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Poster Presentation

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Uncertainty of Satellite-gravity-derived Moho Estimates: Contribution of Data Reductions

In the last years, the unparalleled spatial homogeneity provided by satellite-only global gravity models has been successfully exploited to obtain estimates on mass distribution in the solid Earth. Among these, the depth of the crust-mantle boundary (Mohorovicic discontinuity), has been a successful target of regional and global studies. Even when simplified to a sharp density discontinuity surface, its knowledge enables a reliable infill between terrestrial data, chiefly from seismic methods, and can be applied to the evaluation and comparison of different crustal models, at similar spatial scales.

Owing to the high degrees of GOCE-based GGMs, the theoretical resolving power can be estimated on the order of 0.1 km depth-wise, at less than 1 arc-degree of horizontal resolution. Such estimate assumes a perfectly isolated signal, i.e. no unmodelled masses in the data reductions, in a correctly constrained inversion (no unknown a-priori parameters, e.g. crust-mantle density contrast).
The Moho depth can be estimated from gravity data by solving the inverse problem relating the relief of a density discontinuity to the observed gravity field. This problem requires two input parameters, a density contrast and a reference depth; it is also necessary to isolate the signal due to Moho relief from all other contributions to the gravity field.

Input parameters are usually constrained by seismic data. Data reductions, applied to isolate a "residual anomaly", commonly consists in the forward-modelled effect of topography, of masses both above (e.g. sediments, upper crustal boundaries), and below the crust-mantle boundary (e.g. lateral density variations in the mantle).
Any variance in the input densities and geometries used in the data reduction, if not accounted for, and any uncertainty in the adopted constraints, is mapped in the inversion results, and thus propagated in any subsequent modelling that makes use of crustal thickness (e.g. temperature, rheology, velocity corrections). An uncertainty estimate is now commonly distributed alongside Moho depth models.

Starting from the theoretical Moho depth-error estimate, obtained from formal errors in the global gravity model, we compute the uncertainty effect that each data reduction step adds to this estimate. The gravity uncertainty is then propagated to a depth estimate using a reference inversion operator. This provides a quantitative assessment of the suitability of satellite-only GGMs in detecting Moho features, at different

wavelengths, in a realistic geophysical framework. It also highlights where improvement in critical parameters would be more rewarding in terms of uncertainty reduction.
Up to degree and order 280, the cumulative reduction uncertainty can exceed 200 mGal, in terms of gravity anomaly. This results in local Moho depth uncertainties in the order of 10 km. A 10 points percent simulated improvement in the sediment thickness error improves the Moho depth uncertainty range by up to 1 km. This indicates that even slight improvements, such as the harmonisation of existing near-surface data, can pay off in terms of quality of gravity inversion estimates.