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Optimum topography corrections for gravity and gravity-gradients data from ground to satellite observations

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Accurate and optimum terrain modeling plays an essential role for gravity and gravity gradients interpretation and inversion. Owing to the existence of new satellite and ground-based data that provide the topography at unprecedented resolutions, from global to very local scales, the question of how to best describe the corresponding mass distribution becomes an important issue for gravity studies.
Here we present a novel tool to assess terrain corrections at any altitude of observation, which permits to obtain the effect of topography on both gravity and gravity gradients for applications from regional (∼1000 km) to very local (∼100 m) scales. The computation is accomplished by using the contribution from any plane surfaces-mass density of the polyhedral body to the gravity field. Numerical and parametric investigations have been performed to assess the modeling method, its computation time and precision. The chosen study area is the Himalayan belt region, which is an end-member area in terms of variations of both topography and relief.
Unsurprisingly, our approach confirms that the resolution of the digital elevation model and the altitude of the observations play a critical role. Our study indicates a non-linear dependency between computation time and both the resolution of the meshed topography surface and the radius of the computation area. For optimized computation parameters, our results give a precision for the calculated gravity - gravity gradient of 10 mGal - 40 mE at the GOCE satellite altitude (∼225 km).
Compared to other methods using either spherical harmonics or tesseroid approach for gravity field computation at global scale, our method shows better the distribution of gravity and gravity gradient value in shorter wavelength, hence it appears more efficient and appropriate to assess terrain corrections at local scales. Additional works are thus now needed to study the respective efficiency of these three approaches at regional scales, which can be associated with lithospheric processes.