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Approaches to the Comparison of Ground and Satellite Gravity Measurements

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Two approaches to the comparison of surface and satellite gravity fields are possible. Both use GRACE satellite time variable gravity solutions, and so far the standard spherical harmonic coefficients provided by GFZ and CSR at 1 month intervals, or by GRGS at 10-day intervals. In most cases the ground gravity is provided by superconducting gravimeters (SGs), but occasionally by absolute gravimeters. It is commonly assumed that the imprecision and drift of other ground instruments (e.g. Scintrex, ET meters, or gPhone) renders them unsuitable (unless possibly tightly tied to an SG) for long term detailed comparisons. The first consideration is whether point measurements at single stations have any validity compared to GRACE estimates that are averaged over length scales of 300-500 km. Logic would say these are incompatible, but there are hidden assumptions that might be used to justify the apparently good correlations often obtained for annual variations of gravity. The alternative method uses a spatial averaging of several ground instruments (mostly EOF decomposition) that is more technically correct, but can only be done at the present time in central Europe where the distribution of instruments is suitable. The second issue is whether ground gravity observations have to be corrected for 'local hydrology' before a comparison with satellite measurements can be pursued. If so, what is the correct approach? We illustrate all the above issues using both ground and satellite gravity over Europe for 2002-2007, and include global hydrology models such as GLDAS to provide a confirmation of not only the annual signal, but also inter-annual variations seen especially in the GRGS data. A new feature of the present study is quantitative assessment of the errors in each dataset (GRACE, GGP, GLDAS) and the resulting correlations obtained between them.