Arctic Ocean geoid, ice thickness and mean sea level – the ArcGICE project

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Abstract

Satellite altimetry from ERS, Envisat and ICESat may be used together with updated geoid models based on surface, airborne and satellite gravity field data to derive estimates of Arctic Ocean mean dynamic topography (MDT) as well as sea ice free-board heights. In the paper we use a mean sea surface (MSS), based on ICESat lowest-level filtered laser altimetry and retracked radar altimetry, combined with an improved Arctic geoid model based on terrestrial gravity data and GRACE, to make a consistent estimate of Arctic Ocean MDT. We compare results to oceanographic models, showing that an overall absolute consistency is possible at the dm-level. Arctic Ocean sea ice freeboard heights (and thus thickness) are an integral part of these investigations, and ICESat-derived freeboard heights show a good correlation to multi-year ice distribution as determined from Quikscat. The sea ice presence, which may bias altimetry sea level measurements, as well as the inhomogenous distribution of gravity data and tidal model errors, are limiting factors in the precise MDT determination. We study the characteristics of errors in both space and spectral domains, and outline optimal methods for joint processing of altimetry and gravity for MSS and MDT recovery. The investigations are the core of an ongoing ESA project “ArcGICE”, aimed a.o. at providing a practical algorithm for the estimation of sea surface heights and its associated error covariances, to be used, e.g., as reference for Cryosat measurements of sea ice freeboard.

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