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Opportunities and current limitations of marine gravity field modeling from space: An oceanographic perspective

M. Thomas (1) and H. Dobslaw (1)
GeoForschungsZentrum Potsdam (mthomas@gfz-potsdam.de)

The advent and successive accuracy improvement of satellite altimetry as well as gravimetry missions have greatly enhanced our knowledge about the gravity field over the oceans. However, considerable efforts are still required in order to consistently combine both observation techniques as well as to properly account for the time-variations caused by the strong dynamics of the open oceans. In order to emphasize the importance of various physical processes, their impact on satellite-based observations is reviewed from an oceanographic perspective.

In particular, gravimetry measurements allow the derivation of the geoid as an equipotential surface of the gravity field, while satellite altimetry basically measures the geometric surface of the oceans, which deviates from the geoid due to ocean currents. A consistent combination of both observation types requires the careful consideration of this so called mean dynamic topography based on independent in-situ observations or numerical ocean models.

Moreover, both surfaces are affected by considerable variations in time. While barotropic motions associated with ocean tides and atmospheric loading have similar effects in both the surface and the geoid, additional surface deformations have to be accounted for due to steric compensations of density changes within the water column. Considering the limited resolution in time and space and the orbit configuration preferred for gravity field prospecting, these time-variable effects cannot be resolved from the measurements itself and have to be corrected for by independent methods as, e.g., numerical model approaches.