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Geoid determination based on boundary values of the type modulus of gravity vector, satellite altimetry and GPS/leveling data

Case study: geoid determination at southern coast of Iran

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Geoid computations through the solution of boundary value problem is an inverse problem in potential theory. In this paper we have defined a boundary value problem in such a way that potential field functionals such as modulus of gravity vector (from gravimetry), gravity potential differences (from precise leveling), astronomical longitude and astronomical latitude (from geodetic astronomy), higher derivatives of gravity field (from gradiometery) and computed geoid from other techniques such as satellite altimetry and GPS/Leveling can be simultaneously used as boundary values. The problem has successfully tested for boundary values of the type modulus of gravity vactor, GPS/leveling geoid and derived geoid from satellite altimetry data at the test area.The algorithmic steps of the solution of the boundary value problem are as follows:

- Application of the ellipsoidal harmonic expansion complete up to degree and order 360 and ellipsoidal centrifugal field for the removal of the effect of global gravity and the isostasy field from the gravity intensity at the surface of the earth.
- Application of the ellipsoidal Newton integral on the multi-cylindrical equal area map projection surface for the removal of the effect of residual masses at

the radius of 55 km around the computational point from the gravity intensity, the gravity potential and astronomical observations at the surface of the earth.

- Application of the ellipsoidal harmonic expansion complete up to degree and order 360 and ellipsoidal centrifugal field for the removal from the geoid undulations derived from GPS/Leveling and marine geoid derived from satellite altimetry data.
- Removal of the effect of the topographical masses and the water masses outside the reference ellipsoid within a radius of 55 km around the computational point from the geoid undulations derived from GPS/Leveling and marine geoid derived from satellite altimetry data.
- Least squares solution of the observation equations of the incremental quantities derived from aforementioned steps in order to obtain the incremental gravity potential at the surface of the reference ellipsoid.
- Restore of the removed effects at the application points on the surface of reference ellipsoid.
- Application of ellipsoidal Bruns formula for converting the potential values on the surface of the reference ellipsoid into the geoidal heights with respect to the reference ellipsoid.