Exploring Differences in Global Mean Sea Level Time Series

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Abstract

Satellite radar altimeters, beginning with the TOPEX/Poseidon in 1992, and continuing through the present day with Jason-1 and Jason-2, have allowed estimation of the time series of global mean sea level (GMSL). A number of different research institutions independently produce a GMSL time series, and each of these time series generally show the same basic trend in global mean sea level over the 19-year data record. But the different GMSL time series are each produced using varying techniques and different corrections, and subsequently the time series exhibit different higher-order signals and sensitivity to interannual cycles, such as the ENSO. In this work, we compare the GMSL time series produced by these groups and explore the differences among them. We also compare the various techniques and the applied corrections used by each institution to understand how these affect the differences among the GMSL time series. We find that the various GMSL time series follow the same general trend and computed linear rates once high frequency noise and seasonal signals are removed. Along-track versus gridded means show unexplained differences that may be due to smoothing of interannual signals in the latter. Our goal is to continue to identify improvements in our own GMSL time series so that it can better be used by the science community as a climate data record.

Comparing Unfiltered Time Series

Time series which were available at native resolution (10-day repeat cycle), which included CU, NOAA, and GSFC, were compared before standard 60-day and annual signal filtering (right). Differences in these raw time series were computed (bottom left). These raw differences show that the CU GMSL suffers a large 60-day signal during J99 compared to the NOAA and GSFC estimate. This is most likely due to using the CLS v. 2009 SSH in TOPS without updating the SSH during strong ENSO years. These plots also show that the CU and GSFC differences do not have seasonal component that is evident in the differences with NOAA. These most likely due to the use of along-track means (CU, GSFC) versus gridded means (NOAA).

The annual signal amplitude and phases are shown in the table above. Large amplitudes and offset phases are noted in both the NOAA and AVISO series, and this is most likely due to inclusion of shallow water estimates in these series. CU and GSFC series both use a minimum 120 m depth cut-off.

Comparing Filtered Time Series

Comparing Detrended Time Series

Differences in the smoothed and detrended series (plotted at right) are plotted in the half-pyramid at left as cumulative minus row. The recent drop caused by the string La Nina in 2010 and its deeper trough in the CU and GSFC is evident. The large discrepancies in the TOPEX/Poseidon are highlighted in differences in corrections and algorithms used during that mission.

Future Work

This investigation has illuminated differences in the GMSL series produced by different institutions. Some errors, such as the orbits used in the CU and GSFC series should be corrected, as well as updating the SSH and wind inputs when computing new SSB models (CU). Sensitivity to interannual variations seem to be affected as well by choice of algorithm (along-track versus gridded).

Continued efforts to understand these effects and reach consensus is important for establishing confidence in a sea level climate data record.