Absolute dynamic ocean topography profiles

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Introduction

Since the essential improvements of gravity field models by GRACE, the dynamic ocean topography can be determined the *geodetic* way, that is subtracting geoid heights from sea surface heights. The approach introduced here, avoids

a) any interpolation onto a grid by using directly the sea surface heights on the satellite altimeter profiles,

b) removes the „striping“ pattern of satellite-only gravity fields by a suitable filtering, and performs

c) a consistent filtering of the sea surface height profiles.

This is how it works (cp. Figures right hand):

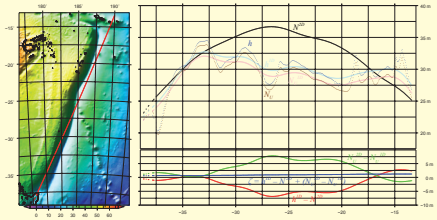
1. The dynamic ocean topography (*DOT*) is estimated by subtracting geoid undulation N from the sea surface heights h

$$DOT = h - N \qquad (1)$$

Sea surface heights are given on profiles; the geoid is known globally. In Eqn. (1) h and N have to be spectrally consistent.

2. The known meridional artifacts („striping“) of ITG03S are removed in the spectral domain (C_{nm}, S_{nm}) by a Gauß filter with 200 km radius and subsequently the smoothed Geoid heights N_S^{2D} are evaluated at the observation points of the altimetry profiles.

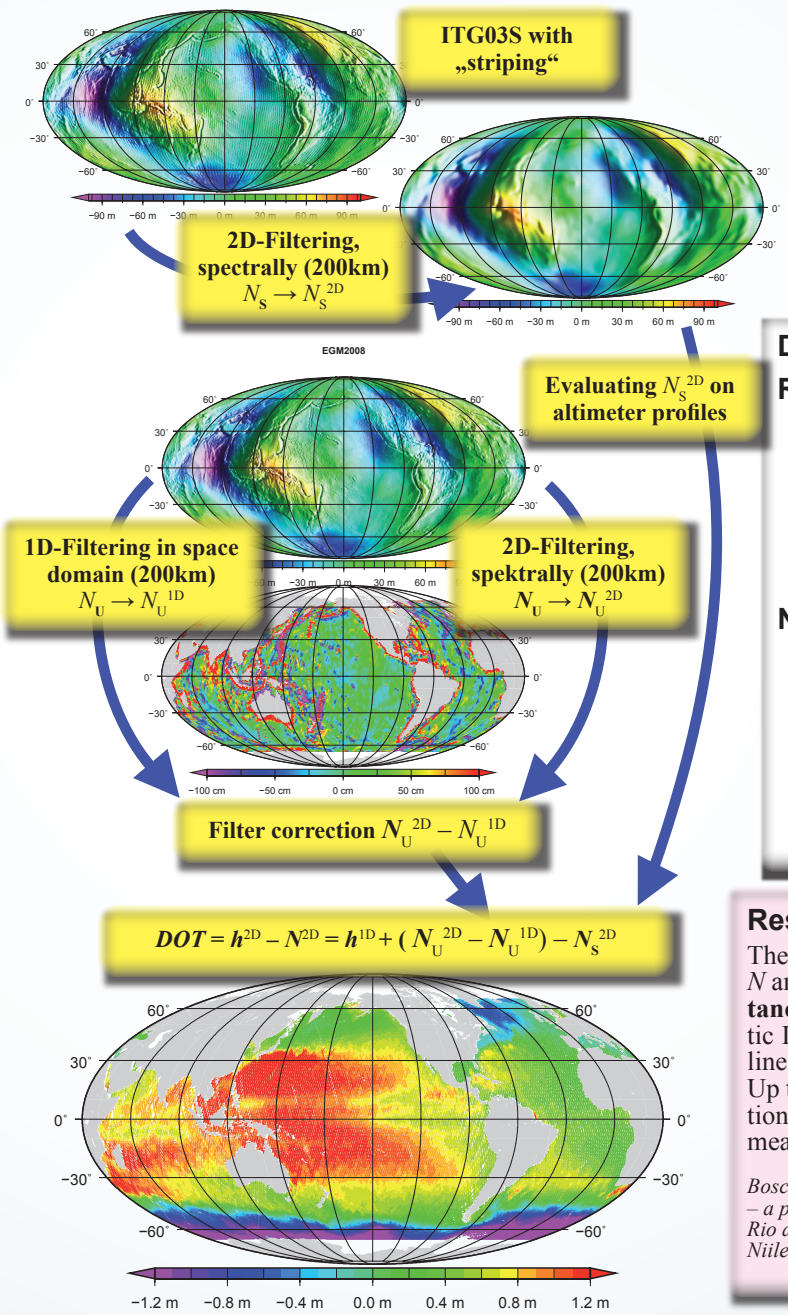
3. In spite of an identical filter radius, a 1D-filtering of the sea surface height profiles is *not* equivalent to the 2D-filtering of the Geoids (the heights of a profile running along the bottom of a trench will be raised by a 2D-filtering, remain however low in case of a 1D-filtering on the ground of the trench)



4. The systematic differences between 1D-filtering (along the profiles) and the 2D-filtering can be accounted for by Eqn.

$$h^{2D} = h^{1D} + (h^{2D} - h^{1D})$$
$$\approx h^{1D} + (N_U^{2D} - N_U^{1D})$$

giving a filter correction if h (right hand) is replaced by Geoid heights N_U of the ultra-high-resolving gravity field EGM2008.



Filtering

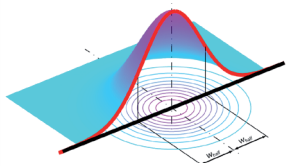
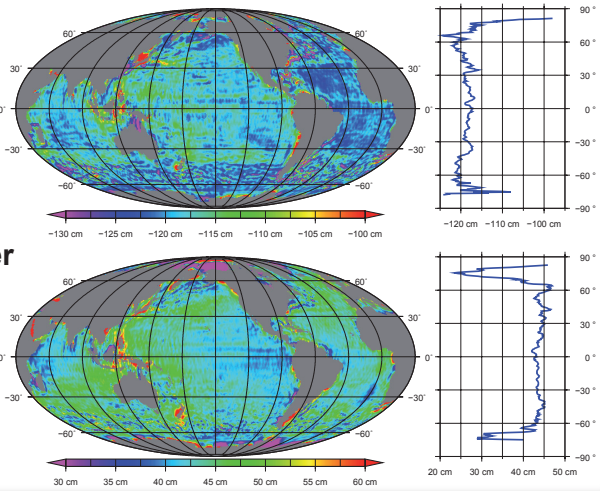


Fig. 1 two-dimensional isotropic Gauss filter (blue surface) with 1D-intersection (red curve)

A Gauss filter has similar shape in both, the frequency and the space domain. Here, the filter is applied in two dimension in the frequency domain, and in one dimension in the space domain. Systematic differences are accounted for by a filter correction.

Differences to independent DOT estimates



Result

The filter correction ensures a consistent filtering of geoid heights N and sea surface height profiles h. This allows to derive **instantaneous and absolute DOT profiles**. The profiles of the geodetic DOT show no artifacts over steep topography or at the coast line.

Up to a constant offset (most likely through the „level-of-no-motion“ assumption) the geodetic DOT is in good agreement with mean *DOT*-estimates based on oceanographic approaches.

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