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Progress in Retracking TOPEX Data for the Climate Data Record

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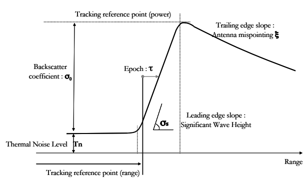
TOPEX/POSEIDON as the first mission in the partnership between NASA and CNES in dedicated, high accuracy ocean altimetry missions forms a crucial part of the 20 year ocean climate record. TOPEX/POSEIDON used three altimeters over its lifetime: TOPEX (NASA) Alt-A and Alt-B and the experimental CNES POSEIDON, 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. In order to 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. After retracking, we will reprocess the TOPEX data to to bring them into conformance with the many advances in orbits and ancillary data that are in use for Jason data in order to insure continuity in the 20 year altimeter climate data record.

Retracking Basis and TOPEX Leakages

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.



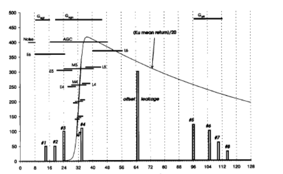
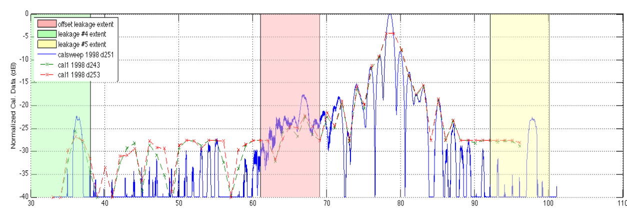


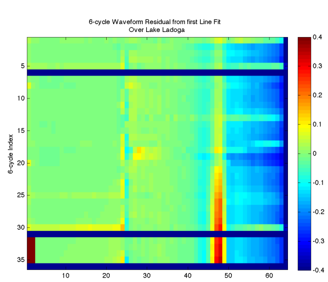
Figure 6. TOPEX Ku altimeter gates, mean return, and center locations of waveform leakage spikes.

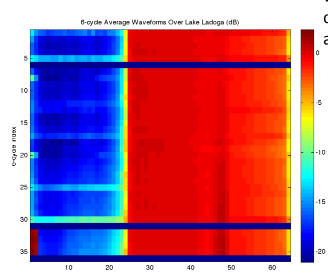
Identified Usable Portion of Cal Data

- Cal1 and CalSweep contaminated by leakages
- Far lobes appear unreliable – Cal1 and CalSweep disagree
- Leakage #4, the most important leakage since it is near the tracker center bin, is apparent in the Cal1 data and can be modeled as a function of time
- Leakages limit lobes of PTR that can be obtained from Cal data to +/-8
  - Simulation has shown that longer PTRs are needed to obtain stable results, so a method to extend the PTR up to +/-30 lobes is needed



- Solving for surface skewness in order to "absorb" the leakages has been the main approach for dealing with them.
- Revisited estimation approaches (LSE, MLE, MAP, Bayes, fitting in dB)
  - All are biased. Some (MLE, MAP, Bayes) have lower variance estimates
  - With leakages, improvements are marginal and may not merit code rewrite and testing
  - Conclusion: Continue to use least squares estimation (LSE), but possibly use dB





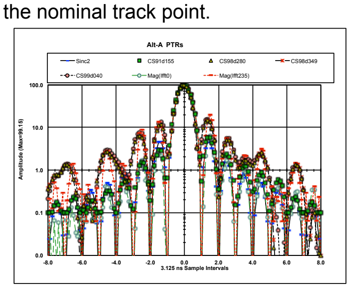
Alt-A PTR Changes

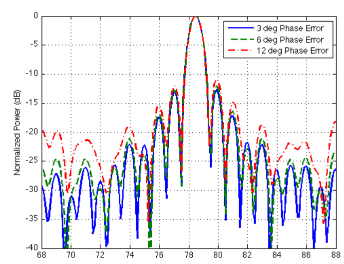
Upper: Changes in Alt-A PTR – increase and distortion of sidelobes (Prelaunch = green squares, last Cycle 235 = orange circles) as observed in Cal1 and CalSweep data.

Lower: Simulation of PTR for I/Q phase shifts of 3, 6, 12 deg.

We derived a closed form expression for the PTR that results from a phase imbalance between the I/Q channels of the SSB mixer – Jensen's (APL) basic hypothesis for the changes in the PTR. The resulting expression produced a PTR whose shape varies not only with the phase imbalance, but also with the waveform sample number – a point target centered at one particular waveform bin would spread energy into the other bins differently than a point target centered at some other bin. As the phase shift increases this approach could produce some of the general features seen in the CalSweep data.

Note that the calibrations (CalSweep, Cal-1) have different centers than the nominal track point.





Changes in PTR from Lake Data

We have investigated changes in the PTR by using data over Lake Ladoga in western Russia. Low wave heights on the lake allow a clear view of waveform features. The images show the variation of the waveform as averaged over 6 cycle sets of Alt-A data. The waveforms clearly show the increase of the zero-frequency leakage. The changes around the leading edge show the PTR changes.