**Table S.1: Closure equations**

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| **Parameter/Term** | **Equation** |
| 1. Viscous stress tensor |  |
| 1. Strain rate tensor |  |
| 1. Granular temperature |  |
| 1. Conservation of the fluctuation energy |  |
| 1. Dissipation of fluctuation energy Jenkins and Savage (1983). |  |
| 1. Diffusion coefficient for granular temperature Syamlal, Rogers, O‘Brien (1993) |  |
| 1. Solid pressure Syamlal, Rogers, O‘Brien (1993) |  |
| 1. Radial distribution function Lun et al. (1984) |  |
| 1. Collisional, kinetic and frictional viscosities |  |
| 1. Solid collision viscosity Syamlal and O’Brien (1993) |  |
| 1. Kinetic viscosity () Syamlal, Rogers, O‘Brien (1988) |  |
| 1. Frictional viscosity Schaeffer (1987) |  |