Impact of revised time variable gravity realizations on geocentric sea level estimates derived from the TOPEX/Poseidon/Jason Climate Data Record

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Abstract: Recent developments in Precise Orbit Determinations (POD) due to in particular to revisions to the terrestrial reference frame realization and the time variable gravity (TVG) continues to provide improvements to the accuracy and stability of the POD directly affecting mean sea level (MSL) estimates. Long-term reliable MSL estimates require the development and continued maintenance of a stable reference frame with high (real-time) and high (post) accuracy requirements. The stringent MSL accuracy requirements of a few tenths of a mm/yr are particularly essential for mass budget closure analysis over the relative short time period of Jason-1 & 2, GRACE, and Argo co-evident measurements. In an effort to adhere to cross mission consistency, we have generated a full time series of experimental orbits (GSFC std1204) for TOPEX/ Poseidon (TP), Jason-1, and GSTM based on the current ITG-2008 terrestrial reference frame (TRF) - and revised TVG (44) realization based on weekly SLR-ITRIS snapshots that span the entire Climate Data Record. In this paper we focus on the TVG induced orbit error impact on Jason-2 regional MSL trends via inter-comparisons with the GSFC std1204 POD, the current GDR_D POD, the prior GDR_C, and the JPL GPS POD. Tide gauge verification results are shown to assess the current stability of the Jason-2 sea surface height time series as well as the 20+ year record.

Global and Regional Mean Sea Level Estimated from TOPEX, Jason-1, and OSTM Altimetry

Global Mean Sea Level Variations

Impact on Jason-2 regional sea level trend estimates from TVG-induced orbit error are shown via linear rates of orbit differences between various POD solutions. Significant regional trends with similar positive correlated error signatures are observed for both the GDR_D and the GSFC std1204 PODs with respect to the initial GDR_C (version C standard) POD (left images). Note the white stars indicate the locations of the 6-disk tide gauge network (Mitchum, 2006). The GDR_C std1204 and GDR_D PODs are based on improved TVG realizations derived from a much larger number of gravity coefficient linear rate terms as compared to the parsimonious accounting of TVC in earlier solutions (e.g. GSFC std1087 and the GDR_C). The GSFC std1204 semi-annual, semi-annual, and linear rate terms are derived from a fit to a 10.6-year regional gravity coefficient time series estimated from weekly SLR-ITRIS snapshots (Lemoine et al., 2013). The GDR_D std1204 (10.6-year) semi-annual, semi-annual, and linear rate terms are derived from GRACE-LAGEOS over 2003-2016. Specifications of the individual POD strategies are detailed in Zelensky et al. poster. Some regional trend differences exist between the GDR_D and the GSFC std1204 POD (above figure). The alignment of these differences with the tide gauge network seem to have a cancelling effect on the tide gauge verification results shown below. An additional assessment is shown (right images) by comparing to the JPL GPS-only POD (gps_rlar_1x1) which is believed to be insensitive to TVG effects (Bertiger, et al., 2010).

Tide Gauge Verification Analyses

Jason-2 Drift Estimations

Tide Gauge Analysis Epilogue

As the SSH time series approached 20+ years a long-period signal became more apparent in the altimeter sea level height residuals (top figure). The 18.6-yr long-period tide was suspected. The middle image above shows the regional structure of the amplitude of the 18.6-yr node tide (all-coincident eigenfrequencies when nodal longitude N = 0°) (Note: N = 0° during years 1987, 1997, 2007). The above figure shows the expected signal that was removed from the altimeter SSH variations, but not the gauge height variations.

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