Assessment of Current Global and Regional Mean Sea Level Estimates Based on the TOPEX/Poseidon, Jason1&2 Climate Data Record

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Abstract:
Recent developments in Terrestrial Reference Frames (TRF) due to particularities associated with the recent generation from geodesy and the data variable gravity (TVG) continues to provide improvements in the accuracy and stability of the TRFs thereby allowing users to better (SSH) estimates. Long-term satellite SSH estimates require the development and continued maintenance of a stable reference frame, along with high-quality modeling of the contributions of the topography, water column, and geophysical factors to the global SSH variability. The accuracy of SSH estimates is constrained by the accuracy and stability of the terrestrial reference frames used for the altimetry analysis. The TOPEX and Jason series are important in the overall SSH framework due to their precise orbit determination and high data density. This paper focuses on analyzing the impacts of the GPS-derived sea surface height from the Jason-2 mission, and the OSTM altimetry data. The analysis includes the assessment of the Global Mean Sea Level (GMSL) estimates from the TOPEX, Jason-1, and OSTM altimetry data. The improved accuracy of the Jason-2 SSH estimates is demonstrated by the significant improvement in the agreement between the OSTM and Jason-2 SSH estimates. The analysis also demonstrates the importance of maintaining the stability of the terrestrial reference frames for the accurate and reliable estimation of the GMSL changes. The paper concludes with a discussion on the implications of these findings for the future development and maintenance of the terrestrial reference frames.

Errors Associated with Estimation of Vertical Rates of Motion of Tide Gauge Sites

Experimental GSFC Replacement Orbits based on revised Time Variable Gravity

Improved Agreement of OSTM Altimetry based on Orbits with revised Time Variable Gravity with Tide Gauge Network

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

Experimental GSFC Replacement Orbits based on revised Time Variable Gravity

Tide Gauge Validation

OSTM Verification Results from Global Tide Gauge Network

Errors Associated with Estimation of Vertical Rates of Motion of Tide Gauge Sites

Left Figure: OSTM (cycle 1-105) altimeter derived SSH variations are compared to tide gauge variations for 64 sites. OSTM SSH data is compared to tide gauge data for 64 sites located in the eastern tropical Pacific. As expected the global mean sea level variation difference between the two solutions is the same magnitude and sign as the above orbit differences and show the same geographical distribution (center figure).

Right Figure: The scatter plots show the comparison of the two solutions for the OSTM and tide gauge SSH data for the 64 sites. The scatter plots are presented for the entire time span of the data.

Right Figure: Mean radial orbit differences over water (200 meter mask) between std1007 and std1110 shows subsequent impact on GMSL estimate. Significant improved agreement of Jason-2 altimetry based on std1110 with tide gauge verification network is realized as shown in right figure, since most of 64 verification gauges are located in the tropical Pacific where rates of orbit differences are at a maximum. Left figure shows typical differences of tide gauge data (after September 29, 2009) from the global mean solution the level of agreement improves but still exceeds 1 mm/yr.

The global mean sea level rate is estimated from linear fit (bold red line) after removal of annual and semi-annual signal. The MSL rate over the entire time span is 3.1 ± 0.41 mm/yr. The inset figure shows such a GPS time series for a specific site, illustrating the importance of GPS data for monitoring small-scale sea level changes. The figure shows the GPS time series for a site located near the equator, illustrating the importance of GPS data for monitoring small-scale sea level changes.

The global mean SSH variations about the linear fit are shown in the center figure. The global mean SSH variations are consistent with the global mean collinear differences estimated from tide gauge comparisons are consistent with the global mean SSH variations estimated from tide gauge comparisons. The linear fit to the global mean SSH variations is shown in the center figure. The global mean SSH variations are consistent with the global mean collinear differences estimated from tide gauge comparisons. The global mean SSH variations are consistent with the global mean collinear differences estimated from tide gauge comparisons.