Research Article

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A first step towards a national realisation of the international height reference system in Sweden with a comparison to RH 2000

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Abstract: The International Height Reference System (IHRS) was defined by the International Association of Geodesy in 2015. Since then, the international geodetic community has been working on the specification and establishment of its realisation, the International Height Reference Frame (IHRF). This frame will primarily be realised by geopotential numbers (or physical heights) in a sparse global reference network. In Sweden, only one such global station is planned. Regional and national realisations (or densifications) computed in accordance with the IHRS definition are needed to enable the best possible unification of height datums. The main purpose of this article is to make a case study for Sweden regarding the national realisation of IHRS and to investigate in what way preliminary IHRF differs from the current Swedish levelling-based realisation of the European Vertical Reference System, RH 2000. The two different quasigeoid models that we consider best over Sweden at the present time are used to compute the preliminary IHRS realisations in the study. The realisations are compared to each other and to RH 2000. It is shown that a very significant part of the difference to RH 2000 is due to the different postglacial land uplift epochs, permanent tide concepts, and zero levels. The standard deviation for the difference between one of the preliminary national IHRS realisations and RH 2000 is reduced from 75.5 to 19.2 mm after correction of the postglacial land uplift and permanent tide effects. The corresponding mean differences are –208.5 and –454.7 mm, respectively. The magnitude of the mean difference thus increases when the corrections in question are applied.

Keywords: GNSS, height datum unification, international height reference frame, postglacial land uplift, regional geoid determination, Sweden

1 Introduction

1.1 Background

1.1.1 International height reference system, IHRS

A common global vertical reference is needed for instance to investigate and monitor climate-related changes in the Earth system (Ihde et al. 2017). A global height system is needed also for many other applications. In 2015, the international height reference system, IHRS, was defined by the International Association of Geodesy, IAG (IAG Resolution No. 1 (2015) in Drewes et al. 2016).

The definition of IHRS includes specification of the equipotential surface with conventional geopotential value W_0 = 62636853.4 m^2 s^{-2} (Sánchez et al. 2016) as vertical reference level. Vertical coordinates in IHRS are given by geopotential numbers, C_{p}, referring to the difference between the geopotential at the point P and the equipotential surface. The International Terrestrial Reference System, ITRS, is specified as the spatial 3D reference for IHRS, and the permanent mean tide concept is used. It is not specified in the IAG resolution what type of physical height should be preferred, but Ihde et al. (2017) recommend the use of normal heights.

1.1.2 International height reference frame (IHRF)

The international geodetic community is now focusing on the specification and establishment of the first realisation of IHRS, i.e. of the first International Height Reference Frame, IHRF (Ihde et al. 2017). At the highest level, IHRF will be realised by geopotential numbers for stations in a

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global reference network. Recently, a global core network of 170 well-distributed stations worldwide was proposed for this purpose (Sánchez et al. 2021a), which includes the three Nordic/Baltic stations Onsala, Riga, and Metsähovi. The global realisation will be computed based on regional gravity field modelling of high resolution when available. Otherwise, a combined global gravitational model of high resolution will be used instead.

The stations in the global core network are too sparse to be well suited to provide national or regional access to IHRF. Regional and national densifications (or realisations) will be needed to enable the best possible unification of height data (Sánchez et al. 2021a). In Sweden, for instance, only one global station is planned.

1.1.3 RH 2000, the Swedish realisation of European vertical reference system (EVRS)

The Swedish realisation of EVRS is RH 2000 (Ågren and Svensson 2011). It is based on the Baltic Levelling Ring network (Mäkinen et al. 2006 August) and is realised in Sweden by around 50,000 benchmarks levelled during approximately 30 years between 1975 and 2003. The adjustment was finalised in 2005. The basic definitions of RH 2000 and the IHRF are listed in Table 1. The relative standard uncertainties of the adjusted heights of RH 2000 with respect to Normal Amsterdam's Peil (NAP) are approximately 2 cm in Sweden. The relative uncertainties within Sweden are below approximately 1 cm (Ågren and Svensson 2011).

1.2 Purpose and delimitations

The main purpose of this article is to make a case study for Sweden regarding realisation of IHRS. The preliminary global realisation (Sánchez et al. 2021b) in the three stations on the Nordic/Baltic mainland (Onsala, Riga, and Metsähovi) and two preliminary pointwise realisations over Sweden are selected for the study. The latter two are based on what we consider the best GNSS data set and regional quasi geoid models available over Sweden for the time being (Section 2.1).

More specifically, we investigate the following research questions:
- How do the selected preliminary national IHRS realisations deviate over Sweden?
- How much do the two preliminary national realisations differ from the global counterparts in the global IHRF station in Onsala?
- How large are the differences between the preliminary national realisations and RH 2000 and to what extent can they be explained by the different zero levels, permanent tide concepts and postglacial land uplift epochs?

The selected IHRS realisations are presented in Table 2.

This study is the first step in a larger project aiming for the best possible realisation of IHRS for Sweden including an optimum transformation to the national height frame RH 2000. Hopefully, the project can be extended to the Nordic/Baltic neighbouring countries cooperating under the umbrella of the Nordic Geodetic Commission (NKG).

1.3 Organisation of the article

Section 1 contains the introduction to the article. The used methods are outlined in Section 2, which includes a description of the input data, the computation of IHRF geopotential numbers and the comparison to RH 2000. The corresponding results are presented in Section 3, which starts by first presenting the geopotential numbers of IHRF GLOBAL, IHRF SWE Prel#1 and IHRF SWE Prel#2 in the three global stations on the Nordic/Baltic mainland (including the Swedish station Onsala). The next section in the result part then presents the difference between IHRF SWE Prel#1 and IHRF SWE Prel#2 in the denser GNSS network. IHRF SWE Prel#1 is finally compared in detail to RH 2000. The results are then analysed and discussed in Section 4, which ends with a few recommendations.

Table 1: Definitions of IHRS/IHRF and EVRS/RH 2000

	IHRS/IHRF	EVRS/RH 2000
Zero level	W_0 = 62636853.4 m^2 s^{-2}	NAP level
Permanent tide concept	Mean tide	Zero tide
Land uplift epoch	2021.04	2000.0
Primary way of realisation	Space geodesy and gravity field modelling	Geodetic precise levelling
Primary height type	Geopotential numbers, C	Normal heights, H

Table 2: The preliminary IHRS realisations included in the study

Realisation	Original GNSS/3D Frame	Quasigeoid model	# Stations
IHRF Global	ITRF 2014, epoch 2021.04	NKG2015	3
IHRF SWE Prel#1	SWEREF 99	NKG2015	197
IHRF SWE Prel#2	SWEREF 99	FAMOS LM7F	184

2 Methods

To compute the two national realisations of IHRS, both gravimetric (quasi-)geoid models and ellipsoidal GNSS heights of high quality are needed in the specified reference frames and time epochs. If needed, the input data must be transformed prior to the computation of the geopotentials. The first part of this section presents the input data and how it was converted prior to computation. After that, we describe the process to compute geopotential numbers in IHRF (Figure 1). Finally, we describe how one of the national realisations was compared to RH 2000.

2.1 Geoid models

We have selected two quasigeoid models to compute the two national realisations for Sweden. The current official Nordic gravimetric model, NKG2015 (Ågren et al. 2016), was chosen as it is considered to be of high quality at the same time as it is the latest official model of the Nordic Geodetic Commission (NKG). The NKG2015 gravimetric model has an estimated relative standard uncertainty of about 10–15 mm on land in Sweden (Ågren et al. 2016). The absolute standard uncertainty is more complicated, but probably around a few centimetres. The FAMOS interim LM7F quasigeoid model was included as it is a slightly updated version of NKG2015 that has been produced as an intermediate result of the FAMOS project including more gravity data, mainly marine data recently collected in the Baltic Sea.

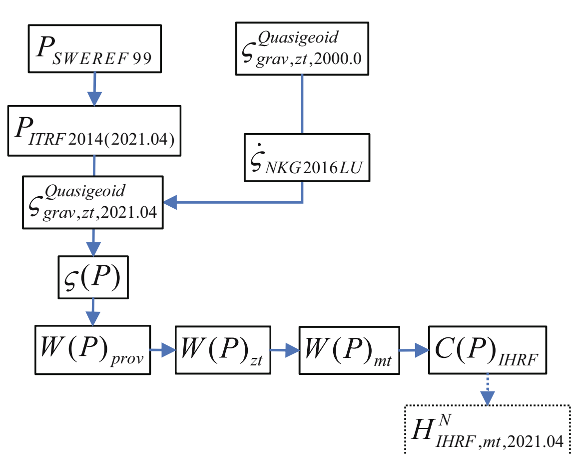

Figure 1: Schematical sketch of the computation of geopotential numbers in IHRF. See the text for explanations.

NKG2015 (Ågren et al. 2016) was computed using the Least Squares Modification of Stokes' formula with Additive corrections method, also named the KTH method (Sjöberg, 1991, 2003). We used here the version of the model referring to the zero permanent tide concept, land uplift epoch 2000.0, and W_0 value of IHRS (Table 1). NKG2015 is based on gravity data in the NKG gravity database and the global satellite-only geopotential model GO_CONS_GCF_2_DIR_R5 (Bruinsma et al. 2013) with a maximum degree of 300.

It should be pointed out that the released version of NKG2015 includes a permanent tide correction and a zero-level shift to approximately adopt the model to the Nordic/Baltic height systems. In this article, however, we used the pure gravimetric model specified above.

The FAMOS LM7F quasigeoid model was computed using the same method as for NKG2015, but with an updated gravity dataset and the more recent global satellite-only geopotential model GO_CONS_GCF_2_DIR_R6 (Förste et al. 2019). The zero level of FAMOS LM7F was originally defined as W_0 = 62636858.18 $m^2\,s^{-2}$, and a conversion had to be made to correct the zero degree term to refer to the W_0 value of IHRS (Table 1). As the target area for the FAMOS project was the Baltic Sea, the FAMOS LM7F is limited to latitudes below 66.5° and thus does not cover the whole of Sweden. This is not considered a problem for the current study. The main purpose of including the FAMOS LM7F model here was to evaluate how much the resulting IHRF potential numbers are affected by the newly added gravity data and the change to the latest global geopotential model.

The reference epoch 2021.04 was selected for the preliminary national IHRS realisations as this epoch was chosen for the global realisation (L. Sánchez, personal communication) to retain consistency between the three realisations of this study (explanation later in Section 2.2). In the Nordic area, the postglacial land uplift makes it very important to be consistent regarding epochs of models and reference systems.

The reference epoch of the quasi geoid models was converted from 2000.0 to this epoch using the geoid change model of NKG2016LU (Vestøl et al. 2019) as follows:

$$\zeta_{(\mathrm{grav,zero,2021.04})} = \zeta_{(\mathrm{grav,zero,2000.0})} + \dot{N}_{\mathrm{NKG2016LU}}(2021.04 - 2000.0), \tag{1}$$

where $\zeta_{(\mathrm{grav,zero,2000.0})}$ is the gravimetric quasigeoid model at epoch 2000.0, and $\dot{N}_{\mathrm{NKG2016LU}}$ is the geoid change model.

2.2 Ellipsoidal GNSS heights

Two data sets of ellipsoidal GNSS heights in ITRF2014 were used for the realisation of IHRS in this study. In the global case (Table 2), spatial coordinates for the three GNSS stations in the global IHRF core network (Onsala, Riga and Metsähovi) were distributed by Laura Sánchez and the IAG Joint Working Group 0.1.3: Implementation of the IHRF (Technische Universität München 2019) in the spatial reference frame ITRF2014 epoch 2021.04.

The two preliminary national realisations (Table 2) are based on a dataset of 197 high-quality GNSS points over Sweden. The IHRF SWE Prel#1 uses all the points in the dataset, while the realisation Prel#2 uses 184 of them. The reason that this number is smaller is that FAMOS LM7F model does not cover the whole of Sweden (Section 2.1). The Onsala station is included in both realisations. The GNSS observations have been determined in the Swedish spatial reference frame SWEREF 99 using more than 48 h of GNSS observations with Dorne Margolin antennas and processing in the Bernese software (Dach et al. 2015). The standard uncertainty of the ellipsoidal heights in the dataset is carefully estimated to be about 6 mm by Jivall et al. (2022). All the points are also well connected to the RH 2000 precise levelling network.

The GNSS dataset was converted from SWEREF 99 to ITRF2014 epoch 2021.04 by making use of the NKG transformation method described by Häkli et al. (2016) but with new updated parameters optimised for SWEREF 99 and ITRF 2014 (L. Jivall, personal communication). The transformation consists of both a seven-parameter Helmert transformation and an epoch conversion making use of the velocity field model NKG_RF17vel (Lantmäteriet 2021).

2.3 Computation of potential numbers in IHRF

The preliminary IHRS realisations (global and national) were computed according to the proposed strategy of Sánchez et al. (2021a) and Sánchez et al. (2021b) for recovering geopotential values from quasigeoid models. Provisional geopotential values are first computed by

$$W_{\mathrm{prov}}(P) = W_0 - (h(P) - \zeta(P))\cdot \bar{\gamma}_{\mathrm{QQ}_0}, \tag{2}$$

where W_0 is the fixed reference potential value in IHRS, $h(P)$ is the ellipsoidal height, $\zeta(P)$ is the height anomaly interpolated from the quasigeoid model, and $\bar{\gamma}_{\mathrm{QQ}_0}$ is the mean normal gravity between the ellipsoid and the telluroid with ellipsoidal parameters of GRS 80 (Moritz 2000).

The geopotential values given by equation (2) are an intermediate result where the permanent tide concept depends on the spatial reference system and gravimetric geoid model used as input (Mäkinen 2021). The spatial positions in ITRF 2014 are given in the tide-free concept, and the gravimetric models in this study are zero tide (Section 2.1). A conversion of the geopotentials to the tidal concept of IHRS, mean tide, was in this case first made by adding a correction, ΔW_{ITRF}, to align the intermediate result to the zero tide concept (Mäkinen 2021). Then, a second correction, W_{T0}, was added to obtain the geopotentials in the mean tide concept as follows:

$$W_{\mathrm{IHRF}} = W_{\mathrm{prov}} + \Delta W_{\mathrm{ITRF}} + \Delta W_{\mathrm{T0}}. \tag{3}$$

Finally, the geopotential numbers, which are the vertical coordinates of IHRF, are obtained by the difference between W_0 and the obtained geopotential values in IHRF

$$C_{\mathrm{IHRF}} = W_0 - W_{\mathrm{IHRF}} = W_0 - (W_{\mathrm{prov}} + \Delta W_{\mathrm{IHRF}} + W_{\mathrm{T0}}). \tag{4}$$

At this stage, the preliminary realisations of IHRS are obtained. As mentioned earlier, the extent of the FAMOS LM7F gravimetric model is limited to 66.5° in the northern latitude; 13 GNSS stations to the north are therefore omitted from the comparison between the two preliminary national realisations.

The geopotential numbers were also converted to normal heights in an iterative manner (Hofmann-Wellenhof and Moritz 2005) for comparisons of normal heights.

2.4 Comparison between IHRF and RH 2000

The IHRF SWE Prel#1 converted to normal heights were then compared to RH 2000 (Table 1). Corrections of the known differences related to the permanent tide, reference epochs, and different zero levels were applied to obtain comparable height values (Figure 2).

2.4.1 Permanent tide correction

A correction was applied to convert the normal heights in IHRF to the permanent tide concept of RH 2000, zero tide

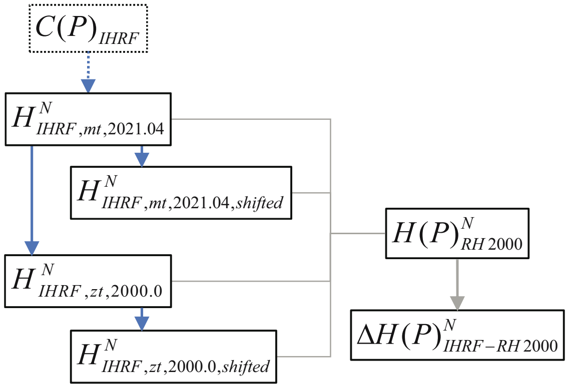

Figure 2: Schematic sketch of the comparisons of the preliminary IHRS realisation and RH 2000 in this study. The grey arrows represent the differences presented in Section 3.3.

(Mäkinen 2021). The correction is latitude dependent, and the applied correction is shown in Figure 3.

2.4.2 Epoch unification

The epoch used for the preliminary IHRS realisations and the epoch of RH 2000 differ by 21.04 years. The postglacial land uplift model NKG2016LU_LEV (Vestøl et al. 2019) was used to reduce the normal heights obtained in IHRF from the epoch 2021.04 to 2000.0. The applied correction (Figure 4) is the accumulated correction over 21.04 years. The estimated uncertainty of the land uplift model in Sweden is between 0.1 and 0.2 mm per year (Vestøl et al. 2019).

2.4.3 Reduction of zero level

The zero levels for the reduced preliminary IHRS realisations and RH 2000 are the equipotential surface of W_0^{IHRS} and the NAP level, respectively (Table 1). The mean difference between the preliminary IHRS realisations and RH 2000 was also subtracted to obtain comparable height values.

$$H^N_{\mathrm{IHRF,\,red.\,zero\,level}} = H^N_{\mathrm{IHRF}} - \Delta\bar{H}^N_{\mathrm{IHRF\text{-}RH2000}}. \tag{5}$$

Both the uncorrected and corrected preliminary IHRS realisations were reduced by the mean difference according to Figure 2.

2.4.4 Comparable height values

By these corrections and reductions, the preliminary realisations of IHRS are converted to normal heights with the same basic definition as the height reference system RH

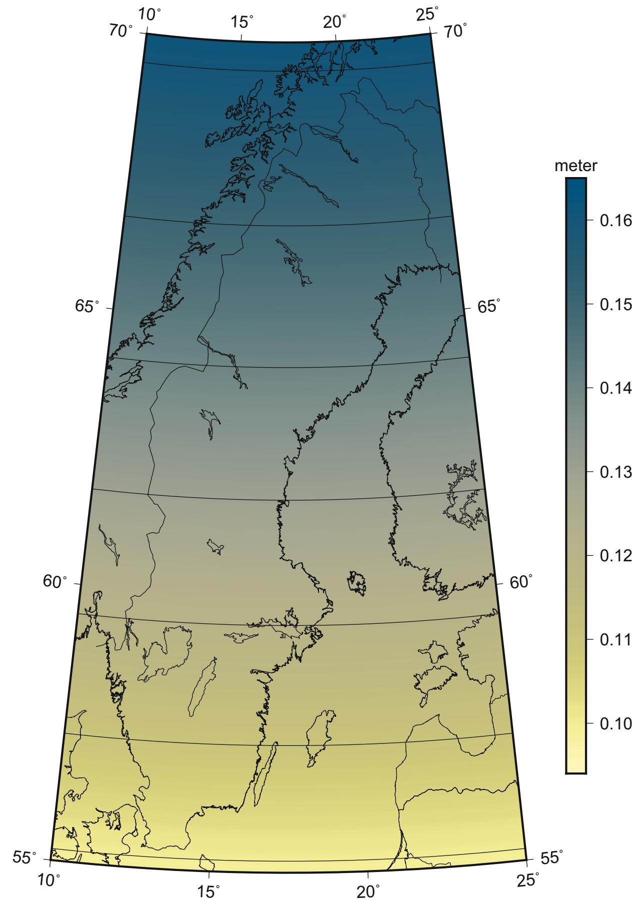

Figure 3: Permanent tide correction between zero tide and mean tide.

2000. The heights are now comparable to each other, and the remaining fundamental differences can be evaluated.

3 Results

3.1 The IHRF GLOBAL realisation

The geopotential numbers and potential values at the three global stations Onsala, Riga, and Metsähovi were computed according to the method described in Sections 2.1–2.3.

The Onsala station was included in all three realisations, and the values from the different realisations are presented in Table 3.

3.2 Difference between the two preliminary national IHRS realisations

The two realisations IHRF SWE Prel#1 and IHRF SWE Prel#2 (see Table 2) were computed with the underlying

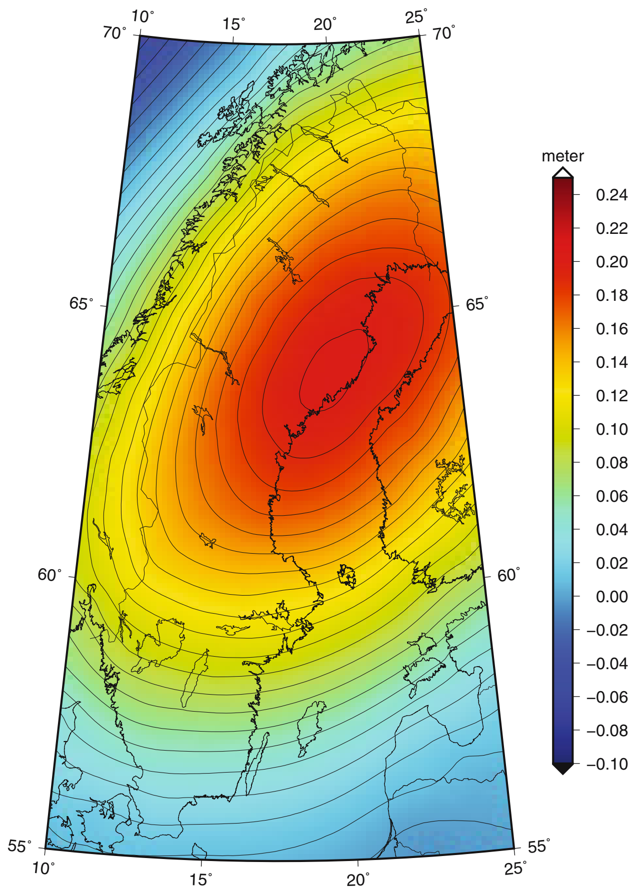

Figure 4: The postglacial land uplift correction for 21.04 years, obtained by the model NKG2016LU.

gravimetric quasigeoid models NKG2015 and FAMOS LM7F, respectively. The differences between the resulting normal heights of the two realisations are presented in Table 4 and the corresponding Figure 5.

3.3 Comparison between the IHRF SWE Prel#1 and RH 2000

The realisation IHRF SWE Prel#1 was selected for comparison to RH 2000 according to the method of Section 2.4. This

Table 4: Statistics for the difference between the two realisations IHRF SWE Prel#1 and IHRF SWE Prel#2

	Difference (mm)
# Points	184
Mean	−2.1
Min	−22.4
Max	17.3
StdDev	6.9
RMS	7.2

solution was selected due to the current official status of the underlying quasi geoid model and due to its nation-wide coverage. Remember that IHRF SWE Prel#2 is limited to south of 66.5 ° latitude, which is due to the limited coverage of the FAMOS LM7F quasigeoid model (Section 2.1).

The comparison was performed at the 197 GNSS points between the normal heights from the preliminary IHRS realisation and the levelled normal heights in RH 2000, according to different alternatives in Figure 2.

The two columns to the left in Table 5 show the total difference between the two realisations prior to any correction of known effects, with and without a shift of the mean difference. To the right, the differences between the preliminary IHRS realisation reduced by both the permanent tide and the postglacial land uplift effects are presented, with and without a shift. The results presented by statistics in Table 5 are plotted for the 197 points in Figures 6–9, respectively. Note the different vector scales in the figures.

4 Discussion and recommendations

We start by considering the differences between the three realisations in Table 2 at the Swedish global station Onsala. The normal height is here 9.166 m in RH 2000 and 8.8377 m in IHRF GLOBAL (Table 3). The total difference −0.3283 m is clearly not representative of the whole of Sweden.

Table 3: IHRF Geopotential values of the three GNSS stations Onsala, Riga, and Metsähovi

Station	Realisation according to Table 2	Potential [$m^2 s^{-2}$]	Geopotential number [$m^2 s^{-2}$]	Normal height [m]
METG10503	IHRF GLOBAL	62636455.022	398.378	40.5709
RIGA12302	IHRF GLOBAL	62636721.234	132.166	13.4634
ONSA10402	IHRF GLOBAL	62636766.640	86.760	8.8377
ONSA10402	IHRF SWE Prel#1	62636766.589	86.811	8.8428
ONSA10402	IHRF SWE Prel#2	62636766.618	86.782	8.8397

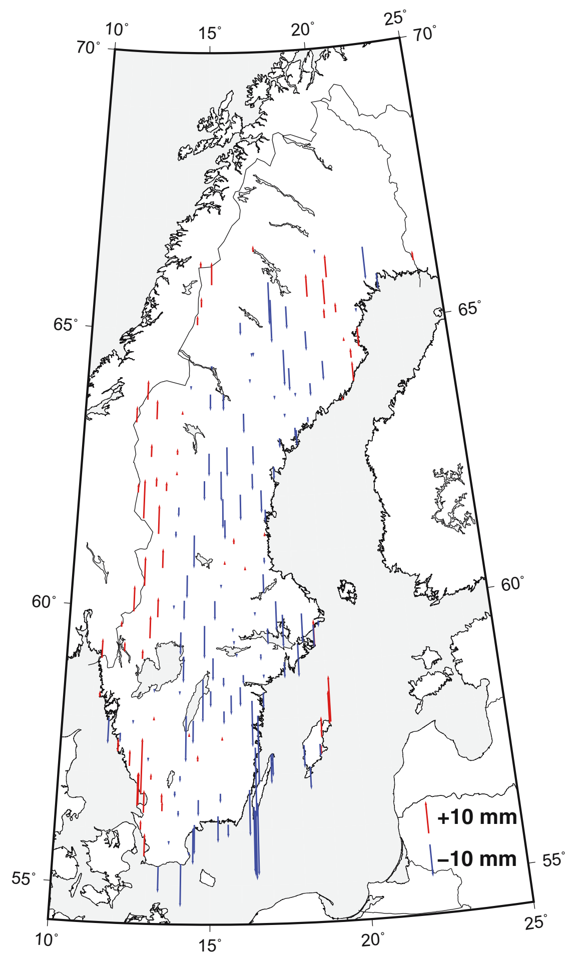

Figure 5: Differences between the preliminary national realisations IHRF SWE Prel#1 and IHRF SWE Prel#2.

This becomes clear by comparing this value with the more detailed picture given in Table 5 and Figure 6.

The normal heights from the realisations IHRF SWE Prel#1 and IHRF SWE Prel#2 at the global Onsala station differ from the IHRF GLOBAL realisation by 5.1 and 2.0 mm, respectively (Table 3). These deviations are reassuringly small and show that the preliminary national realisations are in good agreement with the global one. This is an important check that should be made as soon as a regional or national IHRS realisation is computed.

We turn then to the comparison between the two preliminary national IHRS realisations, IHRF SWE Prel#1 and IHRF SWE Prel#2, in the 184 Swedish GNSS points (Section 3.2). The mean difference is −2.1 mm, the standard deviation is 6.9 mm, and the individual deviations are between −22.4 and +17.3 mm (Table 4 and Figure 5). The only thing that differs between the input data of these two realisations is the underlying gravimetric quasigeoid model. The FAMOS LM7F model includes more recent gravity data compared to NKG2015, mainly marine gravity in the Baltic Sea, and has also been computed using the more recent global geopotential model GO_CONS_GCF_2_DIR_R6 (Förste et al. 2019). NKG2015 used the previous version

Table 5: Statistics of the difference between the IHRF SWE Prel#1 realisation and RH 2000 (unit: mm)

	Total difference		**Difference after reduction of permanent tide and land uplift effects**	
	Difference	**IHRF shifted by +208.5 mm**	**Difference**	**IHRF shifted by +454.7 mm**
# Points	197	197	197	197
Mean	−208.5	0.0	−454.7	0.0
Min	−385.0	−176.5	−504.5	−49.8
Max	−96.8	111.7	−392.5	+62.2
StdDev	75.5	75.5	19.2	19.2
RMS	221.7	75.3	455.1	19.1

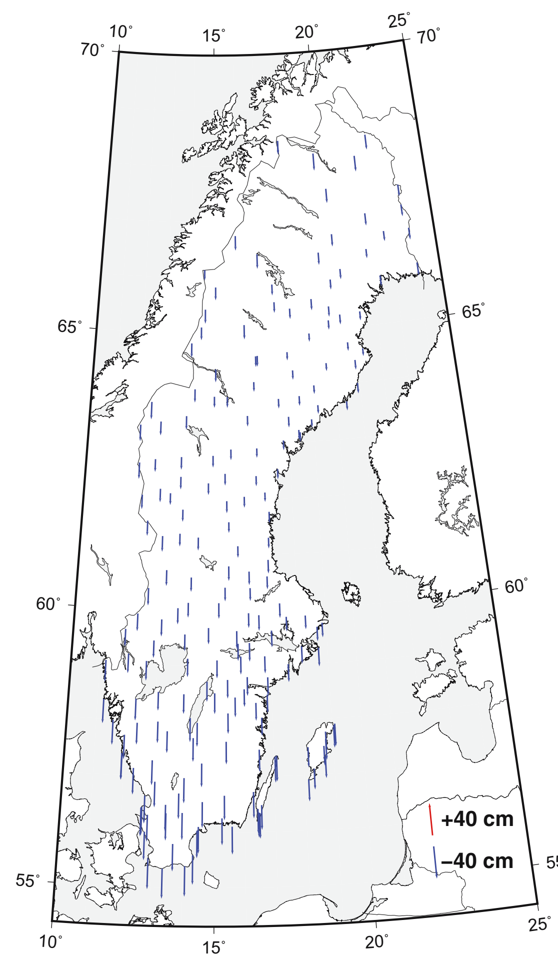

Figure 6: Total difference between IHRF SWE Prel#1 and RH 2000.

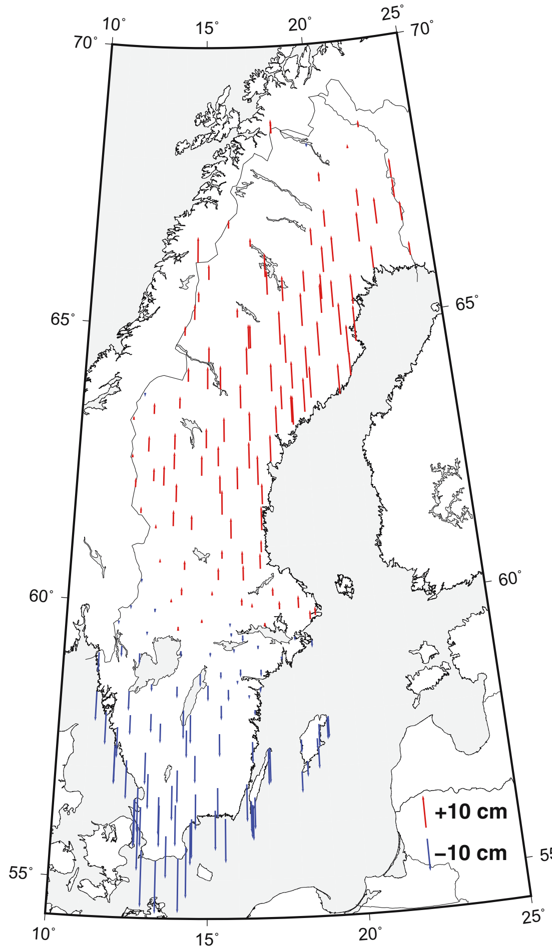

Figure 7: Difference between IHRF SWE Prel#1 and RH 2000 after a shift of +208.5 mm.

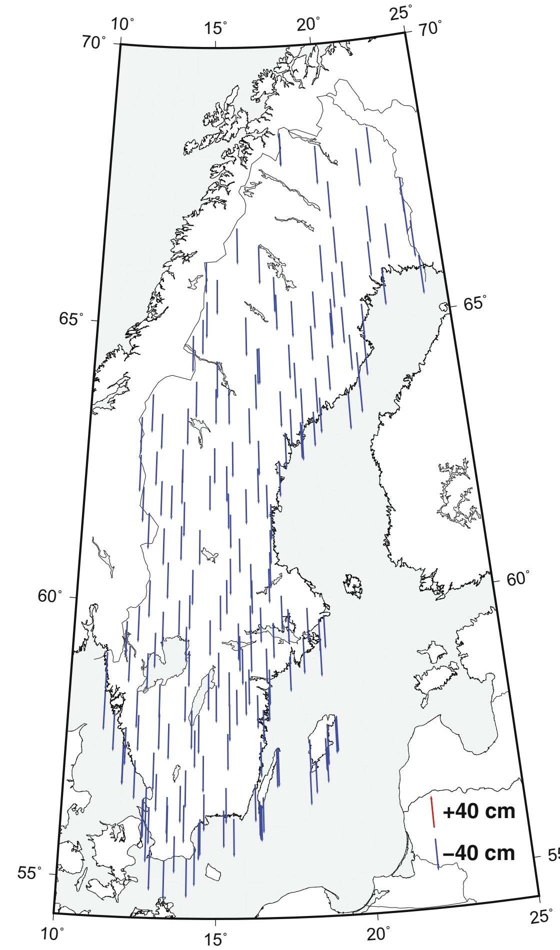

Figure 8: Difference between IHRF SWE Prel#1 and RH 2000 after corrections for the permanent tide and postglacial land uplift effects.

GO_CONS_GCF_2_DIR_R5 (Bruinsma et al. 2013). Figure 5 shows the distribution of the deviations between the corresponding realisations. The large deviations to the southeast are due mainly to the additional marine gravity data of IHRF SWE Prel#2 (FAMOS LM7F), while the deviations in inland Sweden are mainly a result of the different global geopotential models. It should be noted that the above-mentioned gravimetric quasigeoid models have been computed using exactly the same method (Section 2.1). In case different regional geoid determination methods are used, significantly larger deviations can be expected. One reason for selecting FAMOS LM7F to complement NKG2015 was to study how the new gravity data and global geopotential model improve the model. In the future, however, both data updates and methodological improvements will be needed.

The comparison of IHRF SWE Prel#1 with RH 2000 in Section 3.3 shows that the main part of the total difference is due to the different permanent tide concepts, postglacial land uplift epochs, and zero levels. After the reduction of the two former effects, the standard deviation of the difference in the 197 evaluation points is reduced from 75.5 to 19.2 mm. At the same time, the corresponding mean difference related to the different zero levels increased from 208.5 to 454.7 mm (Table 5). The remaining residuals after correcting for these effects (Figure 9) are close to the existing smooth residual surface for the Swedish height correction model SWEN17_RH2000 (Ågren 2017).

The uncertainty of the potential values of the IHRF solutions is mainly due to the uncertainty of the GNSS ellipsoidal heights and of the gravimetric quasigeoid model (Sánchez and Sideris 2017). The uncertainty of the GNSS heights in the present case is about 6 mm (Section 2.2). The gravimetric quasigeoid model has a relative standard uncertainty of 10–15 mm and an absolute uncertainty of around a few centimetres (Section 2.1). The relative standard uncertainty of the IHRS realisation should therefore be somewhere around 12–16 mm within Sweden. However,

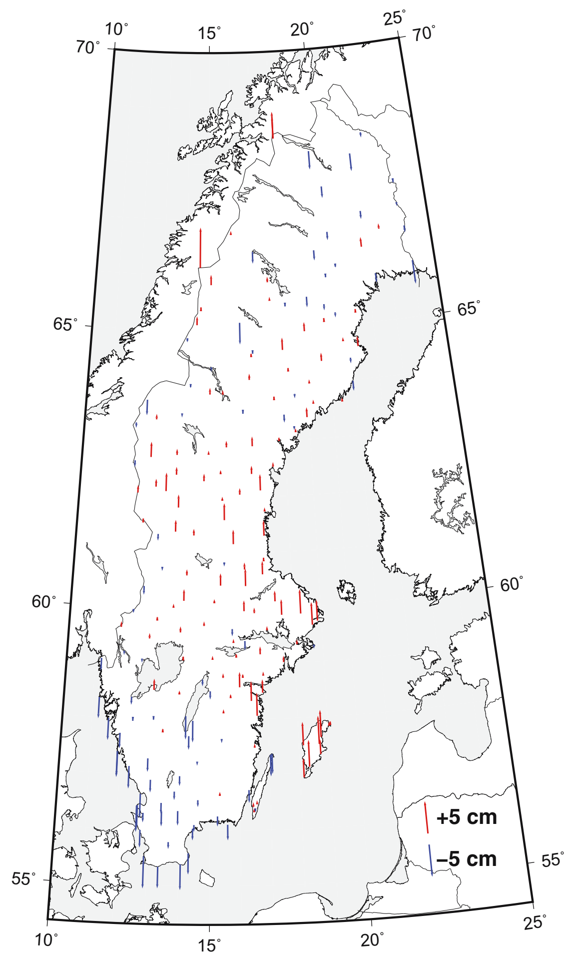

Figure 9: Difference between IHRF SWE Prel#1 and RH 2000 after corrections for the permanent tide and postglacial land uplift effects and a shift of 454.7 mm.

in addition, the uncertainty of any kind of geodynamic modelling required to reach the reference epoch of IHRF (here taken as 2021.04) is also crucial. In this case study, the postglacial land uplift effect had to be carefully modelled both for the Swedish GNSS data and for the gravimetric quasigeoid models by using the NKG2016LU model (Vestøl et al. 2019). We recommend that the reference epoch is clearly specified for the future IHRF. In the current study, we used the epoch 2021.04 of the spatial coordinates in ITRF2014 provided for the global IHRS realisation (L. Sánchez, personal communication; Sections 2.1 and 2.2). The uncertainty aspects remain to be more carefully investigated in the continuation of this project.

The results of the article clearly illustrate that the relation between IHRF and a national/regional height system like RH 2000 cannot be obtained by taking the raw height difference in one global point only. One needs to model the system-related differences (Table 1) carefully and use enough common points to reach a transformation surface of high quality. The role of the global IHRF stations is to work as a well-established and corroborated reference. When computing a regional or national IHRS realisation, it is important to check the agreement with the global station(s). It is easy indeed that something goes wrong in the long chain of computations needed to make a new national/regional IHRS realisation.

The results for the preliminary realisation IHRF GLOBAL in Table 3 were delivered to Laura Sánchez as input to the first global realisation of IHRS. As mentioned in Section 1.2, we recommend that the Swedish project be extended to the computation of a regional Nordic/Baltic IHRS realisation as a cooperation within the NKG.

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Author contributions: AA and JÅ defined the research concept; AA developed and implemented the national realisations with comparisons, and drafted the manuscript; JÅ provided the global realisation; AA and JÅ contributed to the discussion, review, editing and approval of the final manuscript.

Conflict of interest: The authors declare that they have no conflict of interest.

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