Accuracy Assessment of Along Track Sea Surface Slopes: Evaluating TOPEX/POSEIDON and Jason-1

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Introduction

Oftentimes, sea surface height slopes are computed from altimeter data archives that have been corrected to give the most accurate absolute sea level. This practice unnecessarily increases the error in the cross track geostrophic velocity anomalies. Because differentiation acts as a high pass filter, many of the path length corrections applied to altimeter data for absolute height accuracy are unnecessary for corresponding slope calculations.

We have developed an along-track slope archive from TOPEX/POSEIDON measurements and have begun a similar for Jason-1.

Verification of slope data is performed by comparison of cross track geostrophic flow calculations with moored buoy current measurements taken by the Texas Automated Buoy System operated by Texas A&M University.

Calculation of Slopes

To generate slope data, the time, location, and along track sea surface height values are extracted from the Jet Propulsion Laboratory (JPL) altimetry data archive. The archive allows for removal of corrected or uncorrected sea surface heights. The corrected data product incorporates all of the standard corrections. The uncorrected data have no path length or tidal corrections applied. The extracted sea surface height is then differenced against the along track JPL mean sea surface. For valid points within two seconds, the slope as mm/s is calculated for the mid-point location between the two. The calculated slopes are then linearly interpolated to the TOPEX/POSEIDON nominal ground track.

Acknowledgements

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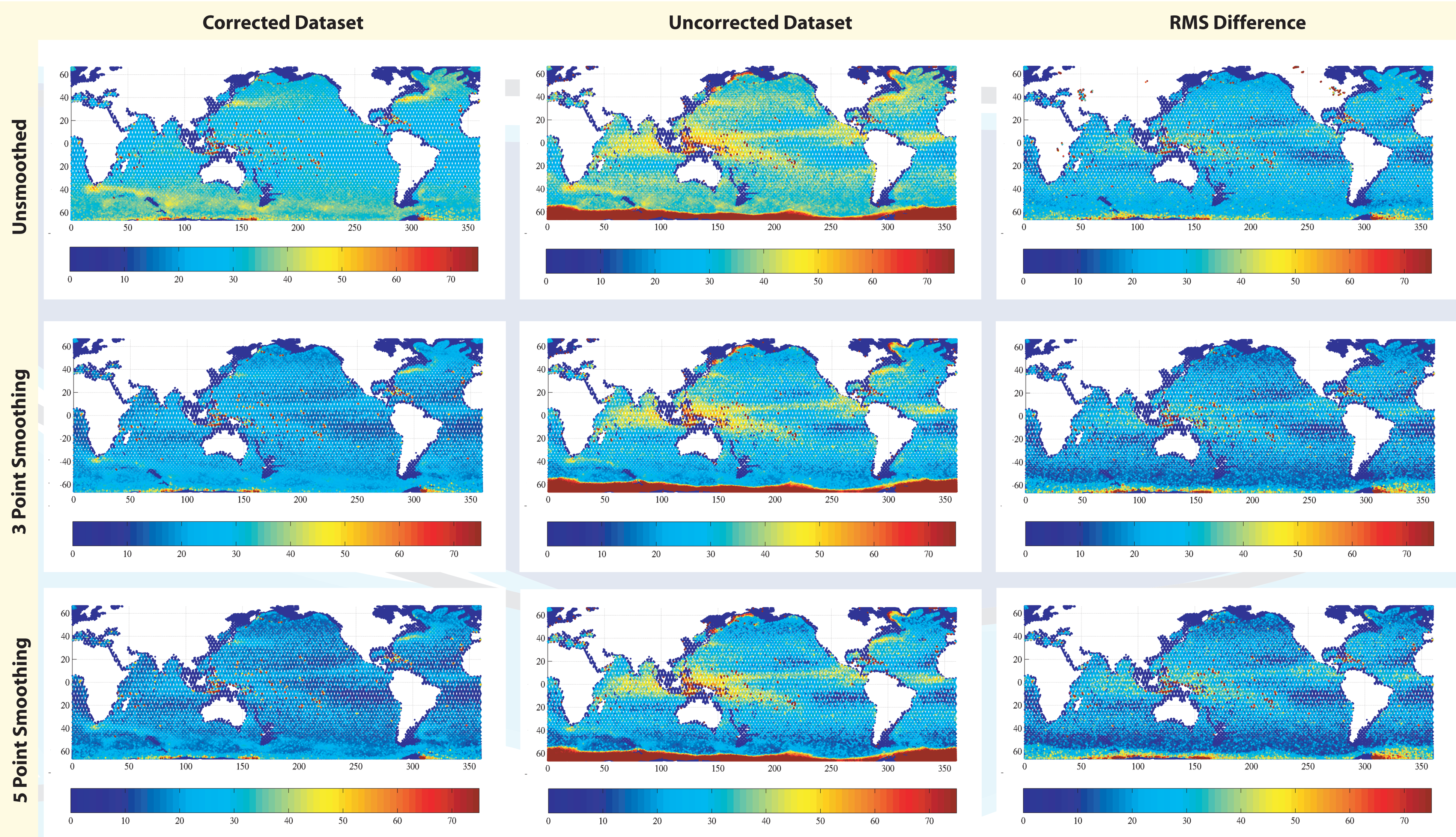
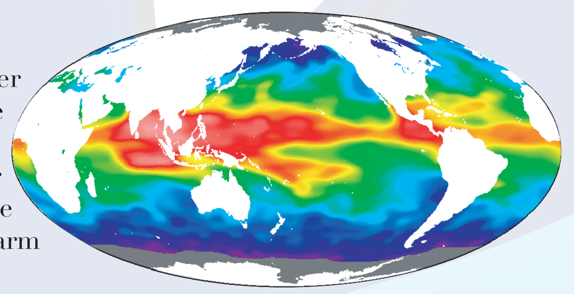
TOPEX/POSEIDON Slopes

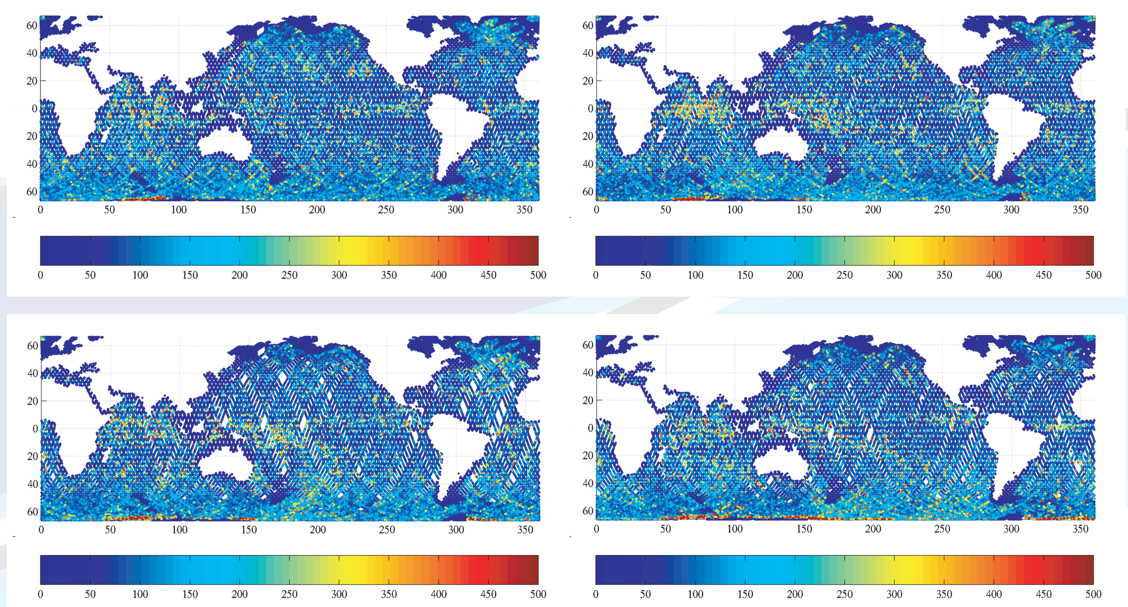


The above panels provide a comparison of RMS noise for slopes derived from corrected and uncorrected data over the lifespan of the TOPEX/POSEIDON mission. Each panel is displayed in mm/s. Each dataset has varying smoothing windows applied to remove high-frequency noise (such as instrument, registration, or mean surface noise). In viewing the RMS noise in the uncorrected dataset, it becomes apparent that the water vapor correction may need to be applied to the dataset before differentiation. The RMS difference between the corrected and uncorrected data is shown in the right-hand column.

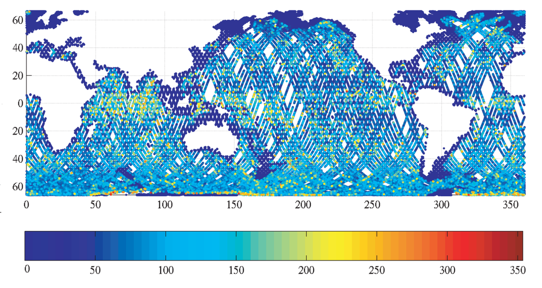
The panel shows the average global water vapor content pattern. It is evident that the uncorrected slope data contains noise due to the lack of applying the water vapor correction. In the above frames for the uncorrected RMS products, the Pacific warm pool greatly raises the noise floor.



TOPEX/POSEIDON & JASON Slopes



Panels showing absolute slope differences between TOPEX/POSEIDON and Jason along track points. All values are shown in mm/s. Each measurement was linearly interpolated to the nominal TOPEX/POSEIDON along track path. Locations of less than 2,000 meter depth were set to zero and any bad values (values in which the slope was greater than 400 mm/s) were thrown out. Top-left panel shows the difference between T/P cycle 351 and Jason cycle 8. Top-right panel show the difference between cycles 352 and 9. Bottom-left panel shows the difference between cycles 353 and 10. Bottom-right panel shows the difference between cycles 354 and 11.



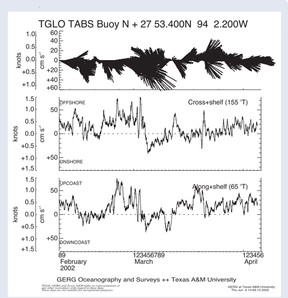
This panel shows the RMS difference for the four cycles of TOPEX/POSEIDON

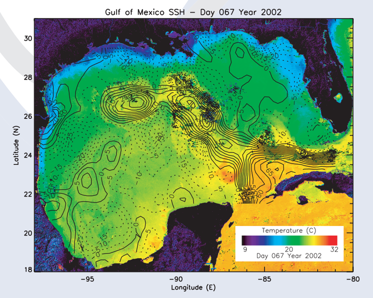
Application: Geostrophic Currents

Calibration and Validation of slope data can be performed by comparing to cross track current measurements using a mooring (Buoy N) placed along the descending TOPEX/POSEIDON ground track number 52 in the Gulf of Mexico. The buoy is part of the Texas Automated Buoy System (TABS) under interagency contracts with Texas A&M University. The buoy telemeters observations in near real-time via satellite to the TABS station located at the Geochemical and Environmental Research Group (GERG) at Texas A&M. The buoy is located on the shelf break at 105 m water depth.

TABS Model II Buoy

Using TOPEX/POSEIDON and Jason slope data, the cross track geostrophic currents can be calculated and compared against data collected by Buoy N from January until May of 2002. The buoy takes measurements every 30 minutes compared to the 10 day sampling of TOPEX/POSEIDON and Jason.

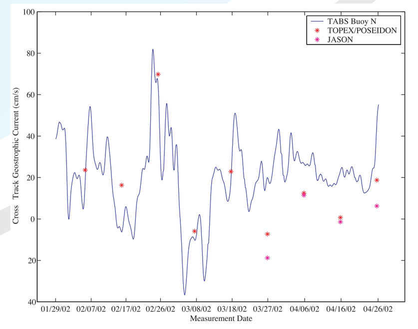




The left panel shows the current as measured every 30 minutes during March, 2002 by buoy N of the TABS. The right panel shows sea surface temperature overlaid with sea surface height contours during a strong eddy event in March, 2002.

Three slopes from the off-shelf location are averaged together to compute the geostrophic current. This current is then projected from the descending 52 track frame to a positive East frame. A 33 hour, low pass filter is applied to the buoy data to remove tidal, intertial, and other high frequency variations.

The top panel shows the comparison between TOPEX/POSEIDON and Jason derived geostrophic currents with the low pass filtered buoy dataset. A rather strong correlation can be seen which validates the uncorrected slope dataset.



The bottom panel shows the same information in comparison with the unfiltered buoy dataset.