Jet Propulsion
Laboratory
California Institute
of Technology

Reprocessing TOPEX Data for the Climate Data Record

Philip S. Callahan and Brent Williams
Jet Propulsion Laboratory, California Institute of Technology

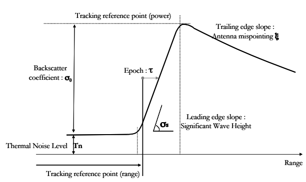
Government sponsorship is acknowledged. This work was supported by the NOAA Climate Data Records program.

TOPEX/POSEIDON as the first mission in the partnership between NASA and CNES in dedicated, high accuracy ocean altimetry missions forms a crucial part of the 20 year ocean climate record. The TOPEX data from 1993 – October 2005 are the beginning and cover more than half of the 20 year altimeter climate record. TOPEX/POSEIDON used three altimeters over its lifetime: TOPEX (NASA) Alt-A and Alt-B and the experimental CNES POSEIDON, forerunner of the Jason series. The TOPEX altimeters had certain waveform features (“leakages”) that have become increasingly important as altimetry is pushed to the sub-millimeter per year accuracy level. There was also the transition from TOPEX Alt-A to Alt-B necessitated by changes in the point target response (PTR) of Alt-A, most clearly manifested by an apparent increase in significant wave height (SWH). In order to bring TOPEX data up to the standard of more recent altimeter data and to correct for waveform features and PTR changes, the TOPEX data are being retracked with newly derived PTRs from calibration data and waveform adjustments (“weights”) to correct for leakages.
In addition to these instrument processing changes many advances in orbits and ancillary data have been made over the years. We are reprocessing the TOPEX data to insure that they are free of artifacts and to bring them into conformance with Jason data in order to insure continuity in the 20 year altimeter climate data record.

The return signal waveform results from convolution of Radar PTR, surface height distribution, flat surface response function.

Left: “Retracking” is solving for the parameters in the waveform model: Range/Epoch, Amplitude/Power (sigma0), Slope (SWH), Antenna Off Nadir Pointing, Noise.

Right: Leakages (x20) in the TOPEX Alt-A waveform from Hayne et als, 1994, JGR 99, 24,941. Also shown are the onboard gates used to estimate the same parameters obtained from retracking. Retracking allows compensation for PTR changes and weighting of samples.



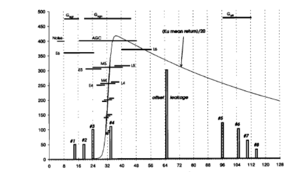
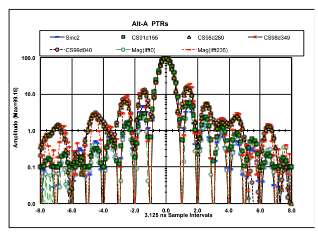
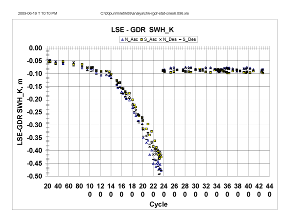


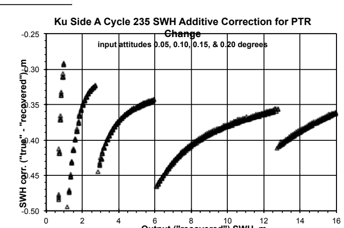
Figure 6. TOPEX Ku altimeter gates, mean return, and center locations of waveform leakage spikes.

Left: Changes in Alt-A PTR – increase and distortion of sidelobes (Prelaunch = green squares, last Cycle 235 = orange circles) – caused changes in SWH (and range) in the original GDR data that are corrected when the when the actual changed PTR is used in processing. **Right:** Change in SWH (difference between Retracked(LSE) and GDR) over TOPEX mission.

Lower Right: Simulation by G. Hayne (WFF) of change in SWH as a function of SWH for PTR of Cyc 235 (discontinuities reflect internal altimeter function). The simulation also provided estimates of the range error of ~ 10-12 mm. The in apparent altimeter SWH will also change the calculated Sea State Bias correction.







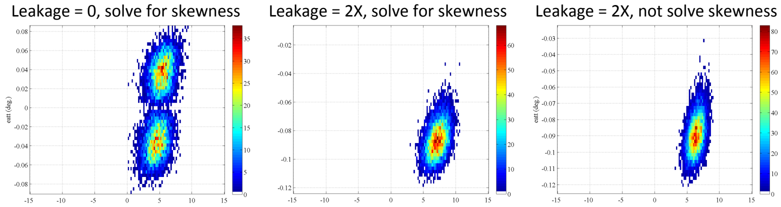
Simulations with Leakages

Simulated conditions: SWH = 2 m; Att = 0; Skew = 0; dH = 5 cm.

Leakage = 0 or 2 X indicates No Leakages or Twice the expected amount shown above.

Solution Parameters (All): dH, SWH, Att^2, Scale, Noise. 2D Histogram of solutions: Att / dH

Leakage = 0, solve for skewness | Leakage = 2X, solve for skewness | Leakage = 2X, not solve skewness

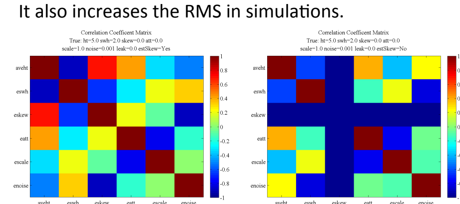


Att^2 is double valued at left because of the form of the model for the waveform. Not solving for skewness in the Leakage=0 case gives a somewhat tighter pattern, similar to the effect seen between the center and right panels. The leakages result in an attitude bias (~ -0.09 deg^2) from the large spike near the center of the waveform “tail” (bin 64) and a range bias of 3-4 cm from the leakages near the leading edge. The range bias is slightly reduced when skewness is not solved for (**Right**).

Solving for surface skewness in order to “absorb” the leakages has been the main approach for dealing with them. The correlations (Right) and the simulation results (Above) suggest that this may not be the best approach. Two alternative approaches – revised “weights” on the waveform samples, corrections estimated from simulations – will be further explored. An attempt at using revised weights in 2009 produced results that were quite different (Below right, negative Mean Sea Level trend for Alt-A) from previous results. It is likely that not enough data were used to derive those weights, so a more robust method of deriving the weights is needed.

Correlations in Solutions

Parameters in the retracking solution are correlated. Solving for surface skewness (Left; Right: not solving for skewness) significantly increases the correlations. It also increases the RMS in simulations.



Mean Sea Level Analysis by S. Labroue (CNES) ‘09 OSTST