Geophysical Research Abstracts, Vol. 7, 10562, 2005
SRef-ID: 1607-7962/gra/EGU05-A-10562

On the accurate computations of sea surface topography based on global gravity field models and satellite altimetry data; case study: SST of Persian Gulf and Oman Sea

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The computations of the Sea Surface Topography based on satellite altimetry data and gravity field models have been classified into 2 classes. Class (A) that is characterized by its formulation at the "potential space" can be achieved as follows:

1. Computations of Mean Sea Level (MSL) by means of satellite altimetry observations and spectral analysis. Zero frequency part of the spectral analysis is indicating the MSL.
2. Using a global gravity field model to computing the gravity potential value at the mesh points of the MSL. Such a global gravity field model can be computed based on the solution of the boundary value problem with the terrestrial and satellite gravimetry data, and can be expressed in terms of spherical or ellipsoidal harmonic expansion to degree/order 360/360. Since the gravity field at the sea area is smooth, degree/order of harmonic expansion up to 360/360 can satisfactorily provide the required gravitational field at the sea areas.
3. Comparison of the computed potential values at the points on the MSL with the geoid's potential value w_0. These potential differences are associated with the geometrical separation between geoid (being identified in potential space by its potential value w_0) and the level at which the MSL is located (being identified point-wise in potential space by its potential value computed via ellipsoidal/spherical harmonic expansion, e.g., to degree/order 360/360).
4. Transformation of the potential differences into height differences. The required

transformation formulas can be obtained by the Taylor series expansion of the ellipsoidal/spherical harmonic expansion at the points on the MSL.

Class (B) that is characterized by its formulation in “geometry space approach” is as follows:

1. Computations of Mean Sea Level (MSL) by means of satellite altimetry observations and spectral analysis.
2. Using a global gravity field model in terms of ellipsoidal/spherical harmonic expansion to compute a global geoid at points where the MSL is computed. Computation of the global geoid based on the global gravity field model has a transformation from the potential space to the geometry space embedded in its Bruns formula. Derivation of Bruns formula is based on Taylor series expansion of the gravitational potential field at the surface of reference ellipsoid.
3. Considering the difference between geoidal heights and MSL heights as SST.

The two classes of approaches are common in:

1. MSL computations.
2. Application of global gravity field model.
3. Transformation from the potential space into geometry.

But differ in:

1. The place where Taylor series expansion is applied.
2. Degree and order of ellipsoidal/spherical harmonic expansion that is used in the Taylor series expansion.

In the Class A approaches the Taylor series expansion is applied at the mean sea level, while at the Class B approaches the Taylor series expansion is applied at the surface of reference ellipsoid.

Our numerical tests of the 2 classes of approach for SST computations based on Topex/Poseidon satellite altimetry data at the geographical region of Persian Gulf and Oman Sea has proven the two approached can be practically the same provided that be applied consistently, and as such can be regarded as the accurate methods form SST computations based on Satellite altimetry data and global gravity field models.