Nýey could never have been responsible for the haze that mystified Europe.[106] Similar reactions had followed the news of newly emerging islands near Santorini in 1707, and in the Azores in 1720.[107]

The Weather of the 1780s

The 1780s were, in many regards, typical of the Little Ice Age. Temperature and precipitation extremes characterized the decade. The Maldà anomaly occurred from 1760

101 The news about Nýey reached Hamburg (28 June), Berlin, Dessau (3 July), Augsburg (7 July) and Munich (10 July), Bamberg, Zurich (11 July), Augsburg (14 July), Leiden and England (18 July), Vienna (3 August). Most of these reports were based on a letter from Copenhagen from 24 June. Hamburgischer Unpartheyischer Correspondent, 28 June 1783; Königlich Privilegirte Zeitung, 3 July 1783: 656; Dessauische Zeitung für die Jugend und ihre Freunde, 3 July 1783: 224; Augsburgische Postzeitung, 7 July 1783: 4; Münchner Zeitung, 10 July 1783: 423–424; Berlinische Nachrichten, 10 July 1783; Hochfürstlich-Bambergisches Wochenblatt, 11 July 1783; Zürcherische Freitagszeitung, 11 July 1783: 2–3; Gazette de Leyde, 18 July 1783: 6; Morning Herald and Daily Advertiser, 18 July 1783; Das Wienerblättchen, 3 August 1783: 5–6; FRANKLIN 2017: 293.

102 Hamburg Unpartheyischer Correspondent, 2 July 1783: Report from Copenhagen, 28 June 1783. "Die jüngst gedachte 7 Meilen von Island in der See empor gekommene Insel soll, auf Königl. Allerhöchsten Befehl an die Rentekammer, sogleich in Besitz genommen werden." The order, therefore, had already been given in June, but it was only executed later.

103 A letter from Copenhagen dated 8 October 1783 detailed Hans VON LEVETZOW's ("Le Chevalier de Levezau") mission to Iceland. Gazette de France, 4 November 1783.

104 WOOD 1992: 71.

105 World Data Center 1984: 12.

106 WOOD 1992: 71; Global Volcanism Program: Reykjanes (Nýey).

107 DEMARÉE and 2001: 230.

to 1800 and caused unusual weather patterns across southwestern Europe.[108] Weather was variable on a season-to-season and year-to-year basis, which caused concern. The Laki eruption heightened this variability from 1783 onward.[109]

The 1780s were a fascinating decade; several meteorological networks were founded that conducted systematic instrumental observations from multiple locations around the globe. In Europe, the most notable were the Societas Meteorologica Palatina (1780–1793) from Mannheim, the Society Royale de Médecine (1776–1789) in France, and the Bavarian Academy of Sciences and Humanities (1781–1789) (Figure 27). The dates speak to the fact that these networks did not survive the French Revolution and the Napoleonic Wars that followed. Outside of Europe, early instrumental weather records also existed in India (1784–1785), Iraq (1782–1784), and New South Wales (from 1788).[110]

Figure 27: Map of weather stations in 1783 that featured in the research for this book.

108 Barriendos, Llasat 2003: 212; Michnowicz 2011: 9–11; Domínguez-Castro et al. 2012.

109 Lamb 1970; Kington 1988: 2; Barriendos, Llasat 2003: 201–202.

110 Damodaran et al. 2018: 517–518.

Charles Theodore, Prince-elector, Count Palatine, and Duke of Bavaria, founded the Societas Meteorologica Palatina. He had studied the natural sciences in university and gradually developed a keen interest in meteorology. His court chaplain, Johann Jakob HEMMER (1733–1790), was the Society's secretary.[111] At its peak, it boasted 39 weather stations in the Northern Hemisphere.[112] The Society's headquarters was in Mannheim in the Palatine region. Although most observatories were in Europe, some were in far-flung destinations such as the Ural Mountains, Greenland, and Massachusetts. Several of the weather stations were monasteries, such as the Andechs, Tegernsee, and Peißenberg stations in Bavaria and the Saint Gotthard Massif station in Switzerland. Each station received special instruments, including thermometers, barometers, and hygrometers, all of which had been calibrated in Mannheim by HEMMER. With these instruments came instructions to measure the temperature, pressure, and air humidity at three specific times during the day: 7 a.m., 2 p.m., and 9 p.m.[113] These measurements, along with general observations, were to be recorded in a standardized form. The records were then sent back to Mannheim every year, where HEMMER edited and published them in Latin as annual *Ephemerides*, roughly two years after they were recorded.[114] The Societas Meteorologica Palatina was unique because of its size and systematic approach to conducting weather observations.

HEMMER passed away in 1790. The Society struggled along, but the network of stations became less reliable, and its financial resources dwindled.[115] Then, in 1795, the French Revolutionary Wars brought chaos to Mannheim. The last volume of the *Ephemerides Societatis Meteorologicae Palatinae* was published on that same year, and the Society was dissolved soon after; Charles Theodore died in 1799.[116]

111 A list of private weather observers and a network of roughly 80 meteorological stations that made weather observations in Europe in the 1780s (either for the Societas Meteorologica Palatina or the Société Royale de Médecine) can be found in KINGTON 1988: 6–11.

112 CAPPEL 1986: 19; FLEMING 1998: 37; SCHMIDT 1999: 39; CAMUFFO 2002: 12.

113 KINGTON 1980: 12–15; KINGTON 1988: 14; BAUER et al. 2010.

114 Societas Meteorologica Palatina 1783: 56–61: The *Ephemerides* of 1783 were published in 1785. They covered the fog (*vaporis*) of 1783 extensively, they reported sightings of the fog in Mannheim and studied the relation of the fog to rain and wind, as well as the visibility of the stars. See also CAPPEL 1986: 19, 23; MÜNCH 1992: 137; MALBERG 2007: 190–191; PAPPERT et al. 2021.

115 CAPPEL 1986: 19, 25; KINGTON 1988: 12.

116 KINGTON 1988: 14; BAUER et al. 2010.

The Summer of 1783

The Extraordinary Dry Fog of 1783

Characteristics and Names of the Dry Fog

During the summer of 1783, a peculiar fog blanketed Europe. Peculiar because of its longevity and its dryness.[117] This haze, or smoke in some cases, had a blue hue.[118] On 17 June 1783, a weather observer named PREUS reported that a fine, smoke-like fog had started to appear around Sagan in Silesia.[119] The hygrometer reading indicated that there was very little moisture in the air, which was highly unusual in the presence of morning fog.[120] Icelandic poet and scholar Sæmundur Magnússon HÓLM (1749–1821) and French naturalist Jacques Antoine MOURGUE DE MONTREDON (1734–1818) both suggested that this dryness was due to sulfur within the mist. Later, and in a similar vein, Dutch mathematician and botanist Jan Hendrik VAN SWINDEN (1746–1823) judged sulfuric acid to be the cause of the dryness in his 1785 report in the *Ephemerides*.[121] In the eighteenth century, sulfuric acid was known as *oil of vitriol*, a byproduct of alchemy and metallurgy processes.[122]

PREUS observed this smoke-like fog at his weather station in varying intensities each day from 17 June to 13 September 1783. At first, it appeared as a fine mist, then on 19 June 1783, he observed thick fog for the first time. On 21 June 1783, he again described the fog as smoke. For the next three months, it remained, whether thick or thin, except for a few days in September. It reappeared, though more sporadically, through October and November.[123] Other similar reports came from the weather stations near the Saint Gotthard hospice in southern Switzerland and Padua in northern Italy.[124]

The unusual dry fog of 1783 is a significant focus of that year's 694-page-long *Ephemerides*; the preface, several special treatises, and the observations from most of their

117 Berlinische Nachrichten, 19 July 1783: Report from the Mannheim observatory, 6 July 1783: 670; PFISTER 1972: 23–24.

118 TITIUS 1783: 206–207. According to François VERDEIL (1747–1832) in Lausanne, Switzerland, the haze was bluish, sometimes red; PFISTER 1972: 24.

119 "Vapor t[enuis] quasi fumus," Societas Meteorologica Palatina 1783: 339. Sagan is today's Żagań in Poland.

120 Societas Meteorologica Palatina 1783, 17 June 1783: 359.

121 STOTHERS 1996: 82–83: It is described as sulfuric acid (by Jan Hendrik VAN SWINDEN in Societas Meteorologica Palatina 1783: 679–688) and volcanic sulfur gases (HÓLM 1784b; MOURGUE DE MONTREDON 1784).

122 KARPENKO, NORRIS 2002; MALILA 2018: 2. VAN SWINDEN calls it "vitriolic-acidic air" in Societas Meteorologica Palatina 1783: 688. "Aciditas, pondus, effectusque hujus *Gas* efficiunt, ut credam, ipsum ad naturam illius Gas, quod *aër-acidus-vitriolicus* dicitur, accessisse."

123 Societas Meteorologica Palatina 1783: 359–368.

124 Societas Meteorologica Palatina 1783: 186; 573.

weather stations mention the dry fog and detail its effects, such as the red coloration of the sun or moon. Most of the weather stations recorded the dry fog in their *meteora* column, referring to it sometimes as a *vapor*, with descriptions such as dry (*siccus*), thick (*spissus*), or fine (*tenuis*). On days with no fog, the observer wrote *nullus*. A symbol resembling the five dots on a die, followed by an asterisk, was also used to indicate thick fog.[125]

The time of year that the fog appeared was also curious. Van Swinden remarked that between 1774 and 1783, he had never observed any fog in June. Typically, a storm, the sun, or winds dissipate a fog; neither rain nor storm seemed capable of dispersing this anomalous haze.[126]

Due to its density, this fog reduced the optical visibility on both land and sea. Richard Stothers calculated that in some parts of Europe, the dry fog reduced the visibility to two kilometers. On a clear day, from a high enough viewpoint (because of the curvature of the Earth), the human eye can see as far as 20 kilometers.[127] Today fog and mist can be separated by their density: fog allows for visibility of less than 1,000 meters, while mist allows for visibility greater than 1,000 meters.[128] Both fog and mist consist of tiny water droplets suspended in a cloud. If visibility is reduced due to dry particles, it is referred to as haze. Another term we use today is smog, which is a mixture of smoke, gases, and chemicals.[129] In 1783, these distinctions were not so clear.

During the summer of 1783, the dry fog was an almost pan-European occurrence and received different names in different regions: for instance, in England, the dry fog was primarily referred to as a *haze*; in France, it was called *vapeur* (vapor) or *brouillard sec* (dry fog); in Sweden, it was called *sol-röken* (sun smoke); and in Italy, it was called *caligine* (haze). In Iceland, the preferred term was *móða* (mist).[130] The German sources have several names for the dry fog, including *Dunst* (haze), *Duft* (smell, but in 1783, a synonym for haze, steam, or fog), *trockener Nebel* (dry fog), and *Höhenrauch* (high smoke).[131] Other German terms in circulation included *Heerrauch* and

125 Societas Meteorologica Palatina 1783: 57. A good explanation and a legend of the different symbols applied in the *Ephemerides* by the Societas Meteorologica Palatina can be found in Kington 1988: 24.

126 Van Swinden 2001: 73; Glaser 2008: 234.

127 Stothers 1996: 82; Grattan, Brayshay, Schüttenhelm 2002: 100. From a high enough viewpoint, on a clear dark night, the human eye can see a candle flame as far as 48 kilometers away.

128 Malberg 2007: 105; Ahrens 2009: 113–115.

129 Gibbons 2018 on weather.com.

130 Cotte 1783; Lapi 1783; Oppenheimer 2011: 277; Casey et al. 2019.

131 "Höhenrauch" in Grimm; Grimm 1877 (1984): 1711. "Duft" in Krünitz 1776/1785, vol. 9. For a further debate on the names *Haarrauch*, *Heerrauch*, *Höhenrauch*, and *Moorrauch*, see Demarée 2014.

Hahlrauch, which was a reference to the fog's dry and "smoky" quality.[132] VAN SWINDEN, writing in Latin, dubbed it *nebula*, which can be translated as "cloud, fog, smoke, mist, or haze."[133]

One consequence of the fog's thickness was the reddish appearance of the sun and the moon, particularly at a few degrees above the horizon. At the Berlin weather station, on 23, 24, and 26 June 1783, as well as 10 and 17 July 1783, "the sun set in the color of blood," as a weather observer by the name of BÉGUELIN notes in the *meteora* column of his journal.[134] On other days during this time, he describes the sun as red.[135] As early as 18 June 1783, with the first appearance of the fog, the sun appeared red at the weather station in Göttingen. The last time the sun and moon were described as red there was 3 September 1783.[136] At the Tegernsee weather station, at a lake in Upper Bavaria, the weather observer P. DONAUBAUER writes in his annotations that the sun and the moon at rising looked very similar to glowing iron.[137] Descriptions of the sun detail how its rays had lost all intensity, and it was either a bluish-white hue or appeared as an iron-like red globe.[138] Many observers note that, at times, the sun was blood-red or cherry-red, as was the moon.[139]

Planets and stars, previously visible to the naked eye from 20 to 40 degrees in the sky, were at times rendered invisible.[140] The 20 brightest stars in the night sky are called first-magnitude stars. When the fog was at its densest, these stars were hidden from view in the lower parts of the sky from Scandinavia all the way to Italy.[141] At times, the sun seemed to disappear entirely below ten degrees, such as in Copenhagen, Geneva, and Narbonne. During this period, parhelia, bright spots to the left and right of the sun, and paraselenae, a similar occurrence involving the moon, were also observed.[142]

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132 Bayerische Akademie der Wissenschaften 1783, 44; "Hal" in Pfälzisches Wörterbuch, CHRISTMANN, KRÄMER 1980: 591.

133 THORDARSON, SELF 2011: 66.

134 "Sol occidit colore sanguineo." Societas Meteorologica Palatina 1783: 108–110.

135 "Sol ruber" (on 11 and 18 July 1783), Societas Meteorologica Palatina 1783: 108–110.

136 Societas Meteorologica Palatina 1783: 663–673.

137 Societas Meteorologica Palatina 1783: 299.

138 STOTHERS 1996: 83–84.

139 PFISTER 1972: 24.

140 STOTHERS 1996: 82; GLASER 2008: 234; BEHRINGER 2011: 213. A description from Ofen, Hungary, indicates that the "vapor-filled air" (*dunstige Luft*) obscured the moon at times, such as on 31 July, 25 August, and 4 November 1783, as stated in a report by the observers WEISS and BRUNA from the Royal Observatory of Ofen in the Berliner Astronomisches Jahrbuch for 1787; BODE 1784: 182–185.

141 Societas Meteorologica Palatina 1783: 60; HÓLM 1784a; HÓLM 1784b; TOALDO 1784; STOTHERS 1996: 82–84.

142 KIESSLING 1885; STOTHERS 1996: 82–83.

The Beginning of the Dry Fog

On 10 June 1783, the dry fog reached the Faroe Islands, 450 kilometers to the southeast of Iceland, only two days after the volcanic activity at the Laki fissure commenced (Figure 28).[143] Around the same time, the fog also appeared above the western coast of Norway and northern Scotland.[144] These first offshoots of the fog were faint. Ashfall was reported in the Faroe Islands and in Trondheim, Norway.[145] According to the 1882 geology textbook by Scottish geologist Archibald GEIKIE (1835–1924), in Caithness, northern Scotland, 1783 is famously remembered "as the year of the ashie," when a fine but persistent ash fall damaged crops and vegetation.[146] Some ash, although substantially less, fell in the Netherlands, Denmark, and northern Germany.[147]

Around 14 June 1783, faint manifestations of the dry fog appeared above the European continent, growing thicker over the next few days. Westerly winds carried yet more ash and dust eastward, and by the end of the month, a continent-wide veil of fog enshrouded the land.[148] On 30 June, the dry fog reached Aleppo in modern-day Syria; one day later, it was visible above Baghdad and the Altai Mountains in western China. The latter is approximately 7,000 kilometers from Iceland.[149]

Jan Hendrik VAN SWINDEN documented how the Norwegian Sea and the North Sea were covered by the dry fog from at least 25 to 30 June 1783. On the last two days of the month, the fog "was so dense, that it nearly removed all view."[150] VAN SWINDEN gathered this information from a logbook that covered the journey of a ship that left Norway on 19 June and reached Groningen on 2 July 1783. From this, VAN SWINDEN concluded that the dry fog must have come to the Dutch Republic from a northern region.[151]

Jens Jacob ESCHELS (1757–1835), a seaman originally from the North Frisian Island of Föhr, wrote his memoirs in 1831 and published them in 1835. He started going to sea in 1769. On 1 May 1783, he traveled from St. Thomas in the Caribbean to Europe

143 There are some descriptions of earlier appearances of the dry fog, such as a sighting on 24 May 1783 in Copenhagen and sightings on 6 and 7 June 1783 in La Rochelle, which were mentioned by KIESSLING (1888, vol. 1: 27–28). This might be either a transcription mistake or occurrences of a "normal" fog. Alternatively, it is possible that these were, in fact, thin offshoots of a dry fog that was produced by activity at Grímsvötn in May 1783 and before the beginning of the Laki eruption.

144 KIESSLING 1888; FIACCO et al. 1994; THORDARSON 1995; THORDARSON, SELF 2001: 66; GLASER 2008: 234.

145 HÓLM 1784; THORODDSEN 1914; THORODDSEN 1925; THORDARSON, SELF 1993: 249. For ashfall in Scandinavia, see NORDENSKIÖLD 1875; ÞÓRARINSSON 1981.

146 GEIKIE 1882: 219; VASEY 1991: 327; STOTHERS 1996: 80. A detailed list of translated historical sources that mention the first appearance of the Laki haze in Europe can be found in THORDARSON, SELF 1993: 20–24.

147 HÓLM 1784a; HÓLM 1784b; THORODDSEN 1914; THORODDSEN 1925; THORDARSON, SELF 1993: 249.

148 STOTHERS (1996: 80–82), OMAN et al. (2005), and THORDARSON and SELF (2003: 21–24) include detailed descriptions from the historical sources of when the dry fog appeared and where.

149 RENOVANZ 1788; ÞÓRARINSSON 1979; STOTHERS 1996: 80–81.

150 VAN SWINDEN 2001: 76 (all translations herein are by Susan LINTLEMAN).

151 VAN SWINDEN 2001: 76.

Figure 28: The beginning of the haze in Europe in June 1783. The numbers represent the date of the first mention of the dry fog in different cities around Europe in June. The dates are based on my sources (see list of illustrations for more detail).

and reached Heligoland on 6 July. When his ship reached the Azores – presumably in mid-June 1783 – he noticed the presence of fog which, according to ESCHELS, lasted until August 1783.[152] He details in his writings how the fog was visible above the Atlantic Ocean, the North Sea, and the Baltic Sea; for this reason, "the old seafarers referred to the year 1783 as the mist year [*das Mistjahr*]." Most of these "old seafarers" believed that earthquakes in Messina and Iceland caused the fog. He writes: "The fog was

152 ESCHELS 1928: 5–13, 128–130.

terrible for sailing as one was not able to see very far, but thank God I found my way! Once we reached the English Channel, we had 14 days of easterly wind and thick fog."[153]

Over the Baltic Sea, the dry fog was also visible, hampering travel. The *Frankfurter Staats-Ristretto* reported that travelers coming from St. Petersburg to the Lower Elbe region by ship had noticed a "great fog [. . .] everywhere" that made passage difficult.[154]

The Mediterranean was affected as well. On 6 July 1783, reports from Italy reached the German Territories stating that on the coast of the Adriatic Sea, the fog was so thick that ships had to signal each other with cannon fire in an effort not to collide.[155] On the Italian west coast, ships fared no better; it was reportedly impossible to navigate without the aid of a compass.[156]

The Fog in the Alps

The fog curtained the Alps from many a disappointed traveler that year; in Munich, one observer complained of being denied the spectacular vista to which they had become accustomed.[157] John Thomas Stanley (1735–1807), a British peer and later politician, traveled through Europe on a Grand Tour in 1783; on or around 28 June 1783, he arrived in Switzerland near Bienne at Lake Biel. Unfortunately for Stanley, this "splendid & beautiful scenery was concealed [. . .] for a considerable time [. . .] by a fog which had spread itself over a great part of Europe. It was of a peculiar kind, having no apparent moisture."[158]

This description corroborates the German newspaper reports that state that the Alps and Lake Geneva were barely visible.[159] Swiss weather observers, including Sigmund Gottlieb Studer (1757–1834) from Bern, note a reduction in visibility; at times,

153 Eschels 1928: 129. "Als wir während dieser Reise auf der Länge der Azorischen Inseln waren, kamen wir in einen Nebel, der dieses Jahr den ganzen Sommer, bis im Augustmonat, im Ozean und in der Nord- und Ostsee war, weshalb das Jahr 1783 von den alten Seeleuten das Mistjahr genannt wird. Dieser Nebel ist der Vermutung nach von dem Erdbeben in Messina (welche Stadt meist unterging) und zu gleicher Zeit in Island entstanden, und weil diesen Sommer die meiste Zeit stiller Wind war und gar kein Sturm wehte, so konnte er nicht weggehen, sondern blieb so lange stehen. Es war für die Seeleute sehr schlimm zu fahren, weil man nicht weit vor sich hinsehen konnte; doch gottlob! ich fand meinen Weg. Als wir in den Englischen Kanal kamen, hatten wir vierzehn Tage Ostwind und dicken Nebel."

154 Frankfurter Staats-Ristretto, 25 July 1783: 486: Report from the Lower Elbe, 16 July 1783. "Reisende die von Petersburg kommen, berichten, daß der grosse Nebel sich auf der See ebenfalls überall verbreitet hat, und daß sie ihre Reise deswegen mit der größten Gefahr zurückgelegt haben."

155 Hamburgischer Unpartheyischer Correspondent, 22 July 1783: Report from Italy, 6 July 1783.

156 Frankfurter Staats-Ristretto, 4 August 1783: 508: Report from Naples, 15 July 1783.

157 Bayerische Akademie der Wissenschaften 1783: 45.

158 John Thomas Stanley, MS, JRL 722, John Rylands Library, University of Manchester, Manchester, UK: 95–96.

159 Berlinische Nachrichten, 31 July 1783: 706: Report from Switzerland, 22 June 1783.

Studer had difficulty spotting the Gurten hill, just south of Bern. Swiss priest Johann Jakob Spruengli (1717–1803), who made his weather observations from Gurzelen, noticed that the Gurnigel mountain, only 6.5 kilometers away, and the Stockhorn mountain range, which was eight kilometers away, were at times completely obscured from view. The Swiss meteorologist and geologist Jean-André Deluc (1729–1812), from his vantage point in Geneva, could scarcely make out Mont Salève, a mere 6.5 kilometers away from him; the Jura Mountains, which were 16 kilometers away, were a faint silhouette.[160]

Mountains afforded naturalists the opportunity to see just how high the dry fog reached: Deluc climbed Mont Salève (1,379 meters above sea level) intending to reach the upper limit of the fog, but even at the summit, he found that the landscape remained veiled.[161] The French botanist, physicist, geologist, and meteorologist Robert Paul de Lamanon (1752–1787) summited Mont Ventoux (1,912 meters) with similar intentions; at the peak, the fog still surrounded him.[162] Alpine herdsmen, who tended to their animals at around 2,000 meters above sea level, reported a mist (*Dunst*) that shrouded the highest plateaus. Swiss chamois hunters observed the dry fog on all the mountains and peaks they worked.[163] Between 1781 and 1789, Capuchin priests Pater Onuphrius and Pater Laurentius carried out observations at regular times at the hospice on the Saint Gotthard Massif for the Societas Meteorologica Palatina (2,469 meters).[164] During the day, they observed the dry fog at the hospice and the nearby summits of 2,700 to 2,900 meters; at night, the upper limit of the dry fog was said to have fallen to as low as 2,350 meters.[165] Even though the fog was perceptible at 3,000 meters above sea level, it became apparent that it thinned with altitude.[166]

The Peak of the Dry Fog

Modern volcanologists have estimated that the Laki eruption released 122 megatons of sulfur dioxide. This volume is equivalent to the emissions of 12,000 coal-fired power plants over one year.[167] 95 megatons of sulfur dioxide were released into the polar jet stream and traveled toward Europe; the lava emitted the remaining 27 megatons, which mainly affected southern Iceland (Figure 29).[168] The sulfur dioxide (SO_2) reacted with moisture in the atmosphere and formed the approximately 180 megatons

160 Pfister 1972: 24.
161 Pfister 1972: 24.
162 Lamanon 1799: 82–83.
163 Pfister 1972: 24.
164 Pfister 1975: 86.
165 Pfister 1972: 24.
166 Lamanon 1784a; Senebier 1784; Stothers 1996: 82–83.
167 Witze, Kanipe 2014: 133–134.
168 Grattan et al. 2005.

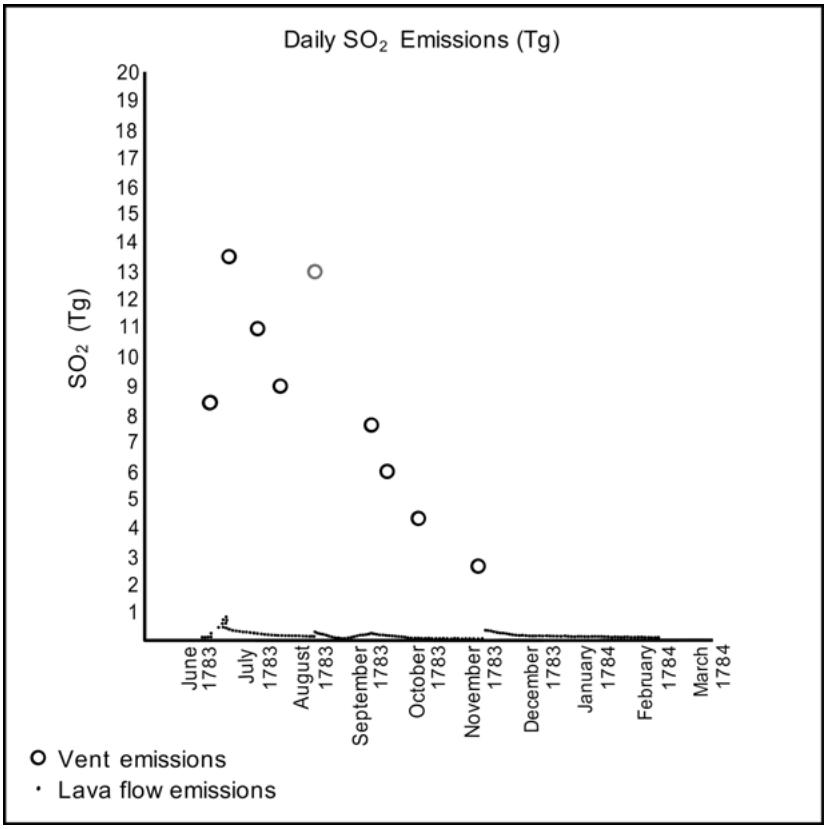

Figure 29: The Laki eruption's emissions of sulfur dioxide.

of sulfuric acid aerosols (H_2SO_4) that saturated the dry fog of 1783.[169] Additionally, seven megatons of chlorine and 15 megatons of fluorine were released.[170] Other gases released by the eruption include hydrogen sulfide (H_2S), ammonia (NH_3), and fluorine (F).[171] The Laki eruption's initial eruptive phases were the most powerful; the first three eruptive phases released as much as 40 megatons of sulfur dioxide over ten days.[172] Between 8 June and 8 July 1783, the first month of the eruption, the fissure released roughly 60 percent of the total volume of gases it would emit.[173] Thorvaldur THORDARSON and Stephen SELF estimate that by 26 June 1783, the dry fog enveloped almost all of Europe

169 THORDARSON, SELF 2003: 9; GRATTAN et al. 2005; THORDARSON 2005: 211.
170 GRATTAN et al. 2005.
171 DURAND, GRATTAN 1999.
172 GRATTAN et al. 2005.
173 GRATTAN, BRAYSHAY 1995.

with varying densities on a regional level. The thickest manifestations lasted roughly from 20 June to 23 July 1783.[174]

Thordarson and Self calculated that the conversion of sulfur dioxide into sulfuric acid aerosols at the altitude of the polar jet stream takes about one to two weeks; this correlates well with the time that passed between the onset of the eruption, the arrival of the dry fog, and the first descriptions of a sulfuric smell in Europe.[175] After 23 June 1783, episodic gaseous bursts, where the volcanic gases within the fog seemingly intensified, lasted a few minutes to a few days. These short-term, extremely poisonous episodes damaged human health, withered vegetation, and even corroded metal surfaces. The first of these bursts struck England and France on 23 June 1783 and the Dutch-German border region one day later; they then moved further south and eventually dispersed.

In England, several sources describe a "severe frost" event that occurred during the night from 23 to 24 June 1783.[176] On 23 June, the British naturalist Gilbert White (1720–1793), in Selbourne, southern England, noted not only the first appearance of the dry fog in his area but also that "[t]he blades of wheat in several fields are turned yellow & look as if scorched with the frost." On 24 June, he wrote, "[. . .] Sun, sultry, misty & hot. [. . .] This is the weather that men think injurious to hops."[177] James Woodforde (1740–1803), an English clergyman based at Weston Longville, Norfolk, also notes "a smart frost this evening" in his diary for 23 June and "[a] smart Frost again this Night" for 24 and 25 June. These descriptions are surprising, considering the previous days had been quite hot, according to his weather diary.[178]

J. Fenton authored a similar report in Nacton in Suffolk, where he kept a weather diary; on 24 June 1783, he wrote that a particular sale at a market "began notwithstanding the close heat in the day, it was commonly reported that there was a sharp freezing rhyme this morning, which on the succeeding day caused the leaves to drop from the Trees."[179] The *Sherborne Mercury* also reported severe plant damage from this "frost" in the eastern parts of England:

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174 Durand, Grattan 1999: 371. Thordarson, Self 2003: 8, Figure 5. This figure compares the Laki haze in Grund, Iceland, and Mannheim, Germany. The haze's thickness in Europe corresponds well with the eruptive episodes that caused it.

175 Thordarson, Self 2001: 68–70.

176 Grattan, Brayshay 1995. John Grattan and F. Brian Pyatt (1999) compiled many descriptions of how the vegetation fared during the presence of the dry fog in 1783.

177 Gilbert White, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 128.

178 James Woodforde, Weather Diary for Weston Longville, Norfolk, vol. 10: 1782–1784, MET/2/1/2/3/467, National Meteorological Library and Archive, Met Office, Exeter, UK.

179 J. Fenton, The Weather, etc. from June 27, 1779 to December 30, 1786 (at Nacton, Suffolk), Bib. No. 178296, National Meteorological Library and Archive, Met Office, Exeter, UK.

> Throughout most of the eastern counties, there was a most severe frost in the night between 23 and 24 June 1783. It turned most of the barley and oats yellow, to their very great damage; the walnut trees lost their leaves, and the larch and firs in plantation suffered severely.[180]

Reverend John CULLUM (1733–1785), a clergyman from Hardwick, Suffolk, writes of the unseasonable frost on these nights with the following words: "All these vegetables appeared exactly as if a fire had been lighted near them, that had shriveled and discoloured their leaves."[181] Thomas BARKER (1722–1809) was a weather observer from Leicestershire in England and brother-in-law to naturalist Gilbert WHITE. BARKER noticed a strange smell on 30 June 1783; it was an evening with "thick smoaky air & smell of fens," with winds from the north to the east.[182] The "smell of fens" was probably hydrogen sulfide, a colorless gas that smells of rotten eggs.[183] On 24 and 25 June 1783, the sulfuric haze also crept north to Scotland.[184]

Although parts of England reportedly suffered episodes of "severe frost" and "thick ice" between 26 and 31 May 1783, in general, a great heat characterized the summer. It is unlikely that the episode on 23 June 1783 resulted from frost.[185] A report from an anonymous correspondent in the *Norwich Mercury*, printed on 19 July 1783, opined "that the late blast which affected the progress of the vegetation was not a frost," but rather an air "impregnated with sulphurous particles" due to the recent earthquakes in Messina and other places.[186] Modern natural scientists, such as John GRATTAN and F. Brian PYATT, have come to the conclusion that the damage described was too selective for a midsummer frost. However, it was "typical of damage by acids and halogens. [. . .] The shedding of leaves is a classic response to concentrations of fluorine, sulphur dioxide and hydrofluoric acid, and charring is typical of damage caused by a sulphuric acid aerosol."[187] Charged by the first three eruptive episodes, it seems fog rather than frost attacked the vegetation.

On the other side of the Channel, on the same evening, the "frost" was remarked upon in Arras, Pas-de-Calais, in northern France. Monsieur BUISSART, a weather observer for Société Royale de Médecine, notes this event not in the "daily observations" column of the standardized sheet but instead in the "special observations" field.[188]

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180 Sherborne Mercury, 14 July 1783 (quoted after GRATTAN, PYATT 1994: 242).

181 CULLUM 1784: 417.

182 Thomas BARKER, Private Weather Diary for Lyndon Hall, Leicestershire, MET/2/1/2/3/227, National Meteorological Library and Archive, Met Office, Exeter, UK.

183 United States Environmental Protection Agency 1980; POWERS 2004; GREENWOOD, EARNSHAW 2008.

184 DAWSON, KIRKBRIDE, COLE 2021: 7.

185 Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 124.

186 Norwich Mercury, 19 July 1783 (quoted after THORDARSON, SELF 2003: 14). A credible argument refuting the notion of an overnight frost during the hot and hazy summer of 1783 can be found in GRATTAN and PYATT (1994).

187 GRATTAN, PYATT 1994: 245.

188 Meteorological Observations for Arras, Pas-de-Calais, France, June 1783, by the Société Royale de Médecine. BUISSART also highlights that he had based this information on hearsay.

Further north, the botanist Eugène-Joseph D'OLMEN, Baron DE POEDERLÉ (1742–1813), based in Brussels and Saintes, then in the Austrian Netherlands, first describes a sulfuric smell in his notes for 24 June 1783.[189] The dry fog most likely reached a peak in sulfuric acid aerosol concentrations here on or around 24 and 25 June 1783. These peak concentrations became particularly apparent in the border regions between the Dutch Republic and the German Territories.

The *Ephemerides* of the Bavarian Academy of Sciences and Humanities reported on the plight of the people of the Dutch Republic, who had not seen daylight for half a week and had to cover their faces with sheets when outside to keep the foul odors at bay.[190] Dutch botanist and physician Sebald Justinus BRUGMANS (1763–1819), then studying in Groningen, wrote and published a book about this dramatic turn of events. He writes of a fog that materialized before 20 June 1783 in various locations across the Dutch Republic. In some areas, such as in Holland and Utrecht, it had no apparent sulfuric odor, but in others, such as in Gelderland and Overijssel, there was "a sulfuric smell [. . .] admixed to the fog."[191] BRUGMANS states that, on 24 June 1783, the fog was so intense that one could taste it with each breath. Although the smell began to dissipate over the following days, the dry fog remained; by the morning of 28 June 1783, the sulfuric smell had vanished entirely.[192]

Jan Hendrik VAN SWINDEN observed the sulfuric odor in Franeker. His description suggests that the town was redolent with a stench that crept through houses and clung to everything. According to VAN SWINDEN, those with "delicate lungs" had trouble with this odor; this was most likely a reference to those with pre-existing respiratory diseases. He pronounced that with each breath, he had to stifle a cough. This unfortunate situation followed him from the city in his retreat to the countryside. A growing number of people complained about headaches and respiratory difficulties, particularly asthma.[193] The connection between pollution and asthma was virtually unknown in the eighteenth century.[194]

In Groß Hesepe, in the neighboring Emsland region, this first wave of particularly sulfurous fog appeared on 24 June 1783, Saint John's Eve, and lingered until the next day. A few days prior, a smell that a local chronicler compared to "heated hay" had already manifested itself. A smell similar to burnt gunpowder and decay became apparent.[195] The comparison to burnt gunpowder strongly suggests that what they

189 DE POEDERLÉ 1784: 336.

190 Bayerische Akademie der Wissenschaften 1783: 45. A similar report can be found in the Frankfurter Staats-Ristretto, 15 July 1783: 465.

191 BRUGMANS 1783, foreword.

192 BRUGMANS 1783: 5.

193 VAN SWINDEN 2001: 73, 75. For a modern description of health problems that can be triggered by volcanic gases, see HANSELL, OPPENHEIMER 2004.

194 DURAND, GRATTAN 1999: 372.

195 SANTEL 1997: 108–110.

smelled was indeed sulfur dioxide, which is known to have a sharp smell similar to that of burnt matches. Locals "felt a sulfuric or saltpeter-like taste in their mouth on 24 June 1783 and the days after; some complained of itchy throats or breathing difficulties. The water in some rain tanks also started to have a saltpeter-like taste."[196]

Relatively low concentrations of sulfur dioxide can cause health problems after only a few minutes of exposure.[197] An itchy or sore throat and breathing difficulties are typical symptoms (Figure 30).[198] The people of Groß Hesepe saw, smelled, and even tasted the aftermath of a volcanic eruption that had occurred almost 2,000 kilometers away.

The Emsland area was no stranger to fog or smoke. Every year, the nearby bog colonists burnt part of the peat bog to generate fertile ash, in which they would plant seeds of buckwheat. This great wave of sulfuric fog was something else.[199] It was dramatically described as a "poisoning thaw," which withered everything it touched and covered all the land and ocean.[200] The *Frankfurter Staats-Ristretto* got wind of the unfolding story and published a report from a correspondent in Münster stating that the "smell of the steam that covers our soil is unhealthy in our region." This "smell" decimated the vegetation on the banks of the Ems River, where lush green rotted to post-autumn brown overnight.[201]

The locals did not mistake this particularly poisonous dry fog for frost in this region.[202] On the morning of 25 June 1783, VAN SWINDEN remarked on the extensive

196 SANTEL 1997: 109–110. "Viele Menschen empfanden am 24. Juni und noch einige Tage danach einen schwefel-bis salpeterartigen Geschmack im Munde, der bei manchen ein Kratzen im Halse und sogar Atmungsbeschwerden hervorrief. Das Wasser in manchen Regenwasserbecken nahm ebenfalls einen salpeterartigen Geschmack an."

197 "Sulfur dioxide (SO_2), Air quality fact sheet," 2005. The threshold beyond which humans can perceive the taste of sulfur dioxide is 0.35 parts per million (ppm) – lower than the threshold to smell this pungent odor, which is possible at concentrations beyond 0.67 ppm; National Research Council (US), Committee on Acute Exposure Guideline Levels, 2010.

198 MEYER 1977.

199 LIER, TONKENS 1792: 263–265; STOCKMAN 1984: 220; DEMARÉE 2014.

200 SANTEL, SANTEL 1992; SANTEL 1997: 108: "vergieftender Thau."

201 Frankfurter Staats-Ristretto, 21 July 1783: 477: Report from Münster, 30 June 1783. "Der Geruch des unsere Erde bedeckenden Dampfes ist hier zu Land ungesund, und wirket auch stark auf die Blätter und Pflanzen. An den Ufern der Emse hin ist in einer Nacht alles Grüne verschwunden, als wenn es schon späte im Herbst wäre. Die Landleute beführchten alles, auch für das Hornvieh, von diesem Nebel, wenn sich nicht bald ein gesunder Regen einstellt." It is possible that not only the Ems region was affected but also Hamburg, located further to the northeast, a similar incident of all trees losing their leaves over night is reported in the Frankfurter Staats-Ristretto, 1 August 1783: 501. "In der Gegend von Hamburg sind alle Bäume in einer Nacht bey dem neulichen Erddampfe entblättert worden."

202 This poisonous dry fog, however, also affected areas further east: Plön in Holstein, for instance, experienced damage to vegetation on the night from 24 to 25 June 1783. Here, the event was compared to "rime" or "frost," as we have already seen for England or France; KUSS 1826: 170; KINDER 1904 (1976): 304–307.

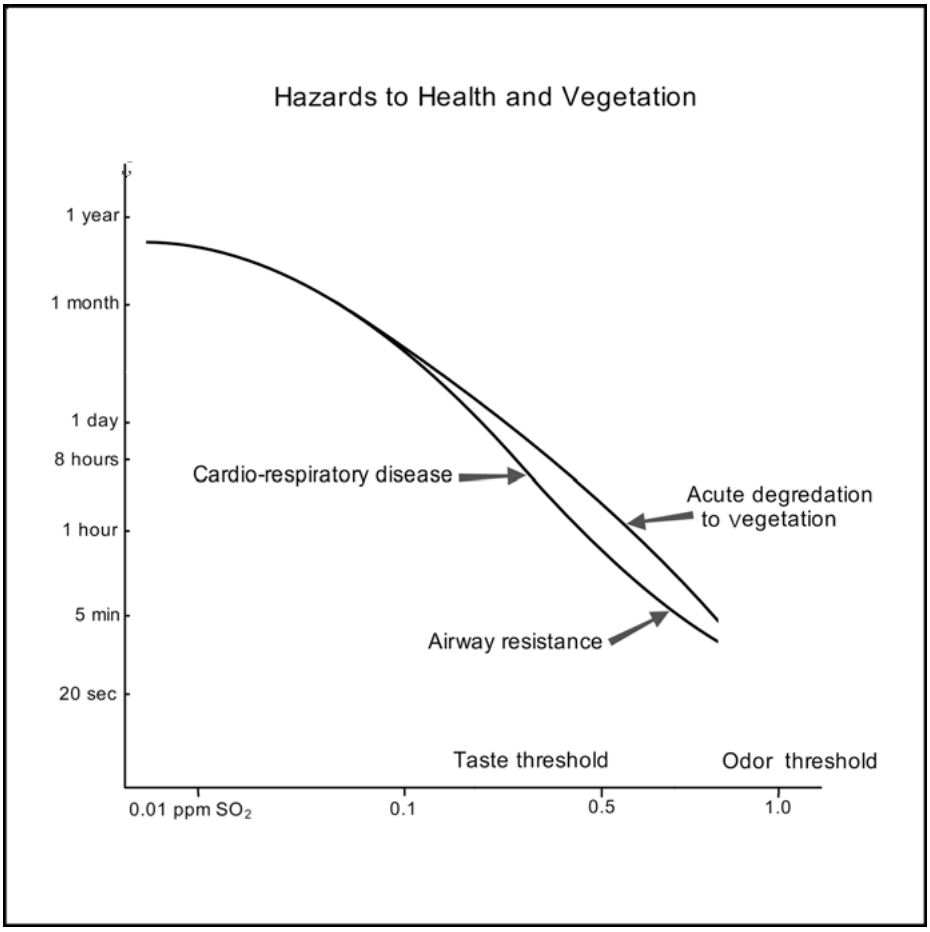

Figure 30: The hazards of sulfur dioxide to health and vegetation. The severity of the impact on human health and the environment depends on concentration and exposure.

damage that it had brought. Leaves had dropped from the trees, and grasses and plants withered. For the same day, BRUGMANS, too, remarked on the damage to plant life: he paid specific attention to their color, commenting on the fact that all around him, the vegetation appeared as it would in mid-winter.[203] He rejoiced that not all plants had been affected in this way. Some of the sturdier ones remained intact and seemed to have survived unscathed. The sudden change from lush green to the

203 VAN SWINDEN 2001: 74–75. Similar reports come from Germany: In Jena, Johann WIEDEBURG (1784: 65–66, 83–84) noticed the orchard fruit grew very little and ripened unevenly. In Schleswig-Holstein, fruit trees were badly affected by the dry fog, bushes lost their leaves, and the fields were also affected; KUSS 1826: 171–172.

autumn colors of brown, black, gray, or white was highly unusual. While it is normal for plants and grass to turn yellow during a heat wave or drought, here, the plants changed their appearance overnight – the very night that the region was affected by the sulfuric smell. Fortunately, most vegetation seemed to recover well from their premature June withering, bearing leaves and fruit again later in the year. Some locals believed this happened because the fog had fertilized the soil with its saltpeter-like substances.[204] Animals living on the trees, mainly insects, were also affected: "[. . .] this haze made a great slaughter of insects, especially fleas, which settle on leaves of trees; when the leaves themselves were damaged, the insects of the trees, which were not injured by the haze, were killed [. . .]."[205]

The fog affected both living organisms and inanimate objects; the chemicals within the fog reacted with cloth, such as wet linen, and metal objects, particularly iron surfaces, which during this night turned green in some areas and rusty in others. "Even some soldiers, who kept watch in Coevorden [in the Dutch Republic, 33 kilometers to the west from Groß Hesepe], noticed a green coating on their gun barrels. Linen laid out on the grass to be bleached gained rusty stains that could not be removed."[206] These effects are similar to that of the vog – volcanic fog – in Hawai'i, where volcanic eruptions are rich in sulfur dioxide. Vog, unsurprisingly, has been linked to cases of asthma and bronchitis in addition to a reduction in agricultural output.[207] The Hawai'ian vog contains sulfuric acid droplets comparable to the corrosive chemicals found in battery acid.[208] Scientists doing fieldwork in Hawai'i have noticed that vog damages their metal equipment, causing it to corrode.[209]

With a few exceptions, these events were limited to England, northern France, the Low Countries, and northwestern Germany between 23 and 25 June 1783 (Figure 31). Thordarson and Self argue that this was due to the locations of two pressure systems. Between 21 June and 5 July 1783, while a low-pressure system was stationary above

204 Santel 1997: 108–110; van Swinden 2001: 74–75.

205 Van Swinden 2001: 75.

206 Santel 1997: 109–110. "Der grüne Ausschlag wurde zuerst von wachhabenden Soldaten in Coevorden an ihren Gewehrläufen festgestellt. Auf dem Rasen zum Bleichen ausgebreitetes Leinen erhielt rostartige Flecke, die sich oft nicht wieder auswaschen ließen."

207 Longo et al. 2010; Elias, Sutton 2017; USGS, "What Health Hazards are Posed by Vog (Volcanic Smog)?" usgs.gov.

208 USGS, "Does Vog (Volcanic Smog) Impact Plants and Animals?" usgs.gov. "Corrosive" is a word that some contemporary sources use in their descriptions of the impacts on vegetation; Königlich Privilegirte Zeitung, 19 July 1783: 708: Report from Thuringia, 4 July 1783. "Viele Bäume, sowohl in Gärten als Holzungen, wurden seit den 23. Juny fast mit einemmale wie vom Feuer versengt, und verlieren ganz, oder zum Theil die Blätter, welche mit einer corrosiven Feuchtigkeit besprüht zu seyn scheinen, wovon sie ein schwarzes oder braunes Ansehen gewinnen, zusammenschrumpfen und verdorren."

209 Broendel et al. 2019, Third Pod from the Sun podcast.

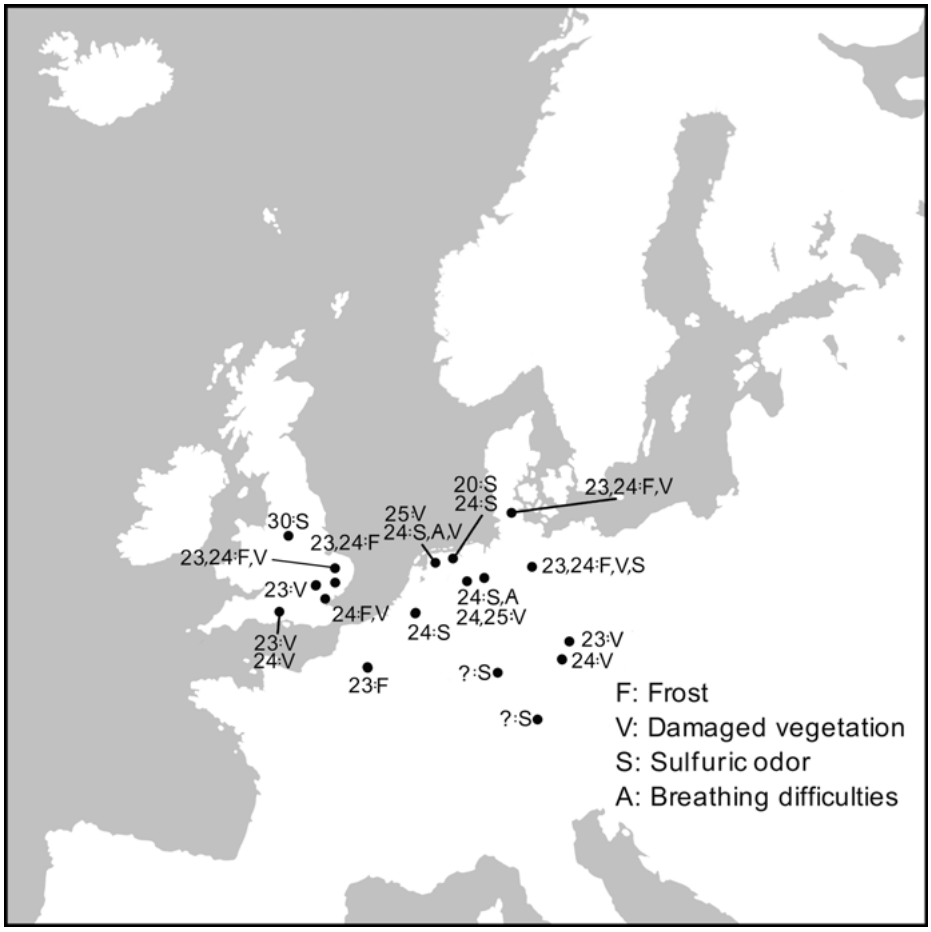

Figure 31: The sulfuric smell and its impact on health and vegetation. The numbers indicate the date in late June 1783 of observations of frost (F), damaged vegetation (V), a sulfuric odor (S), or breathing difficulties (A). (See the list of illustrations for more detail.) Other regions likely experienced these phenomena as well.

Iceland, a long-lasting high-pressure system hovered above northwestern Europe (Figure 32).[210] The polar jet stream transported volcanic aerosols from the Laki eruption in Iceland to Europe; then, the high-pressure system funneled the volcanic aerosols to ground level over the continent in a spiral-like movement (Figure 33). In the lower parts of the atmosphere, the aerosols reacted with the moisture, which caused

210 The locations of low-pressure and high-pressure systems have been reconstructed for every day of the 1780s by John KINGTON, based on contemporary meteorological descriptions; KINGTON 1988.

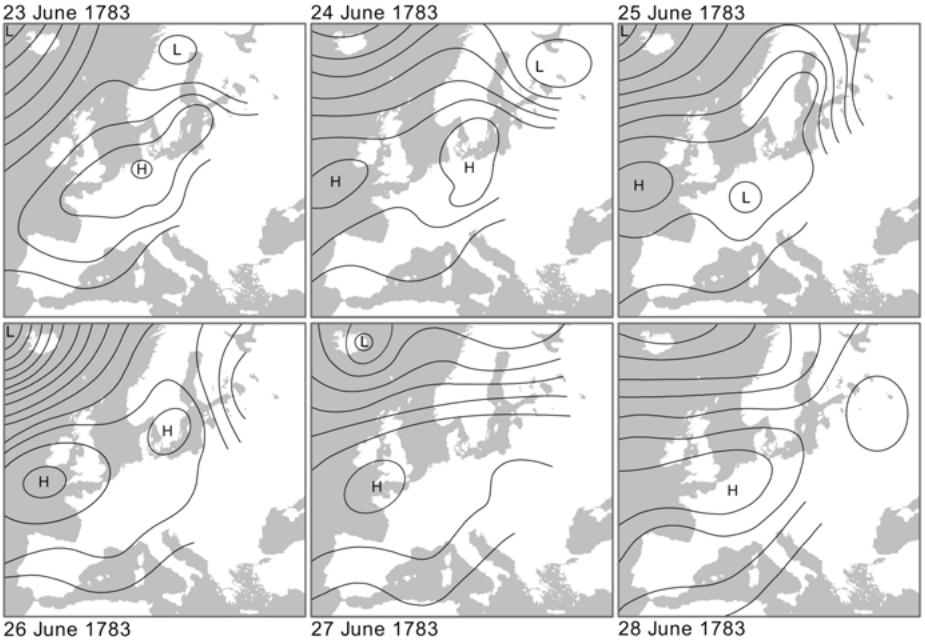

Figure 32: Synoptic weather maps, 23 to 28 June 1783. The maps are based on data from John KINGTON's *The Weather of the 1780s Over Europe*. Reproduced with permission of Cambridge University Press through PLSclear.

the fog to become denser and the air to become very dry.[211] A particularly caustic blast of sulfuric-laden gases, transported by this pressure system, descended upon northwestern Europe on the days in question.

Human Health During the Haze's Peak

When the dry fog descended, it made life difficult for those with pre-existing respiratory problems.[212] The following excerpt from the *Münchner Zeitung* states as much: "In the evening, the fog returned after the thunderstorm, and blanketed the mountains again, and caused a shortness of breath [. . .]."[213] Amidst the gasps for breath

211 THORDARSON, SELF 2011: 70.

212 WITZE, KANIPE 2014: 110–111.

213 Münchner Zeitung, 11 July 1783: 425. "Am Abend nach dem Donnerwetter trat aber der Nebel wider ein, und verhüllte die Gebirge von neuem, macht Engbrüstigkeiten, und vermehrt die Vorurteile der gegenwärtigen Zeit." See also "Engbrüstigkeit" in KRÜNITZ 1777, vol. 11: 11.

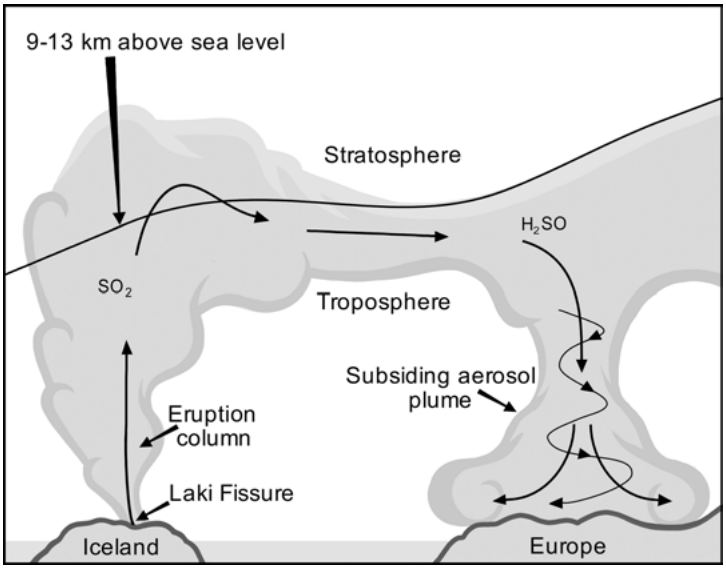

Figure 33: Dispersal of the Laki haze, based on the model developed by THORDARSON and SELF. The Laki eruption emitted ash, sulfur dioxide, and other gases to altitudes of nine to 12 kilometers during its first eruptive episodes between 8 and 14 June 1783. In the jet stream, the sulfur dioxide (SO_2) reacted with moisture and transformed into sulfuric acid aerosols (H_2SO_4), which at this altitude takes about one to two weeks. This "delay" corresponds very well to the time lag between the release of sulfur dioxide in Iceland and the appearance of the dry fog above Europe.

and fits of coughing, a multitude of people began to suffer from eye conditions, likely conjunctivitis.[214]

The poisonous wave of dry fog in the last week of June 1783 was extreme, rare, and perhaps singular in the early modern period. Undoubtedly, the arrival of noxious volcanic gases befouled the air in Europe.[215] Although the gases that arrived in Europe were weaker than they were at their Icelandic point of origin, they nevertheless left their mark.[216] The bitter cocktail consisted primarily of sulfur dioxide, hydrogen sulfides, and fluorine. Sulfur dioxide is detectable from concentrations as low as 0.35 parts per million; asthma worsens when the concentrations are higher than 0.572

214 Königlich Privilegirte Zeitung, 17 July 1783: 700: Report from Dillenburg, 2 July 1783. "In einigen benachbarten Ortschaften sind ganze Familien mit dem Uebel böser Augen behaftet." A similar report, describing people suffering from "bad eyes," presumably eye infections, can also be found in Frankfurter Staats-Ristretto, 11 July 1783: 453: Report from Dillenburg, 2 July 1783; CHRIST 1783: 28–29.

215 GRATTAN, BRAYSHAY 1994; GRATTAN, BRAYSHAY, SCHÜTTENHELM 2002: 92; GRATTAN, DURAND, TAYLOR 2003; GRATTAN et al. 2005.

216 DURAND, GRATTAN 1999: 375; SCARTH 1999: 114.

parts per million (ppm).[217] Hydrogen sulfide concentrations above ten ppm can cause eye irritation, and concentrations above 50 ppm can lead to severe eye damage. Both hydrogen sulfide and ammonia can cause paralysis of the sense of smell within a few minutes, which creates the illusion that the danger has passed even though it has not.[218] Fluorine irritates the eyes and respiratory system when concentrations reach 25 ppm.[219] Other health consequences of exposure to volcanic air pollution include headaches and a loss of appetite.[220]

The question remains: Did the Laki eruption cause excess mortality in European countries outside of Iceland? The mortality rate during June and July 1783 was not exceptional. The extreme spikes occurred in August and September 1783 and in the early months of 1784, which are discussed below.[221] Sources reveal that in June 1783, France reported cases of intermittent fever, possibly caused by malaria, typhoid fever, measles, or smallpox. The following month, dysentery and diarrhea were also reported.[222] Wilfried Pitel and Jérémy Desarthe compared documents from several French cities for the months between June and September 1783. They identified that La Rochelle suffered only slightly higher mortality than usual, whereas, in Créteil, the number of burials was almost double the average for the same time in 1774 and 1789.[223] There is no evidence that this particular spike in mortality was directly related to the dry fog.

Often, in the sources, it is not clear whether heat or pollution was to blame for the plight of the people. In his journal from Selbourne, Gilbert White details the deleterious effects of the weather on the town's laborers. For 11 July 1783, he writes that the temperature was "74 degrees [Fahrenheit]!" or 23.3 °C. The sun on this day was sultry: "[. . .] the heat [overcame] the grassmowers & [made] them sick."[224] Unfortunately, White does not elaborate further on the nature of their sickness, so it is difficult to pinpoint its exact cause.[225] In Switzerland, a striking report from Graubünden on 24 June 1783 mentions that the fog was present for eight days and that many had fallen ill and some had died.[226] Just as in White's report, the nature of the illnesses remains unclear.

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217 Wellburn 1994; Baxter 2000; Witham, Oppenheimer 2004: 23; National Research Council (US), Committee on Acute Exposure Guideline Levels, 2010.

218 United States Environmental Protection Agency 1980; Powers 2004; Greenwood, Earnshaw 2008.

219 Keplinger, Suissa 1968; Lide 2004.

220 Wellburn 1994; Pope, Dockery, Schwartz 1995; Petersen, Fisher, Timpany 1996; Durand, Grattan 1999: 373; Grattan, Durand, Taylor 2003, 401; Behringer 2011: 213; Oppenheimer 2011: 44–46; USGS, "Volcanic Gases and Their Effects."

221 Harreaux 1858: 30–31; Durand, Grattan 1999: 373; Grattan et al. 2003: 20.

222 Société Royale de Médecine 1782/1783: 19–22.

223 Pitel, Desarthe, "Les Brouillards d'Islande événements extrêmes et mortalities"; Garnier 2011.

224 Gilbert White, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 130.

225 Grattan, Durand, Taylor 2003: 411.

226 Königlich Privilegirte Zeitung, 19 July 1783: 708: Report from Graubünden, 24 June 1783.

The *Ephemerides* of the Bavarian Academy of Sciences and Humanities notes that most children and adults who died in 1783 passed between March and May, and most elderly people during June and July. The most common complaints and illnesses during the season of the dry fog were headaches, vertigo, general exhaustion, and strokes.[227] The Societas Meteorologica Palatina published a statement in the newspapers declaring that the nature of the fog had not given them the slightest indication that it had malignant effects: "Quite the opposite, diseases have been reduced, and the grapes are doing very well."[228]

The *Königlich Privilegirte Zeitung* printed an article wherein an author of a local magazine suggested that the "mist does not come from the Earth but comes from the higher regions of the air" and "causes a disadvantageous fermentation in the plants: [. . .] when you eat some portions of it, it causes violent, crampy stomachache." It also gave some practical advice for surviving the dry fog: livestock should remain inside; fodder should be washed outside during heavy rain; and vegetables should be adequately soaked before eating. The anonymous author further recommended smoking tobacco diligently.[229]

The dry fog's concentrations varied from place to place and from time to time. In some areas, the particulates within the fog might have been so great as to induce excess mortality, perhaps in conjunction with one of the many other unfortunate illnesses of the time. Some areas experienced a slow burn and would only play host to a mortality crisis some months later. These are probably the areas in which the fog had lower concentrations of small particulate matter for less time or areas where fever and disease were not so prevalent.

The Fog Days of Summer

In the German Territories, the first mention of the fog in the newspapers was on 5 July 1783 in the *Wiener Zeitung* from Vienna: "Because of the frequent rain that was followed by flooding along the rivers, the hot sun and the completely still air, vapor came up from the Earth and enveloped our horizons these days with a fog, which has

227 Bayerische Akademie der Wissenschaften 1783: 104–109. The sources describe strokes as *Schlagflüsse*, which is a term used to describe a sudden death when the cause of death cannot otherwise be determined; Metzke 2005: 62.

228 Berlinische Nachrichten, 19 July 1783: 670: Report from the Mannheim observatory, 6 July 1783. "Im Gegentheil haben sich die Krankheiten gemindert, und die Trauben haben ein herrliches Gedeihen."

229 Königlich Privilegirte Zeitung, 24 July 1783: 721–722: Report from Hanau, 18 July 1783. "Er glaubt, dieser äußerst subtilisirte Dunst komme nicht aus der Erde, sondern sey aus der höhern Region der Luft, durch die daselbst herrschende Winde und durch die Sonne niedergedrückt. Er bringe in die Röhren der Pflanzen, ziehe sie zusammen, hemme dadurch den Umlauf der Säfte, und verursache eine nachtheilige Gährung in denselben: der an den Baumblättern hängende starke Honigsaft, der, wenn man ihn in einiger Menge verzehre, heftiges Leibreissen verursache, bestätige dieses."

been particularly visible during sunrise and sunset in the morning and evening."[230] On 8 July 1783, a report from Adorf from 26 June 1783, written by an anonymous correspondent, was printed in the *Berlinische Nachrichten*: "Also in our area, like in several areas in Germany since 15 June 1783, we observed a fog that looked similar to the air weighed down by the smoke of a burning forest."[231]

This quote makes it clear that the correspondent was aware of the supra-regional presence of the dry fog. Undoubtedly, most initial observers of this fog assumed it was a local phenomenon until news poured in from other places about its extent.[232] As early as 12 July 1783, the widespread nature of the fog was known in Austria: "The weather here [in Styria] is the same as in the whole of Europe, according to different reports."[233]

On 12 July 1783, the *Hamburgischer Unpartheyischer Correspondent* published a report from Paris dated 4 July*:* "For 14 days now, we daily had thick fogs [. . .] they deny us all the sunrays. Our naturalists now concern themselves with the discovery of the cause of this unusual appearance."[234] Given that many parts of Europe were denied "all the sunrays," it is unsurprising that there existed, among a few, the uneasy apprehension that they were witnessing "a harbinger of Judgement Day."[235]

230 Wiener Zeitung, 5 July 1783. "Die nach einem häufigen Regen, und die dadurch ausgetrettenen Flüsse, bey einer heißen Sonne und gänzlichen Windstille von der Erde aufsteigenden Ausdünstungen umgaben dieser Tagen unsern Horizont gleichsam mit einem Nebel, der des Morgens und Abends bey dem Aufgange und Niedergange der Sonne am meisten sichtbar war."

231 Berlinische Nachrichten, 8 July 1783: 629: Report from Adorf, 26 June 1783. "Auch bey uns herrscht, wie in mehrern Gegenden Deutschlands seit dem 15. dieses [Juni], ein Nebel, welcher einem von der Luft niedergedrückten Rauch eines brennenden Waldes ähnlich sieht [. . .]." There are several Adorfs in the German Territories and it is, unfortunately, unclear which Adorf this report refers to. Similar reports stating an awareness of the supra-regional character of the fog exist from elsewhere, such as in the Hamburgischer Unpartheyischer Correspondent, 11 July 1783: Report from the Lower Elbe, 10 July 1783.

232 Camuffo, Enzi 1995: 139; Stothers 1996: 85. A similar report can be found in the Wiener Zeitung, 9 July 1783: Report from Ofen, 2 July 1783; here, the fog first appeared around 20 June 1783. Either the correspondent from Ofen was aware of the presence of the fog in several parts of Germany, such as Munich, Dresden, and Regensburg, and parts of Hungary – or perhaps this detail was added later by the newspaper's editor.

233 Wiener Zeitung, 19 July 1783: Report from Graz in Styria, 12 July 1783. "Das Wetter ist bey uns eben so, wie es nach verschiedenen Berichten in ganz Europa herrscht. Doch auch wir haben davon nicht im geringsten eine üble Folge verspürt, es wäre denn die heftigen Ausbrüche des Donners, welche in unseren Gegenden geschehen, und hie und da nicht unbeträchtlichen Schaden anrichten."

234 Hamburgischer Unpartheyischer Correspondent, 12 July 1783: Report from Paris, 4 July 1783.

235 Anonymous ("E. R.") 1783: 405–406.

The Extreme Heat of Summer

The summer of 1783 was sweltering in northwestern and central Europe, with the peak of the heat wave arriving in early August. Many a task was left undone as temperatures left people exhausted, so much so that they were unable to work.[236] One report from Thuringia, which appeared in the *Königlich Privilegirte Zeitung* stated, "Also in this area, we noted a strong haze since 17 June 1783, which still continues with unbearable heat and strong northeastern winds."[237] Although the haze affected a much larger geographic area and lasted much longer than the heat wave, in the midst of this sultry spell, many presumed some connection.[238]

In Mannheim, a "great heat" struck on 2 and 3 July 1783; it peaked on the second day with a temperature of 27 ½ °Ré [34.4 °C] in the shade at 2 p.m.[239] England experienced heat and drought conditions as well; Gilbert WHITE recorded a temperature of 74 °F [23.3 °C] on 11 July 1783, and an atmosphere that was close and dark. Drought-like conditions followed: "There was not rain enough in this village [Selbourne] to lay the dust."[240] On 16 July 1783, as if answering WHITE's prayers, there was "a fine refreshing rain," and indeed, this had been the first rain in Selbourne since 20 June 1783.[241] James WOODFORDE from Norfolk kept a diary in which he frequently described the heat throughout the summer: for example, on 13 July 1783, he documented the moment that "one poor Woman by name Hester Dunham fainted in Church."[242] Stories about the heat in Europe, and countermeasures against it, even made it into North American newspapers. One such report told of people in Wales camping in the mountains to find some relief from the heat.[243]

August brought with it another fierce heat that peaked on the second and fourth day of the month. In Selbourne, for 2 August 1783, Gilbert WHITE writes: "Dew, cloudless,

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236 Königlich Privilegirte Zeitung, 19 July 1783: 708: Report from Graubünden, 24 June 1783.

237 Königlich Privilegirte Zeitung, 19 July 1783: 708: Report from Thuringia, 4 July 1783. "Auch in hiesigen Gegenden wird seit den 17. Juny ein heftiger Nebel bemerkt, welcher mit unerträglicher Hitze, bey scharfwehenden Nordostwinden noch immer fortdauert." A similar report from the Lower Rhine area also mentioned that the haze was carried by winds from the north and northeast; Koblenzer Intelligenzblatt, 18 July 1783: Report from the Lower Rhine, 10 July 1783.

238 GRATTAN, SADLER 1999: 169; SCARTH 1999: 118–119; GLASER 2001: 205.

239 Berlinische Nachrichten, 19 July 1783: 670: Report from the Mannheim observatory, 6 July 1783. René-Antoine Ferchault DE RÉAUMUR introduced the Réaumur temperature scale in 1730; it was widely used in the German Territories and France. 0 °Ré is the melting point of ice and 80 °Ré is the boiling point of water.

240 Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 130.

241 Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 131.

242 James WOODFORDE, Weather Diary for Weston Longville, Norfolk, vol. 10: 1782–1784, MET/2/1/2/3/467, National Meteorological Library and Archive, Met Office, Exeter, UK.

243 The Connecticut Journal, 5 November 1783: Reprint of news from London, 22 [?] July 1783, reprint of a letter from Salon, Provence.

sultry, red evening. Burning sun. Workmen complain of the heat. Gardens burn."[244] James WOODFORDE noted the excessive heat on 2 and 3 August 1783 in Norfolk and his relief when, on 4 August, a little rain came in the afternoon, followed by thunder in the evening.[245] Across the water, in Franeker in the northwestern Dutch Republic, Jan Hendrik VAN SWINDEN noticed a particular heat after the fog had vanished, around 28 July 1783, when the thermometer measured 33.4 °C. He further remarked on yet another increase in temperature in August 1783 (Figure 34).[246]

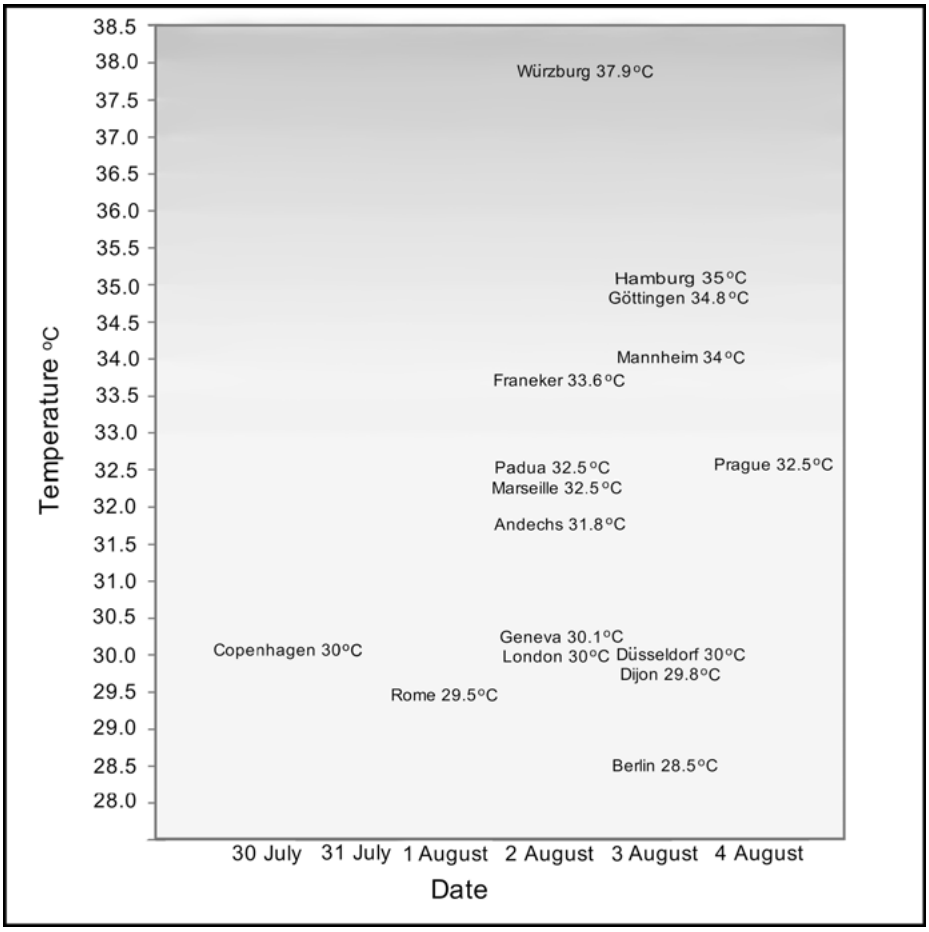

Figure 34: Peak temperatures of the August 1783 heat wave (see list of illustrations for more detail).

244 Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 133.

245 James WOODFORDE, Weather Diary for Weston Longville, Norfolk, vol. 10: 1782–1784, MET/2/1/2/3/467, National Meteorological Library and Archive, Met Office, Exeter, UK.

246 VAN SWINDEN 2001: 80.

Data from temperature records based on 26 weather stations in Europe and three in North America within the Societas Meteorologica Palatina network reveal that temperatures in the summer of 1783 varied significantly between different regions. In north, west, and central Europe, the 1783 summer mean temperatures were 1 to 3 °C above average. However, in southern Europe and North America, temperatures remained within the normal range. Inland regions in Eurasia, from Poland to China, experienced unstable and cold weather.[247] Istanbul, then known as Constantinople, also had a very cold summer: "It is not yet sufficiently warm to put on our summer clothes. The inhabitants from Ankara and Izmir make the same complaints."[248]

Recent climatological studies show that the summer of 1783 was one of the warmest summers of the past three centuries in central and western Europe (Figure 35).[249] The July temperatures in northwest Germany were 2 °C above average for 1768–1798, and in central Germany, they were 1 °C above average for the same period.[250] In central England, July 1783 had an average temperature of 18.8 °C, which made it the hottest month of an entire temperature series, lasting from 1659 to 1973.[251] In fact, it took until 1995 for a hotter July to come around in England.[252] In Copenhagen, July 1783 remained the warmest month until 1893. Circulation dynamics in the atmosphere most likely supported dry and hot conditions above central and western Europe; this produced a rare anticyclone, which is a quasi-stationary high-pressure system, above Europe. High-pressure systems are associated with clear skies. Without clouds to reflect sunlight, the temperature increases during the day. The suffocating heat only compounded the sense of panic and hysteria brought about by the unwelcome fog.[253] As would be expected, the temperatures cooled down once the high-pressure system vanished.[254]

247 Thordarson 2005: 214–215.

248 Journal historique et littéraire, 15 September 1783: 113 (translated by Demarée, Ogilvie 2001: 227).

249 1783 was the warmest summer in western Europe in three centuries; Hochadel 2009: 45. In England, 1783 was the hottest summer in recorded history between 1659 and 1983; Grattan, Sadler 1999: 64.

250 Scarth 1999: 117.

251 Manley 1974: 395, 398.

252 Thordarson 2005: 214–215.

253 Grattan, Brayshay, Sadler 1998: 29 (quote); see also Grattan, Sadler 2001.

254 Grattan, Sadler 1999: 169; Scarth 1999: 118–119; Glaser 2001: 205; Thordarson, Self 2001: 68–70; Glaser 2008: 235. For more information on atmospheric pressure, see Ahrens 2009: 193–210.

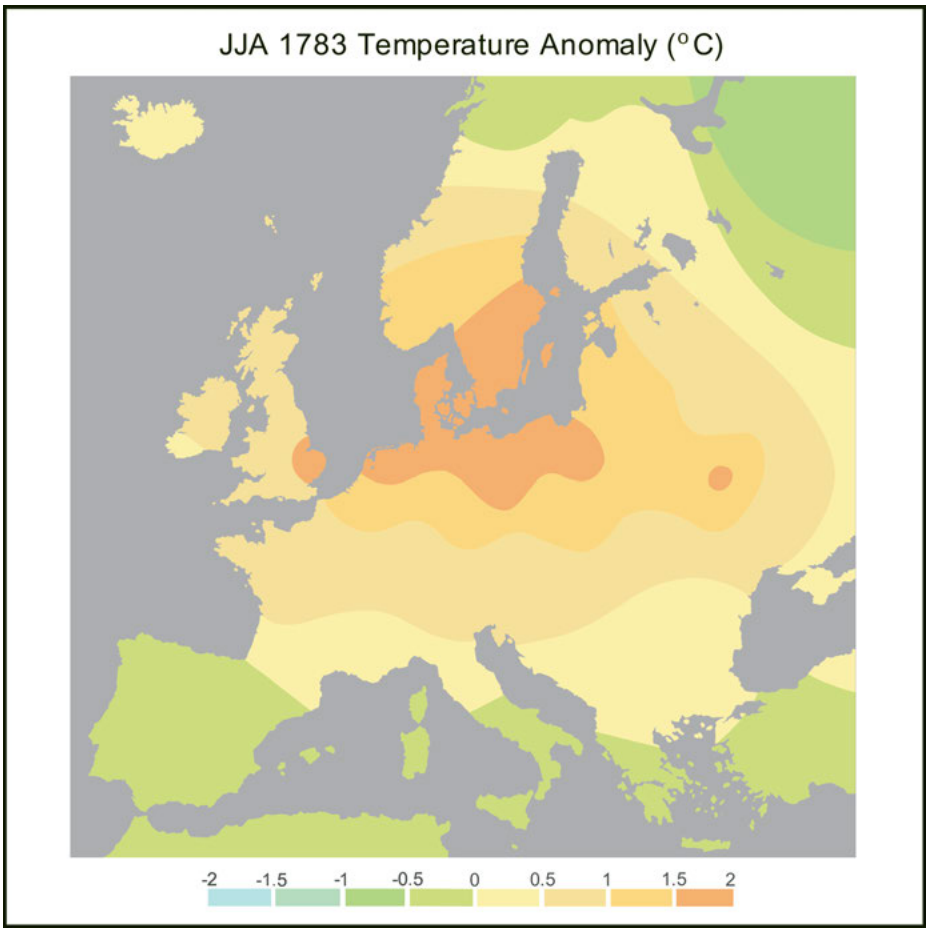

Figure 35: Temperature anomaly for June, July, and August 1783 based upon the 31-year mean, 1770–1800. Central, western, and northern Europe experienced warming, whereas southern Europe and the Mediterranean region experienced cooling.

Thunderclaps and Lightning

Thunderstorms frequently occur during spring and summer in the tropics and mid-latitudes; thus, they are not unusual in central Europe.[255] That said, during the summer of 1783, an alarmingly high number of severe thunderstorms occurred across much of the continent. A report from Zweibrücken dated 6 September 1783, printed in

255 Scarth 1999: 117–118; Witze, Kanipe 2014: 113.

the *Berlinische Nachrichten*, said: "Since time immemorial, this country has not experienced more damage from thunderstorms than in the present year."[256] A newspaper report from Mannheim that appeared in the *Königlich Privilegirte Zeitung* left readers in no doubt as to the ferocity of the storms: "The lightning and thunder, which accompanied the thunderstorm, cannot be described terrifyingly enough."[257] The storms reached the higher-altitude Westerwald region: "[. . .] during one thunderstorm, we did not see any lightning nor the usual storm clouds, but the numbing thunder was even stronger."[258] A consensus was forming. More and more, the word "unprecedented" was on the tips of tongues.[259] The thunderstorms were frightening and deadly; both people and animals were stunned, injured, and even killed by the accompanying lightning.

The prevalence of thunderstorms throughout the summer of 1783 was exceptional. Even though they began prior to the Laki eruption, it is possible that the significant volume of volcanic particles injected into the atmosphere influenced circulation patterns and therefore increased the frequency of the thunderstorms.[260] Rudolf Brázdil and his colleagues attest that the Laki eruption had three "weather effects": the dry fog, the redness of the sun and moon, and the heavy thunderstorms that were sometimes characterized by a lack of rain.[261] Having studied the arguments of the natural scientists, Oliver Hochadel concludes that a causal connection between the dry fog and the thunderstorms is possible, even likely.[262] While scientists today have not yet firmly established a definite connection between the dry fog and the thunderstorms, in 1783, some could not be convinced otherwise. A correspondent in Brieg, Silesia, suggested: "The extraordinarily foggy weather, which has amazed almost all of

256 Berlinische Nachrichten, 25 September 1783: 890: Report from Zweybrücken, 6 September 1783. "Seit undenklichen Jahren hat dieses Land nicht mehr Schaden von Donnerwettern erlitten, als im gegenwärtigen."

257 Königlich Privilegirte Zeitung, 10 July 1783: 679: Report from Mannheim, 29 June 1783. "Die Blitze und Schläge, welche das Gewitter hat, sind nicht erschrecklich genug zu beschreiben; denn sie waren von den gewöhnlichen ganz unterschieden, fürchterlich, und dem Menschen fast unerträglich, die Blitze weißflammend, die unaufhörlichen Schläge rasselnd und knallend, als wenn stets tausend Granaten ins Kreuz und in die Quere auf einmal in der Luft zersprängen, wodurch die Grundfeste unaufhörlich zitterte, und sich alles bewegte."

258 Königlich Privilegirte Zeitung, 17 July 1783: 700: Report from Dillenburg, 2 July 1783. "Bey einem [Gewitter] sahe man keine Blitze auch keine gewöhnlichen Gewitterwolken, aber desto stärker war der betäubende Donner."

259 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Mannheim, 1 July 1783. "Alle Nachrichten stimmen überein, daß das Knallen der Donnerschläge so erschrecklich gewesen, dergleichen noch nie gehört worden."

260 Schlesische Privilegirte Zeitung, 14 June 1783: 714: Report from Halberstadt, 1 June 1783. "Eines solchen Wetters können sich auch die ältesten Menschen bey uns nicht erinnern!"

261 Brázdil et al. 2017: 148, 160.

262 Hochadel 2009: 56–57.

Germany, has also conquered the horizon here and caused thunderstorms on an almost daily basis."[263]

When comparing the dates of the thunderstorms reported at the different weather stations of the Societas Meteorologica Palatina, it becomes apparent that either one large storm lurched across Europe, affecting several areas, or many individual storms occurred simultaneously in separate locations. Between May and September 1783, of all the European cities with weather stations, Rome saw the most thunderstorms, with 40. Padua saw the second most, with 39. Prague and Sagan drew for third, with 32 each.[264] During the summer of 1783, Reverend Karel Bernard HEIN recorded 17 days with thunderstorms between June and August in the Moravian town of Hodonice, the highest number among his observations during the 1780s.[265]

In England, Gilbert WHITE was delighted with the thunder and accompanying deluge of rain that fell upon Selbourne on 14 and 20 June 1783. This "growing weather" undid the damage of the frost a month previous. The "well soaked" ground brought welcome shoots of green to the withered landscape.[266] Soon, however, the color of his reports changed. The storms passed, and the ensuing summer heat left Selbourne parched. Even on 2 July 1783, when "Great thunder-shower[s]" descended upon Britain, Selbourne remained dry.[267] On 26 and 31 August 1783, WHITE wrote enviously about "tremendous thunderstorm[s] in London."[268] His brother, Henry WHITE (1733–1788), rector of Fyfield, also kept a journal. Throughout June and July 1783, he witnessed and documented several powerful thunderstorms.[269]

Reports about damage caused by lightning strikes were plentiful throughout the summer of 1783.[270] In some German newspapers, almost every article dealt with the weather in one form or another.[271] Near Mannheim, trees had been "cut to bits."[272]

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263 Königlich Privilegirte Zeitung, 2 August 1783: 749: Letter from a friend in Brieg [today's Brzeg in Poland], 23 July 1783. "Die außerordentlich neblichte Witterung, welche fast ganz Deutschland in Verwunderung gesetzt, hat auch den hiesigen Horizont eingenommen, und fast täglich Gewitter verursacht." David MCCALLAM (2019: 214) has argued that the volcanic gases increased the humidity and air temperature and thus triggered violent electrical storms.

264 Societas Meteorologica Palatina 1783.

265 BRÁZDIL et al. 2017: 153.

266 Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 126–127.

267 Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 129.

268 Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 138–139.

269 Henry WHITE, Diaries of the Rev. Henry WHITE, Rector of Fyfield, county Southampton, brother of Gilbert WHITE, 1783, Add MS 43816, British Library, London, UK.

270 For an overview of the damage done in different regions in Europe, see DEMARÉE, OGILVIE 2001: 621–622.

271 Such as this one: Königlich Privilegirte Zeitung, 17 July 1783: 700–702.

272 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Mannheim, 1 July 1783. "Zu Eistadt zerschlug ein Blitzstrahl einen Weidenbaum kurz und klein."

In Tönning, on the North Sea, a thunderstorm was briefly confused with an earthquake. In their newspaper report, the anonymous correspondent quickly concedes that "perhaps the houses have only been shaken by the thunderclaps and the whirlwind."[273] In Rendsburg, also in northern Germany, a severe thunderstorm and another unusual whirlwind occurred on 31 August 1783, during which lightning struck a church tower and a farm; 1,000 broken trees lay about the forest in its aftermath.[274]

The spires of the tallest buildings proved threatening to all and sundry that summer.[275] In the Westerwald region, lightning struck a church tower setting it aflame. Quick-thinking locals promptly doused the flames.[276] Unfortunately, people did not always display this presence of mind; in Dresden, a bolt of lightning set the castle on fire, which quickly spread to nearby buildings reducing them to ashes.[277] On 27 June 1783, Lautern in Swabia experienced "the most terrible thunderstorm," in which 46 sheep were killed as they huddled under a tree that was torn apart by lightning.[278]

Some of the most destructive and deadly lightning strikes were those that struck powder magazines; several newspapers tell of such incidents.[279] During a thunderstorm, a garrison and its surroundings were more or less sitting on a powder keg.[280] On 29 June 1783, in Klattau in Bohemia, lightning struck St. Adalbert's Church and set fire to the nearby armory, which naturally housed gunpowder. The place was blown to smithereens. Many were killed and injured.[281]

Less than a month later, on the afternoon of 19 July 1783, in Brieg, Lower Silesia, an artillery captain and a few of his men were on their way to transport "a large amount of gunpowder" into the newly built powder magazine when storm clouds began to gather in the sky. 350 *centner* [ca. 18 metric tonnes] of gunpowder already lay inside the

273 Königlich Privilegirte Zeitung, 19 July 1783: 708: Report from Holstein, 12 July 1783. "Zu Tönningen ist am 3. dieses [Juli], nachdem die Luft seit der Mitte des vorigen Monates sehr warm und mit vielen Dünsten angefüllt gewesen war, ein erschreckliches Gewitter mit Hagel, Wirbelwind gewesen, welches verschiedenemale eingeschlagen hat, und wobey einige eine Art eines Erdbeben bemerkt haben wollen. Vielleicht aber sind die Häuser durch die Donnerschläge und den Wirbelwind erschüttert worden."

274 Königlich Privilegirte Zeitung, 9 September 1783, 854–855: Report from Holstein, 31 August 1783.

275 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Mannheim, 1 July 1783; Berlinische Nachrichten, 31 July 1783: 705: Report from Döbeln, 21 July 1783.

276 Königlich Privilegirte Zeitung, 17 July 1783: 700: Report from Dillenburg, 2 July 1783.

277 Hamburgischer Unpartheyischer Correspondent, 6 September 1783: Report from Saxony, 31 August 1783.

278 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Lautern, 29 June 1783. "Am 27. dieses [Juni] Nachmittags um 2 Uhr hatten wir das fürchterlichste Gewitter, das man jemals hier gesehen hat." The thunderstorm in Lautern was also reported in Gazette van Gent, 17 July 1783: Report from Frankfurt, 11 July 1783.

279 Schiffer 2003: 184.

280 Hochadel 2003: 143.

281 Königlich Privilegirte Zeitung, 15 July 1783: 694: Report from Prague, 3 July 1783; Brázdil, Valášek, Macková 2003: 312. Klattau is today's Klatovy in the Czech Republic.

building.[282] As the sky darkened further, the men closed all the magazine's openings and retreated to a field some distance away. A lightning bolt struck the building but miraculously did not set the gunpowder on fire.[283] An explosion at a garrison could be enormous. On the Italian island of Gorgona, another powder magazine exploded during a lightning strike, which blasted off a part of the fortification; 35 kilometers away on the Italian mainland, residents of Livorno felt the shockwaves of this blast and thought it was an earthquake.[284]

Newspapers shared many stories of people who lost their lives during thunderstorms. Around 10 July 1783, an anonymous correspondent wrote: "In Pilsen, lightning struck a church tower and killed some of the people who, at the time, were ringing the bells."[285] A report from Langensalza on 31 July 1783 graphically described how a similar fate befell a child who was killed and left burnt, with a black tongue and blood running from his nose.[286] In the Holstein region in northern Germany, two female farm workers died during a thunderstorm on 31 August 1783.[287]

While it seemed all were at the mercy of the freakish weather, a pattern was emerging. During a thunderstorm in Hanau, a church tower was struck by lightning. Fortunately, those in the bell tower were only struck down and stunned. An anonymous newspaper correspondent expressed the following desire: "One wishes that the ringing of bells during thunderstorms would be prohibited and that only at the beginning of the thunderstorm would there be a sign for prayer given by the bell."[288] Church towers were often the highest point in the surrounding area and had metallic spires; lightning would strike here first. As early as 1745, German philosopher and theologian Peter Ahlwardt warned in his book, *Reasonable and Theological Considerations about Thunder and Lightning*, that one should not seek refuge in or near a church during a storm.[289]

So, why would anyone be in a bell tower during a thunderstorm? In 1783, in many regions in German-speaking countries, the custom of ringing church bells to avert thunderstorms was still widespread. In the German Territories, this practice

282 In Prussia, a centner was 51.448 kilograms (before 1818); Verdenhalven 2011: 65.

283 Königlich Privilegirte Zeitung, 2 August 1783: 749–750: Letter from a friend in Brieg, 23 July 1783.

284 Hamburgischer Unpartheyischer Correspondent, 5 August 1783: Report from Italy, 20 July 1783.

285 Hamburgischer Unpartheyischer Correspondent, 18 July 1783: Report from Prague, 10 July 1783. "Zu Pilsen traf es den Pfarrkirchthurm, und tödtete von 10 bey dem Gewitter läutenden Personen 6 auf der Stelle." Pilsen is today's Plzeň in the Czech Republic.

286 Berlinische Nachrichten, 12 August 1783: 745–746: Report from Langensalza, 31 July 1783.

287 Königlich Privilegirte Zeitung, 9 September 1783: 854–855: Report from Holstein, 31 August 1783.

288 Königlich Privilegirte Zeitung, 17 July 1783: 700: Report from Hanau, 8 July 1783. "Man wünschet, daß das Läuten unter den Hochgewittern abgestellt, u[nd] in Zukunft beym Anfange derselben das Zeichen zum Gebeth mit einer Glocke gegeben werde."

289 Ahlwardt 1745; Seckel, Edwards 1984.

was referred to as *Wetterläuten*.[290] The belief was that if the bell ringer rang the bells furiously, ideally while praying, the sound would divert the thunderstorm. Many church bells from the fifteenth century onward were inscribed with the phrase *Vivos voco. Mortuos plango. Fulgura frango*, which translates as "I call the living. I mourn the dead. I break lightning." Compounding the problem was the fact that if a bell ringer died during a storm, the incident was concealed from the public, interpreted as divine punishment, or put down to neglect on the bell ringer's part.[291]

Ringing the bells and praying were the most common protection strategies employed to avert thunderstorms. While bell ringing was most prevalent among Catholics, it also existed in Protestant areas.[292] One real benefit of the practice was that it warned all within earshot of an approaching storm.[293] The idea that the ringing of a bell could avert a storm stemmed from the pre-Christian tradition of using it to drive off the God of thunder, Donar, or Thor.[294] The sacristan or members of the community that rang the church bells to prevent thunderstorms received a wage or grain for their services. The possibility of an additional income helped preserve the practice.[295]

The people of the early modern period interpreted thunderstorms in two ways. First, as a form of retribution from God. Thunder was His (angry) voice, and lightning His tool of divine punishment.[296] Second, in contrast to the first, as an expression of a good and loving father who blessed His people: storms cleared the air of haze and provided the fields and gardens with rain.[297] Ulrich Bräker, a farmer and writer from Switzerland, regarded thunderstorms as "God's punishment from beyond the clouds" and believed that they had a more significant influence on people than the words of "a thousand preachers."[298]

By the autumn of 1783, many were calling for the abolishment of "weather ringing." This movement was undoubtedly brought about by a broader awareness of the dangers. On 11 July 1783, the *Münchner Zeitung* posed the question: "Would a human

290 The practice of using noise to fend off evil goes back to the ninth century: A sermon delivered between 822 and 825 by the monk Hrabanus Maurus addressed the common belief that noise or the throwing of projectiles toward the moon during a lunar eclipse could prevent monsters from swallowing the moon; Haarländer 2006: 152–153. I thank Stephan Ebert for this information.

291 Rosinski 2006: 19.

292 Hochadel 1999: 143–144; Hochadel 2009: 51, 61.

293 Missfelder 2009: 88–89.

294 Dross 2004: 287.

295 Münchner Zeitung, 25 July 1783: 460; Rosinski 2006: 11–13.

296 Psalm 50:3–4: "Our God comes and will not be silent; a fire devours before him, and around him a tempest rages. He summons the heavens above, and the earth, that he may judge his people."

297 Schelhorn 1783: 2; Begemann 1987: 87; Briese 1998: 46–47; Missfelder 2009: 90.

298 Böning 1998: 108–109.

be unchristian if – after so many sad examples of the harmfulness of ringing the bells – this misuse would be put under tighter restrictions?"[299] Soon, a new invention would prove itself up to the task of providing protection for villages and towns across Europe and beyond from the perils of lightning.

Beginning in the late 1740s, Benjamin FRANKLIN endeavored to prove that lightning strikes were electrical discharges.[300] In May 1752, the first lightning rod, also called the Franklin rod, was realized in Marly-la-Ville, near Paris. This rod proved that lightning could be harnessed with technical means.[301] Had the news of this experiment reached FRANKLIN in time, he would not have had to conduct his famous and very risky kite experiment during a thunderstorm, which took place in the summer of 1752.[302] FRANKLIN's experimentations with electricity inspired many naturalists around the world to follow suit.[303]

Lightning rods were not an immediate success. In the German Territories, the first lightning rod, also referred to as a *Wetterstange* (weather stick), was installed on St. James' Church in Hamburg in 1770. Very few additional installations followed.[304] Historian Christa MÖHRING estimates that the widespread acceptance of the lightning rod in Germany and Europe occurred between 1780 and 1800.[305] In southern Germany, the Societas Meteorologica Palatina's secretary Johann Jakob HEMMER was the main proponent of the lightning rod; he personally installed as many as 150. He invented a lightning rod with five tips, the first of which he installed in 1776. In the same year, Charles Theodore ordered that all castles and powder towers in the Palatine region be equipped with the device. Over the next few years, HEMMER's five-tipped lightning rod became increasingly popular. When lightning struck it, the tips would fall off, and it had served its purpose. The idea behind the five-tipped design was to prove its functionality. Once lightning struck, an assessment was made: the first indicator was, of course, that the building had not been set on fire. The second

299 Münchner Zeitung, 11 July 1783: 428. "Wäre wohl der Mensch unchristlich, wenn man nach so vilen traurigen Beispilen von der Schädlichkeit dises Läutens dem lange der gewohnten Misbrauch engere Schranken bestimmte?"

300 FRANKLIN 1751; COHEN 1990: 82; HOCHADEL 2003: 145; SCHIFFER 2003: 161–162; MÖHRING 2005: 54–58. E. Philip KRIDER (2004: 1) puts 1746 as the year in which FRANKLIN and his colleagues started to experiment with electricity after they had seen some demonstrations of the phenomenon in Europe in the 1740s.

301 FRANKLIN 1751; COHEN 1990: 72–76; HOCHADEL 1999: 142; SCHIFFER 2003: 188; KRIDER 2004: 4–5; HOCHADEL 2005: 301; MÖHRING 2005: 12.

302 COHEN 1990: 67, 73; KRIDER 2004: 5; KRIDER 2006: 42.

303 WEIGL 1987: 13; BRIESE 1998: 22–23; MÖHRING 2005: 83–105; WEYER, KOCH 2006a: 93. In 1754, in Bohemia, Prokop DIWISCH had invented a lightning rod independent of FRANKLIN; BORNEMANN 1878.

304 WEIGL 1987: 12; MÖHRING 2005: 140–141 (Hamburg).

305 MÖHRING 2005: 123.

indicator was finding one of the splintered tips; this proved that the rod had protected the building by providing a low resistance path to the ground for the electrical current.[306]

When a rod successfully grounded a lightning strike, it often made the news.[307] Sometimes, lightning rods proved their worth right away. One such success story occurred on 28 June 1783 in Mainz, when a lightning rod, installed only six weeks earlier, saved a building during a "very terrible thunderstorm."[308] On that very same day, in Düsseldorf, a similar story unfolded: "The lightning launched onto the weather sticks [lightning rods] atop of two powder towers and happily ran down the lightning rods into the ground. Besides God, we have to thank these weather sticks for preserving the large barracks and the city as a whole."[309]

In France in 1783, many people awaited the outcome of a court case debated at the appeals court of Artois: Charles Dominique DE VISSERY de Bois-Valé, from nearby St. Omer, was appealing the decision of the local authority, which had ordered him to remove a lightning rod that he had installed on top of his chimney three years earlier. DE VISSERY, a lawyer and amateur physicist, complied but took the local authority to court. A lengthy three-year legal battle ensued. The junior lawyer Maximilien ROBESPIERRE (1758–1794), a future politician, a proponent of the Enlightenment, and one of the best-known figures of the French Revolution, made a name for himself by representing DE VISSERY in court.[310] The case was important; its outcome would determine the relationship between science and legal authority for years to come. ROBESPIERRE argued for reason and science, to which humanity's welfare, he suggested, was indebted.[311] Finally, on 31 May 1783, the court ruled for the plaintiff and for the reinstallation of the lightning rod, which occurred two months later.[312]

This trial certainly brought the debate about lightning rods into the public eye. It did much to soothe the public's concerns about the safety of these instruments; even so, widespread adoption was not immediate. The ponderous pace of adoption meant

306 KLEMM 1969: 510; HOCHADEL 1999: 142, 146; HOCHADEL 2003: 145, 147; HOCHADEL 2009: 61.

307 Berlinische Nachrichten, 9 September 1783: 336–337: Report from Munich, 14 August 1783.

308 Münchner Zeitung, 7 July 1783: 414.

309 Königlich Privilegirte Zeitung, 17 July 1783: 700: Report from Düsseldorf, 28 June 1783. "[. . .] der Blitz stürzte sich auf die Wetterstangen zweyer Pulverthürme und lief an den Ableitern glücklich in die Erde herunter. Nächst Gott haben wir die Erhaltung der großen Kaserne und überhaupt der ganzen Stadt, diesen Wetterstangen zu danken."

310 DROSS 2004: 289.

311 WEIGL 1987: 30–31; RISKIN 1999.

312 FRANKLIN 2011: 352–353. A detailed account of this trial can be found in RISKIN 1999; RISKIN 2002.

many continued to suffer.[313] Severe thunderstorms hit Paris on 2, 3, and 15 July 1783, with 14 strikes in one region and four lives lost.[314] Even the Palace of Versailles was struck by a bolt; the Palace's roof was damaged, and falling debris killed some horses.[315] On 21 July 1783, Bethia ALEXANDER (1757–1839), daughter of merchant William ALEXANDER, reached out to Benjamin FRANKLIN, requesting his advice on how to protect her residence in France against a lightning strike. She implored him to hurry with his response; her urgency clearly sprung from the numerous severe thunderstorms terrorizing the country. She writes, "Do hurry, [. . .] because if you delay, and if a lightning bolt should lack the decency to wait until the answers arrive, you will be filled with remorse."[316] FRANKLIN did respond to the request and sent instructions on how to install a lightning rod or *paratonnere*.[317]

In Britain, buildings were struck by lightning and set ablaze, which often affected the crops on the fields and the livestock in the barns.[318] It seems that the much-needed rain overshadowed the destruction, and the storms were viewed more as relief from the excessive heat than as a threat; this despite the fact that the *Gentleman's Magazine* reported in July 1783 that "the thunder has been more alarming, and the lightning more fatal, during the course of the present month, than has been known for many years [. . .]."[319] The first lightning rod on an English church was erected in 1762, with one added to the spire of St. Paul's Cathedral in London in 1768.[320] In general, however, the rate of uptake was as slow in Britain as it was in France and the German Territories. The American declaration of independence in 1776 did not help matters; the "'Franklin rods' were more than ever abhorred by a multitude of persons, learned and unlearned."[321]

Many European sovereigns endorsed lightning rods, ostensibly for the welfare of their subjects; this endeavor also served to portray them as a monarch of the Enlightenment.[322] In July 1783, Mainz enacted a decree to this effect; Bavaria followed in August,

313 Meiningische Wöchentliche Zeitung, 26 July 1783: 120: Report from Frankfurt, 18 July 1783.

314 FRANKLIN 2011: 352–353. The Mercure de France, 28 December 1782: 188–189, reported on the installation of the first lightning rod in Paris.

315 Edinburgh Advertiser, 29 July 1783; BRAYSHAY, GRATTAN 1999: 183.

316 FRANKLIN 2011: 352: Excerpt from a letter from Bethia ALEXANDER to William Temple FRANKLIN.

317 FRANKLIN 2011: 354: Letter written some time after 21 July 1783.

318 BRAYSHAY, GRATTAN 1999: 183.

319 Gentleman's Magazine, July 1783: 621 (quote); James WOODFORDE, Weather Diary for Weston Longville, Norfolk, vol. 10: 1782–1784, MET/2/1/2/3/467, National Meteorological Library and Archive, Met Office, Exeter, UK, July and August 1783.

320 MÖHRING 2005: 272–273.

321 ANDERSON 1880: 42.

322 HOCHADEL 2009: 54.

Prussia in September, and Austria in November.[323] Paris followed in 1786.[324] In Spain, the practice of bell ringing continued until the 1850s, and in Upper Swabia, bells were still rung "to drive away the hail and prevent damage by lightning" as late as the 1860s.[325] It was the German Territories that paved the way for the lightning rod's breakthrough. It is unclear how many lightning rods were installed in 1783 here, but it was definitely no "average" year.[326]

Some regions had abolished the ringing of bells against thunderstorms before 1783. The many storms of the summer most likely accelerated legislative processes that had already been underway.[327] Newspaper reports often mention the presence of the sovereign or ecclesiastical officials during the installation of a lightning rod, almost certainly to bolster support for the invention.[328] Even after lightning rods were installed, people still rang the bells, both as a signal for prayer (at the beginning and during the thunderstorm) and (at the end) as a sign of gratitude.[329] The purpose of the bell ringing had changed but, unfortunately, the risks remained.

Earthquakes in Europe and Beyond

The powder magazine explosion on the Italian island of Gorgona that some thought an earthquake was not a singular occurrence. Throughout the summer of 1783, many phenomena were mistaken for earthquakes, be they thunderstorms, lightning strikes, or hailstorms; even the smallest tremor would be much discussed (Figure 36).[330]

On 1 July 1783, the *Berlinische Nachrichten* printed a report about a thunderstorm in the Silesian town of Schweidnitz on 22 June 1783 that some residents swore was an earthquake.[331] On 4 July 1783, the *Hamburgischer Unpartheyischer Correspondent* commented further on the Silesian region's woes with details of strong rainfall, damaged

323 Hochadel 1999: 143–144; Brázdil, Valášek, Macková 2003: 311–312; Hochadel 2003: 148; Dross 2004: 293; Hochadel 2009: 54.

324 Seckel, Edwards 1984.

325 Cohen 1990: 124.

326 Dross 2004: 289–291; Hochadel 2009: 53–54. Lightning rods were much discussed in the media even before the dry fog of 1783 made an appearance in the newspapers: a rather detailed debate on the lightning rod can be found in the Frankfurter Staats-Ristretto, 28 June 1783: 425, and 1 July 1783: 433–434.

327 Hochadel 2009: 52.

328 Hochadel 1999: 147, 161, 167.

329 Münchner Zeitung, 7 August 1783: 485.

330 Vermij 2003: 234; Reith 2011: 81.

331 Berlinische Nachrichten, 1 July 1783: 605: Report, 25 June 1783. Similar reports can be found in the Königlich Privilegirte Zeitung, 1 July 1783 and the Hamburgischer Unpartheyischer Correspondent, 4 July 1783. Schweidnitz is today's Świdnica in Poland.

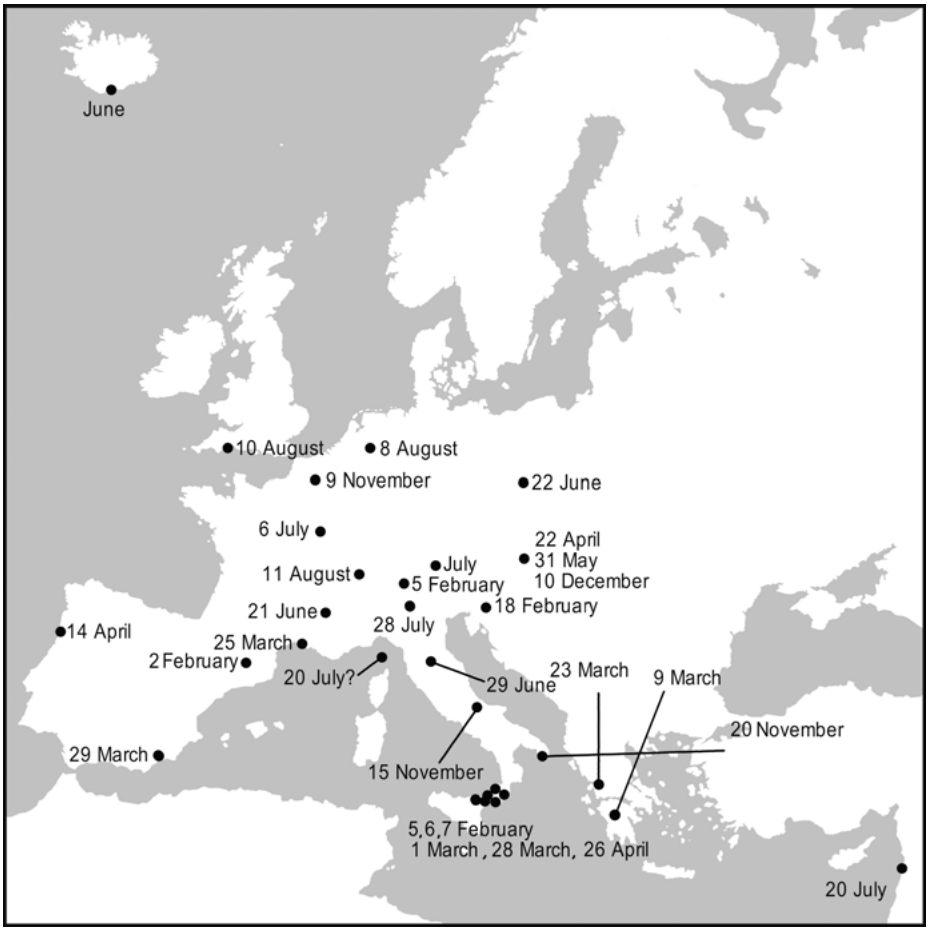

Figure 36: Earthquakes in Europe in 1783.

bridges, tumbled chimneys and cracked walls, and thunder so strong that it "was indistinguishable from an earthquake."[332] One week later, the same newspaper reported on another thunderstorm, this time near Glatz, detailed in letters they had received from Mittenwald. The letters also informed them about tremors at the mountains of Spitzberg and Schwarzberg, both in Lower Silesia. Miners in the coal pits near the Gottesberg "heard such a strong subterraneous roar" that they were compelled to flee for fear

332 Hamburgischer Unpartheyischer Correspondent, 4 July 1783: Report from Schweidnitz, 25 June 1783. "Verwichenen Sonntag, den 22sten dieses [Juni], ist im Glatzischen ein so entsetzliches Donnerwetter gewesen, daß man es von einem Erdbeben nicht hat unterscheiden können."

of the consequences.[333] Today we know that these were most probably violent thunderstorms, misinterpreted. Seismologist Günter LEYDECKER's earthquake catalog for Germany between 800 and 2008 does not list any earthquakes between April 1783 and March 1784; that said, it is incomplete.[334] The seemingly frequent earthquakes of 1783 rattled contemporaries in more ways than one. The fear of earthquakes was real even if, in some cases, the earthquakes themselves were not.

The map (Figure 37) shows the probability of earthquakes occurring in different parts of Europe. Within the German Territories, it becomes apparent that some regions are more prone to earthquakes than others (Figure 38). The area of the Rhine Rift Valley from Basel in Switzerland to the Low Countries, particularly the Cologne Lowland area, has seen some strong earthquakes in the past. One example is the 1756 Düren earthquake. Other areas in Germany with increased seismic risk are those north of the Alps, around Lake Constance and Swabia, and the Vogtland region in eastern Germany. These intraplate earthquakes are caused by the Alpine orogeny, the formation of the Alps by way of the African Plate moving northward into the Eurasian Plate. Intraplate earthquakes, as the name suggests, take place some distance away from continental margins. They are less frequent and often weaker than interplate earthquakes, which occur at plate boundaries. Seismologists estimate that an earthquake with a magnitude of up to 6.4 on the Richter scale is theoretically possible for the Lower Rhine Graben.[335]

The news of the Calabrian earthquakes and their disastrous consequences still dominated the headlines during the summer of 1783.[336] Aftershocks continued throughout the

333 Hamburgischer Unpartheyischer Correspondent, 11 July 1783: Report from Silesia, 6 July 1783. "Eben so haben sich im Mittenwaldischen [Mittenwalde near Glatz, today's Kłodzko in Poland] an den Bergen Spitzberg und Schwarzberg Spuren einer Erderschütterung gezeiget, und in den Kohlengruben bey Gottesberg ist ein so starkes unterirdisches Getöse gehöret worden, daß die Arbeiter aus den Schachten, aus Furcht vor den Folgen, weggegangen sind." For more information on the geography of the region, see Weigel 1803, 105. A similar account can be found for miners in Düsseldorf, who complained that the "Earth vapors" (*Erddämpfe*) prevented them for working: the dry fog made it even darker in the mines, and they heard loud roars underground; Münchner Zeitung, 14 July 1783: 430: Report from Düsseldorf, 28 June 1783.

334 LEYDECKER 2011: 62–63: Between 18 February and 12 April 1783, there were six earthquakes with magnitudes between 4.0 and 5.0. It was recorded at Kraslice (Graslitz in German) in today's Czech Republic. For more information on earthquakes also felt in Bavaria, see GIESSBERGER 1922; GIESSBERGER 1924. John E. EBEL illustrates in his book that most earthquake catalogs not only list real historical earthquakes but also earthquakes that most likely never took place. Either the person who was responsible for the catalog misinterpreted a report, or they misinterpreted an old-style date with a new-style date. He points this out in his chapter "1658: The Earthquake That May Have Never Happened," EBEL 2019: 46–50.

335 HINZEN, REAMER 2007: Based on a 300-year catalog of earthquakes in the northern Rhine region, the authors of this study assume an earthquake with a maximum magnitude of 7.0 is possible here.

336 Even as late as 4 September 1783, the Münchner Zeitung reported that there were still "rather severe shocks of earthquakes" felt in Italy. These particular earthquakes had occurred on 29 and 30 July 1783; Münchner Zeitung, 4 September 1783: 550.

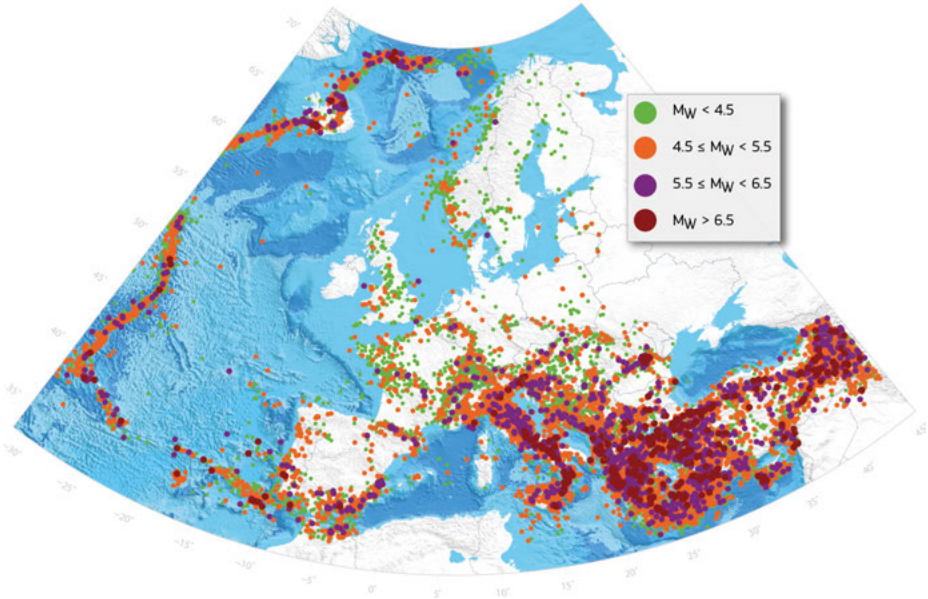

Figure 37: Earthquake history in Europe. This map shows the distribution of over 30,000 earthquakes with magnitudes larger or equal to 3.5 between 1000 and 2006.

summer, frightening locals and those who read the newspapers in faraway towns and cities.[337]

On 21 June 1783, an earthquake occurred in Belledonne near Lyon with a moment magnitude of 3.9.[338] In Florence, on 29 June 1783, at 4:30 a.m., "another weak earthquake" occurred.[339] In July 1783, there were reports about an earthquake in Austria.[340] On 6 July 1783, a notable earthquake was felt over a wide area in eastern France and Switzerland: specifically in Franche-Comté, Burgundy, the Jura, and Geneva. A letter from Dijon dated 7 July 1783 and printed in the *Gazette van Gent* shared some details about the earthquake and suggested a connection to the dry fog: "[. . .] while the atmosphere was covered with a thick fog, as was usual, an earthquake was felt from the east

337 Epp 1787: 30.

338 SHEEC: Belledonne Earthquake, 21 June 1783; Quenet 2005: 541. Today, moment magnitude is used to describe medium and large earthquake magnitudes. Smaller earthquakes are often measured in the local magnitude (Richter).

339 Hamburgischer Unpartheyischer Correspondent, 19 July 1783: Report from Florence, 30 August 1783; Königlich Privilegirte Zeitung, 24 July 1783: 723: Report from Florence, 30 June 1783. "Gestern früh um halb 5 Uhr haben wir hier abermals eine leichte Erderschütterung verspürt."

340 Königlich Privilegirte Zeitung, 31 July 1783: 742: Report from Austria, 19 July 1783.

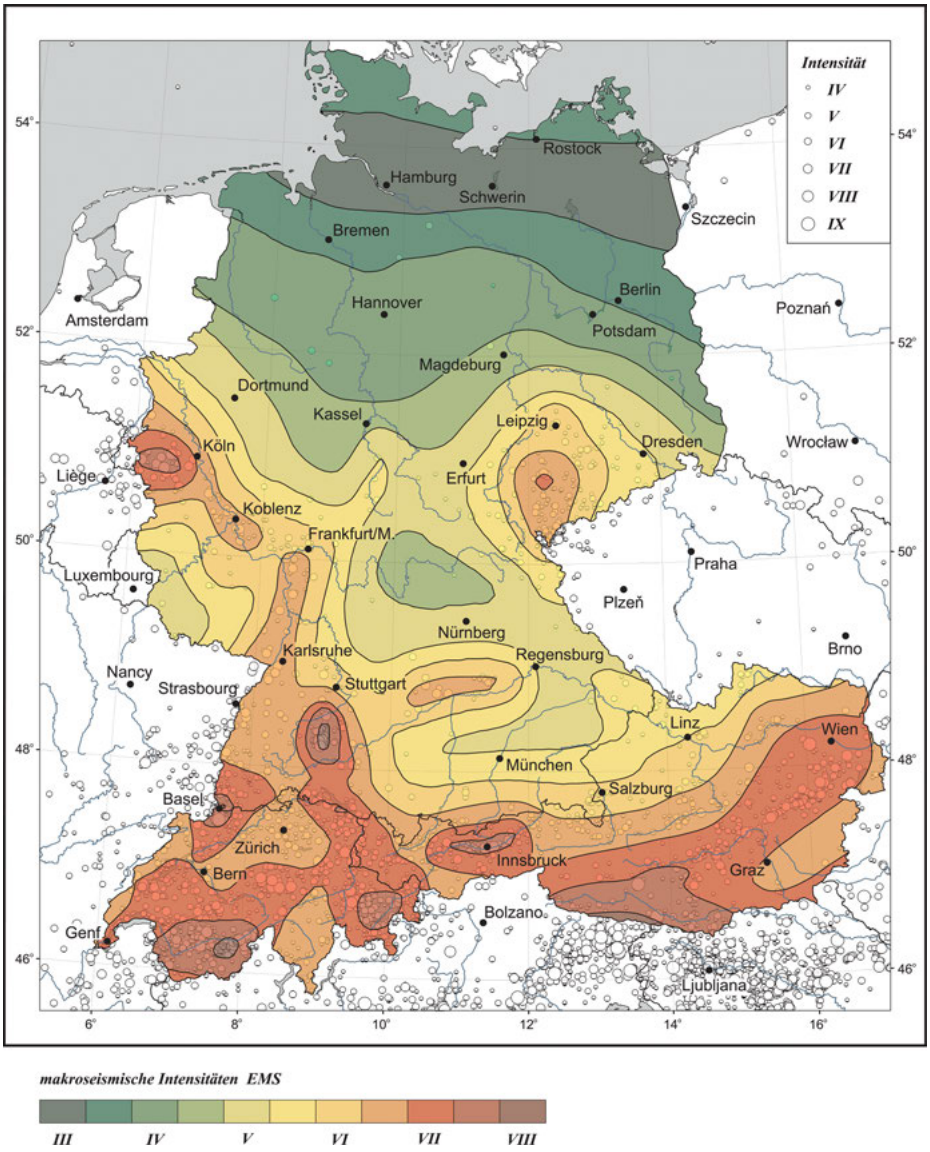

Figure 38: Earthquake risk in today's Germany, Austria, and Switzerland. GRÜNTHAL, Gottfried; MAYER-ROSA, D.; LENHARDT, W.: Abschätzung der Erdbebengefährdung für die D-A-CH-Staaten – Deutschland, Österreich, Schweiz. In: Bautechnik 75, no. 10 (1998), 753–767, here 764, Figure 6.

to the west, lasting three seconds."[341] In the affected areas, particularly in Beaune, glass windows were shattered, and "quite an amount of chimneys fell down."[342] Apart from these minor misfortunes, the area did not suffer much damage.[343] It is estimated that this earthquake originated in Vallée de l'Ouche, near Dijon, had a moment magnitude of 5.1, and reached an intensity of VI on the EMS-98 scale.[344] Another earthquake occurred in the early hours of 8 August 1783 at around 3 a.m. It shook western Germany, the Dutch Republic, and northern France, mainly between Aachen and Maastricht.[345] This month also saw mild tremors shake Devon in England.[346] On 11 August 1783, there was a 3.9-moment-magnitude earthquake in Lucerne, Switzerland.[347] A newspaper report concluded that "the whole of Europe is being haunted by this terror."[348] The sheer number of these rather weak earthquakes significantly increased the magnitude of fear throughout Europe.[349]

Outside of Europe, one significant seismic event occurred near Tripoli, Lebanon, on 20 July 1783.[350] News of this reached Europe in October 1783, with reports emphasizing the fact that this event in the Middle East had coincided with a dry fog.[351] With this news,

341 Gazette van Gent, 17 July 1783: Report from Dijon, 7 July 1783. "[. . .] terwyl de locht met eenen dikkeren mist, als na gewoonte, overdekt was, eene hevige aerdschuddinge van get oosten nae het westen had gevoelt, die dry seconden had geduert, [. . .]."

342 Münchner Zeitung, 25 July 1783: 459. "In Frankreich hat man kürzlich Erdbeben gespüret, wovon eine Menge Schornsteine abgefallen sind. Die Orte dises Vorfalls waren beinahe ganz Burgund, Bresse, Franchecomte, und das Genfer Gebiet, wo es am stärksten gespüret wurde" (quote). Damage in Beaune, particularly to glass windows and chimneys, was reported by the Gazette van Gent, 17 July 1783: Report from Dijon, 7 July 1783.

343 Demarée, Ogilvie 2001: 225.

344 SHEEC: Vallée de l'Ouche Earthquake, 6 June 1783; Quenet 2005: 541.

345 Demarée, Ogilvie 2001: 226; Quenet 2005: 541. That this earthquake occurred at 3 a.m. is reported in the Königlich Privilegirte Zeitung, 21 August 1783: 802: Report from Cologne, 10 August 1783. Note that this newspaper article falsely stated that the earthquake had occurred on August 9, not August 8. It is odd that this earthquake is not listed in the SHEEC database of the European Union.

346 Exeter Flying Post, 14 August 1783 (quoted after Grattan, Brayshay 1995: 6). This earthquake might have had a magnitude of 3.6 (Richter) and was documented on 10 August 1783 in Launceston, Cornwall. It was felt in parts of Devon and Cornwall; British Geological Survey 1989.

347 SHEEC: Luzern [Lucerne] Earthquake, 11 August 1783.

348 Berlinische Nachrichten, 18 September 1783: 686: Report from Paris, 4 September 1783. "Briefe aus Portugall melden, daß man in verschiednen Gegenden dieses Königreichs, am 6. Julius ziemlich heftige Erdbeben empfunden habe; eben dergleichen wird auch aus England und selbst aus Island berichtet; also ist das ganze Europa von diesem Schrecken heimgesucht worden."

349 Briese 1998: 97.

350 Journal historique et littéraire, 1 November 1783: 363.

351 Ambraseys 2009: 613. The earthquake in Tripoli was reported on in the Massachusetts Spy; Massachusetts Spy, 8 January 1784: Report from Tripoli, Syria, 30 July.

Europe became increasingly anxious about the meaning of the earthquakes in Calabria.[352] There were additional vague reports about "terrible earthquakes" from further away, such as in the Antilles, China, Japan, and the Philippines.[353]

Fever and Mortality

As summer turned to autumn, the people of Europe's health deteriorated significantly.[354] In England and France, burial rates were average in June and July 1783, but spiked in August and increased again in September.[355] A study by Claire WITHAM and Clive OPPENHEIMER has identified 1783/1784 as a "mortality 'crisis year'" in England.[356] GRATTAN and colleagues define a "crisis year," in this respect, as when mortality is "greater than 10 percent in excess of the moving 51-year mean."[357] Mortality crises were not unusual in the early modern period due to poor sanitation and infectious diseases that commonly made the rounds, but this was different.[358] WITHAM and OPPENHEIMER identified two distinct periods that show excess mortality, with one lasting from August to September 1783 and the other lasting from January to February 1784. Together, these two periods are estimated to have caused excess mortality of around 20,000 people in England alone. Overall, between July 1783 and June 1784, the mortality in England was 16.7 percent above average.[359]

Sabina MICHNOWICZ analyzed burial records for Dorset, Cheshire, Yorkshire, Northumberland, London, Manchester, and Whitehaven. The records for these regions reflect the complex relationship between environment and mortality; they indicate "that different areas displayed differing sensitivity to environmental influences."[360] The mortality crisis was rather heterogeneous, affecting some regions more than others. Bedfordshire, Leicestershire, and Worcestershire were among the most severely affected in 1783/1784.

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352 Journal historique et littéraire, 1 November 1783: 363. The Gazette van Gent, 17 July 1783: Report from Dijon, 7 July 1783 mentioned that the earthquake near Dijon "combined with the imagination of the Calabrian disasters had created a general fright among the inhabitants of Dijon." ("[. . .] welke aerdschuddinge, gevoegd by de verbeeldinge van de rampen in Calabrien, en by een alderschrikkelykste onderaedsch gedrys, eenen algemeynen schrik onder de Inwoonders van Dijon had verwekt.").

353 Berlinische Nachrichten, 2 August 1783: 715: Report from Paris, 19 July 1783 (Antilles); Berlinische Nachrichten, 26 August 1783: 791–792: Report from Versailles, 10 August 1783 (earthquakes in China, Japan, and the Philippines).

354 DEMARÉE, OGILVIE 2001: 237.

355 GRATTAN, DURAND, TAYLOR 2003: 406.

356 WITHAM, OPPENHEIMER 2004: 15.

357 WRIGLEY, SCHOFIELD 1989; GRATTAN, DURAND, TAYLOR 2003: 401 (quote).

358 GRATTAN, DURAND, TAYLOR 2003: 405.

359 WRIGLEY, SCHOFIELD 1989; WITHAM, OPPENHEIMER 2004: 15–16.

360 MICHNOWICZ 2011: 122. This topic was also researched by GRATTAN, MICHNOWICZ, RABARTIN 2007.

If these deaths were related to the volcanic emissions from the Laki eruption, it would mean that the eruption precipitated more deaths in mainland Europe than in Iceland.[361]

The mortality in the summer months of 1783 is highly unusual, as – under normal circumstances – summers are characterized by minimum mortality. Peak mortality can usually be observed in the spring, between March and April, with the lowest mortality generally occurring in the summer and early autumn months, depending on weather and harvest.[362] WITHAM and OPPENHEIMER pointed out that it was particularly striking that mortality peaked in September 1783, even exceeding that of January 1784 – the latter brought on by the severity of the winter.[363] The monthly mean temperature in England in July 1783 was 18.8 °C, about three degrees higher than average. The hot temperatures lasted roughly from 23 June to 20 July 1783, coinciding with the high-pressure system above Europe.[364] As became apparent during the summer of 2003, heat waves can be deadly in Europe. However, the heat wave was likely not responsible for the peak mortality in 1783 – as the onset of the mortality occurred after the heat wave had already passed.[365]

Several studies discuss the possible causes of the mortality crisis. One possibility is that the warm conditions might have raised the temperature of the soil and led to an increase in pests and so food contamination. Gilbert WHITE remarked that meat was inedible a day after the animal had been killed due to the heat and further complained about the presence of swarms of flies. The sultry conditions allowed mosquitoes to proliferate. Malaria was a problem in England at the time, mostly in areas with marsh and fenland. WITHAM and OPPENHEIMER argue that Kent, which usually saw the most deaths from malaria, did not experience a crisis in the summer of 1783, so perhaps blame cannot be laid on the mosquitoes.[366] Drainage schemes and better sanitation had made malaria less of a problem by the mid-eighteenth century.[367] Other diseases that might have caused the excess mortality include typhoid and dysentery, which spread relatively slowly and primarily affect babies and young children.[368] All of these diseases, together with the polluted air brought upon these people by the fog, likely exacerbated the problems caused by the harsh living conditions and so led to excess mortality.

In England, during August and September 1783, an "ague" or "fever" affected many people; the nature of this epidemic remains unspecified.[369] English poet William COWPER

361 MICHNOWICZ 2011: 118–119; 124.
362 WRIGLEY, SCHOFIELD 1989; GRATTAN, DURAND, TAYLOR 2003: 405.
363 WITHAM, OPPENHEIMER 2004: 18.
364 PARKER, LEGG, FOLLAND 1992; GRATTAN, CHARMAN 1994: 102; GRATTAN, SADLER 1999: 164–165.
365 WITHAM, OPPENHEIMER 2004: 19; CHARPENTIER 2011.
366 DOBSON 1980; DOBSON 1997; WITHAM, OPPENHEIMER 2004: 22–24.
367 EDWARDS 1998: xiv.
368 WITHAM, OPPENHEIMER 2004: 22.
369 WITHAM, OPPENHEIMER 2004: 20.

(1731–1800), who was based in Bedfordshire, wrote a letter on 7 September 1783 indicating that laborers suffering from fever were unable to work, which in turn affected the harvest. Naturalists from different parts of England commented on the "unhealthy season" and documented the several types of fever that were rampant.[370] WITHAM and OPPENHEIMER also argue that British soldiers returning from the American Revolutionary War might have brought diseases with them to which the English were not immune.[371] By September 1783, the dry fog had thinned; the eruptive phases that occurred throughout this month emitted much less sulfur dioxide than the earlier phases.[372] This comparatively small volume of sulfur dioxide, while not as harmful as the earlier blasts, could still have contributed to excess mortality, given that the people had been subjected to sulfur-laden air of varying potencies over the previous two months.

In Paris and the surrounding countryside, many suffered from different kinds of fever, which one anonymous correspondent assumed to be among the consequences of the extraordinary heat.[373] The records of the *Société Royale de Médecine* for 1783 reveal typhoid fever, diarrhea, dysentery, cholera, measles, pox, and sore throats were prevalent in August of that year.[374]

GRATTAN, RABARTIN, SELF, and THORDARSON conducted a study on mortality in France in 1783. They examined birth and burial records from four parishes in Loiret, 44 parishes in Seine-Maritime, and five parishes in Eure-et-Loir. They concluded that more people than usual died in France in August 1783, a number that increased further in September and October; during these months, the burial rate was 38 percent above average. Between August 1783 and May 1784, mortality was 25 percent above average; eastern France suffered the most.[375] Brittany in the northwest, and the regions of Eure-et-Loir in central France, achieved similar grim records. Normal levels of mortality were only seen again in May 1784.[376]

In the Austrian Netherlands, the Baron DE POEDERLÉ noticed that cases of dysentery greatly affected several provinces beginning in August 1783. By September, most had recuperated.[377] Some, including Mathias VAN GEUNS, a doctor from Harderwijk, Groningen, blamed the extraordinary heat and the dry fog.[378] The *Ephemerides* of the Bavarian Academy of Sciences and Humanities in Munich reported that during the dry fog, they did not hear of any increase in deaths or rampant diseases. Nevertheless, they "had to endure other menaces just like other kingdoms in Europe," referring to drought, heat,

370 GRATTAN, DURAND, TAYLOR 2003: 401, 405.
371 WITHAM, OPPENHEIMER 2004: 24.
372 THORDARSON, SELF 2003: 4, Figure 2.
373 Augsburgische Postzeitung, 11 October 1783: Report from Paris, 1 October 1783.
374 Société Royale de Médecine 1782/1783: 22–27; METZKE 2005.
375 GRATTAN et al. 2005.
376 SUTHERLAND 1981; RABARTIN, ROCHER 1993; GRATTAN, DURAND, TAYLOR 2003: 410; GARNIER 2011.
377 DE POEDERLÉ 1784: 342–344.
378 DEMARÉE, OGILVIE 2016: 141.

heavy downpours, and flooding.[379] Some cases of dysentery and typhoid fever affected people in the German Territories. Pox virus infections also presented a problem throughout the year, particularly in November and December 1783.[380] In Stuttgart, in September 1783, many of the city's young people contracted typhoid fever.[381] Reports of dysentery seem mostly absent from the German newspapers – perhaps due to local censorship.

Studies on excess mortality in the aftermath of the Laki eruption conclude that deaths rose by as much as 40 percent in England, France, and the northern parts of the Dutch Republic.[382] Further research analyzing birth and burial records for that time in other regions of Europe has yet to be conducted.[383] There can be no definite conclusion as to what might have caused this significant peak in mortality. While it is very likely the gases and particulate matter emitted by the Laki eruption were detrimental to the health of Europeans at the time, weakening the very young, the elderly, and the asthmatic, it is unlikely the sole cause of the widespread death that followed.

The End of the Fog

With some short interruptions, the dry fog lingered over Europe for much of the summer of 1783.[384] It was omnipresent and became conspicuous by its absence.

379 Bayerische Akademie der Wissenschaften 1783: 46. "Die Fruchtbarkeit war aller Orten überaus gesegnet. Alles Obst und Getreid hat außerordentlich gediehen. Man hat auch nirgend von Sterbefällen und grassierenden Krankheiten gehörtet. Doch mußten wir andere Landplagen erdulden, so wie andere Königreiche Europens."

380 Bayerische Akademie der Wissenschaften 1783: 104–109, "Kindsblattern" could refer to either smallpox or chickenpox.

381 Augsburgische Postzeitung, 30 September 1783: Report from Mannheim, 27 September 1783; Berlinische Nachrichten, 9 October 1783, 935: Report from Stuttgart, 21 September. Here the term *Gallenfieber* is used to describe typhoid fever; Metzke 2005: 60.

382 Demarée, Ogilvie 2016: 142.

383 Recently, Geoffrey Hellman (2021) carried out research using 1,500 parish registers from the British Isles and beyond, which contradicts previous findings.

384 Münchner Zeitung, 10 July 1783: 422: Report from Berlin, 5 July 1783. "Last Tuesday, during the night there were two thunderstorms, the latter one burnt down a few houses nearby. A strong wind came up yesterday, which changed the weather." "Am verfl[ossenen] Dienstage folgten endlich in der Nacht zwei Donnerausbrüche aufeinander, wovon der leztere im nahe gelegenen Dorfe Reustädtl einige Häuser einäscherte. Seit gestern hat ein stärkerer Wind die Witterung geändert." Königlich Privilegirte Zeitung, 9 August 1783: Report from Mannheim, 27 July 1783: Prematurely, an anonymous correspondent remarked, "the long-lasting sad fog is now completely gone. It was lost twice after a thunderstorm before [. . .]." "Der langwierige traurige Nebel ist nun völlig verschwunden. Da er sich 2mal nach einem Gewitter verlohren [. . .]." The dry fog returned, however, in Mannheim, a *vapor tenuis* was last mentioned on 5 October 1783. Societas Meteorologica Palatina 1783: 16.

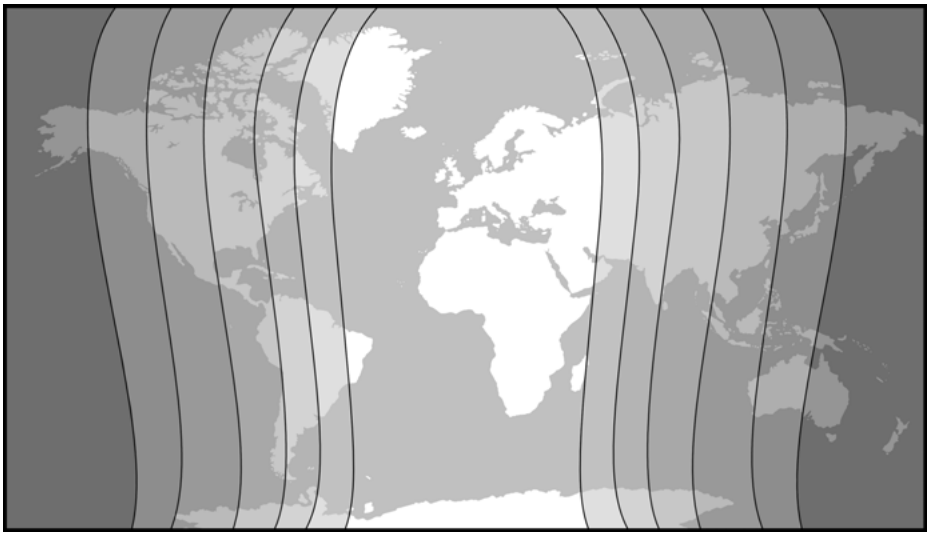

Figure 39: The total lunar eclipse of 10 September 1783. The white areas on this map show where the total lunar eclipse was visible, while gray areas illustrate partial visibility; in the dark areas, it was not visible.

Throughout Europe, a lunar eclipse was observed on 10 September 1783 (Figure 39).[385] That this lunar eclipse was visible is indicative of a significant decrease in the density of the dry fog by that time. In the German Territories, there was great interest in this celestial event.[386] In Berlin, Johann Esaias Silberschlag (1721–1791), a member of the Royal Academy of the Sciences in Berlin, observed and listed 10:40 p.m. as the time when the Earth's shadow first dimmed the moon and 11:39 p.m. as the moment when the moon was entirely eclipsed.[387] The *Münchner Zeitung* reported on the event, even though it was unobservable in Munich; this might have been due to cloud cover.[388] The eclipse was also witnessed in England and as far away as North America.[389] In Nain, a Moravian settlement in Labrador, Benjamin La Trobe (1764–1820) observed it through a

385 National Aeronautics and Space Administration (NASA), Five Millennium Catalog of Lunar Eclipses, −2000 BCE to 3000 CE: A–153.

386 Göttingische Gelehrte Anzeigen 1784, register, 53; Göttingische Anzeigen von gelehrten Sachen, 8 May 1784: 738.

387 Silberschlag 1784: 134–147.

388 Münchner Zeitung, 18 September 1783: 581.

389 It was observed from York, Pigott 1786: 410; and from Selbourne: Gilbert White, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 141; and from Kent, MacKay 1793: 166.

"smoky sky."[390] Reverend Manasseh CUTLER also observed the eclipse from Cambridge, Massachusetts.[391]

It is difficult to ascertain whether the records from October onward refer to the dry fog or a typical humid fog when they mention this kind of weather. In Regensburg, the last "thick fog" occurred on 19 August 1783. There are mentions of fog three times in September and occasionally in November; however, this was likely "normal" fog.[392] In Sagan, the last definite mention of a "fog, like smoke" was on 11 October 1783, with an ambiguous entry in the last days of that month.[393] The last mention of the *vapor tenuis* (fine haze) in Mannheim was on 5 October 1783.[394] In Scotland, where foggy weather is commonplace, there is mention of "a very uncommon fog" in Belmont Castle, Perthshire, that lasted until 31 August 1783. A "thick mist" is recorded on the first two days of October 1783, then again on 13 and 18 October. Once again, the entries are ambiguous.[395] Gilbert WHITE observed some haze and red sunshine on the first few days of September 1783. On 18 and 27 September 1783, he noticed a wet fog, which can confidently be presumed to be of a different origin from the "smoky" mist of the summer.[396]

THORDARSON and SELF created a map containing the last reported observations of the Laki haze across Europe that they found in their sources. Some of these dates are surprisingly late; a reported sighting of the dry fog in Copenhagen exists from as late as January 1784.[397] However, certainty is not guaranteed; the later mentions could very well be fogs typical of the season (Figure 40).[398]

390 Meteorological Observations at Nain & Okak at Labrador, Hudson's Bay Company, MA/143, Archives of the Royal Society, London, UK, here: 10 September 1783.

391 The Continental Journal and Weekly Advertiser, 27 November 1783: 2.

392 KÖNIG 1783, here: Regensburg.

393 Societas Meteorologica Palatina 1783: 346.

394 Societas Meteorologica Palatina 1783: 16.

395 James Stuart MACKENZIE, Weather Reports Journal of James Stuart Mackenzie at Belmont Castle, Perthshire, 1771–1799, RH4/100, National Records of Scotland, Edinburgh, UK.

396 Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 139–142.

397 THORDARSON, SELF 2003: 7.

398 One contemporary source from Austria mentioned that the fog was also present during phases of snowfall during the winter of 1783/1784, however, it is likely this was an occurrence of "normal" fog; STRÖMMER 2003: 208.

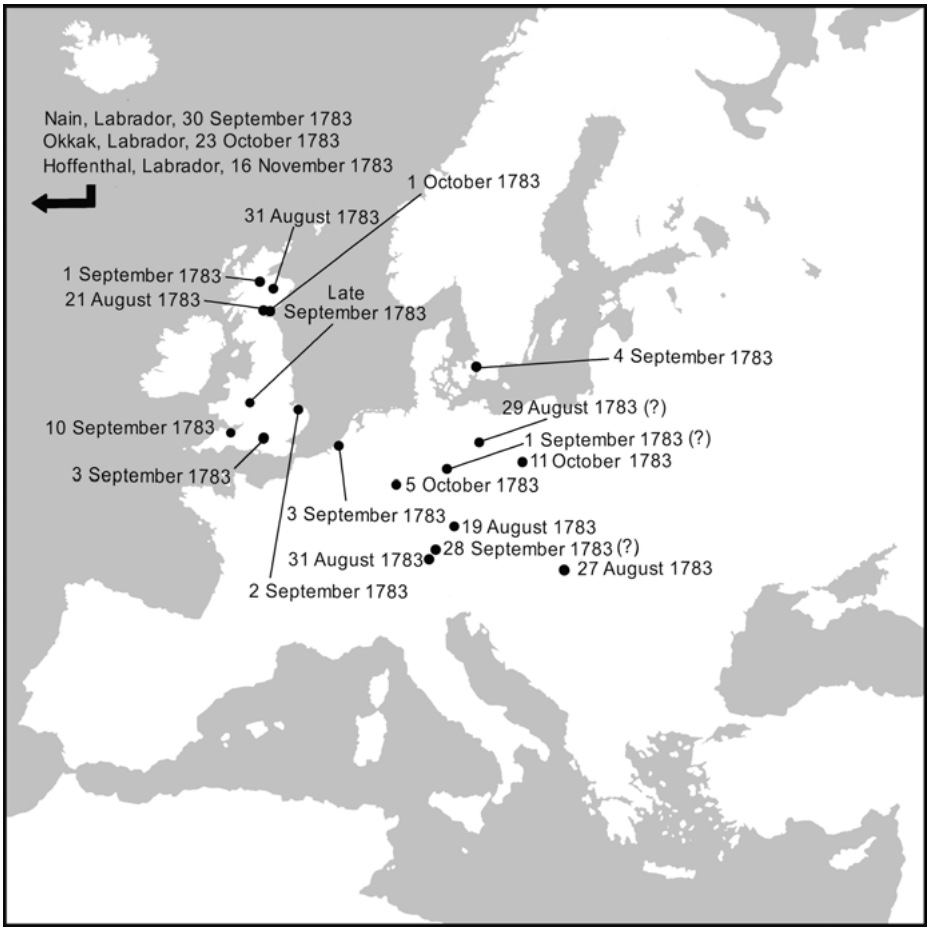

Figure 40: The last observed occurrence of the Laki haze, based on data compiled for this book.

The Harvest

With leaves abscised and vegetation withered and damaged, prospects of a good harvest seemed dim.[399] Newspaper reports from England, the German Territories, Norway, Sweden, France, Italy, and the Dutch Republic remarked that the condition of plant life made it seem as though winter had arrived early.[400] However, what came to pass defied the pessimistic outlook.

399 Demarée, Ogilvie 2001: 233.

400 Grattan, Pyatt 1994; Grattan, Brayshay, Sadler 1998; Thordarson, Self 2003; Thordarson 2005: 214.

A report from late June found that the fields and vineyards around Vienna showed "such an abundance of grapes that we cannot remember such fertility in recent years."[401] Many surmised that the dry fog and the fertility were directly related. A correspondent from Stuttgart interviewed a vinedresser about the dry fog: "I don't know where it is from, the naturalists may decide that, but I can assure you that the weather is magnificent. [. . .] Thank the Lord for blessing us with such a good year." All was well, and the interviewer concluded, "May the populace in the cities and villages become smart from the old vinedresser's comments, be grateful to the Lord, and stop asking ridiculous and useless questions [. . .]."[402]

In mid-July 1783, German newspapers reported that "the field fruits are ripening, [. . .] it is known that the sublimated sulfur agrees with the vegetables."[403] Assumptions that the dry fog had beneficial consequences seemed to outweigh concerns, at least in print. On 19 July 1783, the *Berlinische Nachrichten* printed another calming report, which emphasized that vegetation, particularly the vineyards, were prospering.[404] Another report in the *Meiningische Wöchentliche Nachrichten* confirmed that the dry fog had not stopped the growth of plants: on the contrary, the fruit harvest seemed to increase.[405] Franz VON BEROLDINGEN (1740–1798), a Swiss-German autodidactic geologist and volcanologist, noticed that plants persisted despite the drought and the dry fog. Even his potatoes did well despite only growing small leaves and blooming early.[406]

A report from Mannheim on 19 September 1783 indicated that all regions with vineyards were thriving in the warmth. It further opined that those "who saw hunger when they saw the dry fog and who saw doom when they looked at the blood-red sun, may regret their superstition and now listen to the daily Enlightenment of nature's secrets, which will make them more confident in the future when trusting the

401 Hamburgischer Unpartheyischer Correspondent, 8 July 1783: Report from Vienna, 28 June 1783. "Die Getraidefelder und Weingärten in unserer Nachbarschaft versprechen die reichste Ernte. Es zeigen sich so viel Trauben, daß man sich seit vielen Jahren einer solchen Fruchtbarkeit nicht erinnert."

402 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Stuttgart, 30 June 1783. "[. . .] woher dieser Dunst komme, das weiß ich nicht, das mögen die Gelehrten ausmachen, aber das kann ich ihn versichern, daß die Witterung herrlich ist. [. . .] Gott sey gedankt, der uns mit einem so guten Jahr segnet. – Möchte doch unser Pöbel in Städten und Dörfern von diesem alten Weingärtner lernen klug werden, Gott für den gegenwärtigen Segen danken, und alle fürwitzige und unnütze Fragen von Bedeutungen und vom Zukünftigen ununtersucht lassen."

403 Münchner Zeitung, 15 July 1783: 434. "Bei alle dem haben sich, Gott Lob, weder in unsren Gegenden, noch in irgend einem Orte Europens, wo diser trokne Nebel sich zeigte, die Krankheiten vermehret; noch die Fruchtbarkeit der Erde vermindert. Vielmehr scheinen sich gewisse, sonst in diser Jahreszeit herrschende Krankheiten verloren zu haben; und die Früchte reifen wenigst so gesegnet, als jemals, welches ebenfalls in der Vermutung starker Schwefelausdünstungen bestätiget, da es bekannt ist, das die sublimirten Sulphurteilchen dem vegetabilischen Reiche sehr gut bekommen."

404 Berlinische Nachrichten, 19 July 1783: 670: Report from Mannheim, 6 July 1783.

405 Meiningische Wöchentliche Nachrichten, 12 July 1783:114: Report from Heilbronn, 29 June 1783.

406 BEROLDINGEN 1783: 17–20.

Almighty."[407] Of course, these reports were probably put to print to assuage the fears of the public; however, given the sheer number of such stories, it is likely that the vineyards were genuinely expecting a bumper year.

These prognoses were correct: in the German Territories, the harvest was plentiful. The fruit harvests, particularly the wine grapes, were exceptional. Either the fog was not as injurious as suspected, or the plant life had made a remarkable recovery. In some circles, the fog was now considered a blessing.[408] Reports indicate that the German wine harvest from 1783 surpassed that of 1727 and 1766.[409] The abundance of 1783 extended to the smaller allotments and gardens in and around Munich and many other parts of the German Territories. "The remark of the naturalists seems almost to be confirmed; the long-lasting fog above Europe had a fertilizing power."[410] Mounting evidence suggested a clear connection between the dry fog and the plentiful harvest.

Britain had also profited from a particularly good harvest in 1783.[411] Despite the reports of crop damage in June and July 1783, no documentary evidence supports claims of large-scale harvest failure in England later that year.[412] Gilbert White, however, casts a shadow, noting that some parts of the harvest had not proliferated, including hops and kidney beans.[413] In Scotland, on 17 August 1783, John Alvus at Dalkeith recorded in his weather diary that "The Corn Harvest [began] & the crop [was] generally very good."[414] Another meteorological record from Scotland confirms that early September 1783 was "excellent for harvest work & cut down crops, tho- [ugh] ill-suited for ripening late grain."[415]

The same was true for the Austrian Netherlands. The Baron de Poederlé wrote, for October 1783, that the vegetation was beautiful and healthy for the season and

407 Münchner Zeitung, 25 September 1783: 597: Report from Mannheim, 19 September 1783. "Die auf die Güte des Herrn mistrauischen Menschen, welche in dem Hehrrauche Hunger, und in der blutrothen Sonne Verderben zu ligen glaubten, mögen also ihren Irrwahn bereuen, den täglich heller leuchtenden Aufklärungen der Naturgeheimnisse mehr Gehör verleihen, und eben dadurch künftig zuversichtlicher auf die Wege der Allmacht bauen."

408 Berlinische Nachrichten, 16 October 1783: 956: Report from Vienna, 8 October 1783.

409 Berlinische Nachrichten, 30 September 1783: 902: Report from Saxony, 20 September 1783. A similar report can be found here: Königlich Privilegirte Zeitung, 30 September 1783: 911.

410 Münchner Zeitung, 14 October 1783: 642–643. A similar report can be found here: Berlinische Nachrichten, 16 October 1783: 956: Report from Vienna, 8 October 1783. "Fast scheint sich die Bemerkung der Naturforscher zu bestätigen, daß diese außerordentliche Fruchtbarkeit, dem so lange über Europa geschwebten Nebel zuzuschreiben sey."

411 Das Wienerblättchen, 31 August 1783: 5: Report from London.

412 Witham, Oppenheimer 2004: 24.

413 Gilbert White, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 131–132.

414 John Alvus, Weather Diary for Dalkeith kept by John Alvus, MET1/4/37, National Records of Scotland, Edinburgh, UK.

415 Scottish Meteorological Society, MET1, National Records of Scotland, Edinburgh, UK.

that the plant life was as lush as during September.[416] In Italy, the situation was similar. According to Italian priest and physicist Guiseppe Toaldo (1719–1797), the dry fog had had a detrimental effect on some plants but also "brought forth very great fertility in all fruits of the earth."[417] In France, the harvest occurred earlier than usual because of the hot summer. The grapes were said to be of a higher quality than usual and very sweet.[418] As in England, some plants suffered damage.[419] Historian of medicine Alain Larcan remarked that municipal records from Paris and Lyon did not mention any subsistence crisis throughout the summer or autumn of 1783.[420] In Bohemia, there were reports of crop failure in late August 1783. Heavy rain was followed by extreme cold, and fog covered the region before the heat returned.[421] Here, the cost of rye, barley, and oats dropped between 1782 and 1786, whereas wheat prices increased between 1783 and 1785. Rudolf Brázdil and his colleagues identified similar patterns in Prague and Brno.[422] In Sweden, however, the grain harvest failed in several parts of the kingdom in September 1783; the hay harvest had also produced very little, possibly pushing farmers to cull their livestock for lack of fodder.[423] In neighboring Norway, the vegetation suffered similarly.[424] The Laki eruption and its dry fog did not precipitate an agricultural crisis across western Europe in 1783; in many cases, it had the opposite effect.[425]

A Year of Awe

The dry fog was not the only unusual occurrence of 1783: several geophysical and meteorological events made this year remarkable. Five huge earthquakes devastated Sicily and Calabria; a heat wave scorched many parts of Europe; thunderstorms terrorized the continent with lightning; the sun turned blood-red; and a molten, smoking island appeared off the coast of Iceland. These events profoundly impacted Europeans throughout the year – all of these phenomena were mentioned in the newspapers, time and time again.[426] Contemporaries perceived the almost simultaneous occurrence of

416 De Poederlé 1784: 346–347.
417 Van Swinden 2001: 77.
418 Soukupova 2013: 14.
419 Rabartin, Rocher 1993: 38–42.
420 Alain Larcan's comment to Garnier 2011.
421 Berlinische Nachrichten, 9 September 1783: 835–836: Report from Bohemia, 24 August 1783.
422 Brázdil et al. 2017: 156.
423 Demarée, Ogilvie 2001: 235.
424 Hólm 1784a: 234; Þórarinsson 1981.
425 Grattan, Brayshay, Schüttenhelm 2002: 100.
426 Demarée, Ogilvie 2001: 221.

these phenomena as extraordinary.[427] The year 1783 truly lived up to its designation: *annus mirabilis*, a year of awe.[428] The following subchapter considers how contemporaries responded to the unusual weather that characterized that year.

Reactions to the Unusual Weather

The Response to the Dry Fog

There seemed to be three different, not necessarily mutually exclusive, reactions to the unusual weather: some interpreted it as a harbinger of Judgment Day; some feared the unexplainable, a natural emotion in the face of something unfamiliar; and some were inspired to search for explanations within the scope of the physical world.

A report from Lautern in southwestern Germany from late June 1783 mentions the terrifying thunderstorms, deadly lightning strikes, and very thick fog that "left many people fear-stricken."[429] In Switzerland, the dry fog and other unusual phenomena created "great alarm" in the population.[430] The fog robbed the people of the ability to gaze upon a surety of life: "people almost doubt whether the sun and the moon still exist."[431] According to the *Preßburger Zeitung*, in Preßburg, in mid-July 1783, "everybody was in fear about those things, which might come." The fog was their main concern, and there was hope that the deluge of thunderstorms soaking Europe would disperse it. This fog, however, stubbornly remained, thwarting expectations.[432]

In a similar vein, in England, Gilbert White remarked that the red sun, coupled with the news of earthquakes in Calabria, was enough to bother the enlightened mind.[433] David Higgins argues that White was implying that "something ominous, perhaps even apocalyptic" was taking place on this "most portentous" summer.[434] In

427 Hamburgischer Unpartheyischer Correspondent, 15 August 1783: Report from Munich, 2 August 1783.

428 Mercier 1784; Steinþórsson 1992; Brázdil et al. 2010: 182.

429 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Lautern, 29 June 1783. "Traurig sah das Auf- und Untergehen der Sonne aus, welche die Gestalt und Farbe einer rothglühenden Kugel hatte und viel Leute in Angst setzte."

430 Report from Zurich, Kiessling 1888, part 1: 27–28.

431 Königlich Privilegirte Zeitung, 19 July 1783: 708: Report from Graubünden, 24 June 1783. "Unsere ganze Gegend ist seit 8 Tagen von Nebeln so verfinstert, daß man fast bezweifelt, ob Sonne und Mond noch existiren."

432 Preßburger Zeitung, 30 July 1783: Report from Hermannstadt, 14 July 1783. "Die Einbildung gab dem Nebel einen stinkenden Schwefelgeruch, und jedermann war hier in Furcht über die Dinge, die da kommen sollten." Preßburg is today's Bratislava in Slovakia.

433 Mabey 2006: 265.

434 Higgins 2019: 131–136.

Leicestershire, Thomas Barker likened the summer of 1783 to "Virgil's description of the summer after Julius Cesar's death."[435]

France, too, was struck by "great fear," and gossip spread about the imminent end of the world.[436] Jacques Antoine Mourgue de Montredon got specific, stating that he had heard from some that the end would occur on 1 July 1783.[437] In his book, published in 1784, Johann Ernst Basilius Wiedeburg (1733–1789), a German naturalist and astronomer based in Jena, suggests that 1783 had been one of the most baffling years for naturalists and gave them much reason to debate.[438] Generally, scientific inquiry took precedence over eschatological concerns as to the cause of all this; perhaps this is because a thick fog is not traditionally a harbinger of the end. In biblical stories, particularly in the Book of Revelation, the end is often announced by the appearance of comets.[439]

Generally speaking, the authors of the historical sources make no explicit mention of being panicked or fearful; during the Enlightenment, the discourse was devoid of such talk, with metaphor and rhetoric used in its stead.[440] Metaphors often play a compensatory role when dealing with one's fears of nature.[441] The newspapers found three different ways to hearten their readership. First, they relayed reassuring messages from naturalists. Second, they searched for precedents: the elderly were interviewed about their experiences with similar weather phenomena throughout their long lives, and old records and chronicles were scoured for mentions of similar events in the past. And third, they tried to appeal to their readers' pride by claiming that only the superstitious were panicking, whereas the Enlightened remained calm.

Many newspapers of the day concluded that the fog was nothing special. According to them, similar fogs had occurred in the past and, in all likelihood, they would happen again in the future. Although it is rarely explicitly stated, a certain level of fear and panic must have been in the ether, given the number of subtle and not-so-subtle attempts to spread calm.

The Voice of Reason

In the eighteenth century, it became apparent that individual weather phenomena could affect several different regions or countries.[442] Weather observers in 1783

435 Thomas Barker, Private Weather Diary for Lyndon Hall, Leicestershire, MET/2/1/2/3/227, National Meteorological Library and Archive, Met Office, Exeter, UK: 213.
436 Garnier 2011.
437 Mourgue de Montredon 1784: 764.
438 Wiedeburg 1784: 1.
439 Revelation 12:1–17.
440 Briese 1998: 8–9; Grattan, Brayshay, Schüttenhelm 2002: 98.
441 Briese 1998: 13–14; Schmidt 1999: 297.
442 Kington 1988: 18–19.

quickly concluded that the phenomenon they were witnessing locally, the dry fog, also occurred in several other places around Europe. No remarks in the sources indicate whether the sheer scale of the fog made it more terrifying or less so. Perhaps its incredible expanse encouraged apocalyptic thoughts, or perhaps, to paraphrase fourteenth-century Italian historian Dominicus de Gravina, it brought comfort that others suffered too.[443]

The palpable uncertainty of 1783 prompted some naturalists to intervene. Members of the Societas Meteorologica Palatina of Mannheim felt compelled to draft a statement addressing the weather. The Society's publications were published entirely in Latin and thus remained mysterious to all but the highly educated; however, in early July 1783, they released a statement that made many of the European newspapers. This statement was lengthy and underlined the responsibility of the sciences to inform the public:

> [The] observatory in Mannheim gives us news that the fog started on 16 June and became increasingly thicker. [. . .] Within 15 days, it had covered a large part of Europe. [. . .] From the Réaumur hygrometer, we have learned that the atmosphere was extraordinarily dry, this vapor was no moist precipitation, unlike other fogs, but it consisted of dry, hard particulates, [. . .] which must have had their origin in the electric matter, in the opinion of the observatory, [. . .] Regarding the nature of this dry fog, it was not malignant at all. The mortality did not increase under it; it caused no new illnesses; the mortality rather sunk, and the fruits, particularly the grapes, thrived.[444]

Naturalists in Mannheim favored this positive interpretation of the dry fog, one of many in that vein circulating at the time. The report even went so far as to suggest that the dry fog might have even been beneficial to human health. This further clarifies the report's intention, which was to pacify the public and assure them that although this dry fog was unusual, it was not malevolent.

In his hastily published monograph, Christoph Gottfried Bardili took a strong stand against superstitious interpretations of the dry fog. He saw no need for people to be

443 Dominicus de Gravina 2011.

444 Münchner Zeitung, 10 July 1783: 422. "[. . .] dise brave Sternwarte von Mannheim gibt Nachricht, das der Nebel am 16ten Brachm[onat]. Seinen Anfang nahm, sich allmälig verdikte, selbst die Donnerwolken den Augen entzog, und nach allmäligem Abnehmen eine Dauer von 15 Tagen durch eine grosse Streke Europens vollbrachte. Die Luft war dabei schwer und warm. Aus dem Reaumurschen Feuchtemesser nahm man ab, das die Atmosphäre ungewöhnlich troken, und also diser Duft kein feuchter Niderschlag, gleich anderen Nebeln war, sondern aus troknen, festen Teilchen bestand, die aus den Erdkörpern in die Luft mit grosser Kraft musten erhöhet worden sein, welche Kraft nach Meinung der Sternwarte blos der elektrischen Materie zugeschriben werden kann, deren ungemeine Auflösungskraft den Naturforschern bekannt ist. Was die Natur dises Hehrrauchs betrifft, so war er gar nicht bösartig. Die Sterbefälle haben sich dabei nicht gemehret, keine Krankheiten sind darunter ausgebrochen; diese schinen sich sogar zu vermindern, und die Früchte, besonders der Weinstok hatte ein herrliches Gedeihen." Similar reports can be found in the Frankfurter Staats-Ristretto, 7 July 1783: 444: Report from Mannheim, 2 July 1783 and Berlinische Nachrichten, 19 July 1783: 760: Report from the Mannheim observatory, 6 July 1783.

worried; indeed, he reminded his readers that at this point, in early July 1783, there was too little data available to make grand assumptions about its possible negative consequences.[445] Bardili's publication was aimed at both naturalists and the "uninitiated" (*Uneingeweyhte*), which presumably meant a non-educated, general audience.[446] Franz von Beroldingen conjectures that the fog was indeed harmful but that the cleansing nature of plant life would negate this over time.[447] This statement alludes to photosynthesis, an earlier discovery by Joseph Priestley (1733–1804), an English physicist and philosopher.[448] Nine years prior, Priestley had discovered that plants produced oxygen under the influence of sunshine at the cost of carbon dioxide, essentially filtering toxins from "unclean air."[449] In contrast to von Beroldingen, Johann Wiedeburg predicted that the fog would ultimately prove detrimental to plant life but have no negative consequences for humans or animals.[450]

The red sun particularly upset people.[451] The *Königlich Privilegirte Zeitung* printed a calming explanation: "The current fog does not let any other of the seven colors of the sun through, other than the red one. That is the whole secret! No need to be scared!"[452] Indeed, the scattering of photons as the light traveled through the sulfur-dioxide-laden atmosphere caused the effect. Volcanically induced red sunsets usually occur about one hour after the actual sunset.[453]

On 15 July 1783, the *Königlich Privilegirte Zeitung* stated:

> There is no need to seek refuge in the earthquakes in Italy to explain our German fogs. As soon as you think the fog is from Italy, you feel your chest tightening, see glowing balls falling from the sky, and fear earthquakes. But [. . .] the ghost rumbles in our head.[454]

445 Bardili 1783: 14–16.

446 Bardili 1783: 1–9; 9 (quote).

447 Beroldingen 1783: 30.

448 Schiffer 2003: 71.

449 Stollberg-Rilinger 2011: 168.

450 Beroldingen 1783: 31; Wiedeburg 1784: 66.

451 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Lautern, 29 June 1783.

452 Königlich Privilegirte Zeitung, 15 July 1783: 695: Report from Stuttgart, 1 July 1783. "Der jetzige Nebel läßt uns von den sieben Farben der Sonne eben keine andere, als die rothe, zukommen. Das ist das ganze Geheimniß! Lassen Sie uns nicht bange seyn!"

453 Ahrens 2009: 532–534.

454 Königlich Privilegirte Zeitung, 15 July 1783: 695: Report from Stuttgart, 1 July 1783. "Auszug eines Schreibens aus Stuttgard, vom 1. July. Sie fragen mich über meine Meynung wegen der jetzt so lang anhaltenden Nebel. Ich halte sie für nichts besonders. [. . .] Wir haben also gar nicht nöthig, zu dem Erdbeben in Italien unsre Zuflucht zu nehmen, um unsere deutschen Nebel zu erklären. [. . .] Sehen Sie nur die Liste nach, so werden Sie finden, wie wenig Personen dieser Tage gestorben sind. Aber sobald man denkt, der Nebel komme aus Italien, so fühlt man seine Brust beklemmt, sieht glühende Kügeln vom Himmel fallen, und ahndet Erdbeben. Denn auch hier, wie in tausend andern Fällen, poltert das Gespenst in unserm Kopfe."

Evidently, the author of the publication believed a local explanation would satisfy the newspaper's readership more than a foreign one. News stories of the devastating earthquakes in Calabria had been printed in the same newspaper as the aforementioned quote for some months.[455]

A Search for Precedents

Naturalists and laypersons alike searched through chronicles and other records, hoping to find something that would lead to a better understanding of Europe's current predicament. The *Berlinische Nachrichten* printed a report from a named correspondent, an 84-year-old preacher called HÖPPEL, who had found evidence of similar events in the past. While studying *Saur's Calendario Historico* from 1594, he came across mentions of strange weather in 1157, 1546, and 1571. Those years also featured a great heat, drought, and a thick fog that made the sun look like a fiery ball. The chroniclers did not mention any catastrophic aftermath, which suggested none was to be expected in 1783.[456] Johann Ludwig CHRIST (1739–1813), a German Lutheran pastor from Rodheim and an expert on fruit-growing and insects, wrote a book about the dry fog. In the book's appendix, he documents some evidence he found of a similar event. An old calendar revealed that the summer and autumn of 1652 were affected by a haze and blood-red sunsets and sunrises.[457] Karl Ludwig GRONAU (1742–1826), a German weather observer and Lutheran pastor, gives dates for precedents that were comparable to the reddish haze of 1783: they occurred on or between 22 and 25 April 1547; 15 February 1652; mid-July 1661; 5 and 6 August 1730; 6 to 8 June 1756; and 3 to 7 August 1766.[458] The monk and naturalist Dom Robert HICKMANN (1720–1787), based at the Saint-Hubert Abbaye in the Ardennes region, found records of similar fogs in 1746 and 1764; however, he admits that, unlike the current fog, those had only lasted a few days.[459]

Similarly, Jan Hendrik VAN SWINDEN "remembered without prompting" an event similar to 1783. He was born in 1746, so he must have been familiar with the records: "In 1721, over a vast tract of land, the sun on 1 June had been seen as white, destitute of rays."[460] The 1721 Katla eruption (VEI 5) in Iceland was perhaps the cause of this.[461] MOURGUE DE MONTREDON also looked to the past for similar events and reported on one such incident during the summer of 1721 in Persia, when a great fog enshrouded the

455 Berlinische Nachrichten, 17 July 1783: 664: Report from Naples, 24 June 1783.

456 Berlinische Nachrichten, 12 August 1783: 746: Report from Anspach, 23 July 1783.

457 CHRIST 1783: 3, 34–35. His book was published in July 1783: it was advertised as early as 19 July 1783 in the Frankfurter Staats-Ristretto, 19 July 1783: 473.

458 GRONAU 1785: 97.

459 HICKMANN 1783: 505–507.

460 VAN SWINDEN 2001: 73.

461 VAN SWINDEN 2001: 77–78.

land, and the sun had the color of blood. Both France and Italy experienced similar occurrences that same year.[462] Carl Friedrich HINDENBURG (1741–1808), a mathematician and professor of physics and philosophy, confirmed another of MOURGUE DE MONTREDON's assertations that a haze was observed in June 1721 over parts of France and Italy. Additionally, he came across mentions of a "sun smoke," whereby the sun took on a copper red or blackish appearance in Mecklenburg in July and August 1766. He thought it worth mentioning that there were no adverse effects observed.[463]

In his 1783 publication, *Vues sur la nature et l'origine du brouillard qui a eu lieu cette année*, Robert Paul DE LAMANON includes a long list of prior occurrences of an obscured sun dating as far back as Roman times.[464] Guiseppe TOALDO's publication mentions some of the same precedents: a darkened or reddish sun appeared in the year of Rome 291 [462 BCE], 542 [211 BCE], 552 [201 BCE], 554 [199 BCE], and 710 [44 BCE]. The last example, the year of Caesar's death, is known to be the year of a large volcanic eruption.[465] In the Common Era, the sun had an unusual color in 264, 396, 790, 937, 1020, 1104, 1154, 1206, 1227, 1263, 1383, and 1549.[466]

A correspondent from Hildburghausen interviewed a man who was – allegedly – very old. "A 102-year-old shepherd from nearby Fulda has confirmed that this is the third time he has experienced this great fog. In his experience, they were always followed by fertile years."[467] Many publications interviewed the elderly, using the perceived authority and wisdom that comes with old age to give credence to their point of view.[468]

One might readily question how far the "collective memory culture" of the contemporaries really stretched.[469] "Extreme weather memory" seemed to be fairly short in 1783. A weather event quickly became "the worst in living memory," even if written sources could prove that a comparable event had occurred only a few years before. Christian PFISTER reminds us to consider that the human capacity to remember the past, regarding the weather, can only reach back a few days to weeks.[470] Brian FAGAN comes to a similar conclusion: "The traumas of extreme weather events fade rapidly from human consciousness."[471] In 1783, it was difficult to compare past extreme weather events with one another; often, the descriptions were only qualitative, not quantitative, and exaggerations were commonplace. "The 'worst,' 'coldest,'

462 MOURGUE DE MONTREDON 1784: 763–764.

463 LUDWIG 1783: 219–221.

464 Journal de Paris, 13 August 1784: 964–965. DE LAMANON's publication was also translated into Dutch (1784b) and English (1799). More on DE LAMANON's life can be found in CARTWRIGHT 1997.

465 MCCONNELL et al. (2020) traced the latter eruption to 43 BCE and identified Alaska's Okmok volcano as the eruption's source.

466 TOALDO 1799: 421–422.

467 Königlich Privilegirte Zeitung, 31 July 1783: 742.

468 FLEMING 1998: 5.

469 MÜNCH 1992: 131.

470 PFISTER 1999: 36.

471 FAGAN 2000: xiii.

'hottest,' or 'wettest' weather in living memory seemed to crop up every few years."[472] In the zeitgeist of the Enlightenment, there was also much room for doubts, speculations, and creative ideas.[473]

John GRATTAN and Mark BRAYSHAY studied English newspapers published between June and September 1783 for mentions of the dry fog. They conclude that these newspapers seemingly accepted its unique nature. The British mindset was reflected upon in a letter by William COWPER to John NEWTON on 29 June 1783. First, COWPER describes the state of the weather: "So long, in a country not subject to fogs, we have been cover'd with one of the thickest I remember. We never see the Sun but shorn of his beams, the trees are scarce discernible at a mile's distance, he sets with the face of a red hot salamander, and rises with the same complexion." He continues to speak on the mindset of the people, stating that many had given the origin of these phenomena much thought. In his expressive epistle, COWPER seems fearful or anxious and wonders if he is witnessing the beginning of the end time.[474]

Most British newspapers that GRATTAN and BRAYSHAY studied were less inclined to mention Judgment Day but frequently used the adjective "violent," which appeared in 25 percent of the reports. GRATTAN and BRAYSHAY also caution the reader that the use of hyperbolic language might have been a rhetorical device used during the British Romantic period.[475]

The uniqueness of the dry fog was not generally accepted in France, perhaps because the search for historical precedents had been more successful.[476] The fact that French naturalists and newspaper correspondents considered the weather to be "nothing new" did little to persuade their British counterparts.[477]

Within the German Territories, reactions were more ambiguous than those of the English or French. Some newspaper reports concluded that the dry fog and the thunderstorms of 1783 were incomparable to past events. For instance, a report in the *Königlich Privilegirte Zeitung* remarked that the storm on 27 June 1783 at 2 p.m. was the most terrible that they had ever seen.[478] An article from Mannheim in the same newspaper issue asserted that "The oldest people cannot remember to have experienced something similar. [. . .] the thunder was so terrifying that something similar has never been heard before."[479] In mid-July, the *Münchner Zeitung* stated that "other chroniclers also

472 SCARTH 1999: 117.

473 SCARTH 1999: 117.

474 MENELY 2012: 477.

475 GRATTAN, BRAYSHAY 1995: 130–132.

476 ROBERJOT 1784: 399–400. L'ábbe ROBERTJOT nevertheless published a letter in which he titled the dry fog in France "un Phénomène singulier du Brouillard de 1783."

477 GRATTAN, BRAYSHAY 1995: 132.

478 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Lautern, 29 June 1783.

479 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Mannheim, 1 July 1783. "Der schon seit dem 17. [Juni] Tag und Nacht anhaltende trockene Nebel kann gewiß für eine ganz außerordentliche Erscheinung gehalten werden; den ältesten Leuten ist es nicht erinnerlich, dergleichen erlebt zu haben.

do not know of any such event. In Roman history, we find one that lasted for three summer months, but it was only present in Italy."[480] This confirms findings from a study conducted by atmospheric physicist Dario Camuffo and historian Silvia Enzi on the presence of dry fogs in Italy between 1374 and 1819.[481] In addition to all this, an unsettling connection was established: "some very old people remember that such hot and foggy summers preceded the very severe winters of the years 1709 and 1740. It is [therefore] necessary to [be prepared with] stocks of wood."[482] Mixed messages, and seeds of doubt in a generally reassuring overview, probably left the general public confused.

Blaming the Superstitious

Particularly in the fifteenth and sixteenth centuries, disastrous weather events were considered to be either divine intervention or portents of things to come.[483] The ecclesiastical authorities argued that the natural phenomena were either the expression of God's inscrutable will or manifestations of His righteous anger against the sinfulness of the world.

On occasion, in 1783, the Bible was used to interpret the possible punitive-theological meaning of weather events. Particularly, signs in the sky, such as the red sun and meteors, could be interpreted as bad omens.[484] It is not surprising that some could see their current situation reflected in biblical verses like these: "There will be signs in the sun, moon, and stars. On the earth, nations will be in anguish and perplexity at the roaring and tossing of the sea [. . .] When these things begin to take place, stand up and lift up your heads because your redemption is drawing near."[485]

In the source sample for this book, there were very few concrete mentions of the "end times." That the dry fog, thunderstorms, and flooding coincided with one another did – for some – give the impression of an event of biblical proportions. "In the evening, after the thunderstorm, the dry fog returned and enveloped the mountains again, [. . .]. The cries of the winds, the crying of the people, the banging of the thunder, and the rushing of the water were mixed! [. . .] The Day of Judgment seems to have started already."[486] In Lausanne, the dry fog was seen as the maw from the

480 Münchner Zeitung, 14 July 1783: 429–430: Report from Düsseldorf, 28 June 1783. "Die älteste Mensch erinnert sich nicht um dise Zeit keines so lange anhaltenden und so diken trokenen Duftes; auch unsre Kroniken wissen in älteren Zeiten nichts davon. In der Römischen Geschichte finden wir einen, der die drei Sommermonate hindurch gewähret, aber nur in den Italiänischen Gegenden."

481 Camuffo, Enzi 1995: 156.

482 Demarée, Ogilvie 2001: 239.

483 Schmidt 1999: 43.

484 Jakubowski-Tiessen 1992: 98–99.

485 Luke 21:25–28.

486 Münchner Zeitung, 11 July 1783: 425–426. "Am Abend nach dem Donnerwetter trat aber der Nebel wi[e]der ein, und verhüllte die Gebirge von neuem, macht Engbrüstigkeiten und vermehrt die

underworld, and its presence reminded those who paid attention of a passage in the Book of Revelation 9:2: "when he opened the Abyss, smoke rose from it like the smoke from a gigantic furnace. The sun and sky were darkened by the smoke from the Abyss."[487] In Switzerland, the authorities announced days of repentance, fasting, and prayer to prevent the worst and to prepare the population for the approaching end times.[488] In Pas-de-Calais in France, the bishop called for three days of prayers. In Antwerp, in the Austrian Netherlands, public prayers were ordered from 1 August 1783 onward in the hope that divine intervention would bring rain.[489]

There were other religious and political interpretations of the dry fog. Some believed that the "Enlightened" were responsible, as their thoughts and actions were in clear opposition to the doctrines of the Church. God might have used this natural event as a punishment to correct the "degeneration of the Enlightened zeitgeist." In his poem, *Hänts Leutel sagts mä do* (People, tell me), Austrian writer Peter Gottlieb LINDEMAYR (1723–1783) blamed the introduction of a new law: Emperor Joseph II had introduced the Patent of Toleration in 1781, which allowed Protestants and Jews to practice their religions freely. His Secularization Decree from 1782 also banned several monastic orders and liquidated a third of all monasteries; furthermore, he redefined marriage as a civil contract, forbade pilgrimage and processions, and cut priests' salaries. Needless to say, Catholics opposed all of these new laws and interpreted the fog as punishment for those turning away from Rome. LINDEMAYR wrote this poem in the very last days of his life; he died on 19 July 1783.[490]

Many viewed the fog as a blessing from God. The aforementioned bumper harvests were reason enough to come to this conclusion. For instance, a report from Stuttgart on 30 June 1783 – when the city was in the midst of the fog and under blood-red sunsets and sunrises – attested that the weather was "marvelous," citing the grape harvest as a positive consequence. The report reprimanded the "populace" for such bizarre ideas and suggested they thank God for sending this blessing.[491]

In the late eighteenth century, newspapers began to reach wider audiences due to the increasingly popular practice of reading them aloud in public places. Even so, the content of the reports makes it clear they were still squarely aimed at an audience of educated elites. They frequently ridiculed the irrational and paranoid beliefs of the so-called common folk. The diary of Reverend Henry WHITE, Gilbert WHITE's brother,

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Verurteile der gegenwärtigen Zeit. [. . .] Die Menschen riefen sich von den Dachgibeln einander um Hilfe, ohne sich helfen zu können. Vieh, Bäume, Prüken, Zäune, Trümmer von Hütten, alles wurde unaufhaltbar dahin gerissen. [. . .] Das Heulen der Winde in das Heulen der Menschen, in das Knallen des Donners, und das Brausen des Wassers gemischt! – und denn die kläglichsten Auftritte für das Aug! Der jüngste Tag schi[e]n angebrochen zu sein."

487 Revelation 9:2; VERDEIL 1783; PFISTER 1975: 87.

488 KIESSLING 1888: 28; PFISTER 1975: 87.

489 DEMARÉE, OGILVIE 2001: 234, 237.

490 LINDEMAYR 2010: 132; BRÁZDIL et al. 2017: 159.

491 Königlich Privilegirte Zeitung, 12 July 1783: 687–688: Report from Stuttgart, 30 June 1783.

expresses similar sentiments. He noticed on 19 July 1783, "the air seems clearer from the late blue thickness which has been so very remarkable, that the Superstitious Vulgar in Town & Country have abounded with the most direful presages and prognostications."[492]

It may seem as though Europe was divided, with the fearless "enlightened" and the terrified "superstitious" on opposite sides, but the reality is more complex. Not all "common people" were petrified by the weather, and not all the "enlightened" were free from fear. Famously, Georg Christoph LICHTENBERG (1742–1799), a German naturalist and professor of experimental physics, was so frightened by thunderstorms that he canceled his lectures in Göttingen when inclement weather was approaching.[493] In a letter to an acquaintance, LICHTENBERG mentioned his fear but also relativized it by stating that his primary concern was for his instruments.[494] A goal of the Enlightenment was to reduce superstition and prejudices, the tool for which was rational thought and experimentation. Demonstrating an understanding of natural phenomena was a favorite pastime of proponents of the Enlightenment.[495]

In 1783, the lines between religion and science remained blurred. Physicotheology was a reform movement that started in England and France around 1700.[496] Its aim was to bridge the gap between the natural sciences and faith. The wonders of nature (*physis* in Greek) were evidence of God's existence.[497] For physicotheologians, both nature and the Bible were books of divine revelation.[498] The difference between the naturalist and the ignorant was, according to the *Münchner Zeitung*, that the first did not feel fear when confronted with natural occurrences. In contrast, "the ignorant populace ogles at these wonders of nature and interprets them as sad premonitions."[499]

492 Henry WHITE, Diaries of the Rev. Henry WHITE, Rector of Fyfield, county Southampton, brother of Gilbert WHITE, 1783, Add MS 43816, British Library, London, UK, 30 (19 July 1783).

493 PROSS, PRIESNER 1985; WEIGL 1987: 37.

494 LICHTENBERG 1985: 675, Letter 1123, Georg Christoph LICHTENBERG to Johann Andreas SCHERNHAGEN, Göttingen, 7 August 1783.

495 BEGEMANN 1987: 83–86; HOCHADEL 2003: 21.

496 ALT 2007: 34; REITH 2011: 92; BLAIR, GREYERZ 2020.

497 D'APRILE, SIEBERS 2008: 72.

498 JAKUBOWSKI-TIESSEN 1992: 84.

499 Münchner Zeitung, 30 June 1783: 397: Report from Munich. "Der unkündige Pöbel begasset nun di[e]se Naturwunder, als traurige Vorbedeutungen, und geht mit seinen unsinnigen Spekulationen so weit, das es ihm vom Herzen bange wird, was er von den 3 Geißeln der Menschheit Pest, Hunger, und Krieg für eine für sich herausklauben soll. Der Naturkundige, dem solche Erscheinungen nichts unerwartetes, nichts neues mehr sind, bauet auf Gottes Vorsicht, bewundert die Wunder der Natur, und bleibt ruhig."

Fears of the Fog

Given the sheer quantity of newspaper reports discussing the dry fog and the weather in the summer of 1783, we can infer that the topic interested the readership. Although fear must have been present across Europe, it was rarely explicitly expressed in popular discourse. From the newspapers' overly reassuring pronouncements, it is possible to reconstruct the uncertainty that was present at the time: health was of the utmost concern. On 17 July 1783, the *Münchner Zeitung* printed an article stating that Joseph Jérôme Lefrançois DE LALANDE (1732–1807), also known as DE LA LANDE, a French astronomer and member of the *Académie royale des sciences* in Paris, "has clearly shown, to put the common man's fears at ease, that there was similar weather in 1764, and it did not have any negative consequences for fertility or health."[500]

In the early modern period, fear of nature often amounted to much more than the fear of the phenomena themselves; it extended to a fear of God, His power, and what His actions implied.[501] Faith did not preclude naturalists from thinking about the earthly causes of extreme weather events or nature-induced disasters.[502] An analysis of a sample of newspapers from 1783 shows that contradictory interpretation patterns existed simultaneously.[503]

Although many discoveries throughout the eighteenth century shed light on the development and consequences of weather events, the knowledge of these new advances had not necessarily trickled down into the reasoning of the middle and lower classes. The newspapers attempted to establish a line of communication between the sciences and the general population. The explanations and interpretations, some of which were very detailed, guided the readers and assisted their efforts to make the correct assessment of natural processes.[504] The simultaneity and coexistence of changeable interpretation patterns were a mark of the Enlightenment; theological and magical interpretations coexisted with scientific explanations. New studies focusing on European religiousness in the late eighteenth century show that, particularly in times of crisis, the faithful relied upon a combination of different coping strategies, especially when religious doctrine could not explain the complexity of a crisis.[505]

500 Münchner Zeitung, 17 July 1783, 439–440. "Der berühmte Astronom de la Lande hat, um dem gemeinen Manne die Angst zu benehmen, klar gezeigt, das man im J[ahr] 1764 die ähnliche Witterung gehabt habe, ohne schädliche Folgen für Fruchtbarkeit und Gesundheit." For DE LALANDE, see DEMARÉE, OGILVIE 2016: 125.

501 BEGEMANN 1987: 71, 76; ROHR 2009: 21.

502 ROHR 2009: 20.

503 GLACKEN 1990: 505; SCHMIDT 1999: 47; MISSFELDER 2009: 83.

504 SCHMIDT 1999: 6, 191, 306.

505 HOCHADEL 2003: 29; REITH 2011: 83, 92.

The Speculation about the Cause of the Unusual Weather

The dry fog and the tumultuous weather throughout the summer of 1783 left an indelible mark on the continent. Richard STOTHERS remarked that it had a "profound psychological influence on Europe."[506] In 1783, the Enlightenment was well underway, and the summer's events had given naturalists across Europe something upon which to focus their attention.[507] The weather was studied, experiments were conducted, and findings were published in books, scientific journals, or newspapers. Not only did they try to explain where the dry fog might have originated, but they also attempted to connect the various unusual phenomena. In this subchapter, I share some of their compelling and diffuse explanations.

What was the reach of scientific publications? These texts were for the scholarly community and a small, educated audience with some pre-existing knowledge of science. Scientific publications had a small print run; they were fewer in number and more expensive than newspapers. However, even in 1783, there were lending libraries and book clubs. The biggest challenge was illiteracy. However, some books had an uneducated (perhaps illiterate) audience in mind. Johann Nepomuk FISCHER (1749–1805), a professor of mathematics from Ingolstadt, intended with his book "to convince the ignorant audience [*das ununterrichtete Publikum*] about the nature of thunderstorms and ringing the bells [. . .]."[508] It did not seem impossible or even improbable to him that an uneducated person might read or listen to his book. He particularly wanted members of the clergy to read his book to their parishioners. FISCHER's core message was that ringing the bells against thunderstorms was an injurious practice. Overall, the word choice in the scientific publications analyzed for this book was much less radical than in some of the very polemic newspaper articles: one example of the latter being a report in the *Münchner Zeitung* that explicitly called out the "stupid farmers."[509]

A passage from Franz VON BEROLDINGEN's book shows that the popular discourse was not entirely separate from the scientific discourse. He references German newspaper reports in the following excerpt: "You expect me to share my thoughts about

506 STOTHERS 1996: 79.

507 GRATTAN, BRAYSHAY 1995: 129.

508 FISCHER 1784: 14. "Also ist das Glockenläuten offenbar kein zuverlässiges Mittel gegen die Gewitter. Da aber meine Schrift die Absicht hat, das ununterrichtete Publikum von der Natur des Gewitters, und des Glockenschalles zu überzeugen, daß diese zwey Dinge einander gar nicht widersprechen; so muß es mir genug seyn, diese erwähnte Erfahrung zur Gewährschaft meiner Theorie einmal für allemal angeführt zu haben."

509 Münchner Zeitung, 26 August 1783: 530. "Unweit Altenburg hat die Errichtung eines Blizableiters eine Bauernrevolte (wer als dumme Bauern hätte wohl sonst wider Erfahrung und Vernunft sich empören können!) veranlasset."

the unique long-lasting dry fog, that did not just affect our region, but according to the newspapers has spread throughout Germany and most of Europe."[510]

The different interpretation patterns offer insight into how naturalists in the late eighteenth century tried to find explanations for extraordinary natural events. These hermeneutical devices show that the various disciplines were not yet fully defined. In some cases, earthquakes, lightning, diseases, harvest, and the dry fog, were explained by the presence of one another. The idea that the different phenomena were related dates back to the Renaissance, when the field of astrometeorology was established, which, at its core, was the belief that meteorological events were influenced by other, seemingly unrelated, natural occurrences.[511]

A Naturalist's Perspective

De Lalande authored one of the earliest scientific explanations for the presence of the strange fog: it was published on 2 July 1783 in the *Journal de Paris*.[512] While fog itself was perhaps nothing special, its duration was.[513] De Lalande argued that the vapors were merely the consequence of evaporation after a series of heavy rainfalls.[514] He found a description of a similar fog in 1764. Based on this, he believed the 19-year moon cycle might have influenced the weather.[515] The British and German press printed translations of his findings soon after the initial publication.[516]

Almost as quickly as de Lalande's findings were shared, criticisms of them arose. For amateur weather observers and naturalists, his argument served as the foundation for lively debate. Most took particular offense to his insistence that this was an ordinary fog; many naturalists debunked de Lalande's argument by systematically outlining the differences between this fog and regular, moist fog.

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510 Beroldingen 1783: 3. "Sie verlangen meine Gedanken über den so lange anhaltenen Nebel, der nicht nur in unsrer Gegend ungewöhnlich war, sondern sich auch laut der Zeitungsnachrichten in den meisten Gegenden Deutschlands, ja auch die meiste Provinzen Europens verbreitet hat."

511 Demarée, Ogilvie 2001: 224.

512 Journal de Paris, 2 July 1783: 762–763; Journal de Paris, 9 July 1783: 789–790. The Berlinische Nachrichten quoted a report from Stuttgart, 1 July 1783, that outlined de Lalande's ideas. The Königlich Privilegirte Zeitung quoted a report from Paris, 8 July 1783. Berlinische Nachrichten, 15 July 1783: 654: Report from Stuttgart, 1 July 1783; Königlich Privilegirte Zeitung, 19 July 1783: 708–709: Report from Paris, 8 July 1783. In England, the news about de Lalande's explanation and his precedent findings appeared in the Morning Herald and Daily Advertiser, 15 July 1783; and in Felix Farley's Bristol Journal, 19 July 1783: Report, 4 July 1783. Grattan, Brayshay 1995: 131–132; Hochadel 2009: 60.

513 Stothers 1996: 85.

514 Hamburgischer Unpartheyischer Correspondent, 19 July 1783: Report from Paris, 12 July 1783.

515 Münchner Gelehrte Zeitung, 29 August 1783: 60.

516 De Lalande in Felix Farley's Bristol Journal, 19 July 1783: Report, 4 July 1783. In the German Territories, his findings were printed in Lalande 1783: 95–99.

Because of the avalanche of opposition to his findings, it is unlikely DE LALANDE managed to convince many.[517] The *Hamburgischer Unpartheyischer Correspondent* printed DE LALANDE's explanation right next to a counterstatement that openly doubted it. This counterstatement from Brest in France noted that the dry fog was visible at sea and hindered navigation, refuting DE LALANDE's theory. The correspondent concluded that "The fog definitely has a different cause than the heat after a lot of rain, as is believed by Mr. de la Lande in Paris."[518]

Another fact that refuted the evaporation theory quickly became apparent: the fog was present in regions that had not been affected by long-lasting rainfall and extreme flooding.[519] To their credit, newspapers did not simply collect information and blindly share it; instead, they made efforts to critique their sources. This ability to think and reflect critically is a central tenet of the Enlightenment, which had started to envelop all areas of life.[520]

Still, some naturalists agreed with DE LALANDE's findings. In Geneva, the encyclopedist Charles-Benjamin LUBIERES adopted DE LALANDE's explanation.[521] Many advocated for other arguments, of course. Dom Robert HICKMANN criticized Joseph DE LALANDE's theory; HICKMANN thought that a prolonged rainfall would naturally have created a wet fog rather than a dry one.[522] Franz VON BEROLDINGEN set about proving that the fog was not moist. He had observed a barometer when the sky was dull and hazy, and the reading remained high. This observation was proof that this was "a lighter fog, one that did not press on the mercury column."[523] VON BEROLDINGEN further argued that if the heat was to blame for this fog, it would appear every year, and concludes: "An extraordinary occurrence must have an extraordinary cause."[524] He also reasoned that sulfuric air had to come from inside Earth. VON BEROLDINGEN believed earthquakes, particularly those in Calabria and Sicily, were the source of the haze. He

517 HOCHADEL 2009: 50; WITZE, KANIPE 2014: 119.

518 Hamburgischer Unpartheyischer Correspondent, 19 July 1783: Report from Brest, 4 July 1783. "Der Nebel hat also gewiß eine andere Ursache, als Hitze nach vielem Regen, wie Herr de la Lande zu Paris glaubt."

519 Münchner Gelehrte Zeitung, 29 August 1783: 61.

520 WÜRGLER 2009: 43. The Münchner Zeitung was particularly good at signaling which reports sported editorial comments by placing them at the end of a report and highlighting them with a small asterisk at the beginning of the comment.

521 PFISTER 1972: 25.

522 HICKMANN 1783: 505–507.

523 BEROLDINGEN 1783: 3–4, 23 (quote). "Der Stand des Barometers war, wie die ganze Zeit über bey dem trüben, neblichten Himmel, hoch; genugsamer Beweis, daß die die Sonne verdunkelnden Dünste keine wässerigten Dünste, sondern von leichter Art gewesen seyn müssen, die nicht auf die Säule des Quecksilbers drückten."

524 BEROLDINGEN 1783: 9. "Ganz recht, mein Freund! eine ausserordentliche Erscheinung muß auch eine ausserordentliche Ursache haben."

felt the reddish color of the fog was another indicator that it was flammable air rather than a normal fog, which has a grayish tone.[525]

As VON BEROLDINGEN criticized DE LALANDE, so he too was criticized. In particular, Georg Christoph LICHTENBERG engaged with Franz VON BEROLDINGEN's publication. Although LICHTENBERG enjoyed his train of thought, he did not appreciate the description of the fog as simply "flammable air," which alone, he said, could not constitute a fog.[526] LICHTENBERG received so many letters regarding the fog and the unusual state of the atmosphere that he had trouble answering them. As a joke, he signed one of his letters with "*in nebula nebulorum*," which means "in the fog of fogs."[527]

Reverend HILLIGER in Niedersgörsdorf, south of Berlin, noted a burning smell on 31 July 1783. He suggested that the dry fog originated in boggy peat areas or heathland regions and was then carried on the wind to the four corners of the continent. Given that the prevailing winds came from the northeast at the time, he deemed it possible that the smell came from Pomerania or Lüneburg.[528] Sebald Justinus BRUGMANS' book, published on 9 July 1783, argues that although the north had no shortage of potential sources that could produce a continuous sulfuric vapor, such as the fire-spitting mountain Hekla, he did not believe that this fog hailed from that location. According to BRUGMANS, either exhalations originating from the sulfuric innards of the Earth had produced the dry fog, or it had come from the upper atmosphere.[529]

In 1783, several theories on the origin of the fog were in circulation; earthquakes, volcanoes, and lightning rods were among the most prevalent. Whether the fog was singular in living memory and its very essence was up for debate. Some further hypotheses are analyzed in greater detail in the following subchapters.

Active Volcanoes, Active Imaginations

An extraordinary explanation unlike any other materialized that summer. This explanation stood in stark contrast to the reassuring tone of DE LALANDE's and involved at least four volcanic eruptions within the German Territories.[530]

Newspapers ran reports of fire-spitting mountains and one burning mountain within the German Territories. News of the "eruptions" featured alongside articles about national and international political and military affairs. While volcanism in

525 BEROLDINGEN 1783: 10–13.

526 LICHTENBERG 1985: 702, Letter 1144, Georg Christoph LICHTENBERG to Johann Andreas SCHERNHAGEN, Göttingen, 18 September 1783.

527 HOCHADEL 2009: 49.

528 HILLIGER 1783: 277–278.

529 BRUGMANS 1783: 54–55.

530 Parts of the subchapter, "Active Volcanoes, Active Imaginations," were originally published in *Global Environment*, see KLEEMANN 2022a.

Germany is not entirely extinct, the last known Holocene eruption took place in the Eifel region around 10,762 years ago (± 150 years), creating the Ulmener Maar.[531] In 1783, naturalists were aware of the German Territories' volcanic past.[532] It was known, for instance, that the landscape around Frankfurt am Main and the Laacher See was of volcanic origin, the latter described in at least one scientific publication as "an old crater."[533] The Laacher See is a caldera filled with water. The last eruption of this volcano took place around 12,900 years ago; it was a Plinian eruption that reached a six on the index of volcanic explosivity.[534] In 1774, the first researchers came to the Vulkaneifel to study its landscape. After the Napoleonic Wars, more geologists followed.[535]

The Cottaberg and the Gleichberg

The first mention of volcanic activity within the German Territories in my source sample was in an article published in the *Königlich Privilegirte Zeitung* on 8 July 1783. The story dealt with a report from the Meißen region in the Electorate of Saxony dated 1 July 1783: "For a few days, the Cottaberg has been throwing out burnt stones, which allows the assumption that in this area a fire-spitting volcano wants to come to life, too."[536] The *Hamburgischer Unpartheyischer Correspondent* ran with an almost identical account on 11 July 1783, as did the *Münchner Zeitung* on 24 July 1783.[537] Today, the Cottaberg is referred to as Cottaer Spitzberg due to its proximity to the town of Cotta. The formation is a 390-meter-tall basalt dome on the western edge of Saxon Switzerland, around 30 kilometers away from the city of Dresden. The hill is of volcanic origin, but the last eruption occurred 25 million years ago, long before 1783. During the Paleogene and the Neogene, two consecutive geological periods that began 66 million years ago and lasted almost 64 million years, the region was shaped by intense volcanism; individual intrusions of magma forced their way through the sandstone platform of the Elbe Sandstone Mountains. One such intrusion resulted in the formation of the Cottaberg.[538] It was a quarry in the nineteenth century, and today it looks more like a knoll. It still dominates the surrounding landscape and is a prominent landmark.

The Cottaberg was not the only eruption reported in the German Territories in the summer of 1783. Just a few days after the report about the Cottaberg, came news

531 Global Volcanism Program: West Eifel Volcanic Field; Grattan, Gilbertson, Dill 2000: 307, 313; Lutz, Lorenz 2013: 1. The term "maar" was first used in 1819.

532 Bardili 1783: 16.

533 Göttingische Anzeigen von gelehrten Sachen, 17 July 1783: 1144.

534 Riede 2017; VOGRIPA: East Eifel Volcanic Field.

535 Lutz, Lorenz 2013: 2.

536 Königlich Privilegirte Zeitung, 8 July 1783: 670: Meißen region, 1 July 1783.

537 Hamburgischer Unpartheyischer Correspondent, 11 July 1783; Münchner Zeitung, 24 July 1783: 453.

538 The Cottaberg is one hill in a line of volcanic inselbergs.

that the Gleichberg had sprung to life. On 12 July 1783, the *Augsburgische Ordinari Postzeitung* printed an extract of a letter from Hildburghausen, dated 24 June 1783. Unlike the report about the Cottaberg, this one was quite detailed. The letter declared that since Easter, the Gleichberg had been steaming intensely, which had created a thick fog between Römhild and Hildburghausen.

> All the forests in the area are white instead of green; the whole sky looks like chalk; the fog is true natural sulfur, which spoils everything that it touches; the sun and moon always set in a blood-red color. For eight days now, inside the mountain there has been a horrendous and frightening bashing, as if cannons were being fired; then, finally, the whole mountain opened up under the plumes of thick sulfuric smoke; and in the entire area you can hear a constant terrible roaring and rushing [*Sausen und Brausen*] from the opening.[539]

The report continued to detail how terrified locals were fleeing, how people in the churches of the surrounding towns were praying, and how "the whole mountain might collapse and create further disaster."[540] Extracts from the letter from Hildburghausen were printed in the *Frankfurter Staats-Ristretto* on 12 July 1783, the *Münchner Zeitung* on 15 July 1783, and the *Königlich Privilegirte Zeitung* on 22 July 1783.[541] Another report from 22 July 1783, printed in the *Berlinische Nachrichten*, quoted a letter from Frankfurt am Main from 12 July 1783 confirming that the Gleichberg seemed to be a fire-spitting mountain; the wording was very similar to the letter from Hildburghausen.[542]

In addition, an article in the *Münchner Zeitung* stated that a correspondent from Hildburghausen confirmed the Gleichberg had been erupting for three weeks and was

539 Augsburgische Postzeitung, 12 July 1783: Report from Hildburghausen, 24 June 1783. "Die Wälder in dieser ganzen Gegend sind alle weiß statt grün; der ganze Himmel wie aufgeflogener oder sublimirter Kalck; der Nebel ist wahrer natürlicher Schwefel, welcher alles was er berührt, verderbt; Sonne und Mond gehen immer bluthroth auf und unter. Seit etwa 8. Tagen that es in dem Berg so entsetzliche und fürchterliche Schläge als würden Kanonen gelöset; denn öffnete sich endlich der Berg ganz unter lauter dickem Schwefelrauch; und in der ganzen dasigen Gegend weit umher hört man aus seiner Oefnung ein beständig fortdauerndes entsetzliches Sausen und Brausen; in allen Kirchen werden Bethstunden gehalten; aus allen umliegenden Ortschaften haben sich die erschrockenen Einwohner bereits geflüchtet, da sie befürchten und vermuthen, der ganze Berg möchte endlich einstürzen, oder noch mehr anderes Unglück bringen. Das fernere Wichtige dieser Sache will ich Ihnen ebenfalls schriftlich melden. Also haben wir dennun in unserm lieben Deutschland auch einen feuerspeyenden Berg, den Gleichberg." A very similar report can be found in the Frankfurter Staats-Ristretto, 12 July 1783: 456: Report from Hildburghausen, 24 June 1783.

540 Augsburgische Postzeitung, 12 July 1783.

541 Frankfurter Staats-Ristretto, 12 July 1783: 456: Report from Hildburghausen, 24 June 1783; Münchner Zeitung, 15 July 1783: 433–434; Königlich Privilegirte Zeitung, 22 July 1783: 714: Report from Hildburghausen, 24 June 1783.

542 Berlinische Nachrichten, 22 July 1783: 677–678: Report from Frankfurt am Main, 12 July 1783.

like a coal oven, emitting steam and choking sulfuric smoke without any interruption all day and night.[543] Despite these descriptions, newspapers were calm and considered in their reactions. The report further speculated on the origin of all this chaos: "[. . .] the Earth has experienced an enormous overburden of subterraneous sulfur, which is being unburdened via flammable matter or harmless vapors."[544]

The identity of the correspondent(s) in question remains obscure: very little information about the network of correspondents for newspapers from this period is available. The wording of the articles suggests that several newspapers used the same source(s). What remains unknown is whether the correspondent(s) sent their letters to several publishers or whether one newspaper simply copied the other.

The Gleichberg, technically speaking, is made up of two hills of 679 and 641 meters in height, the *Großer* and *Kleiner Gleichberg*, located in what was then the county of Henneberg-Römhild.[545] As with the Cottaberg, the Gleichberg was known at the time to be of volcanic origin. The mountains are part of the *Heldburger Gangschar* system, which formed due to Cenozoic volcanic activity.[546] Today only a few of the volcanoes of this system are still visible at surface level. The Gleichberg is younger than the Cottaberg; the last eruption occurred as recently as 15 million years ago. Like the Cottaberg, it consists of volcanic basalt cones. The volcano cannot be classified as entirely dormant yet as there is still geothermal activity there today, which results in hot springs and could explain the steaming mentioned in the report.[547]

What is fascinating about this alleged eruption is how believable it seems – and the fact that it was reported on 24 June 1783, when the fog was at its most intense and a mere week after it first appeared over the German Territories. Importantly, this would have been before the naturalists and thinkers of Europe had had the chance to firmly establish the idea that the fog was of volcanic origin. The letters describe a blood-red sun and moon, a somewhat hazy sky, and thick dry fog accompanied by the

543 Münchner Zeitung, 15 July 1783: 433–434. Similar reports about thick sulfuric smoke spoiling everything it touched also appeared in Berlin; Berlinische Nachrichten, 22 July 1783: 677–678: Report from Frankfurt am Main, 12 July 1783; Königlich Privilegirte Zeitung, 22 July 1783: 714: Report from Hildburghausen, 24 June 1783.

544 Münchner Zeitung, 15 July 1783: 433–434. "[Der Ausbruch des Gleichbergs und der Nebel] macht einen nicht unbeträchtlichen Beitrag zu der Vermutung, das die Erde sich einer ungeheuren Ueberladung von lange Zeit über gesammeltem unterirdischen Schwefel, und anderen brennbaren Materien zu entbürden, und also sich teils durch unschädliches Ausdünsten, teils an Orten, wo den Ausdünstungen grösserer Widerstand geschieht, oder wo der auszuführenden Materia peccans zu vil ist, durch heftige Ausbrüche, oder Vulkane in die Atmosphäre auszuschütten habe. Ein Correspondent aus gedachtem Hildburghausen beteuert uns wirklich, das der vor 3 Wochen aus dem Gleichberge, wie aus einem innerlich brennenden Kolenofen, ringsum emporgestigene Dampf die vollkommene Farbe sowohl, als ganz den erstikenden Geruch des Schwefelrauchs gehabt habe."

545 Köbler 2007: 268.

546 The Cenozoic is the current geological era; it extends from around 66 million years ago to the present.

547 Grattan, Gilbertson, Dill 2000: 307; Hofbauer 2008: 71.

strange, "choking smell" of "sulfuric smoke." Whereas the dry fog can explain all the aforementioned phenomena, what can account for the rest?

The Gleichberg "eruption" was said to have sounded like cannon fire. The whole area could perceive a "constant terrible roaring and rushing."[548] These noises might have been thunderstorms, which we know had been plentiful in 1783; indeed, contemporary sources endow the thunder of that summer with an almost mystical quality, with noises the likes of which they had never heard before.[549] It is possible that these storms, which others so easily mistook for earthquakes, could also give the impression that a volcano was erupting. Although the *Ephemerides* of the Societas Meteorologica Palatina did not have a weather station close to the Gleichberg, other German stations did record several thunderstorms over the eight days in question.[550]

Thunderstorms consist of both thunder and lightning; however, it is possible that the lightning remained obscured by the fog. Without this visual component, the panicked locals could have easily jumped to conclusions. Descriptions from that year of thunderstorms with apparently no lightning are available: for instance, in Dillenburg in early July, one report went as follows: "With one [thunderstorm], one saw no flashes of lightning and no normal thunder clouds, but that made the thunder much more numbing."[551]

One element of the letter from Hildburghausen that remains mysterious is the mention that the beginning of the "eruption" is said to have been around Easter. Additionally, how the Cottaberg "eruption" threw out stones could have nothing to do with the Laki eruption and perhaps has more to do with the overactive imagination of the correspondent.

Other "Volcanic Activity": The Roßberg, the Gottesberg, and the Burning Mountain

More of this imagined volcanic activity followed. The newspapers reported on at least two more that year (for a map of the locations, see Figure 41). It is quite extraordinary that reports of dramatic eruptions in the German Territories occurred in a year when a very real eruption was influencing all of Europe.

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548 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Mannheim, 1 July 1783.

549 Königlich Privilegirte Zeitung, 12 July 1783: 686: Report from Mannheim, 1 July 1783. "Alle Nachrichten stimmen überein, daß das Knallen der Donnerschläge so erschrecklich gewesen, dergleichen noch nie gehört worden."

550 Societas Meteorologica Palatina 1783. For instance: Erfurt was plagued by thunderstorms on 15 and 20 June; Würzburg on 15 and 21 June; Ingolstadt on 14, 15, 16, and 24 June; Berlin on 15, 16, 20, and 22 June; and Sagan on 12, 13, 16, 20, and 21 June.

551 Königlich Privilegirte Zeitung, 17 July 1783: 700: Report from Dillenburg, 2 July 1783. "Während dem auch in hiesigen Gegenden und auf dem ganzen hohen Westerwalde ausgebreiteten Dufte, sind verschiedene sonderbare Gewitter bemerket worden. Bey einem sahe man keine Blitze auch keine gewöhnlichen Gewitterwolken, aber desto stärker war der betäubende Donner." A very similar report can be found in Frankfurter Staats-Ristretto, 11 July 1783: 453: Report from Dillenburg, 2 July 1783.

Figure 41: The locations of the different German "volcanic eruptions" in 1783.

The Roßberg near Tübingen, in the southwest of Germany, allegedly sprung to life on 18 July 1783: "The well-known Roßberg near Genkingen is producing a subsurface roar [*unterirdisches Getöse*]. For a few weeks, some have complained about eye infections here."[552] The Roßberg is located at the western margin of the Swabian Jura (*Schwäbische Alb*) and is about 100 meters higher than the surrounding area. As with the Gleichberg and Cottaberg, Roßberg is located in an area known to have had Neogene volcanic activity and is in the proximity of the Swabian volcano (active 17 to

552 Königlich Privilegirte Zeitung, 9 August 1783: 773: Report from Tübingen, 18 July 1783. "Man will versichern, der bekannte Roßberg bey Genkingen lasse auch ein unterirdisch Getöse von sich hören. – Seit einigen Wochen klagen hier verschiedene Personen über Augenkrankheiten."

11 million years ago). Geologists have identified more than 350 volcanic vents in this area.[553]

Although the Roßberg might be of volcanic origin, there was certainly no volcanic activity there in 1783. This newspaper report was much shorter and lacked the detail of the Gleichberg account. The "subsurface roar" could well have been loud thunder, once again mistaken for the rumblings of a volcano. It is worth noting that this area is one of the most seismically active in Germany.[554] It is possible that an earthquake, coupled with thunder and the dry fog, could have given locals the impression that the Roßberg was erupting. The accounts of eye infections mirror reports from other parts of the country, so it can be inferred that the dry fog was present in this area too.

Talk of a "subsurface roar" was probably a genuine attempt to give a local explanation for a frightening occurrence; however, the possibility remains that this element was fabricated. A similar "strong subterraneous roar" was reported near the Gottesberg in Lower Silesia. That noise terrified local coal miners and prompted them to flee.[555] As with the Roßberg, this event might have been caused by an earthquake or severe thunder.

In the west of Germany, near Dudweiler, there was another "volcano." The *Allerneueste Mannigfaltigkeiten* reported on this event in great detail; descriptions of lava and unbearable smells color the report.[556] While the term "burning mountain" was synonymous with "volcano" in 1783, in this case, the name of the alleged source of the eruption actually is *Brennender Berg* (burning mountain). In the seventeenth century, this 356-meter-high mountain was a shale mine. A smoldering coal-seam fire started inside the mountain in the 1660s and continues until the present. Attempts to extinguish the fire were unsuccessful. Initially, a fiery glow was visible, which weakened over time. Today, smoke seeping from the mountain is occasionally visible.

Additional research may unearth even more false eruptions within the German Territories; furthermore, it would be interesting to study non-German sources to see whether people in other countries also applied this explanation strategy.

Retractions

The Gleichberg, Cottaberg, Roßberg, and Gottesberg did not erupt in 1783. The Burning Mountain is real; the eruptions were not. Despite best efforts, false stories sometimes made it to print.[557] Apparent corroborative evidence from multiple newspapers was anything but.

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553 Geological Map of the Urach-Kirchheimer region, 2015.

554 Modern earthquake catalogs do not list any earthquakes in the region for 1783; however, these catalogs are not necessarily complete; Leydecker 2011.

555 Hamburgischer Unpartheyischer Correspondent, 11 July 1783: Report from Silesia, 6 July 1783; Münchner Zeitung, 14 July 1783: 430: Report from Düsseldorf, 28 June 1783.

556 Allerneueste Mannigfaltigkeiten, week 31 (late July/early August), 1783: 473–476.

557 Grattan, Brayshay, Schüttenhelm 2002: 101.

The first newspaper to dispute the story of the Gleichberg eruption was the *Meiningische Wöchentliche Zeitung* on 19 July 1783, the headquarters of which was only a short distance from the mountain. The letter in the *Frankfurter Staats-Ristretto* had come to the attention of the editor of the *Meiningische Wöchentliche Zeitung* in the days following its publication. The editor stated that it was "almost funny" to read and commented on the "strange influence of this evil fog on the heads of the people."[558] The editor found harsh words to criticize the spread of this story:

> One should be ashamed to terrify the superstitious people among the common folk. [. . .] Our eyes do not see, and our ears do not hear anything about the fleeing terrified residents, the threatening collapse of the Gleichberg, the roaring and bashing, the thick sulfuric smoke, [. . .]. One also does not taste anything of the sulfur on cherries or berries, of which there have been plenty this year.[559]

That sulfur was perceptible in the air was a particularly controversial topic. It seems those who did not experience it personally did not believe those who claimed to have smelled or even tasted it during the summer and thought it a fantastical and outlandish claim. The evidence suggests that the sulfuric odor was most potent in the Low Countries and some western parts of the German Territories during the last week of June 1783. Perhaps Meiningen, due to its location, was spared from this stench; that said, the previous newspaper issue from 12 July 1783 had referred to the dry fog as *der Duft* ("the smell").[560]

The editor of the *Meiningische Wöchentliche Zeitung* disproved most aspects of the story mentioned in the original "letter from Hildburghausen" and further mentioned that the dry fog and the unusual coloration of the sun and moon were not unique to the Gleichberg; this shows that the editor was aware of the supra-regional reach of the dry fog. As a closing thought, the editor expressed doubt as to whether the letter even originated in Hildburghausen and suggested instead that "the author of this untruth" must be located near Frankfurt.[561] The editor must have been unaware that the same

558 Meiningische Wöchentliche Zeitung, 19 July 1783: 116: Report from Meiningen, 18 July 1783. "Es ist fast lustig zu lesen und zu bemerken, welchen sonderbaren Einfluß der böse Nebel auf Menschenköpfe gehabt hat."

559 Meiningische Wöchentliche Zeitung, 19 July 1783: 116. "So würde er [der Verfasser des Schreibens aus Hildburghausen] sich schämen, abergläubische Personen unter dem gemeinen Volk in Furcht zu setzen. [. . .] Eben so ungegründet ist alles übrige Vorgeben. Vom Wegflüchten der erschrockenen Einwohner, vom angedrohten Einsturz des Gleichbergs, von dessen Sausen, Brausen, Krachen, dickem Schwefelrauch, der den Wäldern ein weißes Kleid angelegt haben soll; sehen unsere Augen und hören unsere Ohren nichts. Auch schmeckt man nichts von dem angeblichen wahren natürlichen Schwefel an Kirschen und Beeren, woran dies Jahr besonders reichhaltig ist."

560 Meiningische Wöchentliche Zeitung, 12 July 1783: 113: Report from Meiningen, 3 July 1783.

561 Meiningische Wöchentliche Zeitung, 12 July 1783: 117. "Man glaubt gar nicht, daß diese Legende in Hildburghausen ist verfertigt worden; sondern es ist vielmehr wahrscheinlicher, daß der Verfasser dieser Unwahrheit sich in der Nähe von Frankfurt aufhalten müsse."

letter was printed in Augsburg on the same day and in various other German newspapers shortly afterward.

Within a relatively short period, updates arrived from the affected regions, which revealed that they had, in fact, avoided devastation. On 25 July 1783, the *Hamburgischer Unpartheyischer Correspondent* printed a report from Bayreuth, dated 17 July 1783: "Travelers, who are coming from Hildburghausen, do not know of any change at the Gleichberg, nor of its uproar or fire-spitting. A fog prophet [*Nebelprophet*], of which there are many these days and who do not sense anything but bad luck, has probably spread the terrible news about this mountain."[562] On 28 July 1783, the *Münchner Zeitung* printed a report that stated: "The Cottaberg [. . .] and the Gleichberg [. . .] have cracked, but instead of hatching a volcano, they gave birth to a mouse. Someone has, we don't know where from, cooked up this stunning lie."[563] Later, on 31 July 1783, the *Königlich Privilegirte Zeitung* printed a letter from Hildburghausen, dated 16 July 1783. It reads: "at a steep wall, there is an outcrop, and one can see the basalt columns, which make up the inner part of the mountain, and they are still standing upright and look to be intact."[564] As the basalt columns were intact, the correspondent concluded that no recent volcanic eruption could have occurred there.

In September 1783, the editor of the *Dessauische Zeitung für die Jugend und ihre Freunde* admitted they had reported on the Cottaberg and Gleichberg eruptions "without reason." Around the time of their retraction, the editor had realized that stories about the mountains emitting "terrible steam and throwing out stones" might have agitated those with sensitive souls, for which they pleaded for the readers' forgiveness.[565]

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562 Hamburgischer Unpartheyischer Correspondent, 25 July 1783: Report from Bayreuth, 17 July 1783. "Reisende, welche von Hildburghausen kommen, wissen von keiner Veränderung am Gleichberg, weder daß er tobe noch Feuer speye. Vermuthlich hatte ein Nebelprophet, dergleichen es jetzt viel giebt, und die nichts als Unglück wittern, die fürchterliche Nachricht von diesem Berge verbreitet."

563 Münchner Zeitung, 28 July 1783: 461. "Der Cottaberg im Meissnischen, und der Gleichberg bei Hildburghausen haben gekracht; aber anstatt einen Vulkan auszubrüten, eine Maus gebohren. Man hat uns, weis nicht woher, die schöne Lüge angebunden."

564 Königlich Privilegirte Zeitung, 31 July 1783: 742. "Dieser Berg [. . .] ist [. . .] vulkanischen Ursprungs. An einer steilen Wand desselben, die von Erde und Gesträuch entblößt ist, kann man die Basaltsäulen, die das Innere ausmachen, noch aufrecht stehend und unzerstückt erblicken." The same letter is quoted in the Frankfurter Staats-Ristretto: 22 July 1783: 480.

565 Dessauische Zeitung für die Jugend und ihre Freunde, no. 39, September 1783: 305: Report from Dessau, 20 September 1783. "Zum Schlusse dieses 5ten Quartals der Jugendzeitung sehe ich mich genötigt, den Lesern das offenherzige Geständnis zu tun, daß es mit dem Zeitungswesen nicht anders, als mit andern menschlichen Dingen beschaffen ist: überall schleichen sich Irtümer und Täuschungen neben der Wahrheit ein. Am meisten geschieht dieses alsdenn, wenn meine Herren Korrespondenzen nicht fleißig und prom[p]t sind, und mich in der Notwendigkeit lassen, andern öffentlichen Blättern zu folgen. Auf diese Art habe ich z.B. ohne Grund den Cottaberg (St. 30, S. 235) und den Gleichberg (32, 242) einen gewaltigen Dampf und eine Menge Steine auswerfen lassen, und dadurch vielleicht manche zärtliche Gemüter in Furcht und Schrecken versezt; weswegen ich sie hier inständig um Verzeihung bitte."

A Grand Hoax?

German climatologist Rüdiger GLASER calls the story of the Gleichberg one of the more obscure speculations in the discourse on the origin of the dry fog.[566] The tone of these stories is altogether more alarming and sensational than most others circulating at the time. Reports of several volcanic eruptions within the German Territories were terrifying, especially in the context of the many earthquakes that rocked other parts of Europe in 1783. How did these fallacious rumors find their way to print? Was it just a hoax fabricated by an unknown perpetrator to generate panic?

The news about a German volcanic eruption quickly crossed borders. The story of "Mount Gleichberg" was printed in the *Whitehall Evening Post,* the *Morning Herald and the Daily Advertiser* on 12 August 1783. John GRATTAN and his colleagues studied the case further, using English and German newspaper articles and geological information. Their aim was to determine whether it is possible to reconstruct geological events from historical documents, a technique they refer to as "excavating words." They concluded that it is very unlikely the Gleichberg erupted in 1783. Perhaps if the eruption was said to have taken place in a more distant period, in Roman times, for example, they might not have been so certain.[567]

Regarding the credibility of the accounts published by the newspapers, GRATTAN and his team admit that some of the statements are quite detailed and convincing.[568] The correspondent, who seemingly knew what to expect of a volcanic eruption, could have intended "to exploit the fear and panic that was becoming widespread in Europe from early July [1783]."[569] They conclude that "the original reports described above were either an elaborate hoax or the result of a genuine misunderstanding."[570]

It seems probable that the stories of these volcanic "eruptions" were ultimately unsuccessful attempts to explain the strange weather; it was known at the time that the Gleichberg, and the other mountains, were of volcanic origin, so it was not impossible to imagine that they might have come back to life. This, coupled with what felt like an urgent need for an explanation, might have forced the correspondent(s) to jump to certain conclusions. This was a mere eight days after the arrival of the dry fog in the German Territories, which meant whoever had written this account did not yet know that this was a country-wide, and indeed Europe-wide, occurrence. A local occurrence naturally would have a local source.

Newspapers at the time were subject to strict censorship regarding local news. To circumvent this censorship, they tended to print news from other regions.[571] The

566 GLASER 2008: 234.

567 GRATTAN, GILBERTSON, DILL 2000: 311–314. The principle of "excavating words" was established by Stefi WEISBURG (1985: 91–94).

568 GRATTAN, GILBERTSON, DILL 2000: 313.

569 GRATTAN, GILBERTSON, DILL 2000: 313.

570 GRATTAN, GILBERTSON, DILL 2000: 314.

571 GRATTAN, BRAYSHAY 1995: 127; WÜRGLER 2009.

correspondent must have known that the people who would read this letter would not be local. Thus, any motive for a hoax that depends on the correspondent's inclination to whip up some panic can be dismissed because the people in the correspondent's locality would likely never read the report. Additionally, as the correspondent put pen to paper, for all they knew, the towns in which their reports would be printed could have been basking in sunshine and unlikely to be shaken by news of a distant weather event.

The Gleichberg and Cottaberg reports appeared almost at the same time. The Cottaberg story was based on a letter from 1 July 1783 and printed on 8 July 1783 in Berlin; the Gleichberg story was based on a letter from 24 June 1783 and printed on 12 July 1783 in Augsburg. Both reports were printed for the first time within five days of one another in different parts of the German Territories. Newspapers almost always printed extracts from letters they received anonymously, only stating the letter's date and place of origin. As the correspondents in both cases were anonymous, it is possible that they were one and the same person. This assumes, however, that one correspondent would know about mountains of volcanic origin in different parts of the German Territories. Could it have been possible that it was two hoaxers working in tandem? Possibly, however, this interpretation works on the assumption that at least one of them had a basic idea of ancient volcanic activity within the German Territories and also had the will and the inclination to orchestrate a multi-person hoax. And then, the question that appears so obvious when we consider that two or more of these eruptions were part of a grand hoax is, of course, why would one report be so rich in detail and highly dramatic and the other less so?

And so, if we reason that these were independent incidents, with no element of human communication between them, to assume they were hoaxes would be to assume that several people, independently of one another and within a short space of time, conjured up the same plan. Therefore, I argue that the Gleichberg, Cottaberg, Roßberg, and Gottesberg eruptions were genuine attempts to explain and link unusual phenomena that were otherwise impossible to explain. A persistent dry fog, a sulfuric smell, breathing difficulties, sore eyes, and withered plants were all conveniently explained by the local volcano.

A Time of a Subsurface Revolution

Physician Christian Ludwig (1749–1784) published a report in the *Leipziger Magazin zur Naturkunde, Mathematik und Oekonomie*, in which he and his friend, Carl Friedrich Hindenburg, one of the editors of the journal, discussed the thick fog. Ludwig calls this "the currently fashionable conversation" (*Modegespräch*) and notes the

contemporaneous occurrence of the dry fog and the Calabrian earthquakes; he believed both events to be connected.[572]

Ludwig was not alone in his assessment. The idea that strong earthquakes in Calabria had caused the dry fog came to be one of the most popular theories regarding its origin. The thinking behind the theory was that subterraneous winds and fermentation processes had initiated violent chain reactions underground, which were then expressed by volcanic eruptions and earthquakes in Italy and beyond. These violent occurrences released flammable air through cracks in the Earth caused by earthquakes. For proponents of this idea, questions regarding the origin of the dry fog could be put to bed. With the matter seemingly settled, for some, there was no reason to look elsewhere.

Based on newspaper reports, it is clear that this theory was in circulation as early as July 1783. A few, like this correspondent, still appeared to be on the fence:

> Some naturalists want to assign the dry fog to the revolution caused by the earthquake in Messina and Calabria, as subsurface roars [*unterirdisches Getöse*] have been heard in different parts of Germany and France. Others say that during the dry season of the year, these sort of fogs are normal.[573]

The last remark is an oblique reference to Joseph de Lalande's theory. Some newspaper reports hoped to debunk the theory that the Calabrian earthquakes caused the dry fog by promoting de Lalande's theory: "Herein [de Lalande's theory] and not within the earthquakes lies the cause this appearance."[574]

The idea that the Calabrian earthquakes had a connection to the unusual weather was given further credence with the news that a similar fog had allegedly occurred during the first tremors in February 1783. Furthermore, the earthquakes in Calabria were far from over; on 8, 11, and 12 June 1783, aftershocks occurred, and on 20 June 1783, another unusual fog appeared.[575] Johann Wiedeburg remarked that the disappearance of

572 Ludwig 1783: 211–212.

573 The term can be found as early as 11 July 1783: Hamburgischer Unpartheyischer Correspondent, 11 July 1783: Report from the Lower Elbe, 10 July 1783. "Einige Naturforscher wollen selbigen [den Nebel] der durch das Erdbeben in Meßina und Calabrien verursachten Revolution zuschreiben, weil man in verschiedenen Gegenden Deutschlands, auch Frankreichs, ein unterirdisches Getöse gehört habe. Andere sagen, daß bey einer anhaltenden tröckenen Jahrszeit dergleichen Nebel gewöhnlich wären." Hannoverisches Magazin, 15 September 1783.

574 Berlinische Nachrichten, 15 July 1783: 654: Report from Stuttgart, 1 July 1783. "Von den vielen Gewittern, Regen, Wolkenbrüchen, und Ueberschwemmungen, womit so manche Gegenden heimgesucht worden, steigen eine Menge Dünste auf, die sich sonst in der Luft zu zerstreuen pflegen, aber jetzt von der kühlen, herbstgleichen Witterung verdickt, und folglich daran verhindert werden. Hierinn und nicht im Erdbeben liegt die Ursach dieser Erscheinung."

575 Berlinische Nachrichten, 17 July 1783: 664: Report from Naples, 24 June 1783; Wiedeburg 1784: 63–64.

the dry fog at around the time of the cessation of the last earthquakes in Calabria and Sicily suggested a direct connection between them.[576] The *Berlinische Nachrichten* commented on an earthquake in France on 6 July 1783 with the following: "One has noticed that the local, strange fogs have ceased once the tremors began in Dijon and Besançon."[577] The report not only suggests a connection but goes further and suggests that the earthquakes had a role in dispersing the fog. That said, another report printed in the same newspaper one week later suggested the opposite: "The latest reports from Messina tell us that for some weeks, there has been such a thick fog here that one person can barely see another; since [this occurrence began] one has not felt any earthquakes."[578] These conflicting reports undoubtedly added to the confusion about the connection between the fog and the earthquakes.

Italian naturalist Michele Torcia (1736–1808) suggested that the dry fog was the thickest and most sulfurous in southern Italy, where the epicenters of the Calabrian earthquakes had been and where the aftershocks still rattled the Earth.[579] Guiseppe Toaldo also linked the dry fog in northern Italy to the Calabrian earthquakes, suggesting that winds from the south "may have carried with them a large mass of exhalations."[580] What struck him as strange, but did not push him to reevaluate, was that the dry fog did not seem to be an exhalation from below; rather, it seemed to have "proceeded downwards as if it had fallen from the atmosphere."[581] Robert de Lamanon postulated a slightly more complex set of events, which was necessary, he thought, as the Calabrian earthquakes had taken place in February 1783, and the dry fog only appeared in mid-June, "that is to say, [not] till more than four months after."[582] He believed that when the exhalations rose to the sky, they lingered until they became saturated and fell back to Earth, where they formed the fog. Robert de Lamanon believed Toaldo to be a reliable naturalist but suggested he might not have known that the dry fog was not unique to Italy.[583] This kind of critical interaction was becoming commonplace, as we have seen.

576 Wiedeburg 1784: 77–78.

577 Berlinische Nachrichten, 2 August 1783: 715: Report from Paris, 19 July 1783. "Man hat die Bemerkung gemacht: daß die hiesigen sonderbaren Nebel aufgehört haben, da man die Erdstöße von Dijon bis Besançon verspürte."

578 Berlinische Nachrichten, 9 August 1783: 739: Report from Naples, 20 July 1783. "Die neuesten Berichte aus Messina bringen mit: daß daselbst seit einigen Wochen ein so dicker Nebel vorhanden sey: daß ein Mensch den anderen kaum erblicken könne; seit dem habe man auch keinen Erdstoß mehr verspürt."

579 Torcia 1783b: 840; McCallam 2019: 230.

580 Toaldo 1784; Toaldo 1799: 419 (quote); Grattan, Brayshay, Sadler 1998: 26.

581 Toaldo 1799: 419.

582 Lamanon 1799: 86–87.

583 Lamanon 1799: 86–89.

Jacques Antoine Mourgue de Montredon and German naturalist Christoph Gottfried Bardili developed surprisingly similar theories to explain the cause of the numerous earthquakes and volcanic eruptions occurring in Europe. Bardili suggested that Europe's current geological mood swings were down to a subterraneous fire. Furthermore, he believed an earthquake in one location could activate the fiery parts (*Feuertheilchen*) of another location, even over great distances.[584] In the autumn of 1783, Mourgue de Montredon wrote about these underground fires (*des feux souterrains*) and traced the path they had taken. He followed this "subterraneous revolution" from the newly emerging island off the coast of Iceland and the volcanic eruption near Mount Hekla (which later turned out to be the Laki eruption) through Europe, past the Gleichberg and Calabria, and all the way to the earthquakes in Tripoli. This "fiery path" underneath Europe, according to Mourgue de Montredon, had left volcanic eruptions, earthquakes, sulfuric exhalations of flammable air, and thick fog in its wake.[585]

The *Münchner Zeitung*, too, opined that recent events seemed "to indicate a violent revolution of planet Earth" and continued, "this leads to the presumption that planet Earth is attempting to discharge an enormous overload of subsurface sulfur and other combustible materials [. . .] into the atmosphere via strong eruptions or volcanoes."[586] This idea was grand enough to fit with Franz von Beroldingen's assertion that an extraordinary phenomenon needed an extraordinary explanation.[587]

While news of the Calabrian earthquakes had been present in the media since the spring, reports of other earthquakes poured in over the summer and autumn, further stoking the (subterraneous) fire. The *Berlinische Nachrichten* summed up these concerns in a letter that concluded, "[. . .] the whole of Europe seems to have been plagued by this horror."[588] The idea of a subsurface revolution was much more than a fringe theory, for it had been seemingly corroborated by naturalists such as Mourgue de Montredon, Bardili, von Beroldingen, and Wiedeburg, among others.

In his book, Wiedeburg remarks that early "naturalists believed the occurrences of volcanoes and earthquakes to be the mere impact of mineral vapors and air that were locked in subterraneous cavities."[589] Wiedeburg is leaning on Aristotle's idea, which

584 Bardili 1783: 9–10. The preface in his book is dated to 9 July 1783.

585 Mourgue de Montredon 1784: 757–761.

586 Münchner Zeitung, 15 July 1783: 433. For the German original, see above.

587 Beroldingen 1783: 9–12.

588 Berlinische Nachrichten, 18 September 1783: 868–869: Report from Paris, 4 September 1783. "[. . .] also ist das ganze Europa von diesem Schrecken heimgesucht worden."

589 Wiedeburg 1784: 30. "Schon die ältesten Naturforscher hielten die Erscheinungen der Vulkane sowohl als der Erdbeben vor eine blose Wirkung unterirdischer mineralischer verschlossener Dünste und der Luft in Höhlungen."

proposed that the Earth's interior consisted of gases and that earthquakes and volcanic eruptions were the consequences of subterraneous winds that released flammable materials.[590] Aristotle's *Meteora* and other knowledge from antiquity were still commonly referenced in the eighteenth century.[591] The idea of *subterraneous* fires that rage beneath our feet was not new. Athanasius KIRCHER had already postulated in 1665 that all volcanoes were connected by fire channels, as mentioned above; he also argued that chemical reactions in subterraneous passages and caverns caused earthquakes and volcanic eruptions.[592] In the eighteenth century, Nicholas LÉMERY, Georges-Louis LECLERC, Comte DE BUFFON, and Immanuel KANT promoted these ideas. The sheer number of unusual subsurface phenomena and their purported accidental nature overwhelmed many in 1783. The subsurface *revolution* hypothesis was a grand, overarching, and satisfying explanation. Historian of geology Rhoda RAPPAPORT distinguishes accidents and revolutions with the following statement: "Accidents are always local, revolutions usually so. But an accident is merely local and thus not very important, while revolutions are part of a recurrent, common pattern."[593]

To the contemporaries, it seemed that there was more seismic and volcanic activity than ever before, but this was not true. News of such events simply traveled faster and further than ever before.[594] It is also possible that people of the time suffered from a cognitive bias called frequency illusion, which shaped their perception of the news. In this case, after experiencing their first earthquake or reading sensational stories about such events, they were more likely to notice reports on earthquakes than ever before.

Elektrizitätstaumel: Are Lightning Rods to Blame?

The eighteenth century saw the spread of "a true 'electricity delirium' in Germany."[595] Electricity became the explanation par excellence; everything that had previously

590 ROHR, VLACHOS 2010: 467–474; CRAIG 2011: 62–64.

591 OESER 2003: 13–16; DEMARÉE et al. 2007; GLASER 2007: 793.

592 ZIEHEN 1783, vol. 1: 45–46.

593 RAPPAPORT 1982: 40–41.

594 Conevery Bolton VALENCIUS (2015: 197) found that there was "a sense of global interconnection" in the aftermath of the 1811–1812 New Madrid earthquakes: reports of the New Madrid earthquakes were mentioned together with other, seemingly simultaneous, events around the globe, such as earthquakes or volcanic eruptions, which were perceived as "terrestrial symptoms of deep and powerful disturbance."

595 CAPPEL 1986: 20.

been hard to explain became a byproduct of electricity.[596] The idea that lightning rods might even make cities earthquake-proof was still entertained. To some, it seemed too much of a coincidence that those cities severely affected by earthquakes, such as Lisbon and Messina, were those without lightning rods.[597] The technological optimism in the 1780s was boundless, and many thought rain and hail rods were conceivable.[598] At the height of the fever pitch, in the *Münchner Zeitung*, a perhaps exasperated correspondent commented: "We do not see why one always has to include electrical matter in everything [. . .]."[599] It is, therefore, unsurprising that naturalists also attempted to explain the presence of the Laki haze with hypotheses involving electricity.

In the late eighteenth century, lightning rods were installed in great numbers across Europe, changing how people viewed nature.[600] However, doubt remained and some questioned whether they were a step too far. The proponents of the lightning rods argued that their installation was an act of self-preservation, just as flood barriers were.[601] God had given humanity intellect, by which means they were able to invent the lightning rod in the first place. Would God have allowed the invention of the lightning rod if it was not part of His plan?[602]

The new technology elicited new questions.[603] Would the fertility of agricultural fields decline if lightning could not strike naturally? Would the lightning rod cause rainfall to decrease? Could the rods cause an imbalance that would precipitate earthquakes?[604] The severe thunderstorms of 1783 led to a sharp increase in the uptake of lightning rods; this, ironically, led to suggestions that the lightning rods had caused the many thunderstorms.

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596 This also applies to the Calabrian earthquakes: Christoph Gottfried Bardili (1783: 1–10) suggested the Calabrian earthquakes had increased the electricity on the Earth's surface, which attracted the fog and prevented it from dissipating. A similar theory was posited in the *Königlich Privilegirte Zeitung* on 9 August 1783; Königlich Privilegirte Zeitung, 9 August 1783: Report from Mannheim, 27 July 1783.

597 Riskin 1999: 73; Dross 2004: 301; Hochadel 2009: 50–51; Behringer 2011: 203–204. There are exceptions to this train of thought. In 1755, after Boston and much of New England had been affected by the magnitude 5.9 Cape Ann earthquake off the coast of Massachusetts, it was debated whether the installation of a lightning rod was in itself a blasphemous act. The Franklin rod was a brand-new invention at the time. Benjamin Franklin, who was originally from Boston, invented them. And in 1755, Boston had more lightning rods than any other town in New England – and, coincidentally or not, Boston seemed to have been "more deadfully shaken" than any other town, as claimed by the reverend Thomas Prince, who published about this; Tilton 1940: 85–97.

598 Fischer 1784: 99–100; Wiedeburg 1784: 46; Briese 1998: 23.

599 Münchner Zeitung, 10 July 1783: 422. "Wir sehen nicht, warum man immer die elektrische Materie überall ins Spil ziehen; oder ihr die Kraft eines Monstrums beilegen soll."

600 Begemann 1987: 90.

601 Cappel 1987: 20; Kittsteiner 1987: 20.

602 Schelhorn 1783: 16–17.

603 Kittsteiner 1987: 26; Riskin 1999: 77; Hochadel 2003: 151.

604 Münchner Gelehrte Zeitung, June 1783: 44–48: "Von der Unschädlichkeit der Blitzableiter." Weigl 1987: 13; Hochadel 2009: 50.

Newspapers reveled in the back-and-forth frenzy the rods had ignited. These questions formed the basis for a clash between the established religious authority and scientific rationalization. The latter was in its infancy and seemed a weak replacement for the traditional and time-tested religious explanations.[605] Although strong resistance to the installation of lightning rods was uncommon in the long run, they remained under fire from a vocal minority and were eyed suspiciously by those looking for quick answers.[606] "If one thinks how common the weather rods have become [. . .], one naturally has to think that this invention could have contributed a lot to the current foggy haze [*Nebeldünsten*] [. . .], which otherwise would have been absorbed by the lightning or the northern lights."[607] In this instance, the correspondent insists the rods gave rise to the fog and blames the Dutch, who happened to be fond of Franklin's new invention, for exacerbating this sad situation.

In 1783, there was rarely a distinction made between thunder and lightning.[608] German-language sources of the time indicate that a thunderclap was still considered dangerous.[609] Once there was a distinction, the lightning rod became a tool to disarm God.[610] Thunder, too, became a tool used as a means to determine the distance of a storm.[611] Thunderstorms were no longer random but rather one part of nature.[612] This realization led to a growing disenchantment with nature.[613] However, at the end of the eighteenth century, superstitious explanation strategies still had a strong foothold, partly because naturalists were not always successful in their efforts to convey new scientific ideas to the general public in a comprehensible manner.[614] Nevertheless, progress and reasoning led to a decline in apocalyptic proclamations in the late eighteenth century, as the lightning rod continued to protect both those who championed it and those who did not.[615]

605 Briese 1998: 20–21.

606 Hochadel 1999: 145; Dross 2004: 284–294, 302.

607 Münchner Gelehrte Zeitung, 29 August 1783: 60. "Denn denket man nach, wie sehr der Gebrauch der Wetterableiter seit einigen Jahren in Aengelland, und in den Niderlanden überhandgenommen, und fast zum Misbrauch geworden, so mus man natürlicher Weise auf den Gedanken fallen, das dise Erfindung viles zu den izigen Nebeldünsten beigetragen haben könne. [. . .] Was kann natürlicher daraus folgen, als das die aufgezogenen Schwefeldünste, welche sonst durch das elektrische Feuer oder Wetterleuchten verzehrt wurden, in der Luft zurükbleiben, und denjenigen trokenen Nebel verursachen, den uns die Niderländer bisher mit ihrem Winde so häufig zugeschickt haben."

608 Missfelder 2009: 91.

609 Schelhorn 1783: 20.

610 Begemann 1987: 79.

611 Missfelder 2009: 91–92.

612 Kittsteiner 1987: 21, 25; Greyerz 2009: 46; Reith 2011: 88–92.

613 Weber 1993; Graf 2006: 342; Lehmann 2009: 9, 19–20.

614 Schmidt 1999: 310.

615 Fleming 1998: 6–7.

The Fireball

In Britain, 18 August 1783 was another hot and sultry summer's day. It had been a "clear" day at Gordon Castle in the Scottish Grampians.[616] Thomas Barker describes the weather as "sunny and hot & calm" in Leicestershire.[617] Similarly, William Hutchinson of Liverpool remarks that it was "mostly hazy, but [with] some faint sunshine, warm and pleasant."[618] James Woodforde of Weston Longville, Norfolk, also writes of hot weather that day: "Morn very fair & very hot, Afternoon ditto."[619]

As this hot day drew to a close, something extraordinary happened. In the twilight hours, with many still out and about, William Cooper, at Hartlepool, near Stockton, notes:

> something singularly striking in the appearance of the night, not merely from its stillness and darkness, but from the sulphureous vapours which seemed to surround us on every side. In the midst of this gloom, and on an instant, a brilliant tremulous light appeared to the N.W. by N.[620]

Sometime between 9:15 p.m. and 9:30 p.m., a meteoroid entered the atmosphere somewhere over the North Sea to the north of Scotland.[621] This bolide – a bright meteor – shot over the eastern parts of Scotland and England at great speed. Next, it crossed the Channel, illuminating the skies over the Austrian Netherlands (today's Belgium) and northeastern France (Dunkirk, Calais, Ostend, Brussels, and Leiden). It continued toward southeastern France and northern Italy until it struck the Earth's surface, thus becoming a meteorite.[622]

The meteor was described as a fireball or globe of fire. In his painting (Figure 42), Henry Robinson, a schoolmaster from Nottinghamshire, calls it a "*Draco Volans* or flying dragon," a shooting star.[623] At the time of the meteor's appearance, the sky was dark enough over the British Isles and mainland Europe for it to produce a stark

616 T. Hoy, Private Weather Diary for Gordon Castle, Grampian, Scotland, MET/2/1/2/3/486, National Meteorological Library and Archive, Met Office, Exeter, UK.

617 Thomas Barker, Private Weather Diary for Lyndon Hall, Leicestershire, MET/2/1/2/3/227, National Meteorological Library and Archive, Met Office, Exeter, UK, 18 August 1783: 201.

618 William Hutchinson, Private Weather Diary for Liverpool Dock, MET/2/1/2/3/230, National Meteorological Library and Archive, Met Office, Exeter, UK.

619 James Woodforde, Weather Diary for Weston Longville, Norfolk, vol. 10: 1782–1784, MET/2/1/2/3/467, National Meteorological Library and Archive, Met Office, Exeter, UK, 18 August 1783.

620 Cooper 1784: 116. It is important to note here that Cooper wrote his letter to Banks on 19 August, the day after this event, so his impressions of the meteor were still very fresh.

621 The times the meteor was observed vary greatly, but most are within this 15-minute window. An asteroid has a size larger than one meter in diameter, whereas meteoroids have a diameter between one centimeter and one meter. Shooting stars are only a few millimeters in size. Meteoroids become meteors when they enter the Earth's atmosphere. Meteors become meteorites when they hit the surface of the Earth.

622 Payne 2011: 21. Evidence for Burgundy and Belgium: Demarée, Ogilvie 2016: 142. Evidence for Calais, Dunkirk, and Ostende, Blagden 1784: 203–204. Evidence for Brussels, Leiden, Payne 2011: 21.

623 Burke 1986: 6.

contrast against the evening gloom.[624] British amateur astronomer and businessman Alexander AUBERT (1730–1805) estimated that the meteor's brightness equaled that of two full moons.[625] It traversed the sky from the northwest to the southeast.[626] The meteor was extraordinary because it was visible for quite some time, somewhere

Figure 42: A contemporary depiction of the Great Meteor. Henry ROBINSON, "An accurate representation of the meteor," as seen at Winthorpe, Nottinghamshire, England, on 18 August 1783. © The Trustees of the British Museum. Shared under a Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International (CC BY-NC-SA 4.0) license.

624 At Windsor, England, the sun set at 7:17 p.m. and astronomical twilight ended at 9:36 p.m. At 9:17 p.m. or 9:23 p.m., by the time the fireball appeared, it was very dark. Although it was not proper night yet, most stars should have been visible. The moon was a little fuller than a half moon that night, almost in its third quarter. In Blair Athol, Scotland, the sun set at 7:46 p.m., nautical twilight (which is lighter than astronomical twilight) ended at 9:28 p.m., so the sky was illuminated by the sun a little bit more than in Windsor when the meteor was visible; based upon information from the Time and Date website.

625 AUBERT 1784: 274.

626 John ATKINS, "The Meteorological Journal for the Year 1783. Kept at Minehead in Somersetshire by Mr. John ATKINS. Presented at the Royal Society in London on 19 January 1786," MA/166, Archives of the Royal Society, London, UK; Thomas HUGHES, Private Weather Diary for Stroud, Gloucestershire, MET/2/1/2/3/410, National Meteorological Library and Archive, Met Office, Exeter, UK, August 1783.

between 12 and 30 seconds, and traveled an estimated 1,600 to 1,900 kilometers, which is an exceptional distance (Figure 43).[627]

A number of private weather observers noticed the meteor and wrote brief journal entries about it. Many were in awe; some were frightened.[628] The man depicted in Figure 42 seems to be taken aback by the sight, even raising his hands as if to take a defensive position while observing the meteor, which at this point has already broken up into one principal fireball and several smaller fireballs that make up its tail (Figure 44). Joseph Banks, then the president of the Royal Society of London, made the timely decision to collect accounts of the meteor's passage.[629] In 1784, many of these accounts were published in the *Philosophical Transactions of the Royal Society*. Historian Noah Moxham views these efforts as an example of "crowd-sourcing" in eighteenth-century science.[630]

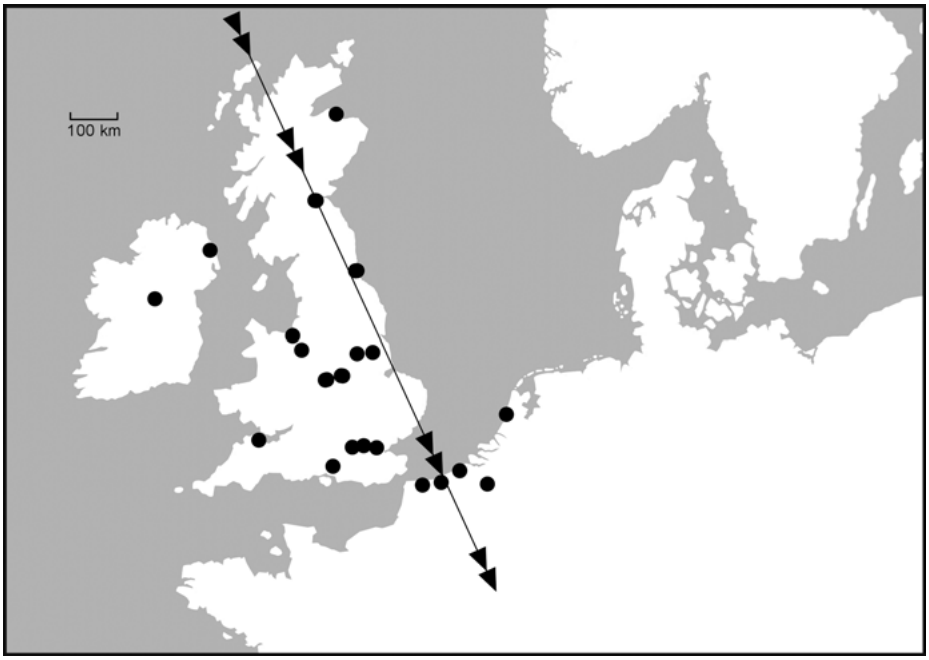

Figure 43: The approximate path of the meteor on 18 August 1783.

627 Beech 1989: 131; Demarée, Ogilvie 2001: 229; Payne 2011: 20–23; Witze, Kanipe 2014: 115–116.
628 Cooper 1784: 116–117.
629 Beech 1989: 130–132.
630 Moxham 2013.

Figure 44: Paul SANDBY's watercolor, "The Meteor of 1783, as seen from the East Angle of the North Terrace, Windsor Castle." The watercolor shows the procession of the meteor and portrays the most famous spectators of this event.[631]

In one contemporary account, Alexander AUBERT states that the haze obscured any stars below eight degrees; however, some naturalists put this figure at up to 20 degrees. AUBERT asserts further that even though the meteor "had got high enough to be quite out of the hazy part of the horizon, it was surrounded and accompanied in its whole course with a kind of whitish mist or light vapour."[632] This information is crucial; it shows that the Laki haze still lay thickly on the horizon. Observers wondered whether the omnipresent haze gave the meteor its bluish and later red color.[633] From Mullingar in Ireland, the meteor appeared in "the most vivid colours; the foremost part being in the brightest blue, followed by different shades of red."[634]

The *Gentlemen's Magazine*, a London-based monthly publication of letters and reports from Britain, continental Europe, and beyond, published several reports about the "uncommon meteor." An anonymous author stated that they presumed

> [it] may have been occasioned by some of the vapours issuing from the volcanoes upon the New Island lately sprung up in the ocean, about nine leagues to the S.W. of Iceland, or perhaps only from that profess exhalation of vapours occasioned by the excessive warm and dry weather we have experienced this summer.[635]

631 BEECH 1989: 130–134.

632 AUBERT 1784: 112–115, 113 (quote). Tiberius CAVALLO (1783: 108–111) estimated the stars at Windsor had set 18 to 20 ° above the horizon; STOTHERS 1996: 83–84.

633 CAVALLO 1784: 109.

634 EDGEWORTH 1784.

635 Gentleman's Magazine 1783: 711–713.

News about the fireball(s) spread. In the German Territories, the first reports appeared on 30 August 1783.[636] The *Münchner Zeitung* was critical of the British reaction. One correspondent argued thusly: "It seems every country has their prophets of doom, disadvantages, and fools." This statement referred to the fact that in Britain, all efforts seemingly focused on establishing whether this fireball was a bad omen.[637]

In 1783, it was thought outlandish to presume that rocks fell from the sky.[638] It was considered more likely that meteors were simply terrestrial exhalations; this idea persisted throughout the eighteenth century, even though British astronomer Edmond HALLEY postulated an extraterrestrial origin for these rocks in 1714.[639] The European intelligentsia was averse to the idea that meteors could possibly come from outer space. On the other side of the Atlantic, however, the discourse was markedly different: John WINTHROP, a professor of natural philosophy and astronomy at Harvard, wrote a paper on the extraterrestrial origin of meteors, which proved so controversial that the Royal Society refused to publish it.[640] With mounting evidence, the consensus shifted in the early nineteenth century and, gradually, the idea that extraterrestrial rocks came crashing into the Earth's atmosphere from space was accepted.[641]

1783 saw several other fireballs: sightings were reported on 26 September and 4, 19, and 29 October.[642] The most notable of these occurred on 4 October 1783: this fireball was visible above Britain, lasting three or four seconds. Descriptions include several discrepancies regarding its size, color, and trajectory.[643] Surprisingly, there was confusion over how to differentiate meteors from hot-air balloons; few people had seen either of these "flying balls" with their own eyes.[644]

636 Berlinische Nachrichten, 30 August 1783: 305: Report from Nieuwerkerk, 19 August 1783.

637 Münchner Zeitung, 8 September 1783: 559.

638 BLAGDEN 1784: 201. Even Aristotle believed comets to be meteors in the higher parts of the atmosphere. In the sixteenth century, Tycho BRAHE showed that comets were astronomical phenomena; BURKE 1986: 6.

639 BURKE 1986: 5–8.

640 MOXHAM 2013.

641 BURKE 1986: 11, 37–58; PRINCE 1986: 102–103; BEECH 1989: 132–134.

642 PAYNE 2010: 4; WITZE, KANIPE 2014: 117.

643 BLAGDEN 1784: 219–212: BLAGDEN was based in London. On 4 October 1783, the sun set there at 5:30 p.m. It was already fairly dark at 6:43 p.m., and the meteor occurred during astronomical twilight, the third phase of twilight that occurs just before it becomes proper night, based on the Time and Date website. Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 143.

644 Parker's General Advertiser and Morning Intelligencer, 9 October 1783; ALEXANDER 1996; PAYNE 2011: 23. This is not only true for Britain, but also for Germany. In the Münchner Zeitung, a report about the "fire balls" in England was followed by an article about "artificial meteors," which referred to hot-air balloons; Münchner Zeitung, 8 September 1783: 559–560. Another report stated that these

In May 1784, Benjamin Franklin wrote a letter to his friend, the Manchester physician Thomas Percival (1740–1804), who read it at a meeting of the Manchester Literary and Philosophical Society on 22 December 1784. In his letter, Franklin offered an explanation for the dry fog of the previous year: he suggested meteors might be to blame.[645] The following passage from Franklin's letter is particularly interesting:

> The cause of this universal fog is not yet ascertained. Whether it was adventitious to this earth and merely a smoke proceeding from the consumption by fire of some of those great burning balls or globes which we happen to meet with in our rapid course round the sun, and which are sometimes seen to kindle and be destroyed in passing our atmosphere, and whose smoke might be attracted and retained by our earth.[646]

Franklin was familiar with the American discourse on meteors and corresponded with American astronomer David Rittenhouse (1732–1796).[647] Thus, he was drawn to the idea that the Laki haze was in some way connected with the fireball that was visible in August, even though this fireball arrived two months after the dry fog's initial appearance.

Experiments on the Origin of the Dry Fog

Several naturalists were inspired to conduct experiments on the fog, some of which were physically demanding, even dangerous. Independently of one another, Johann Wiedeburg in Jena and Benjamin Franklin in Passy conducted tests that seemed to show that the fog weakened solar radiation. Wiedeburg outlined how he tried to melt lead with the help of a magnifying glass. In previous experiments with the same equipment, the lead had begun to melt after ten minutes; in this instance, it resisted.[648] In his letter to Manchester, Benjamin Franklin remarked upon his version of the experiment, stating that the rays of the sun "were indeed rendered so faint in

balls were "no terrible air phenomena, but only machines made from light canvas und covered by paper that cannot cause bad luck [. . .]"; Königlich Privilegirte Zeitung 18 September 1783: 882–883: Report from Paris, 5 September 1783. "Diejenigen also, welche dergleichen Kugeln, welche das Ansehen des verdunkelten Mondes haben, am Himmel entdecken sollten, werden hierdurch benachrichtiget, daß es gar keine fürchterliche Lufterscheinung, sondern nur von Taft oder leichter Leinwand gemachte und mit Papier überzogene Maschinen sind, die kein Unglück stiften können [. . .]."

645 Payne 2011: 23.

646 Franklin 1785: 373–377.

647 Rittenhouse 1786: 173–176; Burke 1986: 17–24; Payne 2010: 2–5; Franklin 2017: 293.

648 Wiedeburg 1784: 70.

passing through [the fog], that when collected in the focus of a burning glass [magnifying glass], they would scarce[ly] kindle brown paper."[649] FRANKLIN's results corroborate the findings of WIEDEBURG's experiment.[650]

Johann WIEDEBURG conducted other experiments, including collecting dew from the fog and – in the spirit of the Enlightenment – tasting it.[651] He was not the only one who used his body for the advancement of science. Georg Christoph LICHTENBERG, despite having a laboratory full of equipment at his disposal, used his body as a "trained instrument." In a letter, he humorously remarks, "my body is, as one can expect of the body of a physics professor, a never-disappointing barometer, thermometer, hygrometer, manometer, etc." He did not believe the dry fog had deleterious consequences, as he did not experience any.[652] Sebald Justinus BRUGMANS also tasted the dry fog; it is unclear if this was deliberate or whether, during the peak of the dry fog in the Dutch Republic, anybody could avoid tasting it.[653]

Many reported that they could look directly at the sun without any injurious effects. WIEDEBURG even peeked at the sun through a telescope with his naked eye without "punishment."[654] Jan Hendrik VAN SWINDEN, who first noticed the haze in Franeker on 19 June 1783, noted the "deep red" color of the sun, which he too dared to stare at, at midday no less, without apparent damage to his retina.[655]

VAN SWINDEN also detailed an account relayed to him by M. DU VASQUIER of Neuchâtel, Switzerland, who had waited for particularly foggy days and left presumably mediocre paintings exposed in a meadow for quite some time, which resulted in the discoloration of the canvas. "The red of the paintings first became orange, then purple when washed with water. The black paint was partly washed away. The purple lost its vivacity."[656] An attempt was made to reproduce these results using different acids with known chemical reactions; for this purpose, DU VASQUIER colored a canvas with red, violet, and black and then immersed half of it in diluted acid. A similar result was obtained, particularly with nitric and sulfuric acid. DU VASQUIER was convinced that these chemicals, or chemicals with similar properties, resided within the dry fog.[657]

649 FRANKLIN 1785: 259–361; PAYNE 2010: 3.

650 GLASER 2001: 204.

651 WIEDEBURG 1784: 70.

652 LICHTENBERG 1985: 640, Letter 1102, Georg Christoph LICHTENBERG to Gottfried Hieronymus AMELUNG, Göttingen, 3 July 1783. "Mein Körper ist, wie es sich für den Cörper eines Prof. Physices geziemt, ein nie versagendes Barometer, Thermometer, Hygrometer, Manometer pp. allein ich empfinde von diesem Nebel keine besondere Wirckung; wir haben ihn hier sehr starck, und bemercken auch allerley, aber nichts was sich nicht auch von einer trockenen Hitze erwarten liese. Man kan bey solchen Dingen nicht genug zweifeln."

653 BRUGMANS 1783: 58.

654 WIEDEBURG 1784: 70.

655 VAN SWINDEN 2001: 78–79.

656 VAN SWINDEN 2001: 78–79.

657 VAN SWINDEN 2001: 73, 78–80.

Christoph Gottfried Bardili, upon reading reports from the German Territories about the smell of sulfur that was said to have accompanied the fog, became convinced that it must partially consist of sulfur. He suggested an experiment whereby a piece of silver would be left exposed to the haze. If the silver turned black – then a known result of a reaction of sulfuric particles with this precious metal – one could ascertain if the haze did indeed contain sulfuric particles. He remained doubtful whether the particles were large enough to cause a reaction and concluded that even if the silver objects did not turn black, there could still be sulfuric particles in the dry fog.[658]

In Paris, members of the local observatory attached meat to kites and guided them into the haze. The meat was "entirely corrupted," which was seen as proof that the haze had a deleterious effect on organic material and possibly human health.[659]

News from Iceland

As Iceland was a Danish dependency, news from the island was usually disseminated throughout Europe via Copenhagen.[660] The revelatory story of the Laki eruption was published in *Kjøbenhavns Adresse-Contoirs Efterretninger* on 5 September 1783. The report described a fire that broke out in the "Skaftefields district" on Whitsunday and dried up the "Skaptaa" River, destroying two churches and eight farmsteads. Smoke, ash, and sand filled the air, covering the whole country in a haze.[661] On 6 September 1783, this news item appeared in the *Hamburgischer Unpartheyischer Correspondent,* apparently

658 Bardili 1783: 12–13.

659 Garnier 2011: 1046; McCallam 2019: 227–228.

660 Demarée, Ogilvie 2001: 220.

661 Kjøbenhavns Adresse-Contoirs Efterretninger, 5 September 1783. The report is based on a letter from Iceland, dated 24 June 1783. A newspaper report in the Münchner Zeitung, 15 July 1783: 433, mentions: "The Danes give us news that Mount Hecla [sic] in Iceland has begun to spit fire and fill rivers with burning lava from its fiery maw. They add that several springs have started to run dry on this ice-covered island." "Die Dänen geben uns bei diser Gelegenheit Nachricht, das der Berg Hecla in Island vil Feuer auszuwerfen, und mit ganzen Strömen von brennender Lava aus seinem Feuerschlunde die Gegenden zu überschwemmen angefangen habe. Sie se[t]zen hinzu, das mehrere Quellen mit siedendem Wasser sich in verschidenen Gegenden diser beeisten Insel eröffnet haben." This news cannot be found anywhere else. It is unclear whether the newspaper really received a letter from a correspondent so early. Nobody else received it or followed up on it. Given that all the news about any unusual natural phenomena was widely shared, it is highly unlikely that the news of a Hekla eruption would have received so little attention. The lava flows in southeastern Iceland appeared on 12 June 1783; even if a report about these events had been written and sent aboard a vessel from Iceland this early, it is unlikely that the news would have reached Munich by mid-July. This is evidenced by the fact that news written on 24 July 1783 reached Copenhagen in early September.

based on a letter from Copenhagen dated 2 September.[662] There remains the possibility that one of the merchant vessels returned in late August rather than early September 1783. A report from Copenhagen, dated 26 August 1783, found its way into the *Berlinische Nachrichten* and was published on 18 September 1783. It included similar details to the previously mentioned report but described a haze that made the "sun gleam like a lump of fire." It sketched out how the "fires" hampered fishing efforts and affected grass growth and the production of milk.[663]

> Ships that have returned from Iceland yesterday relay the unpleasant news that in Skaptefields Syssel [sic], not far from Mount Hekla, several new volcanoes, including Myrdals Jökull [Mýrdalsjökull], have erupted steam and fire, and their lava flooded the Skaptaa [Skaftá] River, along a length of 15 miles and a width of 7 miles, like a stream of water; three churches and a monastery have fallen victim to the lava. The air itself has been filled ever since with a steam and fine dust, which darkened the sun and damages the fields. The newly formed island near Reickenäs [Reykjanes] is ever increasing, it burns and smokes incessantly.[664]

The report contains geographic inaccuracies: Mýrdalsjökull is a glacier that covers the caldera of Katla, which was not part of this eruption. Another glacier, called Vatnajökull, directly borders the Laki fissure. Unsurprisingly, the Laki fissure is not named as such. It is interesting that Hekla is highlighted here. The Laki fissure is closer to Katla than Hekla, but Hekla is singled out, being the more famous of the two.[665]

From September 1783, this report found its way onto the pages of many other newspapers, almost word for word.[666] The news was printed in Hamburg (6 September), Berlin, Stockholm (11 September), Breslau (15 September), Munich, Augsburg, The Hague (18 September), Vienna (20 September), Brussels, St. Petersburg (22 September), Bamberg, London (23 September), Florence (27 September), Paris (30 September), Luxembourg, Bern (1 October), Warsaw (8 October), Madrid (17 October), Lisbon

662 Interestingly, the German newspapers seem to refer back to a letter from Copenhagen on 2 September 1783, while the French newspapers refer to a letter from Copenhagen on 5 September 1783. Perhaps it was a typo or there simply were two letters.

663 Berlinische Nachrichten, 18 September 1783: 686: Report from Copenhagen, 26 August 1783. "[. . .] wenn sie [die Sonne] sich bey Auf- oder Untergange durch die schrecklich dicke Luft zeigt, wie ein Feuerklumpen schimmert."

664 Hamburgischer Unpartheyischer Correspondent, 6 September 1783: Report from Copenhagen, 2 September 1783. "Mit den gestern von Island zurückgekommenen Schiffen erfährt man die unangenehme Nachricht daß in Skaptefields Syssel, unweit dem Berge Hekla, verschiedene neue Vulcane, worunter auch der sogenannte Myrdals Jökull, mit Dampf und Feuer ausgebrochen sind, und mit ihrer Lava die ganze Gegend bey dem Fluß Skaptaa, die eine Strecke von 15 Meilen in die Länge und 7 Meilen in die Breite ausmacht, wie ein Wasserstrom überschwemmt, auch 3 Kirchen und ein Kloster zerstöhrt haben. Die Luft daselbst ist seitdem beständig mit Dampf und feinem Staube angefüllt, der die Sonne verfinstert und die Felder beschädiget. Die bey Reickenäs entstandene neue Insel nimmt immer mehr zu; sie brennt und raucht aber noch unaufhörlich."

665 Frömming 2005: 104, 124.

666 Only the number of destroyed or damaged churches and farms varied slightly.

(24 October), and Barcelona (25 October), among other places.[667] News about the Skaftá Fires did not precipitate any revelatory conclusions concerning the dry fog, which had all but disappeared by this time.[668]

More detailed accounts would eventually make the rounds; for example, on 13 March 1784, the Austrian newspaper *Provinzialnachrichten aus den Kaiserlich Königlichen Staaten* published a four-page-long report about the eruption, with a follow-up on 17 March.[669]

Speculating about a Connection

Some naturalists, independently of each other, considered a volcanic eruption a viable explanation for the fog. It remains debated in the modern scholarly community who was the first to propose the idea.[670]

Dom Robert HICKMANN wrote a letter to the *Journal encyclopédique ou universel* on 29 July 1783, responding to and criticizing Joseph DE LALANDE's theory. HICKMANN's letter was published in the journal's issue on 15 September 1783.[671] He argued, no doubt inspired by Athanasius KIRCHER, that there was a permanent fire in the center of the Earth (*un feu permanent dans le centre de notre globe*) with more or less vertical subterraneous canals forming volcanoes from one pole to the other; some new, some old, and some extinct. He believed the fire moved from one volcano to another (via *canaux de communication*) and caused earthquakes, eruptions, and other convulsions. Concerning the dry fog, HICKMANN rightly assumed that the convulsions (*ces bouleversemens*) in Iceland were more significant than the Calabrian earthquakes. He attributes the "famous dry and sulfuric fog" to the Icelandic "convulsions," by which he meant the formation of Nýey.

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667 Hamburg: Hamburgischer Unpartheyischer Correspondent, 6 September 1783; Berlin: Königlich Privilegirte Zeitung, 11. September 1783: 863; Berlinische Nachrichten, 11 September 1783, more detailed information followed in the issue published on 18 September 1783: 686; Munich: Münchner Zeitung, 18 September 1783: 583; Bamberg: Hochfürstlich-Bambergische wochentliche Frag- und Anzeigenachrichten, 26 September 1783; Augsburg: Augsburgische Postzeitung, 18 September 1783; Paris: Gazette de France, 30 September 1783: 345; Breslau [today's Wrocław in Poland]: Schlesische Privilegirte Zeitung, 15 September 1783: 1099. The other towns and dates have been mentioned by Gaston DEMARÉE and Astrid OGILVIE (2001: 239–240; 2016: 136).

668 WOOD 1992: 70; DEMARÉE, OGILVIE 2001: 239–240.

669 Provinzialnachrichten aus den Kaiserlich Königlichen Staaten, 13 March 1784: 330–333 (part 1), 17 March 1784: 349–350 (part 2).

670 SCARTH 1999: 116; THORDARSON, SELF 2003: 2; GRATTAN et al. 2005: 644.

671 That Dom Robert HICKMANN was one of the first, if not *the* first, to presume a connection between the fog and Icelandic volcanoes is detailed in MONGE et al. 1793: 232–236; HICKMANN 1783: 512. At the end of his report, HICKMANN gives the date as 29 July 1783.

Hickmann admitted that it was strange that the "convulsions" in Iceland took place in March 1783 and the fog only became visible that June; he would not be drawn to pinpoint a fixed time for the fog's first occurrence and suggested that the newspapers did not sufficiently inform the public about the exact date that the dry fog descended upon Europe. He considered it possible that shifting winds had only eventually brought the dry fog to the continent after carrying it here and there.[672] As news from Iceland traveled slowly, Hickmann remained unaware that another "convulsion" was rocking Iceland as he wrote.

Another naturalist who established the connection was Jacques Antoine Mourgue de Montredon. He presented his idea in front of the Société Royale des Sciences in Montpellier on 7 August 1783, about a week after Hickmann had written down his findings.[673] Mourgue de Montredon's work was published in 1784 and was updated after August 1783. This is apparent because the published version includes details about events in Iceland that only reached European ears in early September.[674] Mourgue de Montredon states that the vapors in the atmosphere were a rare phenomenon and of the type that affected the educated reader just as much as the general population. He observed that during the last four days of June, strong northern winds did not disperse the vapors; on the contrary, they seemed to add to their density. Indeed, the fog had never been so thick nor the sun so red as when Boreas breezed by at the close of the month.

Mourgue De Montredon describes a great number of the unusual phenomena of the year, including the eruption of the Gleichberg. The earthquakes and other upheavals of the year led him to believe that the subterraneous fires (*les principaux foyers des feux souterrains*) existed and reached from Iceland to Syria via Calabria. He also acknowledges that he had heard about the emergence of Nýey in early June 1783 and comments on its extremely thick smoke and duration. He wonders rhetorically whether this new volcanic eruption could explain the vapors that hung over Europe. Mourgue de Montredon opined that exhalations from some volcanic eruption overloaded the atmosphere with flammable air, which led to the frequent thunderstorms that had spread across the continent. He also believed the interplay of the flammable air with the atmosphere had caused the "terrible and impressive meteors."[675]

Another naturalist who was very familiar with Icelandic volcanism and who was said to have established the island's connection to the dry fog was Christian Gottlieb Kratzenstein. Originally from Germany, he was then a professor of physics at the University of Copenhagen, where, in the second half of 1783, he presented his hypothesis in a lecture. Sæmundur Magnússon Hólm likely attended this lecture and put this idea to paper, acknowledging Kratzenstein. Hólm writes that when poisoning rain fell

672 Hickmann 1783: 507–512.

673 Mourgue de Montredon (1784: 761) mentions "nouveaux volcans à peu de distance du mont Hecla."

674 His publication also included copies of his daily observations from 1 June to 30 September 1783.

675 Mourgue de Montredon 1784: 754–763.

in Iceland, it soon after fell in Norway, "burnt" the leaves on the trees, and turned the grass in the fields black. Furthermore, he points out that the Faroe Islands experienced sand and ashfall accompanied by a "sulfur vapor" when the winds came from the northwest; this also suggested that these gases and vapors could travel long distances. HÓLM bolsters the idea further by commenting on several ships that sailed between Iceland and Copenhagen that were reportedly covered in black sand and other fine particles. He points to all this as evidence that the fog in Denmark was connected to an "earth/soil fire" (*Jordbranden* in Danish, *Erdbrand* in German, and *earth fire* in English) in Iceland. This remark can be found in HÓLM's original Danish book, written in late 1783 or early 1784, as well as in the German translation.[676] Both books were published in Copenhagen in early 1784, with the foreword in the Danish version dated 25 February 1784.[677]

A naturalist called H. GUERIN also noticed that southern winds thinned the fog, and northern winds made it thicker. He was drawn to conclude that "terrible volcanic eruptions in Iceland" had caused this "evil." GUERIN blamed the eruptions for the frequent diseases of 1783, which he says were characterized by decay and inflammation.[678] This information, however, is only second-hand; GUERIN's findings were published in the daily Swiss newspaper *Neue Zürcher Zeitung* on 5 November 1783 in the miscellaneous section. He presented these findings in the weeks before 5 November, either verbally or in writing; the original account remains missing.

A naturalist by the name of Johann Rudolf VON SALIS-MARSCHLINS (1756–1835) wrote a report for the weekly Swiss newspaper *Der Sammler: eine gemeinnützige Wochenschrift für Bündten* titled, "Some remarks on the general vapor, which spread also in our area in June and July of this year," which was most likely published between 17 and 23 November 1783. The article includes his weather observations from June through August 1783 and references the news from Copenhagen about the eruption in Iceland, so it was likely written sometime in September. VON SALIS-MARSCHLINS observes that the "terrible eruption of the fire-spitting mountain in Iceland" occurred at the same time as the "vapor." Just as GUERIN had done, VON SALIS-MARSCHLINS notes the direction of the wind and details how this played a role in his assumptions.[679] He asks

676 HÓLM 1784a: 52–53; HÓLM 1784b: 66–67.

677 The foreword in the German version is a translation of the Danish foreword dated 25 February 1784.

678 DEMARÉE, OGILVIE 2016: 135; Neue Zürcher Zeitung, 5 November 1783: 3–4. "Ein Naturforscher Nahmens H. Guerin hat beobachtet, daß die Nebel, so dieß Jahr Europa bedeckt haben, durch die Südwinde vermindert und hergegen durch Nordwinde verdickt worden seyen. Hieraus hat es die Folge gezogen, daß die schrecklichen vulkanischen Eruptionen in Island diese Nebel verursacht hätten. Dieser Eruption schreibt er auch die häufigen Krankheiten zu, die dieses Jahr geherrscht, und durch Symptome der Fäulung und Inflammation die Aerzte in Verwirrung über die Natur gesetzt haben, da die Kranken, welchen Blut gelassen worden, wie die Bemerkungen der medicinischen Fakultät zu Paris besagen, meist das Opfer dieses Irrthums geworden sind."

679 SALIS-MARSCHLINS 1783: 397.

rhetorically: "[. . .] Should the coincidence of these two natural phenomena make us think of a relationship between the two?"[680]

The editor of *Leipziger Magazin zur Naturkunde, Mathematik und Oekonomie*, Carl Friedrich HINDENBURG, commented on a letter published in his magazine written by Christian LUDWIG, which suggested a causal relationship between the Calabrian earthquakes and the fog. HINDENBURG supplemented LUDWIG's idea by listing other possible sources of the dry fog, referring to the "earth fire" in "Skaptaa Jokul."[681] It is uncertain when this was published; however, judging by its content, it was likely put to print between September and December 1783.

In early 1784, the Baron DE POEDERLÉ, a botanist, studied the effects of the dry fog on plants and trees in detail. *L'Esprit des Journaux François et Étrangers: Par une Société de Gens-de-lettres* published his study in May 1784. The text includes observations from January through December 1783, so it is safe to assume he wrote it sometime in early 1784.[682] DE POEDERLÉ, using reasoning similar to that of GUERIN and VON SALIS-MARSCHLINS, decided that the seemingly ceaseless eruption near Mount Hekla,[683] which filled the air with dust and caught the rays of the sun, was an integral part of the equation. DE POEDERLÉ did not think this was the sole cause of the dry fog; he also blamed the earthquakes in northern and central Europe. He thought it too much of a coincidence that when an earthquake occurred in Messina on 19 June 1783, the fog appeared. He mapped out more of his theory, suggesting that the earthquakes ceased because they had released all of their previously pent-up gases. He lauds 1783 as remarkable in several regards. He hoped that scholars of meteorology, agriculture, and medicine would later show an interest in the events he had witnessed.[684]

Benjamin FRANKLIN, in the same letter detailed above in which he addressed the issue of meteors, also discussed a possible connection between the fog and Iceland.[685] Regarding the fog's origin, FRANKLIN writes: "[. . .] whether it was the vast quantity of smoke, long continuing to issue during the summer from Hecla in Iceland, and that other volcano which arose out of the sea near that island, which smoke might be

680 SALIS-MARSCHLINS 1783: 393. "Wenn die Nachrichten von dem fürchterlichen Ausbruche eines feuerspeienden Berges in Island, der den 8 Junius erfolgt seyn sollte, zuverläßig sind, sollte die verhältnismäßige Uebereinstimmung der Zeit, nebst dem bemerkten Umstande, daß der Dampf sich beym Nordwind starker einfand, und hingegen vom Südwind einigermassen vertrieben wurde, uns nicht auf den Gedanken eines Zusammenhanges zwischen diesen zwei Naturbegebenheiten bringen?"

681 LUDWIG 1783: 219–221.

682 DEMARÉE, OGILVIE 2016: 137.

683 Of course, it was Laki, undiscovered in the Icelandic highlands, that was ceaselessly erupting.

684 DE POEDERLÉ 1784: 336, 349.

685 FRANKLIN's letter is dated to May 1784. It is likely that FRANKLIN kept notes about the weather throughout 1783. FRANKLIN's friend Thomas PERCIVAL in Manchester read the letter titled "Meteorological Imaginations and Conjectures" in front of the Manchester Literary and Philosophical Society on 22 December 1784.

spread by various winds over the northern part of the world, is yet uncertain."[686] While DE POEDERLÉ argued very precisely that he believed the volcanic eruption that had commenced on 8 June 1783 *near* Mount Hekla was the culprit, FRANKLIN's conjectures were more speculative. He thought, as many naturalists did at the time, that the origin of the fog was not simply near Hekla but Hekla itself or perhaps Nýey.[687] This confusion is unsurprising; the newspaper reports often gave only vague descriptions of this new "fire" in the Skaftá region, which were often riddled with errors.[688] FRANKLIN may have been the first English-language author to write about the Icelandic connection; it seems, however, he was ultimately more convinced that comets had caused the dry fog.

Jan Hendrik VAN SWINDEN, based at Franeker in the Dutch Republic, observed the dry fog of 1783. The *Ephemerides* of the Societas Meteorologica Palatina published his insights in 1785. His article consists of three parts: a summary of his observations during 1783; the expert opinions of his friend and colleague Sebald Justinus BRUGMANS about the impact of the dry fog on plants; and VAN SWINDEN's own speculations as to the cause of the dry fog. He comments on the numerous earthquakes, the "dense haze," the coincidental nature of the appearance of the "haze" together with "a new mountain catching fire in Iceland" on 8 June 1783, and the new island that had appeared near Iceland. VAN SWINDEN noticed the simultaneity of the strange fog in Europe and the two volcanic eruptions in Iceland during the summer. He describes the aftermath of the eruption "in the middle of the mountains called Skaftan." He remarks that there was "ash, such that it obscured the air." VAN SWINDEN failed to see the similarities to the weather he himself had experienced. After considering all the evidence, he concluded that, in all probability, earthquakes caused the fog.[689]

The naturalists mentioned above established links between the volcanic eruptions in Iceland and the weather in Europe. Modern insights have proven that they were correct in their assumptions; however, for differing reasons, they failed to pinpoint the true cause of the dry fog.[690] The Laki fissure was unknown to naturalists at the time, so, unsurprisingly, there is no mention of it in their speculations. Hekla and Nýey were considered possible sources of the fog but were somewhat lost in the sea of other possible explanations, which included: too much or too little electricity in the atmosphere; aurora borealis; the smoke of meteors; vapors from a comet passing by the Earth; the smoke of peat fires; or – arguably the most popular explanation – vapors from deep within the Earth released during earthquakes.[691]

686 FRANKLIN 1785: 360.

687 DEMARÉE, OGILVIE 2016: 137.

688 OSLUND 2011: 180, note 10: "Benjamin Franklin commented on the dense fog experienced in North America in the summer of 1783. Like many of his contemporaries, he incorrectly attributed its cause to an eruption of Hekla rather than Laki."

689 VAN SWINDEN 2001: 78.

690 PAYNE 2011: 23.

691 STOTHERS 1996: 85.

The Summer of 1783 outside of Europe

Although it was soon common knowledge that the dry fog was more than a local phenomenon, the true extent was likely not known at the time; in the west, the dry fog reached North America. Reports from three different settlements in Labrador – today's Canada – also note a "smokey haze" that lasted up to five weeks. The dry fog may even have reached Alaska. Local weather observers in Labrador believed that Indigenous tribes "let some great woods on fire [as] they do so sometimes."[692] In the east, it was also visible as far away as the Altai Mountains on the western border of China and possibly triggered famine in India and Egypt (Figure 45).

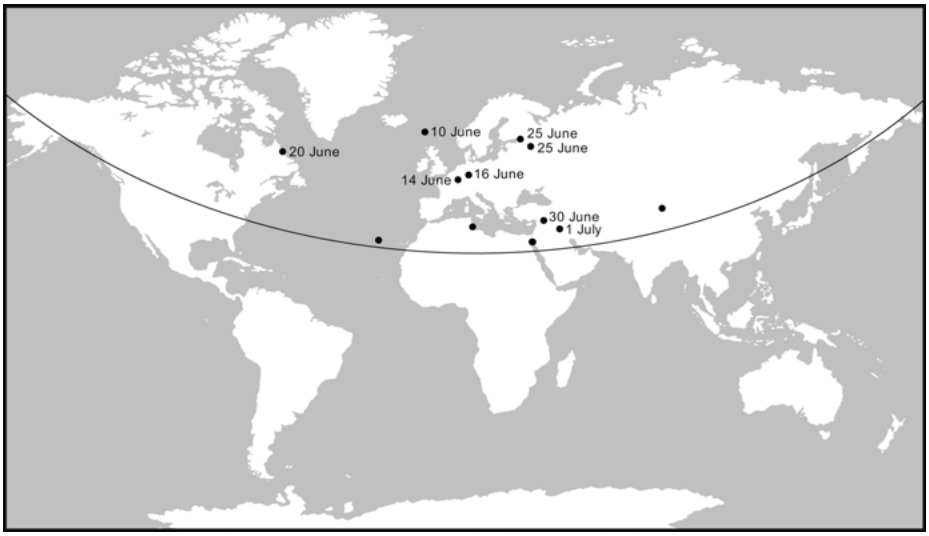

Figure 45: First appearance of the dry fog across the Northern Hemisphere. The dry fog appeared in the area north of the black line. For a detailed map of Europe, see Figure 28.

The Western Hemisphere

The United States of America

North America did not suffer the same tribulations as Europe. The *Continental Journal* from Boston printed the following on 5 August 1783: "we have not experienced finer weather for agriculture for some time past. From almost every part of the country,

692 Meteorological Observations at Okkak and at Hoffenthal, Hudson's Bay Company, Labrador, Newfoundland, 1782–1786, MA/144, Archives of the Royal Society, London, UK, 2–4 July 1783.

we have the most satisfactory information that all appearances indicate a year of astonishing plenty."[693]

In a letter written in May 1784, Benjamin FRANKLIN remarks that the dry fog had been visible over a "great part of North America."[694] Robert DE LAMANON argues in a footnote in his 1799 publication that he presumed the dry fog had appeared in North America after an eight-year-long drought, which was, in his eyes, a primary cause of the dry fog.[695] Prior to the English edition, DE LAMANON had published his text in French in 1784 with the same footnote at the end of the article.[696] It is very likely that Benjamin FRANKLIN read DE LAMANON's argument before he wrote his conjectures about the dry fog in his letter to the Manchester Literary and Philosophical Society and that this was the source of his information. Richard STOTHERS suggests that the dry fog was not visible in North America, based on weather diaries from Michigan, Massachusetts, and North Carolina.[697]

Other North American weather diaries suggest that the dry fog was not visible between New England and Delaware. According to the weather diary of Jacob HILTZHEIMER, based in Philadelphia, the summer of 1783 was mostly warm and pleasant.[698] William ADAIR from Delaware describes June 1783 as fair, with warmer spells and occasions of fog toward the end of the month. He gives no indication that these fogs were in any way unusual. He describes July and August 1783 as variable, with a mix of clear and cloudy weather.[699] Caleb GANNETT, who kept a daily weather log at Cambridge, Massachusetts, notes a mixture of fair and cloudy days between June and October 1783, with an occasional rainy day and no mention of fog.[700] Edward WIGGLESWORTH kept another daily weather diary in Cambridge, Massachusetts, and noted foggy weather on 21 June 1783, "hazey" weather on 9, 10, and 17 July 1783, and "hazey" weather again on 5, 6, and 9 August 1783. Otherwise, the weather during this time was, according to WIGGLESWORTH, usually "fair."[701]

Cotton TUFTS, a physician, kept an annotated almanac at Weymouth, Massachusetts. According to his records, the weather during the summer of 1783 was mainly warm and hot. However, he notes occasional foggy and misty days, such as 16 June

693 The Continental Journal and Weekly Advertiser, 5 August 1783: Report from Hartford, CT.

694 FRANKLIN 1785: 357–361.

695 LAMANON 1799: 88–89.

696 LAMANON 1784a: 17.

697 STOTHERS 1996: 82.

698 Jacob HILTZHEIMER Diaries, vol. 13 (March 1783 to February 1784), Mss.B.H56d, American Philosophical Society, Philadelphia, PA, USA.

699 William ADAIR Meteorological Notebook, Meteorological observations taken at Lewes, Delaware, 1776–1788, Mss.551.5.Ad1, American Philosophical Society, Philadelphia, PA, USA.

700 Caleb GANNETT, A meteorological register kept at Cambridge 1783, MS Am 1360, bMS Am 1360 (7), Houghton Library, Harvard, Cambridge, MA, USA.

701 Edward WIGGLESWORTH, Meteorological journal. A.MS.s. Cambridge, 1780–1789, 1793, MS Am 1361 vol 33, Houghton Library, Harvard, Cambridge, MA, USA.

and 18 and 19 July.[702] Edward Holyoke, also a physician, describes June 1783 as very hot, with some thunderstorms, July and August as unusually rainy, and September as variable.[703] As these occasions of fog received little attention, it can be assumed they were regarded as normal. In Massachusetts, two weather diaries note frost on 10 August 1783. Reverend Joseph Lee at Concord, Massachusetts, annotates his almanac thusly: "This morning we got frost."[704] Ezra Wheeler, also at Concord, writes of 10 August and 4 September, "frost so as to kill things."[705] In Nova Scotia, Mary Sewall, who fled from Massachusetts with her family during the war, describes June 1783 as a warm month. For 26 June 1783, she writes: "The weather is so exceeding[ly] warm I can hardly do anything."[706]

When, precisely, did the news of the Laki haze reach the United States? The first mention was in the *Pennsylvania Packet and General Advertiser* on 21 October 1783. The source was a letter from Salon in Provence, France, dated 11 July 1783: "For twenty days, a singular fog, such as the oldest man here has before not seen, has reigned [. . .] similar observations have been made at Paris and in many parts of Italy."[707] The same letter was also printed in the *Connecticut Journal* on 5 November 1783, in the *Massachusetts Spy* on 20 November 1783, and in the *Vermont Journal* and the *Universal Advertiser* on 3 December 1783.[708] The letter was written by Robert de Lamanon, who also referred to his experience in Salon in his *Observations on the Nature of the Fog of 1783*.[709]

Other reports of a thick, dry fog in Europe appeared in American newspapers, too; on 25 October 1783, the *Royal Gazette* printed a report from Naples, where from 23 June 1783, "the atmosphere [was] loaded with a thick fog."[710] Likewise, on 2 December 1783, the *Connecticut Courant* printed a report about "an uncommon fog, [that]

702 Cotton Tufts diaries, 1748–1794, Ms. N-1686, Massachusetts Historical Society, Boston, MA, USA.

703 Edward Holyoke, Medical Records, 1782–1788, Folder 2 (1783), Ms. N-1427, Massachusetts Historical Society, Boston, MA, USA.

704 Lee Family Diaries [manuscript], 1783–1807, vol. 1 (1783), 271762, American Antiquarian Society, Worcester, MA, USA.

705 Ezra Wheeler Diary, 1783, Almanacs Mass. B490 1783a, American Antiquarian Society, Worcester, MA, USA.

706 Mary Robie Sewall Diary, May–October 1783, call no. Ms. N-804, Massachusetts Historical Society, Boston, MA, USA.

707 The Pennsylvania Packet and General Advertiser, 21 October 1783: 2: Extract of a Letter from Salon in Provence, 11 July 1783.

708 The Connecticut Journal, 5 November 1783: 2: Reprint from news from London, 22 July 1783, reprint of Letter from Salon, Provence. The Massachusetts Spy, 20 November 1783: 2.

709 Lamanon 1784a; Lamanon 1784b; Lamanon 1799. Salon-de-Crau is today known as Salon-en-Provence.

710 Royal Gazette, 25 October 1783: 2: Reprint from London, 4 August 1783. It is unclear whether the newspaper article refers to 23 June or 23 July 1783.

has during the past summer, overspread that [French] kingdom – a phenomenon that has excited the attention of the greatest philosophers."[711] An almost verbatim report was printed in the *Norwich Packet* (Connecticut) on 4 December 1783, in the *Newport Mercury* (Rhode Island) on 6 December 1783, and in the *Rivington's New York Gazette* on 20 December 1783.[712]

In late December 1783, an article in the *Independent Ledger* from Boston remarked that newspapers had reported on more violent storms over the past 12 months than in any other year. The report concluded that "It may not be improper to add, that the European papers contain accounts of a variety of unusual natural phenomena that have appeared in the course of the last twelve months." By which they meant the Calabrian earthquakes, the uncommon fog, the new island Nýey (which they mistakenly placed in the Hebrides), and the "burning and eruption of vast bodies of sulphurous matter from the bowels of the earth."[713] By the end of the year 1783, the American periodicals were up to speed. Comparisons between the phenomena in Europe and North America were drawn, but for the most part, Americans remained unconcerned.

Province of Quebec

In Labrador, weather journals from three different coastal settlements called Nain, Okkak, and Hoffenthal contain strong evidence for the presence of the dry fog (Figure 46). The Moravian Church founded these settlements between 1771 and 1782 to proselytize the migratory Inuit tribes.[714] Weather observers made several daily recordings as well as qualitative remarks about the sky, sea ice in the bay, and the northern lights. The weather observations were presented at the Royal Society in London by British-American architect Benjamin La Trobe in 1786. In the same year, the German astronomer Johann Daniel Titius (1729–1796) published them in his monthly extract in the *Wittenbergisches Wochenblatt*, a weekly newspaper in the German Territories.[715] Titius remarked that the mention of vapor at the coast of Labrador confirmed that the mist was present across the entire Northern Hemisphere.[716]

711 The Connecticut Courant and Weekly Intelligencer, 2 December 1783: 2.

712 Norwich Packet or The Chronicle of Freedom, 4 December 1783: 3; The Newport Mercury from Newport, Rhode Island, 6 December 1783: 3; Rivington New York Gazette and Universal Advertiser, 20 December 1783: 3.

713 Independent Ledger, 22 December 1783: 3: Report from Boston, 22 December 1783.

714 Demarée, Ogilvie 2006. Hoffenthal is today's Hopedale in Canada.

715 Meteorological Observations at Nain & Okak at Labrador, Hudson's Bay Company, MA/143; and Meteorological Observations at Okkak and at Hoffenthal, Hudson's Bay Company, Labrador, Newfoundland, 1782–1786, MA/144, Archives of the Royal Society, London, UK; Wittenbergisches Wochenblatt, 19 May 1786: 153–160.

716 Wittenbergisches Wochenblatt, 19 May 1786: 156: "Es giebt uns daher diese Bemerkung auf der Küste von Labrador in den Ursachen der damaligen Dunstluft eine große Aufklärung. Denn es scheint, daß diese Dunstluft über die ganze nördliche Halbkugel, wo nicht weiter, möge gegangen sein."

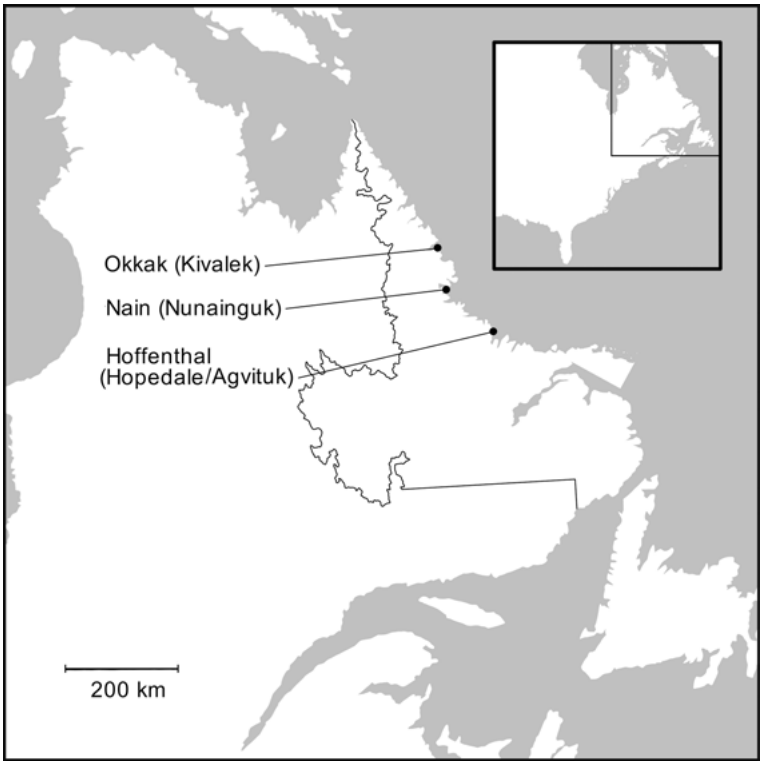

Figure 46: The locations of Okkak, Nain, and Hoffenthal in Labrador.

The weather observer in Okkak was either James Branagin or Johannes Beck.[717] On 20 June 1783, he first mentioned what could be presumed to be the fog: "Heazey [sic] and sun shine." On 3 July 1783, he remarked: "Heazey sun shine and rain. For several days thick smoke fog [sic] throw the Air as from a great fire so we pose the Ykas [?] let some great woods on fire, they do so sometimes." Thus, he surmised that this smoke was a result of forest fires started by local Inuit tribes. On 23 October 1783, the "heazey" weather was mentioned for the last time.[718] The diary mentions phenomena similar to those in Europe, including paraselenae and parhelia. In Nain, descriptions of the fog, written by Daniel Krügelstein, were in a similar vein.[719] In the

717 Demarée, Ogilvie 2006: 428. A table lists the names of the different weather observers in the Moravian settlements, if they are known.

718 Meteorological Observations at Okkak and at Hoffenthal, Hudson's Bay Company, Labrador, Newfoundland, 1782–1786, MA/144, Archives of the Royal Society, London, UK, 2–4 July 1783. The name of the tribe might also be Elaas [?].

719 Meteorological Observations at Nain & Okak at Labrador, Hudson's Bay Company, MA/143; Archives of the Royal Society, London, UK.

neighboring settlement of Hoffenthal, an anonymous weather observer witnessed "dark mist with much rain" and mentioned that the summer of 1783 was "very dark, [with] little sunshine."[720]

Richard Stothers briefly mentions the occurrence of the haze in Labrador in his 1996 paper "The Great Dry Fog of 1783." Gaston Demarée and Astrid Ogilvie added detail about the Moravian settlement in their response to his paper in 1998. The latter publication also delivers evidence from sailors who navigated the waters around Newfoundland and reported "a thick fog."[721] These reports from Labrador are clear evidence that the dry fog also reached North America. Deliberate burning practices and forest or brush fires were (and are) common in North America, and they cause "smoky" weather and even "dark days" in the southern parts of the Province of Quebec and the United States.[722] The timing of this "smoky" weather from mid-June to October 1783 and the known dates for the Laki eruption fit too perfectly to dismiss them as anything but the Laki haze. That the weather observer in Okkak looked for explanations of this unusual "heazey" weather on a local level is fascinating. The observer never knew that this "smoke" had spread further than his locality and therefore did not look further than his locality for an explanation.

Alaska

Thorvaldur Thordarson argues that the Arctic, including the Faroe Islands, Lapland, and Alaska, was extremely cold during the summer of 1783. As a result, the trees in these regions show narrow tree rings and a low density for the latewood, which is the growth of conifer trees that occurs later in the year. Thordarson attributes this to the "noxious dews" from the Laki eruption.[723] An analysis of tree rings in northwestern Alaska reveals that the maximum latewood density for 1783 has the lowest value in more than four centuries, possibly even the lowest in nine centuries.[724] Temperature reconstructions for northern Alaska reveal that the summer temperature (May to August) in 1783 was around 4 °C below the mean.[725] Unfortunately, there are very few written histories about this area for this period. Therefore, Gordon Jacoby and his colleagues utilize transcriptions penned by William Oquilluk in 1973 of oral traditions passed down by the Kauwerak

720 Meteorological Observations at Okkak and at Hoffenthal, Hudson's Bay Company, Labrador, Newfoundland, 1782–1786, MA/144, Archives of the Royal Society, London, UK.

721 Stothers 1996: 79; Demarée, Ogilvie, Zhang 1998: 727.

722 Campanella 2007; Pyne 2007.

723 Thordarson 2005: 213–214.

724 The study was conducted in 1999, which means the 400-year-period refers to the time prior to 1999; Jacoby, Workman, D'Arrigo 1999: 1366, 1370. In a recent study using trees from Alaska, Edwards et al. (2021) demonstrated that conventional methods for assessing maximum latewood density overestimates cooling during the summer, whereas a detailed analysis of early- and latewood cells draws a clearer picture.

725 Jacoby, Workman, D'Arrigo 1999: 1365–1367.

people from northwest Alaska. These stories refer to four disasters, the third of which they believe happened in 1783. Although exact years are missing from the text, a rough time frame can be established by ascertaining the generation during which an event took place. The oral tradition of the third disaster describes their ancestors' survival during "the time summertime did not come."[726]

The spring had been typical: the snow had melted, and the migratory birds had arrived. But then suddenly, at the end of June 1783, the sky became overcast and the weather turned cold again. Then, in the middle of summer, the rivers froze and it snowed, making fishing and collecting plants impossible. Warmer weather did not return until April of the following year. A young woman and her son were the only survivors of their village; they traveled 300 kilometers, surviving on very little until they met survivors from elsewhere who told similar stories of starvation and death. JACOBY and his team deduced that this oral tradition probably dates back to a time before 1800, a period of population decrease in the area between 1779 and 1791, and before the arrival of Europeans. From tree ring analysis, we know that the impact of the 1815 Tambora eruption on northwestern Alaska was not that severe; therefore, it is probable that this tradition refers to the effects of the Laki eruption.[727]

The Eastern Hemisphere

The Baltic

Estonian environmental historian Priit RAUDKIVI reconstructed the weather conditions of the summer of 1783 in the Baltic region: there, it was foggy and a sulfuric smell lingered in the air, the cause of which damaged plant life. RAUDKIVI analyzed death records and concluded that mortality was high in Estonia, particularly in the south. Whereas in England and France, the mortality crisis only started in August, in Estonia, it began in June.[728] From Latvia and Estonia, one account regarding air pollution in the region was published a decade after the eruption.[729] According to this source, from 1794, June 1783 was "insufferably hot," July was characterized by frequent thunderstorms and rain, and August saw many storms.[730] Finland saw significant crop failure during and after the Laki eruption. By virtue of its location near and inside the Arctic Circle, Finland's agriculture is particularly vulnerable to unseasonal frost. In particular, between 1300 and 1930, Finland experienced 1.7 major crop failures per decade on average. During the eighteenth century, there was an average of 3.3 per decade; this meant that the grim specter of famine haunted the country three years

726 OQUILLUK 1973; JACOBY, WORKMAN, D'ARRIGO 1999: 1365–1367.
727 JACOBY, WORKMAN, D'ARRIGO 1999: 1369–1370.
728 RAUDKIVI 2014.
729 RAUDKIVI 2016: 193–194.
730 SNELL 1794: 148–149.

per decade. More than one crop failure in a row was often devastating in pre-modern societies. From 1783 to 1785, Finland experienced three consecutive years of major crop failure.[731]

Northwestern Siberia

From tree ring records at two locations in the Ural Mountains in Siberia, dendrochronologists have established that during the summer of 1783, a particularly severe temperature event occurred in this region. They analyzed Siberian junipers and larches in the Polar Ural Mountains and the Yamal Peninsula, reconstructed tree ring data for the years between 742 and 2003 CE, and found frost rings and light tree rings for 1783. Based on the growth period for the trees in this region, it is evident that there were frosts in late June and early July 1783. In fact, the whole summer season is believed to have been extremely cold. Cooling as a consequence of a strong volcanic eruption impacted the second half of the growing season for those trees. Their growth during 1783 was the lowest for the past 500 to 600 years.[732]

North Africa

Between 1783 and 1785, Constantin-François Volney (1757–1820), a French philosopher, traveled through Egypt and Syria. Upon his return to France, he published a travel diary. He outlined how, in July and August 1783, he regularly observed a fog during sunrise that vanished later in the day. He also noticed that the sky was often overcast, and "the sun was often invisible the whole afternoon [. . .] I was frequently so enveloped in a white, humid, warm, and opake [sic] mist, so as not to be able to see four paces before me."[733] The foggy appearance of the atmosphere seemed to be so familiar to him that he rather noticed its absence than its presence: "On my return from Suez, [. . . .] between the 24th and 26th of July, we had no fog during the two nights we passed in the desert."[734] These descriptions of fog, mist and even vapors indicate that some type of fog was also visible in Egypt, possibly as far south as 29 degrees north of the equator.[735]

Linguist Vermondo Brugnatelli and environmental scientist Alessandro Tibaldi have discovered one mention of the Laki haze in North Africa in a chronicle of events on the island of Djerba, in today's southern Tunisia (33 degrees north), written by Muhammad b. Yusef al-Musabi in 1792/1793. The text describes a mist "similar to smoke" and a red sun that lasted for about half a month. However, the dating is not precise;

731 Myllyntaus 2009: 80, 83.

732 Hantemirov, Gorlanova, Shiyatov 2000: 170–172; Hantemirov, Gorlanova, Shiyatov 2004.

733 Volney 1788: 345, 347.

734 Volney 1788: 346.

735 Volney 1788: 351. Contemporary scholars were aware of the geographic reach of the Laki haze: Mourgue de Montredon (1784: 754–763) knew that the dry fog affected not only Europe but also Asia and North Africa.

the source only indicated that it took place before the beginning of the Islamic year 1198, which began on 26 November 1783.[736]

It has been well-established that distant volcanic eruptions can impact the Nile River floods and the weather in Egypt.[737] The volcanic matter that the Laki eruption ejected into the atmosphere had a detrimental effect on the African and Indian Ocean monsoon circulations. Usually, the Indian Ocean monsoon brings rain to the Ethiopian highlands in early summer. The rain then feeds the Nile River. In July, the Nile River floods reach Cairo; the peak of the floods usually takes place in August or September. Zambri and colleagues argue that asymmetric cooling in the Northern Hemisphere after the Laki eruption in June 1783 shifted the Intertropical Convergence Zone southward; this interrupted the monsoon rains over the Indian Ocean and eastern Africa, which led to a low flow of the Nile River in 1783 and 1784 and triggered drought and famine in Egypt. The decrease in precipitation also triggered droughts in India.[738]

India

An unusual El Niño produced dry conditions in wide parts of India, which led to drought and scarcity between 1781 and 1784. In the north, it affected Kashmir and Punjab; in the west, Rajasthan; and in the east, Uttar Pradesh. The lack of rain often disrupted agricultural employment patterns, leaving workers without an income. In part, the scarcity was fueled by hostile invasions and pests, including swarms of rats, locusts, or ants. In South India, there was famine between 1782 and 1783. North India also experienced drought during this time: in September and October 1783, the lack of rain was particularly unusual and resulted in famine, which lasted until early 1784.

In South Asia, this period of scarcity and famine in 1783 and 1784 is remembered as the "great Chalisa famine," which is estimated to have caused as many as 11 million deaths; victims succumbed to starvation or the epidemics that followed. Some areas suffered from depopulation due to this famine and did not recover until the 1790s. In this part of the world, the unpredictable weather of the 1780s caused as many as six notable famines between 1780 and 1791. While other severe famines occurred in India before and after this decade, such as in 1770s, such a high frequency of this type of event in a single decade is unusual.[739]

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736 Brugnatelli, Tibaldi 2020: 73.

737 Manning et al. 2017.

738 Zambri et al. 2019b: 6787. On the connections between ENSO and the Nile River, see Bell 1970; Ortlieb 2004. Alan Mikhail details the consequences for Egypt, including diseases, theft, and violence, in the aftermath of the Laki eruption; Oman et al. 2006a; Mikhail 2015; Mikhail 2017: 184–197; Damodaran et al. 2018: 534–538.

739 There was an El Niño-Southern Oscillation event in the Pacific between 1782 and 1784, which was unusual because it lasted longer than 24 months; D'Arrigo et al. 2011; Damodaran et al. 2018: 521. The El Niño was followed by La Niña conditions that lasted from 1785 to 1790. Other scholars, such as

Japan

In Japan, from 9 May until 5 August 1783, Mount Asama erupted. Asama is Honshu's most active volcano, located 140 kilometers northwest of Tokyo. The Global Volcanism Program of the Smithsonian Institution rates this eruption as a four on the index of volcanic explosivity.[740] The climax of the eruption occurred on 4 August 1783 and lasted almost 15 hours, during which time it produced pumice falls, pyroclastic surges, and lava flows that killed approximately 1,400 people directly.[741] At the time of the eruption, Japan was suffering through the Great Tenmei Famine, one of the most severe in its history.[742] The famine began in 1782; most of the country's food reserves had already been used by the time of the eruption.[743] Japan saw very unstable and variable weather during the 1780s, particularly in 1783, 1784, and 1786, which all had unusually wet and cool summers. The weather led to terrible summer rice harvests in the north and east of the country.[744] Thus, 1783 is known as a year without a summer in Japan.[745]

Europeans only learned of Mount Asama's eruption in the 1820s from an account by Isaac Titsingh (1745–1812), a Dutch scholar, merchant, and ambassador based in Nagasaki. His description of the eruption was based on Japanese sources and posthumously published in French in 1820 and English in 1822.[746] The eruption of Mount Asama had a minimal effect on the climate of the Northern Hemisphere, according to studies of the GISP2 ice core in Greenland.[747] The Laki eruption likely caused most of the volcanic cooling of the mid-1780s.

China

The westerlies are prevailing winds from the west to the east in the mid-latitudes between 60 and 30 degrees north. These winds carried the Laki haze to Europe, the Middle East, and even the Altai Mountains in China, where the haze was said to have arrived on 1 July 1783.[748] Richard Stothers discovered that the dry fog only lasted for 17 days in the Altai Mountains, whereas it lasted upward of two months in Europe.[749]

Richard Grove (2007: 80), believed that the El Niño lasted from 1789 to 1793; Damodaran et al. 2018: 522–530, 540–541.

740 Global Volcanism Program: Asamayama.

741 Richards 2003: 177.

742 Thordarson 2005: 214–215.

743 Damodaran et al. 2018: 534.

744 Damodaran et al. 2018: 534–535.

745 Mikami, Tsukamura 1992; Jacoby, Workman, D'Arrigo 1999: 1368.

746 Titsingh 1820 (French); Titsingh 1822: 98–100 (English).

747 Zielinski et al. 1994; Jacoby, Workman, D'Arrigo 1999: 1366.

748 Stothers 1996; Jacoby, Workman, D'Arrigo 1999: 1366.

749 Stothers 1996: 81.

Gaston Demarée and his colleagues argue that the dry fog possibly reached further east. A Chinese chronicle for the Henan province mentions "severe dry fog," and there are accounts of dark skies during 1783. Another chronicler recounted how a reoccurring haze made the sky so dark it was impossible to see. These accounts, unfortunately, do not give exact dates or further indications as to the nature of this haze or dry fog. Perhaps these instances were local dust storms or a fog caused by the eruption of Mount Asama.[750] Based on multi-proxy records, a new study has established that China, especially the eastern parts of the country, experienced drought in the years following the Laki eruption, which was followed by locust swarms, famine, and disease.[751]

The Winter of 1783/1784: A Touch of Frost

While the summer of 1783 had been unusually warm in western Europe, the winter of 1783/1784 was extremely cold. Much of Europe and the eastern United States witnessed winters that were colder than average between 1783 and 1786. The cooling in the winter of 1783/1784 reduced temperatures by as much as 3 °C below the mean.[752] 1783 to 1786 might have even been the coldest period in the second half of the eighteenth century.[753] When the low temperatures of the winter of 1783/1784 are compared to the Central European Temperature series from 1760 to 2009, we see that the winter was 4.5 °C colder than the reference period of 1961 to 1990. Only 18 winters, including 1783/1784, between 1500 and 2009, are estimated to have had such low mean temperatures.[754]

The Winter in Europe

In Iceland, winter came early that year: in September 1783, uncommonly thick snow covered much of Iceland's lowlands, and severe sea ice was present.[755] Icelanders had to house their surviving cattle and sheep throughout the frosty period of the year, from mid-October to April. Some parts of Iceland saw continuous frost during that

750 Demarée, Ogilvie, Zhang 1998.
751 Gao, Yang, Liu 2021: 196.
752 Ludlum 1966: 64–68.
753 Thordarson 2005: 215.
754 Brázdil et al. 2010: 182–184.
755 Ogilvie 1986: 71.

period, and by February 1784, all fjords were frozen, which had not happened in 39 years.[756] Many counties faced a cold spring and an equally chilly and wet summer in 1784.[757] Thick ice remained in vast swathes across Iceland until May 1784, and the ground remained frozen well into July.[758] During the twentieth century, the mean winter temperature was −0.9 °C in west Iceland and −1.7 °C in north Iceland. In 1783/1784, the temperatures stayed below −15 °C for much of the winter, leading to an average temperature of 5 °C below the 225-year average.[759] Astrid OGILVIE describes 1783/1784 as the most interesting period of the eighteenth century for environmental historians and, conversely, the most devastating for the Icelanders.[760]

In Europe, the cold came at the end of 1783, with piercing winds from the northeast. The extreme cold and snowy weather lasted, for the most part, until late February 1784 (Figure 47). Some places had snowfall as late as May that year.[761] Deep snow made travel across land difficult, and the frozen rivers made passage for ships impossible. In addition, many towns had shortages of food and firewood, which meant the authorities had to step up to prevent the masses from freezing and starving in their homes.[762] In Paris, the municipal authorities imposed a rationing system that privileged bakeries so that they would have enough fuel to bake bread and therefore feed the people.[763] Travel across the Channel was also fraught with difficulties; in early January 1784, John ADAMS, future president of the United States, traveled from London to the Hague and later told Benjamin FRANKLIN about the unpleasant journey:

> At Harwich we were obliged to wait Several Days for fair Weather, which when it arrived brought Us little Comfort as it was very cold And the Wind exactly against Us. [. . .] So unsteady a Course, and Such a tossing Vessell that We could not keep a fire, the Weather very cold and the Passengers all very Seasick. [. . .].[764]

FRANKLIN agreed with ADAMS: "The season has been, and continues [to be], uncommonly severe, and you must have suffered much."[765] In another letter, FRANKLIN remarks: "We

756 Morning Herald and Daily Advertiser, 25 August 1784: Extract of a Letter from Copenhagen, 30 July 1784; WOOD 1992: 60.

757 OGILVIE 1986: 71.

758 THORDARSON 2005: 215.

759 WOOD 1992: 64; MIKHAIL 2017: 190–192.

760 OGILVIE 1986: 72.

761 Bayerische Akademie der Wissenschaften 1784: 48.

762 GLASER 2008: 235.

763 FRANKLIN 2014: 258. In the face of firewood scarcity, Benjamin FRANKLIN received a request asking if he could help in the construction of a coal-fired oven. FRANKLIN 2017: 99 (note): "Ordonnance de police, concernant la distribution des bois à brûler aux boulangers et au public. Du 7 Février 1784." For the shortage of bread, also see KAPLAN 1996: 53–58, 76–77. In Saxony, the flooding destroyed many mills along the River Elbe, which led to a shortage of flour; POLIWODA 2007: 75.

764 FRANKLIN 2014: 498, letter from John ADAMS to FRANKLIN, The Hague, 24 January 1784.

765 FRANKLIN 2014: 533, FRANKLIN responded to ADAMS on 5 February 1784, from Passy.

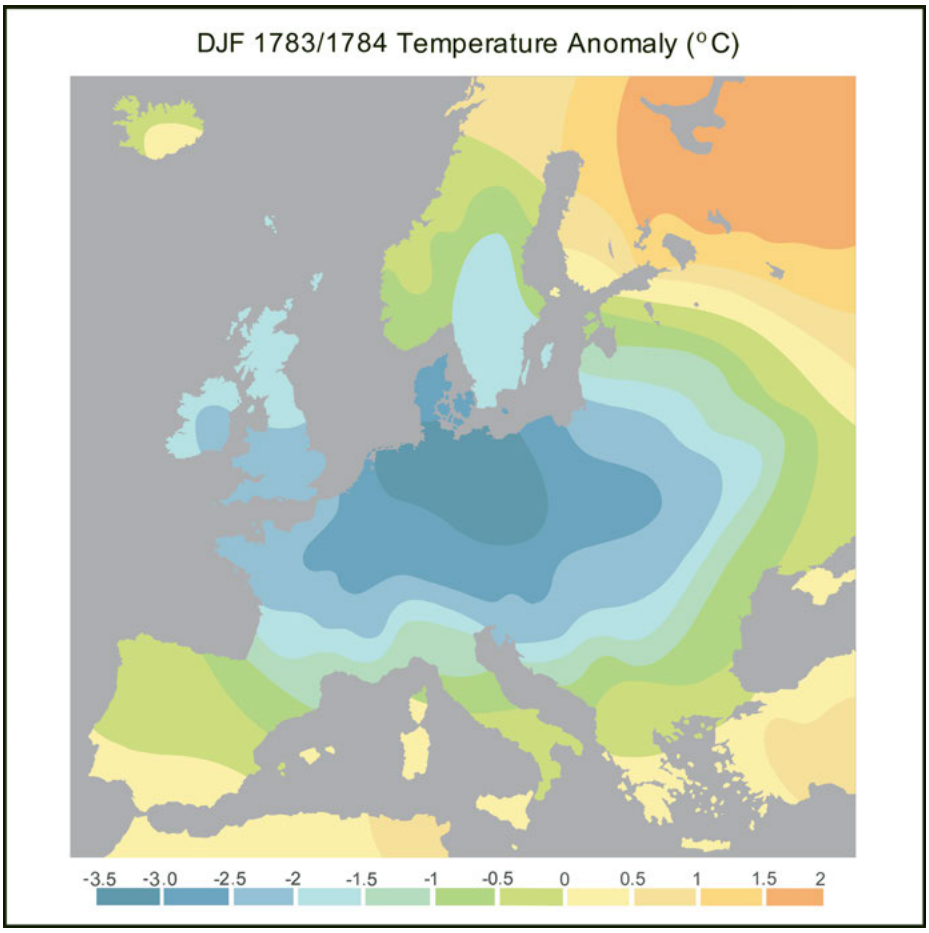

Figure 47: Temperature anomaly for December 1783, January and February 1784 based upon 31-year mean, 1770–1800.

have had a terrible Winter too, here, such as the oldest Men do not remember; and indeed, it has been very severe all over Europe."[766]

Records from the weather observatory in Mannheim reveal that it snowed 29 times between 24 December 1783 and 21 February 1784, with some snowfall continuing for several days without interruption. By 28 January 1784, the snow was roughly 154 centimeters high.[767] According to Karl Ludwig GRONAU, a keen weather observer, the winter in Mannheim that year was not as cold as 1739/1740 [−21.1 °C], but was, however, as cold as 1709 [−19.4 °C]. The coldest temperature that he measured in 1784 was on 7 January

766 FRANKLIN 2017: 28, letter from FRANKLIN to Charles THOMSON, from Passy, 9 March 1784.
767 GLASER 2008: 235; Societas Meteorologica Palatina 1784, 1–75.

at 8 a.m.: the Fahrenheit thermometer showed, as in 1709, 3 °F below zero [−19.4 °C], and the Réaumur thermometer showed −15.75 °Ré [−19.7 °C].[768]

In Munich, the coldest temperature of 1783 was on the morning of 31 December, −12 °Ré [−15 °C]. In December, the snow was so plentiful that trees collapsed under its sheer weight.[769] January 1784 remained extremely cold. For 28 days, not once did the thermometer rise above freezing. The total snow load reached a depth of ten shoes [ca. 292 centimeters].[770] In 1784, the coldest temperature in Munich was on 6 January 1784, −13.8 °Ré [−17.3 °C]. In February 1784, the thermometer remained below freezing for 21 days; the mountains of snow reached terrifying heights. Snow continued to fall until April, with frigid weather as late as 30 May 1784.[771]

Similarly, in Switzerland, the second half of the winter of 1783/1784 was extraordinary. In Bern, as much as 150 centimeters of snow fell from 12 to 13 March 1784; in the uplands, 270 centimeters fell. Bern was blanketed in snow for 154 days. For comparison, in the extreme winter of 1962/1963, the city saw 86 snow days. The cherry blossoms in Bern only began to bloom on 14 May 1784, three weeks later than usual. Geneva saw an estimated total snowfall of 240 centimeters. In Switzerland, the severity of the winter of 1783/1784 was only surpassed by the winter of 1739/1740.[772] The following winter, 1784/1785, was also said to be "extremely severe."[773]

The snowy conditions impacted game and birds, which could hardly find enough to eat. Wolves became more aggressive in their pursuit of food, attacking farm animals and even people.[774] In northern and southern Germany, the cold was so intense that birds froze in the skies and fell to the ground.[775] According to Ulrich Bräker, in Switzerland, the summer of 1784 was silent, devoid of birdsong.[776]

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768 Gronau 1784: 246–247, 251–252: In addition to his Fahrenheit and his Réaumur thermometer, Gronau also had a Rosenthal thermometer that showed 861 °Rosenthal [−19.5 °C]. Furthermore, he found it odd that there had been another very severe winter exactly a century prior, in 1684. He feared that the proponents of the 100-year-calendar, which he did not regard very highly, would use this as an argument for its reliability.

769 Bayerische Akademie der Wissenschaften 1783: 48.

770 Verdenhalven 2011: 19–20, in Munich, one foot or shoe (*Fuß* was often used interchangeably with *Schuh*) was 29.186 centimeters, albeit since 1811. In 1783, the length might have been slightly different.

771 Bayerische Akademie der Wissenschaften 1784: 48, 69–70, 75–76.

772 Pfister 1975: 84.

773 Wood 1992.

774 Wiener Zeitung, 14 February 1784: 302; Provinzialnachrichten aus den Kaiserlich Königlichen Staaten und Erbländern, 18 February 1784: 211; Münchner Zeitung, 19 February 1784: 110.

775 These reports exist for northwestern Germany and also Bavaria. Bayerische Akademie der Wissenschaften 1783: 48; Santel 1997: 111.

776 Pfister 1975: 84; Bräker 2010.

British climatologist Gordon MANLEY calculated that central England had an average temperature of 7.8 °C in 1783, which made it the coldest year of the 1780s. It remained the coldest year until 1814 when the average temperature was 7.7 °C.[777] Between 1770 and 1922, the winters of 1783/1784 (0 °C mean temperature) and 1784/1785 (0.3 °C mean temperature) were the second- and third-coldest winters on record in central England, behind 1794/1795 (−0.2 °C) and before 1788/1789 (1 °C).[778]

Sometimes the cold was so severe that taking notes with a pen was impossible. Scottish printer and publisher William STRAHAN wrote to Benjamin FRANKLIN from London on 1 February 1784: "The Frost is now so intense here this Morning, that there is no getting [obscured by inkblots: any Pen?] to write."[779] Gilbert WHITE noted on 26 December 1783 that the ground froze over. Two days later, he added that the "ground [was] so icy that people get frequent falls." On 31 December 1783, the temperature had been between −10 and −8.6 °C, resulting in "Ice [appearing] under people's beds" and "Water bottles burst[ing] in chambers."[780]

The cold at the end of 1783 in England was so intense that frost intruded into homes. In the new year, there was a thaw on 2 January 1784, which resulted in flooding in Selbourne until a hard frost returned on 6 January. In and around Selbourne, frost and snow lasted until April 1784.[781] The Reverend James WOODFORDE had similar encounters with snow and ice: the night between 28 and 29 January 1784 was, he remarks, "one of the coldest nights we have had yet." The frost continued after that, and the following days remained "bitter cold."[782] On 7 February 1784, WOODFORDE traveled to Norwich by horse-drawn carriage; on 8 February, he was due to preach at the cathedral there. Travel conditions, however, had not been ideal: it was freezing, and the snow on the road had been so deep that the "Tract of Wheels" could not be seen. "The Snow in some Places was almost up to the Horses Shoulders," which made the roads almost impassable. Fortunately, WOODFORDE eventually made it to Norwich, where the streets were "nothing but Ice, very dangerous walking about, very bad also for Carriages."[783]

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777 MANLEY 1974: 393–398. The coldest year on average out of the series 1659–1973 was 1740 with 6.8 °C and the 1690s (1692: 7.7 °C, 1694: 7.7 °C, 1695: 7.2 °C, 1698: 7.7 °C).

778 G. T. WILLIAMS, Private Weather Diary for Greenwich and Somerset House, MET/2/1/2/3/161, National Meteorological Library and Archive, Met Office, Exeter, UK.

779 FRANKLIN 2014: 528.

780 Gilbert WHITE, "The Naturalist's Journal," 1783, Add MS 31848, British Library, London, UK: 154–155.

781 Gilbert WHITE, "The Naturalist's Journal," 1784, Add MS 31849, British Library, London, UK.

782 James WOODFORDE, Weather Diary for Weston Longville, Norfolk, vol. 10: 1782–1784, MET/2/1/2/3/467, National Meteorological Library and Archive, Met Office, Exeter, UK, 1784: 212.

783 James WOODFORDE, Weather Diary for Weston Longville, Norfolk, vol. 10: 1782–1784, MET/2/1/2/3/467, National Meteorological Library and Archive, Met Office, Exeter, UK, 1784: 212.

The winter of 1783/1784 seemed interminable: Woodforde noticed the frost creeping through his door as late as 1 April 1784. On 2 April, he stated, "I never knew so severe nor so long a Winter as this has turned out [. . .]. The Land has not been free from Snow since the 23rd of December last."[784] He was not the only one to make such observations, for Thomas Barker mentions that "the Spring was very backward and frosty till mid-April, and frequent frost till the first week in May, then suddenly hot and remarkably fine, the grass and leaves remarkably green, and everything came on at a great rate."[785] Unfortunately, on 25 and 26 May 1784, a "sharp rime" came back and killed off the young shoots.[786]

Many European countries were affected by the frequent and heavy snowfall; some of the descriptions in newspapers were so over-the-top they almost seemed outlandish.[787] However, contemporary weather observers, modern climate historians, and scientists are in good agreement that the winter of 1783/1784 was indeed extreme. In the Low Countries, people could not travel by foot or horse, such was the severity of the weather.[788] In Paris, Benjamin Franklin described the winter as unprecedented: "[. . .] such another [winter] in this Country is not remembered by any Man living. The Snow has lain thick upon the Ground ever since Christmas, and the Frost constant."[789] This snow lasted until mid-April 1784. The Seine froze over, which made transportation of firewood difficult, and a shortage ensued.[790] Vienna was also affected by a firewood shortage. The Danish Straits were completely frozen; it was possible to travel from Denmark to Sweden with sleds and carriages. Jutland was covered in as much as one meter of snow as late as mid-April. In early 1784, the Zuiderzee, a shallow bay northwest of the Dutch Republic, was frozen. The Dutch traveled on lakes and along the frozen coast with ice skates and sleds.[791] In Rotterdam, the ice was thick enough to support the "largest fair on ice ever known."[792] In Italy, blizzards and heavy snowfall affected Rome throughout February 1784. The frost was so bad that many lemon trees were damaged or destroyed.[793]

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784 James Woodforde, Weather Diary for Weston Longville, Norfolk, vol. 10: 1782–1784, MET/2/1/2/3/467, National Meteorological Library and Archive, Met Office, Exeter, UK, 1784: 227; Edwards 1998, introduction.

785 Thomas Barker, Private Weather Diary for Lyndon Hall, Leicestershire, MET/2/1/2/3/227, National Meteorological Library and Archive, Met Office, Exeter, UK: 242–243.

786 Thomas Barker, Private Weather Diary for Lyndon Hall, Leicestershire, MET/2/1/2/3/227, National Meteorological Library and Archive, Met Office, Exeter, UK: 213.

787 Hamburger Adreß- und Comptoir-Nachrichten 1784 (quoted after Glaser 2008: 235).

788 De Poederlé 1784: 347–349.

789 Franklin 2014: 558.

790 Franklin 2017: liii, xlix; Mikhail 2017: 190–192.

791 Schmidt 2000: 259; Thordarson 2005: 215. The Dutch had learned to utilize their frozen channels and lakes throughout the coldest decades of the Little Ice Age, Degroot 2018a: 109–151.

792 Grattan, Brayshay, Sadler 1998: 32–33.

793 Gentleman's Magazine, March 1784: 221; Grattan, Brayshay, Sadler 1998: 32–33; Thordarson 2005: 215.

Ice Drift and Flooding in Europe

The extreme cold and heavy snow were not the only problems throughout the winter. Huge ice blocks piled up in the rivers, especially near bridges; in Mannheim, men and women went to the Neckar River to admire the "snow and ice colossuses." One spectator commented on their regret that the ice blocks could "not be kept as a memory aid of the greatest cold of the eighteenth century for the ensuing ages."[794] Another report from Heidelberg from 22 January 1784 describes the "monstrous icebergs" that came down the Neckar River and damaged houses, walls, and the bridge; it compares the calamitous situation to the "Calabrian convulsions [*calabrische Verwüstungen*]."[795]

In much of Europe, the winter of 1783/1784 was characterized by freezing temperatures, the accumulation of large amounts of snow, and severe flooding when a sudden thaw occurred. Rudolf Brázdil and his colleagues have identified three flooding phases in central and western Europe: late December 1783, late February/early March 1784, and late March/early April 1784. The first phase mainly affected Britain, Ireland, France, the Low Countries, and historical Hungary. The second had a more substantial impact and affected France, central Europe, and the Danube River in southeast central Europe. The third phase affected mainly historical Hungary.[796]

For the German Territories, the second phase was the most devastating. German climate scientist Rüdiger Glaser determined that a blocking high-pressure system above eastern Europe resulted in a southerly current of warm air toward central Europe. Around 23 February 1784, temperatures in western Europe suddenly increased above freezing, which led to thaw, the melting of snow, and a sudden increase in water levels in the rivers.[797] The clash of the warm Mediterranean air and the cold air from the north led to severe rain, which added to the swelling.[798] It was not only high water that affected populations near these rivers: the influx of warm air also led to

794 Münchner Zeitung, 23 January 1784: 49: Report from Mannheim, no date. "Täglich wird diese Schnee- und Eiskolosse von sehr vielen hiesigen Inwohnern beiderlei Geschlechts besuchet, und bewundert. Schade, daß sie der Nachwelt nicht als ein Gedächtnisstük der grösten Kälte des 18. Jahrhunderts aufbewahret werden kann."

795 Königlich Privilegirte Zeitung, 7 February 1784: 107: Report from Heidelberg, 22 January 1784. "Es ist fast nicht zu viel gesagt, wenn man unser Unglück eine calabrische Verwüstung nennt. Mauern ohne Dach, ungeheure Eisberge, halb eingerissene Häuser, Schiffe zu oberst an die abgeworfene Dachung hingezwängt, Gebäude ohne Thüren und Fenster, halb zwischen dem Eis hervorstehendes erstarrtes Vieh, die weltberühmte gedekte Brücke ohne Seitenwände, welche man selbst hat abnehmen müssen, um eine noch höhere Wasserschwellung abzuwenden."

796 Brázdil et al. 2010. Several of the accounts of the different regions that had been affected by the ice drifts and floods can be found here: Weikinn 2000.

797 Glaser 2008: 235.

798 In Vienna, for instance, the temperatures rose from freezing to 10 °C between 25 and 26 February; Brázdil et al. 2010: 177.

the ice breaking up around 27 and 28 February 1784.[799] Rivers cascaded through the landscape and carried with them huge masses of debris, including ice, uprooted trees, parts of damaged mills, and other masonry.[800] Peak flooding occurred over the three days between 28 February and 1 March 1784. In many towns, people lost their homes, and some lost their lives. Afterward, homelessness, hunger, and petty theft became serious problems in many municipalities.[801]

The 2 March 1784 issue of the *Königlich Privilegirte Zeitung* was the first newspaper to feature reports from Hamburg and Vienna about sudden thawing. Many more reports about flooding (*Sündfluth*), ice floes, and destruction were to follow in the March editions of almost all other newspapers. Slowly, different stories poured in from all over the German Territories and beyond, describing different stages of the flooding event.[802]

Cologne, located on the Rhine River, was famously affected by ice drifts and severe flooding.[803] Over the winter of 1783/1784, the ice on the Rhine River was thick enough to walk on for 47 days. On 27 February 1784, at 5 a.m., the ice broke with a rumble; by 7 a.m., half the city was flooded (Figure 48). The extent of the flooding must have been genuinely terrifying; Cologne was at the mercy of an "ocean of ice."[804] An anonymous author, who published a book about *Das Arme Köln* ("The poor Cologne") in 1784, wrote that their curiosity and fear made them climb one of Cologne's highest towers:

799 Schmidt 2000: 258–263; Munzar, Elleder, Deutsch 2005: 8–24; Brázdil et al. 2010: 173–178; Sartor 2010: 73–76.

800 Schmidt 2000: 258–263; Glaser 2008: 236.

801 Anonymous 1784: 79–84; Weichselgartner 2001: 107–109; Degroot et al. 2021: 546.

802 Königlich Privilegirte Zeitung, 2 March 1784: Report from Hamburg, 24 February, and letter from Vienna, 15 February 1784. The term *Sündfluth* was used by Königlich Privilegirte Zeitung, 11 March 1784: Report from Nuremberg, 20 February 1784. The Berlinische Nachrichten featured a report about "a kind of *Sündfluth*" on 11 March 1784: Report from Nuremberg, 29 February 1784. The term *Sündfluth* refers to a large and severe flood that affected large parts of a country. The first syllable either refers to the German word *Sünde* (sin), i.e., human sinfulness caused the flooding, or it derives from the word *Sund* (sound, as in Fehmarn Sound) meaning the word *Sündfluth* simply means a flood of water; Adelung 1793–1804, 504. All newspaper issues of the Königlich Privilegirte Zeitung mention reports of flooding across the German Territories: Cochem, Bamberg, Cologne, Koblenz, Frankfurt am Main, etc., but also mentioned reports of flooding affecting Maastricht, Paris, or Warsaw. In the Berlinische Nachrichten, the news about the "endless icefield[s]" that have "piled up like rocks" began on 9 March 1784; in the Hamburgischer Unpartheyischer Correspondent, the reports began on 6 March 1784, with news of "such a high flood" in Lüneburg from 3 March 1784.

803 Thelen 1784; Spata 2017; Degroot et al. 2021.

804 Anonymous 1784: 40. "Wie saßen itzt wie mitten in dem Meere, rund um her nur Wasser und Eis."

Figure 48: Floodmarks at the portal of St. Maria in Lyskirchen, Cologne. This church shows two floodmarks, one above the door, marked by a line, and one to the right of the entrance with a line indicating the height of the flood. The water reached approximately 3.50 meters above street level.

> God! Which spectacle did I witness with my own eyes? I saw an entire ocean and mountains of ice floes between Cologne and [the nearby town of] Bensberg; there was nothing but air and water. Deutz, Mülheim, Rodenkirchen, and other towns near the river, were not visible apart from the tips of their towers and the roofs of their houses.[805]

In Cologne, the floodwaters reached 33 centimeters above the peak height of the St. Mary Magdalene's flood of 1342, which had affected half of central Europe.[806]

In Cologne and elsewhere, the aftermath of the flood was characterized by the cold and a lack of firewood and food. In the eighteenth century, insurances against

805 Anonymous 1784: 6. "Gott! Welch ein Schauspiel öfnete sich hier meinen Augen? Ich sah ein ganzes, ganzes Meer, und Berge von Eisschollen, zwischen Köln und Bensberg schier nichts als Luft und Wasser. Deuz, Mülheim, Rodenkirchen, und die dem Strome nächst gelegenen Oerter ließen nichts von sich sehen als die Spitzen der Thürmen und die Dächer der Häuser."

806 Spata (2017: 10) gives 13.3 meters as the height of the 1342 flood in Cologne and 13.63 meters as the height of the water in 1784. For more information on the St. Mary Magdalene's flood, see: Bauch 2014; Bauch 2019; Bauch, Schenk 2020: 2–3.

flooding were uncommon; instead, losses were mitigated by working harder. The Church played an important role by raising money for flood victims, distributing goods, organizing processions, and bringing people together to pray.[807] Private individuals, wealthy and poor alike, made charitable efforts: flood victims were housed and sheltered, cooked for, and given clothes, shoes, and blankets. The local governing body did not actively prevent flooding; its actions were primarily reactive. The authorities handed out food and firewood and issued orders that flooded houses had to be scrubbed and disinfected; some severely damaged dwellings were demolished. They also offered direct financial aid, either as a handout or tax exemption.[808]

Glaser regards the flooding event of 1784 as one of the worst environmental catastrophes in central Europe during the early modern period. Many floodmarks from 1784 still exist in various cities along several rivers in Germany; these high-water marks help historians reconstruct the flooding event.[809] In some cities, the floodmarks indicate that this was the highest flooding ever recorded, while in others, it was second to the aforementioned St. Mary Magdalene's flood of 1342.[810] Many artists immortalized the flooding, ice drifts, and their aftermath in various European cities: below is one such example.[811]

The painting by an unknown artist shown in Figure 49 was made for a zograscope in Augsburg and would have been displayed at fairs or entertainment parlors. One could inspect it closely by looking through a "peep hole" into a "peep box," which would have been lit up from behind by a candle. This technique was very popular in Europe from the 1740s onward. Often these paintings were exaggerated for entertainment's sake.[812]

In Würzburg, the ice started to break up on 27 February 1784. Large ice floes and floating tree trunks (*Holländerbäume*) caused much damage. On 28 February, the Main River had significantly risen and continued to do so until 29 February at around 4 a.m. At this point, it reached the entrance arch of the building that today houses Würzburg's town hall, where a floodmark remains.[813]

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807 Weichselgartner 2001: 97, 107–113.

808 Anonymous 1784: 79–83; Weichselgartner 2001: 98–99; Brázdil 2010: 179–180; Degroot et al. 2021.

809 Glaser 2008: 233–236.

810 Glaser 2008: 238; Brázdil et al. 2010: 185; Börngen 2011: 119; Brázdil et al. 2012: 147–148.

811 Famous examples are a series of paintings by Ferdinand Kobell that depicted the consequences of the ice drift and flooding along the Neckar River in Heidelberg; Friedrich Rübner painted the collapse of a bridge and damage to houses close to the Regnitz River in Bamberg; Franz Erban produced a copperplate engraving of the flood in Prague; Deurer 1784; Fricke 1988; Glaser 2008: 237. In Prague, the flooding of the Vltava/Moldau River resulted in several casualties, buildings were dislodged, bridges were carried away, mills had become unusable, and gardens, fields, and trees were buried under mud; Brázdil, Valášek, Macková 2003: 313–314; Munzar, Elleder, Deutsch 2005: 8–17; Glaser 2008: 237.

812 This image is also featured in Glaser, Hagedorn 1990: 11. The image is mirrored in their publication; more info on *laterna magica*; Faulstich 2006: 30.

813 Glaser 2008: 236–237.

Figure 49: Contemporary depiction of flooding in Würzburg in 1784.

Figure 49 depicts Würzburg on the Main River and shows distressed residents climbing onto roofs and boats to survive. Debris is flowing on the river. Cannons are being fired from the Marienberg Fortress, aimed at the ice, in a desperate attempt to break it up to prevent further damage.[814] Several residents can be seen on the bridge, equipped with long sticks; they are trying to push the ice and debris through the now-submerged bridge opening. Würzburg experienced no loss of life during this flooding event, but the financial losses were devastating; damage to infrastructure took years to repair.[815]

Many other riverine cities were affected by the flooding. The list is too lengthy to name them all. In Austria, Vienna was affected by floods that began on 26/27 February 1784 and lasted until 10 March.[816] Further along the Danube River, Regensburg was also affected. On 27 February 1784, the Danube River rose by three feet [94 centimeters].

814 Demarée 2006: 895. Ice jams formed at obstacles, such as bridges, where a lot of debris gathered. This led to very high water levels that produced floods and caused dikes to burst. Gaston Demarée regards ice jams as the main reason for flooding along the Rhine River and the Meuse River.

815 Glaser, Hagedorn 1990: 1–14; Schott 2004, vol. 2: 37–39.

816 Strömmer 2003: 209–211; Rohr 2020: 204–207.

This was followed by an ice drift and a further rise of nine feet [282 centimeters].[817] In Munich, the temperatures rose on 22 February and the thawing began.[818] The large amounts of snow melted quickly and "the saddest inundations followed."[819] France and the Low Countries were also affected by ice drifts and flooding in late February 1784. In Paris, ice on the Seine River broke up and began to melt on 26 and 27 February flooding low-lying parts of the city.[820]

Northern Germany suffered the consequences of the rapid thaw, too: heavy winter snow blanketed county Bentheim until 22 February 1784, when temperatures rose, resulting in flooding at the Vechte River. Local records state that nobody could remember such a terrible flooding event. In February and March 1784, more flooding followed at many other northern German rivers.[821] Between 7 and 10 March 1784, the Elbe River flooded the area around Dannenberg. Strong winds pushed large blocks of ice upstream, which damaged bridges.[822] By 22 March 1784, the Elbe River was navigable again, and Hamburg was able to receive ships from London and Lisbon.[823] After the flooding had occurred, the cold returned once more. It brought snow with it. Then, in May 1784, it slowly became warmer.[824]

Although the severe cold and flooding cost lives, the mortality rate of the late summer of 1783 remained larger than that of the severe winter of 1783/1784.[825] Nevertheless, the February–March 1784 flooding in much of central Europe was one of "the most disastrous events during the past millennium."[826] Like the events of the summer, some interpreted the floods as divine intervention, while others searched for rational explanations.[827]

The Winter in North America

The winter in North America had been one of the harshest on record.[828] In Okkak, one of the Moravian settlements in Labrador, it started snowing on 21 July 1783. More snow

817 König 1784: 52–54; Societas Meteorologica Palatina 1784: 53–54. According to Verdenhalven (2011: 19–20), in Regensburg, one foot was 31.374 centimeters before 1811.
818 Bayerische Akademie der Wissenschaften 1784: 69–70, 75–76.
819 Bayerische Akademie der Wissenschaften 1784: 48. "[. . .] denn es fieng an aufzuthauen, der Schnee schmolz, und die traurigsten Ueberschwemmungen folgten nach."
820 Franklin 2017: 294. See also McCloy 1941: 7–12; Demaréé 2006; Brázdil et al. 2010.
821 Hamm 1976: 118–119; Santel 1997: 111; Poliwoda 2007: 59–84.
822 Puffahrt 2008: 20.
823 Königlich Privilegirte Zeitung, 27 March 1784: Report from Hamburg, 22 March 1784.
824 Strömmer 2003: 210–213.
825 Brázdil et al. 2010: 182.
826 Brázdil et al. 2010: 185.
827 Glaser 2008: 236.
828 Ludlum 1966.

followed in August, with "thick snow" on 21 September and throughout October 1783. On 26 November 1783, the bay near Okkak froze over. It snowed as late as 15 May 1784 and again on 8 June. On 3 July 1784, one observer wrote: "Ice on the ponds not broke[n] yet, [. . .] never so late before." Later in July 1784, the bay was "covered over with new ice, ice comes in again from [the] sea." On 2 August 1784, one weather observer summarized the preceding months thusly: "The winter was not very cold we had not much snow till new year but from new year till May I never seen so much snow and there is very much yet and very much Ice all over the sea as far as the eye can see."[829]

Further south, in the eastern United States, the winter of 1783/1784 was perhaps the coldest of the past 250 years; the temperatures were 4.8 °C below the 225-year mean.[830] Records from this winter reveal that New England saw the most prolonged period of temperatures below 0 °C in its history.[831] In early December 1783, the Schuylkill River in Philadelphia froze over.[832] The Delaware River, which also runs through Philadelphia and flows into the Atlantic, was frozen solid from December 1783. The icy conditions continued.[833] In fact, all the rivers in Pennsylvania were frozen in the winter "so as to bear wagons and sleds with immense weights." It was so cold that the thermometers "stood several times at 5 degrees below 0" [−5 °F = −20.5 °C].[834]

In Trenton, ice on the Delaware River "had frozen to an amazing thickness." However, in late January 1784, heavy rains broke up the ice, at least for a few days.[835] Richard BACHE called the winter "remarkable severe & tedious" in a letter to Benjamin FRANKLIN, his father-in-law, on 7 March 1784. He was "looking impatiently for the approach of Spring." He told of vessels in the bay off Philadelphia that had been stuck there for ten weeks, unable to travel to the city because of the ice, which had stagnated business.[836] On 18 March 1784, after three months of ice, the Delaware River opened at Philadelphia, and vessels were free to resume travel. "Such has been the severity of the weather and continued frost, that the inhabitants of Philadelphia have not experienced

829 Meteorological Observations at Okkak and at Hoffenthal, Hudson's Bay Company, Labrador, Newfoundland, 1782–1786, MA/144, Archives of the Royal Society, London, UK.

830 LUDLUM 1966; LUDLUM 1968; THORDARSON 2005: 215; D'ARRIGO et al. 2011: L05706; MIKHAIL 2017: 190–192. Apart from 1783/1784, the other severe winters occurred in the eastern United States in 1740/1741 and 1779/1780.

831 LUDLUM 1966: 64; WOOD 1992: 64–65.

832 Pennsylvania Packet, 18 March 1784: 2.

833 The Providence Gazette and Country Journal, 17 January 1784: 3: Report from Philadelphia. "For some Days past our Harbour has been shut up by Ice."

834 The American Museum, or Universal Magazine 1789: 253; this report had previously been published in the Columbian Magazine, November 1786.

835 United States Chronicle, 26 February 1784: 2: Report from Trenton, 27 January 1784.

836 FRANKLIN 2017: 21, letter from Richard BACHE to FRANKLIN, Philadelphia, 7 March 1784.

a winter since the year 1750–1751, that has been more intensive cold, disagreeable and distressing."[837] Around the same time, the frozen Schuylkill River suddenly broke up, and flooding followed. The river carried "large bodies of ice," flooded houses, drowned livestock, and forced people to retire to their second floor.[838] "Retiring" was a euphemism used in the United States and Europe when one had to evacuate the ground or lower floors because of flooding.[839]

In New Haven, by mid-February 1784, the weather had been so cold that the western part of the Long Island Sound was frozen "for several miles – at White-Stone, to such a degree, that people pass to and from Long Island on the Ice."[840] In Boston, the harbor froze over on the last days of 1783, a freeze that lasted for at least three weeks. Although the frozen rivers and harbors hindered the shipping industry and commerce, they did provide certain advantages.[841] Frozen waterways enabled easy transport across rivers and lakes. However, this was far from a safe endeavor: sometimes, the ice broke, and people and animals were lost to the frigid waters. Similar fates befell those trying to evacuate stranded ships.[842]

As late as March 1784, American newspapers reported that the Chesapeake Bay was covered in ice. Harbors and channels in the region were closed for boats for the longest time in the region's history.[843] In February 1784, the winter "produced ice in the harbor of Charlestown [Charleston] strong enough for skating on, which is very uncommon here."[844]

When FRANKLIN received updates about the winter in North America, particularly the status of the ratification of the Treaty of Paris, he remarked: "The Winter it seems has been as severe in America as in Europe, and has hindered the Meeting of a full Congress [. . .],"[845] and so, the necessary number of delegates to ratify the Treaty of

837 Norwich Packet, 1 April 1784: 3. A very similar report can be found in the Massachusetts Spy, 8 April 1784: Report from New York, 25 March 1784.

838 Pennsylvania Packet, 18 March 1784: 2.

839 GLASER 2008: 236. GLASER mentioned that Ludwig VAN BEETHOVEN, at the time 12 years old, was a famous witness to the ice floods. Together with his family, who were staying at a friend's house in Bonn, he had to "retire" to the first floor when the floods came.

840 Norwich Packet, 26 February 1784: 3–4: Report from New-Haven, 17 February 1784.

841 American Herald and the General Advertiser, 19 January 1784: 3.

842 Spooner's Vermont Journal, 25 February 1784: 3: Report from Hartford, 10 February 1784; Vermont Gazette, 14 February 1784: 2: Report from New-London, 29 January 1784; United States Chronicle, 26 February 1784: 2: Report from Philadelphia, 7 February 1784.

843 LUDLUM 1966: 32–35, 64–68; FRANKLIN 2014: 560–563, founding Father Robert MORRIS wrote FRANKLIN a letter from the Office of Finance in the US on 12 February 1784. He expressed his hope that the "intemperate" season would end soon and ships would be able to depart Chesapeake Bay by early April.

844 New-York Packet, 18 March 1784: 3: Report from Philadelphia, 10 March 1784.

845 FRANKLIN 2017: 46, letter from Benjamin FRANKLIN to David HARTLEY, written at Passy, 11 March 1784.

Paris. Ice in the harbors and adverse weather conditions further delayed the transport of the signed Treaty of Paris from the United States to Europe.[846] On 30 March 1784, FRANKLIN informed John JAY by letter that the courier, Josiah HARMER, had reached him and handed over the ratified treaty. Ice in the New York harbor had stopped HARMER's ship from setting sail for about a month, during which time, some passengers aboard had frozen to death. HARMER was the one to inform FRANKLIN about the "uncommonly severe" winter in America.[847]

Once spring came around, the ice and snow began to melt. Now, news started to pour in from further afield. The severity of the winter had been underestimated; in mid-April 1784, news reached the northeast that ice (or ice floes) had gone as far south as Jamaica.[848] Jamaica is in the tropics, so ice is rare, although snow is not unknown on the elevated parts of the island.[849]

In mid-May 1784, news also reached the United States that on 28 February 1784, "a small flight of snow fell" in Bermuda, and the temperature "was lower than ever it was known before."[850] Bermuda is north of the Caribbean and benefits from the warm waters of the Gulf Stream, which usually ensures its islands remain snow- and ice-free.[851] However, in the winter of 1783/1784, there was at least some snow in late February.

In mid-May 1784, news reached the eastern seaboard that "the Mississippi has been fast bound up by ice."[852] The river had frozen over at New Orleans between 13 and 19 February 1784. When the ice broke, ice blocks were seen about 100 kilometers south of New Orleans in the Gulf of Mexico.[853] The reports indicate that even in 1784, this was regarded as something extraordinary.[854]

846 SMITH 1963: 420–430; FRANKLIN 2017: xlix.

847 FRANKLIN 2017: 89, Benjamin FRANKLIN in a letter to John JAY, written at Passy, 30 March 1784. FRANKLIN 2017: 105, letter by Benjamin FRANKLIN and John JAY to David HARTLEY, 31 March 1784.

848 Massachusetts Spy, 14 April 1784: 3.

849 CHENOWETH 2003: 77.

850 Massachusetts Spy, 13 May 1784: 3: Report from Bermuda, 1 March 1784. The temperature measured outside was 44 °F, which is 6.6 °C.

851 FORBES, "Bermuda's Climate, Weather & Hurricane Conditions."

852 Massachusetts Spy, 13 May 1784: 3: Extract from a Letter from St. John's, East-Florida, 14 February 1784. Similar accounts were also published in other newspapers, such as the Salem Gazette, 18 May 1784; South-Carolina Weekly Gazette, 26 May1784; and Spooner's Vermont Journal, 2 June 1784.

853 LUDLUM 1966: 154; WOOD 1992: 66; THORDARSON 2005: 215; MIKHAIL 2017: 190–192.

854 LUDLUM 1966: 222–223. David M. LUDLUM mentions that Detroit also experienced one of the severest winters of the eighteenth century in 1784.

Searching for a Connection

The winter of 1783/1784 was indeed extreme on both sides of the Atlantic, and those who experienced it first-hand were aware of this fact. Just as in the summer, weather observers and newspaper correspondents searched for precedents. In some but not all cases, they found previous weather events that were comparable. Did contemporaries consider this most severe of winters and this most unusual of summers as part of the same phenomenon?

There was certainly some speculation about the matter. In Austria, an anonymous clerk believed "this special Earth vapor [*Erddunst*], which had caused the extraordinary heat and the many thunderstorms, also had the potential to cause the extraordinary amounts of snow and cold during this winter." And indeed, during the winter, there were further reports of haze.[855] The *Münchner Zeitung* reported that the haze had returned for just a few days, appearing during the snowfall, just as it had during the rain of the summer.[856]

Karl Ludwig Gronau found records that indicated a fog was present in the same year as an intense cold in 1739/1740 and 1775/1776, just as in 1783/1784. According to the documents available to him, the winter of 1739/1740 was the coldest of the eighteenth century, and the temperature during the winter of 1775/1776 reached −8 °F [−22.2 °C]. Ultimately, he left it up to his readers to speculate whether the fog of 1783 had something to do with the cold of 1784.[857]

In his letter to Manchester in 1785, Benjamin Franklin also postulated a connection between the dry fog and the cold of the winter. The dry fog had:

> rendered [the sun's rays] so faint in passing through [to the Earth]. [. . .] Of course, their summer effect in heating the earth was exceedingly diminished. Hence the surface was early frozen. Hence the first snows remained on it unmelted and received continual additions. Hence the air was more chilled, and the winds more severely cold. Hence perhaps the winter of 1783/1784 was more severe than any that had happened for many years.[858]

855 StAKI, Karton 220, Nr. 41 NR, fol. 266v (quoted after Strömmer 2003: 208). "Der in dem vorigen Sommer so merkwürdige Nebl, ließ sich im heurigen Winter [1784], nur wenige Tage ausgenommen, deutlich bemerken. Mitten unter den Schneeflocken erkannte man ihn meist, so wie er in dem vorigen Sommer stets mitten im Regen sich gezeigt hatte. Es ist hieraus billig zu schließen, daß dieser besondere Erddunst, so wie er im vorigen Sommer die ausserordentliche Hitze, und die verheerende Gewitter verursachet, auch diesen Winter den Stoff zu den ausserordentlichen Schnee, und Kälte verursachet haben mag."

856 Münchner Zeitung, 9 February 1784: 86–87.

857 Gronau 1784: 252–253.

858 Franklin 1785: 359–361.

Franklin suggested that further research on previous harsh winters after unusually long-lasting summer fogs should be conducted.[859] Given the historical precedents of unusual hazes preceding cold winters, Franklin's argument seemed very plausible.

Outlook

Cold Temperatures Continued

In Europe, another punishing winter followed in 1784/1785. The summer of 1785 was cool and dry in Europe and the United States.[860] According to current scholarship, the Laki eruption is believed to have impacted the weather over much of the Northern Hemisphere for up to three years.[861]

In England, the spring of 1784 came late, and then it was "wet & cold till Mid-July." The harvest came in late too, but it was "plenty." The winter of 1784/1785 was "severe" and brought with it heavy snow.[862] On 8 December 1784, Gilbert White called the weather "Siberian." The day after, the snow on White's property was 30 to 40 centimeters deep. One of his neighbors, Thomas Hoar, lost 41 sheep to the heavy snowfall. In his diary, White concludes, "No such snow since January 1776."[863] On the following day, White writes, "Extreme frost!!! Temperature below zero!"[864] The snow had fallen uninterrupted for 24 hours. Food items, such as bread, cheese, meat, potatoes, and apples, froze if they "were not secured in cellars under ground."[865] White was curious about the true temperature outside, so he experimented with two different thermometers: "We hung out two thermometers, one made by Dollond & one by B. Martin: the latter was graduated only to 4 below ten, or 6 degrees short of zero [6 °F=−14.4 °C]: so that when the cold became intense, & our remarks interesting, the mercury went all into the ball & the instrument was of no service."[866] White was frustrated with his instruments; both were inadequate and he was unable to assess the exact temperature outside.

The cold weather continued into the spring; on 2 March 1785, White claimed that the ground became "as hard as iron." On 14 March, a "fierce frost" crept through doors and windows and into the bedrooms of all and sundry. On 23 March, "colds & coughs [were]

859 Franklin 1785: 359–361.

860 Kington 1980: 30; Wood 1992: 68. The period from August 1784 to July 1785 was the driest consecutive 12-month period since the rainfall series began in 1727 for England and Wales (at least until 1980 when this study was published).

861 Thordarson, Self 1993; Therrell 2005: 203–207; Thordarson 2005: 215.

862 Meteorological Observations at Dundee, Scotland, 1782–1801, "General Results from a Meteorological Journal Kept at Crescent near Dundee," MA/45, Archives of the Royal Society, London, UK.

863 Gilbert White, "The Naturalist's Journal," 1784, Add MS 31849, British Library, London, UK.

864 If the temperature was −1 °F, that means it reached a low of −18.3 °C.

865 Gilbert White, "The Naturalist's Journal," 1784, Add MS 31849, British Library, London, UK.

866 Gilbert White, "The Naturalist's Journal," 1784, Add MS 31849, British Library, London, UK.

frequent."[867] Correlating well with these observations, J. Rothwell called March 1785 the coldest month on record for Greater Central England.[868] Additionally, White noticed the last frost of the season as late as 22 May.[869] The spring of 1785 was the coldest in Europe between 1500 and 2004.[870]

In the German Territories, it seemed that the cold of early 1785, March in particular, exceeded that of the winter of 1783/1784. A report in the *Münchner Zeitung* was adamant that March 1785 was by all measures a more challenging month than the March of the previous year. It goes so far as to claim that it outdid the coldest years on record.[871] The *Augsburgisches Extra-Blatt* made similar claims and remarked, in a way typical of the time, that this was the worst March in living memory.[872] In Schnürpflingen, in southern Germany, the snow came in late October 1784 and lasted until spring 1785; at Easter [27 March], the town's people were still trudging through snow as swallows froze to death in the skies above them.[873] According to the *Ephemerides* of the Societas Meteorologica Palatina, in Sagan, Silesia, 1785 was the coldest year of the observation period between 1781 and 1792. The average air temperature in 1785 was 6.3 °C, compared to 7.9 °C for that 12-year period. This cold spell drew to a close after 1786.[874]

In Austria, temperatures plummeted in November 1784, marking the beginning of a bitterly cold spell which lasted at least until April 1785. The winter of 1784/1785 was even colder than the previous year and was followed by flooding and ice drift events. The winter of 1785/1786 was cold again and succeeded by yet more flooding events along the Danube River, among others. It was remarked that 1784 through 1786 had produced poor-quality wines.[875] In the Czech Lands, the slightly warmer summer of 1783 was followed by unseasonably cold temperatures until the end of 1786; the two winters following the eruption were particularly cold. Spring 1785 was the coldest on record, according to data at the Prague-Klementinum observatory, whose records date back to 1775.[876] The years that followed 1783 were much the same in the Czech Lands as they were in the rest of Europe, with significant cooling and the frequent flooding that usually follows.[877]

867 Gilbert White, "The Naturalist's Journal," 1785, Add MS 31849, British Library, London, UK.
868 Anonymous, Private Weather Diary, "Greater Central England" Climatological series 56BC–AD2010 Archive, MET/2/1/2/3/545, National Meteorological Library and Archive, Met Office, Exeter, UK.
869 Gilbert White, "The Naturalist's Journal," 1785, Add MS 31849, British Library, London, UK.
870 Xoplaki 2005: L15713, Figure 1; Písek, Brázdil 2006.
871 Münchner Zeitung, 4 March 1784: 149.
872 Augsburgisches Extra-Blatt, 10 March 1785: Report from Frankfurt, 5 March 1785.
873 Gemeindechronik Schnürpflingen, Alb-Donau-Kreis, schnuerpflingen.de.
874 Przybylak et al. 2014: 2408, 2414.
875 Strömmer 2003: 213–223.
876 Brázdil, Valášek, Macková 2003; Písek, Brázdil 2006; Brázdil et al. 2017: 150.
877 Písek, Brázdil 2006; Brázdil et al. 2017: 160.

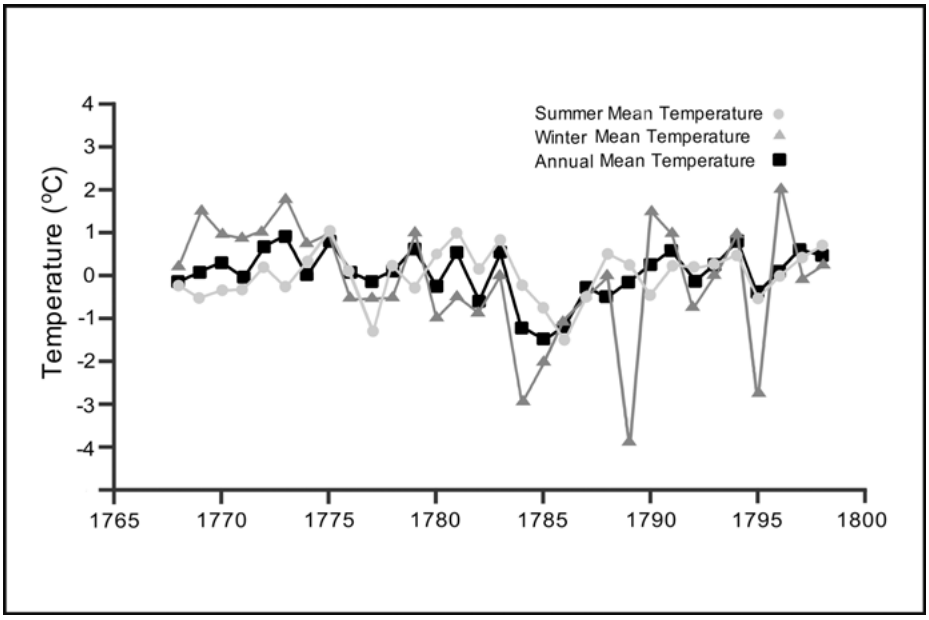

Figure 50: Mean surface temperatures for the late eighteenth century. This temperature reconstruction is based on data from Europe and the northeastern United States analyzed over a 31-year period, 1768 to 1798.

As this graph (Figure 50) reveals, the annual mean temperature dropped after the eruption. While 1783 was overall rather warm, 1784 was significantly colder. In fact, 1784 had been 1 °C colder than the 31-year mean. 1785 was the coldest year of the period, with 1786 being about as cold as 1784. Only after 1786 did the weather become warmer again. The summer of 1788 was almost the same temperature as that of 1783. The weather took another downturn between 1788 and 1790: the winter of 1788/1789 was long and severe. The Thames was covered in a sheet of ice so thick that Londoners were able to hold a frost fair on it, the first since the winter of 1739/1740.[878]

Some scholars argue that the Laki eruption "helped trigger" the French Revolution in 1789.[879] This idea, however, has been debunked by French climate historian Emmanuel Le Roy Ladurie, who argues that the harvests in France had been good up until 1787 (inclusive). In 1788, a modest yield was followed by subsistence riots and social unrest that lasted well into the summer of 1789. Le Roy Ladurie suggests any perceived connection between the Laki eruption and the French revolution is simply

878 Kington 1980: 32.

879 Neale 2010; Garnier 2011: 1053–1054; Spence 2014.

an "old Anglo-Saxon 'historiographic legend.'"[880] David McCallam also called it an "overly simplistic historical assumption."[881] There is no doubt that the Laki eruption impacted various regions differently. Some were plunged into famine, some endured pollution and cold, and many were rife with fear and confusion. In most places, hardship was not evenly divided between the rungs of social standing. These regions did not exist in a vacuum; the Laki eruption, in many instances, only stirred up preexisting conditions and sentiments.[882]

Europe endured several extreme weather events in the wake of the Laki eruption. The most acute and immediate was a strange polluting fog that persisted for months. Thereafter, a stiflingly hot summer and several colder-than-usual seasons tormented the continent further. Excess mortality ensued in the late summer and autumn of 1783 and the winter and spring of 1784. The fine particulates of the haze that plagued Europe, which took their toll over months, coupled with bouts of dysentery or fever, most likely contributed to this. It seems that outside of Iceland, the Laki eruption did not trigger a societal or agricultural crisis. These findings are in good agreement with the research of Rudolf Brázdil and his team into the impact of the Laki eruption on the Czech Lands, which shows reasonably steady agricultural output and little change in grain prices. The Laki eruption seems not to have caused a socio-economic crisis. Indeed, the social impact is described as "negligible," especially in comparison to the Tambora eruption, which (as mentioned) caused a "year without a summer" in 1816. A profusion of misfortunes followed Tambora, including a poor grain harvest, an increase in grain prices, and a lack of food, followed by widespread hunger, increased crime, and an overall societal crisis.[883]

Natural scientists are still debating whether the Laki eruption triggered the cold period between 1783 and 1786 or whether it was caused by natural climatic variability.[884] The Laki eruption occurred during the Little Ice Age (1250/1300–1850) and, more specifically, the Dalton Minimum (1760–1850).[885] During this overall colder period, the weather became even more variable. Some scientists argue that El Niño-Southern Oscillation played a role: estimates of the exact dates differ, but Vinita Damodaran and her colleagues argue in *The Palgrave Handbook for Climate History* that there

880 Garnier 2011, commentary by Emmanuel Le Roy Ladurie, translated from French. Le Roy Ladurie (2006: 77–180) documented the climate throughout the 1780s for France. Here he also discusses the seven seasons between 1787 and 1789 that he believed to have "triggered" the French Revolution; McCallam 2019: 218, note 77.

881 McCallam 2019: 199.

882 McCallam 2019: 218.

883 Brázdil et al. 2017: 159–160.

884 For this debate, see D'Arrigo et al. 2011; Pausata et al. 2015; Pausata et al. 2016; Zambri et al. 2019b: 6787; Dawson, Kirkbride, Cole 2021.

885 Wagner, Zorita 2005.

were prolonged El Niño and La Niña phases from 1782 to 1784 and from 1785 to 1790, respectively.[886] Climate scientists of the future are charged with the further exploration of the climate forcing associated with the Laki eruption.

Annus Arcanus

In 1784, Jean Senebier (1742–1809), a Swiss naturalist and librarian in Geneva, detailed how some believed the cause of the dry fog to be the earthquakes in Calabria, others, the new volcano that formed on 8 June 1783 in Iceland.[887] These two theories were deemed possible for decades. Over time, the suggestion that the vapors had come from the north – owing to the prevailing wind directions at the time – grew in popularity.

> [. . .] An eruption was taking place at the time in Iceland, and there can be no doubt of the volcanic smoke having affected the atmosphere, of the connection where the fog prevailed. The mountain of Skaptefeld vomited its columns of fire furiously during the period the fog lasted, and the wind blew chiefly from the Northwest. I traced the fall of ashes from the Orkneys through the Faroe Islands to Jutland. & some fine dust was noticed to have fallen in Germany.[888]

John Thomas Stanley speculated that the dry fog he had witnessed in Switzerland in the summer of 1783 was caused by a volcanic eruption in Iceland, even going as far as placing the eruption in the "Skaptefeld" region. Stanley wrote these memoirs after the French Revolution (possibly in the 1790s); therefore, it is unsurprising that he was aware that the dry fog was a Europe-wide phenomenon.[889]

On 28 March 1787, a Bavarian naturalist and member of the Electoral Academy of Science, Franz Xaver Epp (1733–1789), gave a lecture about the "so-called vapor, which did not only appear in Bavaria but in all of Europe in 1783." Epp stated that in Bavaria, the dry fog lasted from mid-June to the end of August 1783. He then detailed the various theories on the origin of the fog that were circulating, illustrating that even in 1787, there was no consensus among naturalists. Epp dismissed the idea that it might have been a sea fog, as claimed by the Swedish scholar D. Gißler, citing the distance of Bavaria from the ocean and the fact that the fog was as intense there as anywhere else. Others suggested it was a normal "sun smoke" that occurred naturally during hot and dry days, but this, too, he dismissed: an extraordinary phenomenon such as this needed to have an extraordinary origin. Another possible explanation was that a

886 Damodaran et al. 2018.

887 Senebier 1784: 410. Jean Senebier also served as the observer for the Geneva weather station of the Societas Meteorologica Palatina; Societas Meteorologica Palatina 1783: 417–435.

888 John Thomas Stanley, MS, JRL 722, John Rylands Library, University of Manchester, Manchester, UK: 95–96.

889 John Thomas Stanley, MS, JRL 722, John Rylands Library, University of Manchester, Manchester, UK: 103.

large forest fire in Finland or Sweden was the source of the smoke, but Epp, once again, was not convinced.[890]

Franz Xaver Epp concluded that the most likely origin was a "fire in Iceland" in 1783. He summarized the most important information from Sæmundur Magnússon Hólm's book, including the passages on the negative impact on the animals in Iceland and the tribulations of the Icelanders.[891] Epp wondered whether this large volume of "smoke, haze, and vapors" from Iceland was enough to fill the atmosphere of an entire continent and whether it could travel such a great distance. He concluded that if the smoke of a forest fire from Finland could reach the German Territories, so too could smoke from Iceland.[892]

The Montgolfier brothers' new invention allowed Epp to clear up an old misconception: the idea that the wind was calm at great heights in the sky. The people who had risked traveling in hot-air balloons in the four years prior could attest that it could be rather windy in the upper atmosphere, far above the highest peaks. These winds "were certainly capable of spreading the Icelandic smoke far and wide."[893] Epp doubted that the smoke was detrimental to the health of those in Europe. He surmised that as the potency of chimney smoke lessens with distance, so too should the smoke from Iceland; therefore, although he believed that Icelanders smelled sulfur, he was certain the people of Bavaria had not.[894] He wrongly believed that the "ocean of fire," the lava in Iceland – which he thought to be the source of the dry fog – ceased to exist in August 1783. Epp established a link between the dry fog in Europe and an eruption in Iceland. The exact nature of the connection remained obscure. Like many other naturalists at the time, he did not dare repudiate the most popular explanation entirely; therefore, he added, "I do not want to deny that the numerous and devastating earthquakes of 1783 also added to the summer fog."[895]

A possible link between the Icelandic volcanic eruption(s) and the dry fog remained a topic of speculation; the year of awe remained a year of mystery, *annus arcanus*. In 1806, the Krünitz encyclopedia published a volume that included an entry for *Nebel* (fog), which mentioned the strange fog of 1783, but neglected to broach the topic of its cause. Even 23 years after the Laki haze, its connection to an Icelandic volcanic eruption was not widely accepted.[896] The *Physical Dictionary* from 1833 lists several possible theories regarding the origin of the dry fog: it suggests it might have been the manifestation of an overload of electricity in the air from the tail of a comet;

890 Epp 1787: 1–24.

891 Epp 1787: 1–24.

892 Epp 1787: 24. "Rauch, Dunst und Dampfe."

893 Epp 1787: 25. "Diese waren gewiß fähig den Isländischen Rauch weit und breit zu vertheilen."

894 Epp 1787: 25–28.

895 Epp 1787: 30. "Ich will nicht verneinen, daß die in dem Jahre 1783 so zahlreichen und verheerenden Erderschütterungen zu diesem Sommernebel auch was beygetragen haben."

896 "Nebel" in Krünitz 1806, vol. 101: 759–760.

vapors produced by earthquakes or volcanic eruptions; or smoke from peat fires. The article concludes that with so many different hypotheses, the phenomenon should not remain a mystery for much longer.[897] In the late eighteenth century, the natural sciences had not yet reached the point at which they could dissociate unrelated phenomena.[898] This would change in the late nineteenth century, as we will see in the next chapter.

897 Brandes et al. 1833: 34–53.

898 Demarée, Ogilvie 2001: 224.