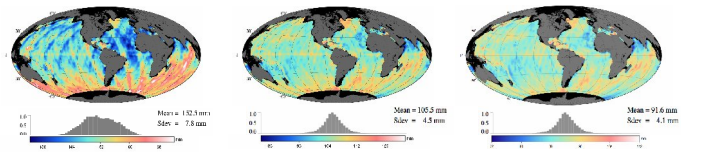
Assessment of Recent Revisions to the TOPEX/Jason Sea Surface Height Series

B. Beckley, N. Zelensky - SGT, Inc.
F. Lemoine, S. Luthcke, R. Ray – NASA/GSFC
S. Desai, P. Callahan – JPL
G. Mitchum – Univ. of S. Florida
S. Labroue, N. Tran - CLS

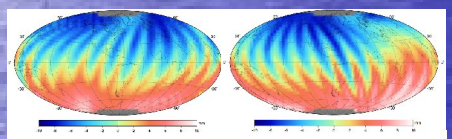
The Jason-1 verification phase has proven to be a unique and successful calibration experiment to quantify the agreement with its predecessor TOPEX/POSEIDON (TP). Although both missions have met prescribed error budgets, comparison of the mean and time varying sea surface height (SSH) profiles from near simultaneous observations derived from the missions' initial versions of Geophysical Data Records (GDR) exhibit significant basin scale differences. The terrestrial reference frame is linked inseparably to the measurement of global mean sea level estimates from satellite altimetry and provides the context for the interpretation of the causes of current mean sea level trends. In an effort to adhere to cross mission consistency, we have generated the full time series of orbits for both TP and Jason-1 through reduced dynamic methods based on the GGM02c GRACE derived gravity field within a consistent well defined ITRF2005 terrestrial reference frame. Recent revisions to the Jason-1 GDR and the TOPEX GDR Compatibility Product (GCP) also require the further re-examination of TP/Jason-1 consistency issues. Here we present an assessment of these recent improvements to the accuracy of the TP/Jason-1 SSH time series via tide gauge validation procedures, global crossover and collinear SSH residual statistical analysis, and evaluate the subsequent impact on global and regional mean sea level estimates.

Jason - TOPEX Mean Sea Surface Height

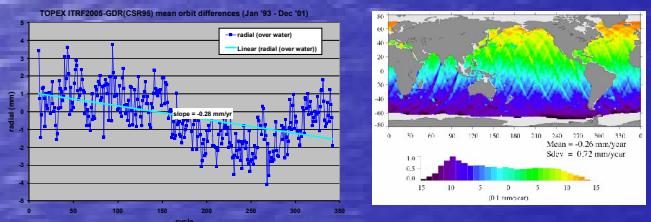
Verification Phase



Images above show progressive improved agreement of Jason/TOPEX mean SSH during the verification phase. SSH differences in left image are based on TOPEX MGDR_B (JGM3 orbits, CSR95 terrestrial reference frame), and Jason GDR_A (JGM3 orbits, ITRF2000). In the middle image the SSH is based on GSFC ITRF2000 (GGM02c) replacement orbits for both TOPEX and Jason GDR_A. In the right image the SSH is based on GSFC ITRF2005 (GGM02c) replacement orbits for both TOPEX and Jason GDR_B.

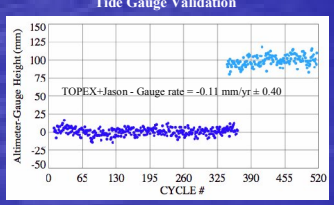


TOPEX orbit differences between GSFC JGM3 reduced dynamic replacement orbits based on ITRF2000 and GDR JGM3 orbits based on CSR95 terrestrial reference frame are shown for ascending and descending passes during the Jason verification phase. The source of the dominant hemispherical Jason/TOPEX mean sea surface height difference in above figure is due primarily to the terrestrial reference frame inconsistency that exists between Jason-1 and TOPEX GDR (Geophysical Data Record) based orbits.



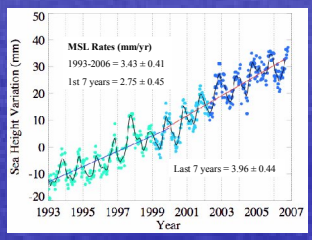
TOPEX global mean differences between GSFC ITRF2005 (GGM02c) replacement orbits and MGDR_B CSR95 (JGM3) based orbits are shown in left figure for 1993 through 2001. Although the direct impact on global mean sea level estimates is a few tenths of mm/year, the impact on regional trends is more substantial approaching 1.5 mm/yr as shown in the right figure which illustrates the differences of local mean sea level trends as a result of the orbit inconsistencies with regard to the terrestrial reference frame and gravity field.

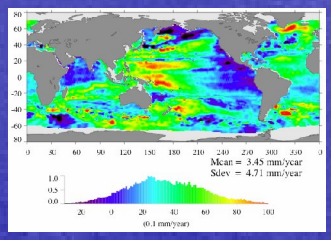
Tide Gauge Validation



TOPEX and Jason-1 sea surface height variations are compared to tide gauge variations from 64 sites. Altimeter SSH values are based on GSFC ITRF2005 (GGM02c) orbits, and most resent recalibrated TMR and JMR wet tropospheric range corrections. After adjustment of the decimeter level instrument bias computed from Jason-TOPEX collinear differences during the verification phase, the total residual drift equals -0.11 mm/year.

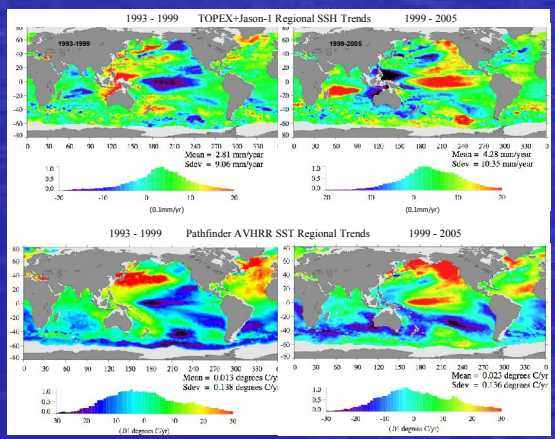
TOPEX +Jason-1 Global and Regional Mean Sea Level Rates



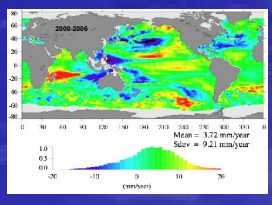


Global mean SSH variations from TOPEX and Jason-1 with respect to 1993 – 2002 mean are plotted every 10 days in left image. The light green dots represent TOPEX Side A, light blue dots TOPEX Side B, and dark blue dots Jason-1. The solid black line is a 60-day Hanning filter of the altimetric time series. The blue line is linear fit of smoothed SSH variations from 1993 through 1999 (2.75±0.45 mm/yr). The red line is linear fit of smoothed SSH variations from August 1999 through August 2006 (3.96±0.44 mm/yr). The MSL rate over the entire time span is 3.43 ± 0.41 mm/yr. SSH values throughout entire series are based on consistent ITRF2005 (GGM02c) orbit, recent recalibration of TMR and JMR, MOG2d barometric correction applied. Rates reported have been computed after removal of annual and semi-annual signal. MSL rate error bars reported above are the root-square sum of the tide gauge precision and the variance of the global mean SSH variations about the linear fit. Regional MSL trends over the entire 14 year time span are shown above in right image.

Inter-Decadal Variability



Regional sea surface height trends from TOPEX+Jason-1 altimetry (upper image), and sea surface temperature trends from AVHRR are computed over the seven year time spans of 1993-1999 and 1999-2005 (overlap in 1999). The most apparent correlated features exhibited in both the SSH and SST regional trends is the basin scale polarity (particularly in the tropical and North Pacific) between the two time frames revealing pronounced inter-decadal variability modulated by the strong ENSO event in the late nineties.



Regional SSH trends from TOPEX+Jason altimetry are computed over the last seven years of the 14 year time span. While a persistent high exists in the central Indian Ocean, the Pacific suggests a transition phase from the strong decadal signature shown in the SSH and SST maps above.