How to validate GRACE satellite data with ground based gravity using EOF analysis

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This talk is a continuation of many recent papers and conference presentations on the combined use of superconducting gravimeters (SGs) of the Global Geodynamics Project (GGP) with GRACE satellite data and global hydrology models such as GLDAS. The team for this cooperative research has usually included J. Hinderer, C. de Linage, and J.-P. Boy, all associated with IPG Strasbourg.

Some recent references are:

Crossley, D., C. de Linage, J.-P. Boy, and J. Hinderer, 2009. Hydrology in Central Europe – a Comparison Between Data from the GRACE Satellite Mission and Ground Superconducting Gravimeters, *poster XY640, EGU2009-8126, Vienna, April 2009*.

Hinderer J., O. Anderson, F. Lemoine, D. Crossley, and J.-P. Boy, 2006. Seasonal changes in the European gravity field from GRACE: a comparison with superconducting gravimeters and hydrology model predictions, *J. Geodynamics*, 41, 59-68.

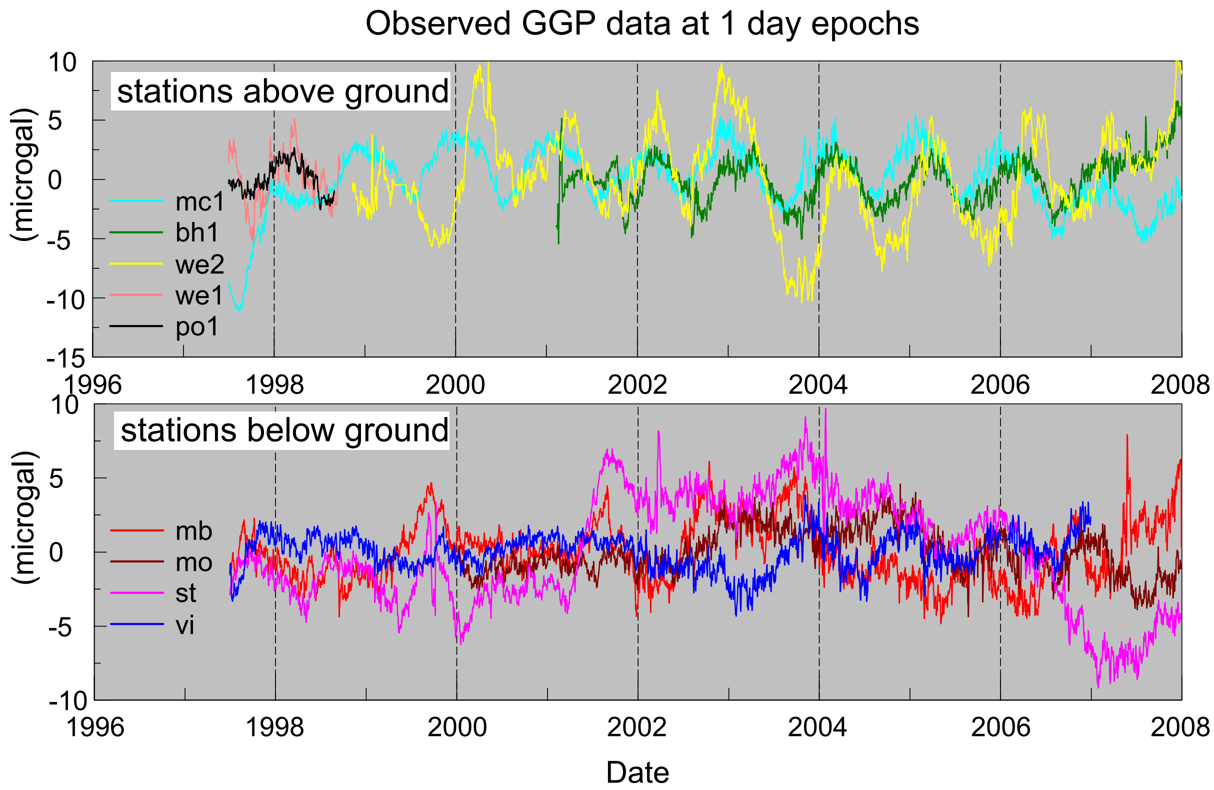
Crossley D., Hinderer, J., de Linnage C., and Boy, J.-P., 2006. Estimation of hydrology in Europe using GRACE and GGP data, *Geophys. Res. Abs.* **8**, 09779, Ref-ID: 1607-7962/gra/EGU06-A-09779, EGU.

Crossley, D., Hinderer, J., and Boy, J.-P., 2005. Time variation of the European gravity field from superconducting gravimeters, *Geophys. J. Int*., **161**, 257-264.

Crossley, D. and J. Hinderer, 2005, Using SG arrays in hydrology in comparison with GRACE satellite data, with extension to seismic and volcanic hazards, *Kor. J. Rem. Sens*., **21** (1), 31-49.

Summary

The surface gravity field is subject to many influences of mass redistribution within the Earth system, operating at the microgal (10^{-8} m s^{-2}) level and at timescales from minutes to years. We include deformation within the Earth (tides, polar motion), motions within the atmosphere (local, regional, and global loading; also mass attractions), the oceans (non-tidal currents), and near-surface hydrology derived from rainfall (local, regional, and global contributions). In central Europe a network of 7 superconducting gravimeters (the only instrument with the required resolution for this type of work) has been operating for many years, recording variations at the sub-microgal level. Hydrology is the largest component in the un-modelled residual signal, most of which comes from an area within a few hundred m of the instrument. We use data from 2002-2007 to construct a regionalized ground gravity data set that is analyzed by Principal Component (EOF) analysis to extract the predominantly seasonal signal common to all stations. This we compare with the GRACE-derived field using solutions from GFZ Potsdam, CSR Texas, and GRGS Toulouse. There is very good agreement on the phase of the two different types of data, but the amplitude of the ground signal is complicated by the local hydrology around several of the stations, which is both above and below the instrument. We show our most recent analysis and compare the results with the GLDAS global hydrology model from NASA.



This figure shows the residual gravity after subtraction of tides, atmospheric pressure (local, global, and 3d mass attraction), and polar motion. Stations are separated according to their location with respect to ground level and thus soil moisture horizons.

After decimating the data to the same time period as the GRACE gravity fields (10 days for GRGS, 1 month for CSR and GFZ), we extract the EOF principle components and eigenvectors. These are then compared to a similar analysis for the GRACE and GLDAS hydrology fields. An example below shows two versions of the comparison of the 1st principle component of the GRGS and GGP data. On the left we use all 7 of the European stations, on the right we use just the 3 stations above ground.