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Computation of atmospheric gravity changes from 3-dimensional numerical weather models

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Beside the tides of the solid Earth and the ocean, mass fluctuations in the atmosphere are the main signal constituent in precise gravity measurements. In order to separate other parts of the signal, this effect is routinely eliminated by multiplying the local air pressure record with a constant or a varying factor being determined by linear regression, and substracting the product from the gravimeter time series. In this way a major part of the atmospheric noise is eliminated. However, air mass variations which are not apparent in the local air pressure, like seasonal vertical mass shifts under constant surface pressure or distant pressure anomalies, are not covered by this technique although affecting the gravimeter. The remaining atmospheric noise may superimpose other signals of interest like annual tides or accelerations due to polar motion.

The physical model is based on 3-dimensional weather models of regional and global scale, where the Newtonian attraction of each element on the instrument site is computed and summed up component-wise. The problem of the low temporal resolution of usually 6 hours and the improper point-mass assumption in the near field is solved by a cylindrical local model, where the attraction in each layer is computed analytically on the basis of the local air pressure with high temporal resolution.

The results show differences up to 2 microgal as compared to the linear regression method. The 3-dimensional atmospheric correction now allows the identification of other systematic components in the residual gravity signal like hydrological effects, and an improved determination especially of long period tidal waves. In addition the horizontal components are very useful for the attraction correction of tiltmeters, where

the local air pressure is not suitable.