M2 Tidal Parameters revealed by Superconducting Gravimeter time series

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Analyzing 1-yr data sets of ten European superconducting gravimeters (SG) reveals statistically significant temporal variations of the principal lunar semi-diurnal (M2) tidal parameters identifying both short-term (< 2 yr) and long-term (> 2 yr) features. Different response to the loading suggests the observed modulation caused by insufficient frequency resolution of limited time series. The variations provide the upper accuracy limit for Earth model validation and permit estimating the temporal stability of SG scale factors and assessing the quality of gravity time series.

Common long-term features in the M2 tidal parameter variations are clearly visible at all SG stations after analyzing successive 1-yr intervals (Fig. 1). Similar signatures can be observed in the amplitude factors at almost all stations between 2000.5 and 2007. A relatively sharp phase decrease appears from mid-2007 to mid-2008.

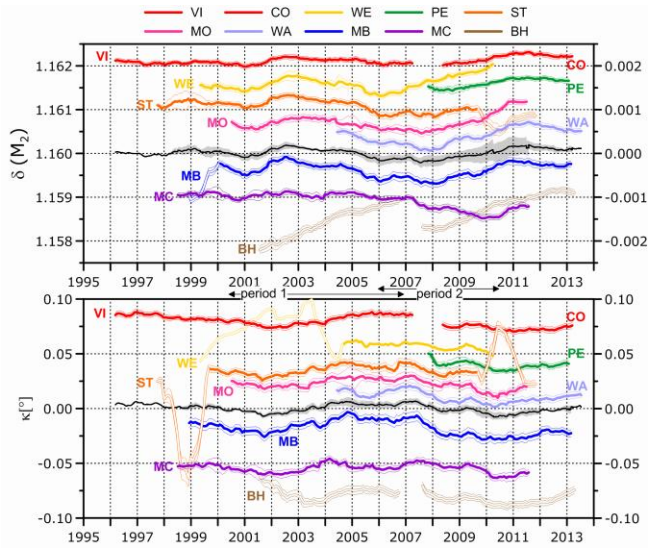

Figure 1: Temporal variation of M2 tidal parameters derived from 1-yr gravity time series of ten observatories (CO indicates the record of the Conrad Observatory). Thin solid lines: errors of the delta factors and phases. Arbitrary offsets for clarity reasons. Stack results are displayed as black line, standard deviation range as shaded area. Transparent lines mark data disregarded both in correlation analyses and in stacking.

For the complete time series, statistically significant correlation is observed in 58% of all pairs for the amplitude factor and 65% for the phase variation. When disregarding the MC station, positive correlation coefficients exist for 72% of all station pairs for amplitude factors and phases. Comparison with synthetic tide models suggests the M2 tidal parameter variation to be caused by insufficient frequency resolution of limited time series as 2nd and 3rd degree constituents within the M2 group respond differently to ocean loading. Though the modulation amplitude is as small as 0.2‰ it could be captured in the investigated SG time series. If the scale factor instability were larger, it would be very unlikely to observe common features in the tidal parameter variations of M2. This temporal stability justifies averaging the SG scale factors derived from repeated calibration experiments to increase the scale factor accuracy well below the 1‰ level.

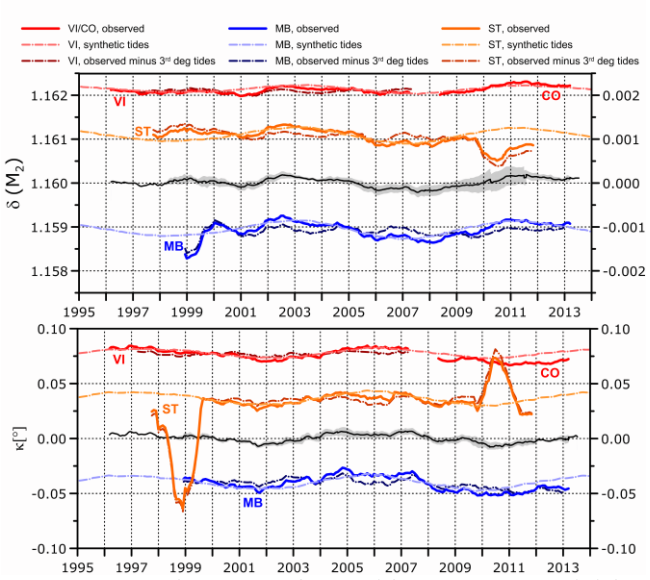

Figure 2: Temporal variation of M2 tidal parameters provided by analyses of synthetic tide models and observed data at MB, ST and VI. Observed: bold solid lines. Synthetic time series (DDW body tides + TPXO7.2 ocean load): dashed lines, light colors. Observed minus 3rd degree DDW body tides: dashed lines, dark colors

References:
Meurers B., Van Camp M., Francis O., Pálinkáš V., 2016: Temporal variation of tidal parameters in superconducting gravimeter time-series. Geophysical Journal International, 205, 284-300.

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