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Influence of different ocean areas on the annual variations of the M2 tidal parameters at SG stations

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An annual variation of the tidal parameters of wave group M2 is observed globally and is in the order of 10^{-4} for the gravimetric factor (GF) and $10^{-2\circ}$ for the phase at almost all European superconducting gravimeters (SG).
With sea surface heights (SSH) from non-stationary, non-linear ocean models which potentially describe the annual variation of the M2 ocean tide the gravity loading can be calculated. We add the loading signal to synthetic Earth tides and analyse the resulting signal with a moving window tidal analysis (MWA). The amplitude of the annual variation of the tidal parameters obtained that way is in the same order of magnitude, as the tidal parameters obtained from measurements.
The annual changes of the M2-amplitude are largest in shelf areas. As they are close to the SG stations on the continents they probably have a large influence on the gravity recordings. On the other hand, although the amplitudes in the pelagic areas are small, they cover large areas and could sum up to a large loading signal. In this study we investigate which areas of the global ocean contribute most to the observed variation at a SG station. The amplitudes of the annual variation of M2 obtained with harmonic analysis of the SSH of the global ocean model 'Stormtide' are used to calculate the contribution that every single grid point causes at the station Black Forest Observatory (BFO, Germany). We use this to define thresholds for the analyses of synthetic data, taking into account only those grid points whose contributions are above the threshold. The variations of the tidal parameters obtained with these reduced data sets are compared to the tidal parameters we obtain for the total ocean model data set and the measured data.
0.003% of all grid points of the model have a contribution above a threshold of $10^{-4}\frac{nm}{s^2}$. The resulting tidal parameters obtained with them show an annual variation in the order of 10^{-5} for the GF and 0.004° in phase, which is about 10% of the variation observed for the total model. About 3% of all grid points exceed a $10^{-6}\frac{nm}{s^2}$-threshold which is sufficient to explain 80% to 90% of the result for the global ocean. These points are distributed over large areas in the North Atlantic as well as smaller shelf areas in even more than 140° distance.
We conclude that not only the very close coastal area but distant ocean regions have a significant contribution to the annual variation of the M2 tidal parameters. Accordingly, the influence of the annual variation of the M2 amplitude on SG stations has to be studied at least on a regional scale. At the same time a comparison of MWA for synthetic loading with MWA of recorded data from several globally destributed SGs can be used to evaluate global time-varying tidal ocean models.