Calibration and Validation of Reprocessed TOPEX Geophysical Data Records

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Abstract

We present preliminary results from the calibration and validation of reprocessed TOPEX Geophysical Data Records (GDRs). These products have been generated in 2018 through a collaborative effort between JPL and CNES. They adopt new approaches to retracking the TOPEX altimeter Ku- and C-band waveform data, the most recent ITRF2014-based precise orbit determination solutions from the Goddard Space Flight Center, a recent regeneration of the TOPEX Microwave Radiometer enhanced path delay product, sea state bias models derived from the retracked altimeter data, and the most recent GDR-E-based standards for geophysical corrections. We highlight differences between ground retracking of waveforms being performed for this reprocessed TOPEX data product and the original TOPEX GDR. The overall impact on accuracy is evaluated using comparisons with the Jason-1 GDR-E data record during the tandem period when TOPEX/POSEIDON and Jason-1 were flying approximately one minute apart.

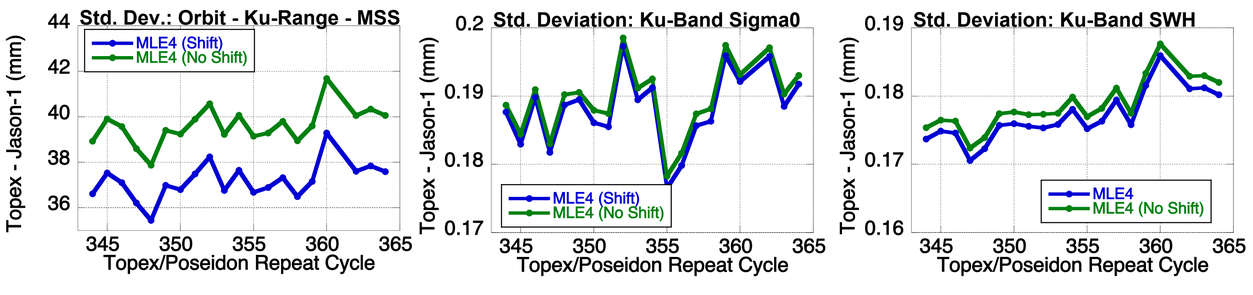
Introduction

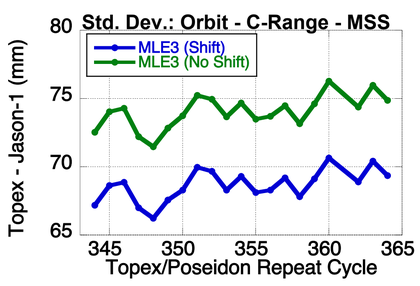
- **Joint effort between JPL and CNES to generate end-of-mission TOPEX/POSEIDON Geophysical Data Records (GDRs).**
- Ground retracking of TOPEX (side-A and side-B) and POSEIDON waveforms.
- Adopt end-of-mission calibration of TOPEX Microwave Radiometer (Brown et al., 2007) (Includes coastal path delay algorithm).
- Use ITRF2014 DORIS+SLR precise orbit determination solutions from Goddard Space Flight Center (Lemoine et al., 2017)
- Adopt current standards for geophysical corrections and models.

Three Retracking Approaches for TOPEX Waveforms Compared to Original GDRs.

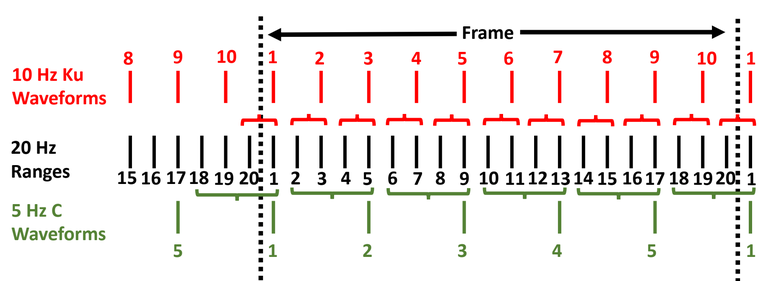
Name	Description
MLE4	• Numerical retracking: **Ku-band only.** • Estimate epoch (range), SWH, power (sigma0), and square of mispointing angle for 10 Hz waveforms. • Uses Average Point Target Response during T/P-Jason-1 tandem phase.
MLE3	• Numerical retracking: **Ku- and C-band.** • Estimate epoch (range), SWH, and power (sigma0) for 10 Hz Ku-band and 5 Hz C-band waveforms. • Uses Average Point Target Response during T/P-Jason-1 tandem phase.
GAUSS	• Gaussian retracking (E. Rodriguez, used since ~2004.): **Ku- and C-band** • Estimates epoch (range) from 10 Hz Ku-band and 5 Hz C-band waveforms, SWH, amplitude, square of mispointing angle over 1 Hz. • Uses set of Gaussians fitted to Point Target Response. • One Point Target Response per repeat cycle.
GDR	• Onboard tracking as provided on original GDR and MGDR data products. • Derived from 20 Hz **Ku- and C- band** ranges provided on Topex science data record product (without ground retracking), SWH and sigma0 from GDR.

Alignment of Waveforms in Data Frames

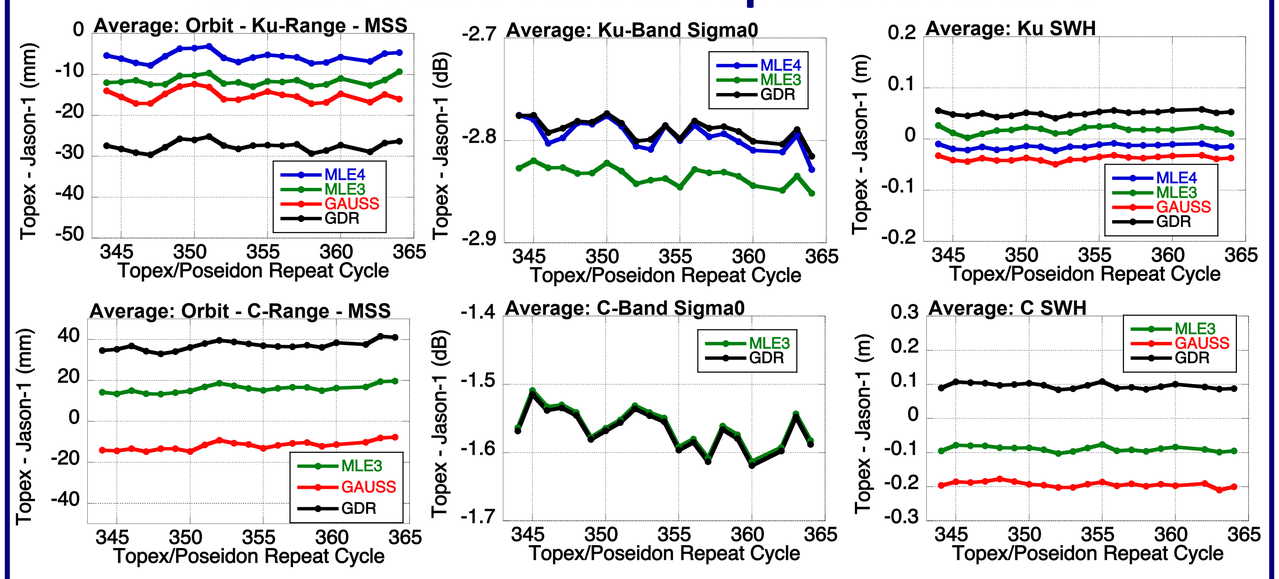




- Each Topex data frame reports:
  - 10 Hz Ku-band and 5 Hz C-band waveforms.
  - 20 Hz Ku- and C-band ranges and AGC.
- **Best consistency (lowest std. dev.) with Jason-1 data when first waveform in frame is aligned (i.e. "Shift"ed) to first reported 20 Hz Ku (C) range/AGC from current frame and last 1 (3) from prior frame.**
  - Time tag assigned to data is from each frame.
  - Alignment applied here to MLE4 and MLE3 only.

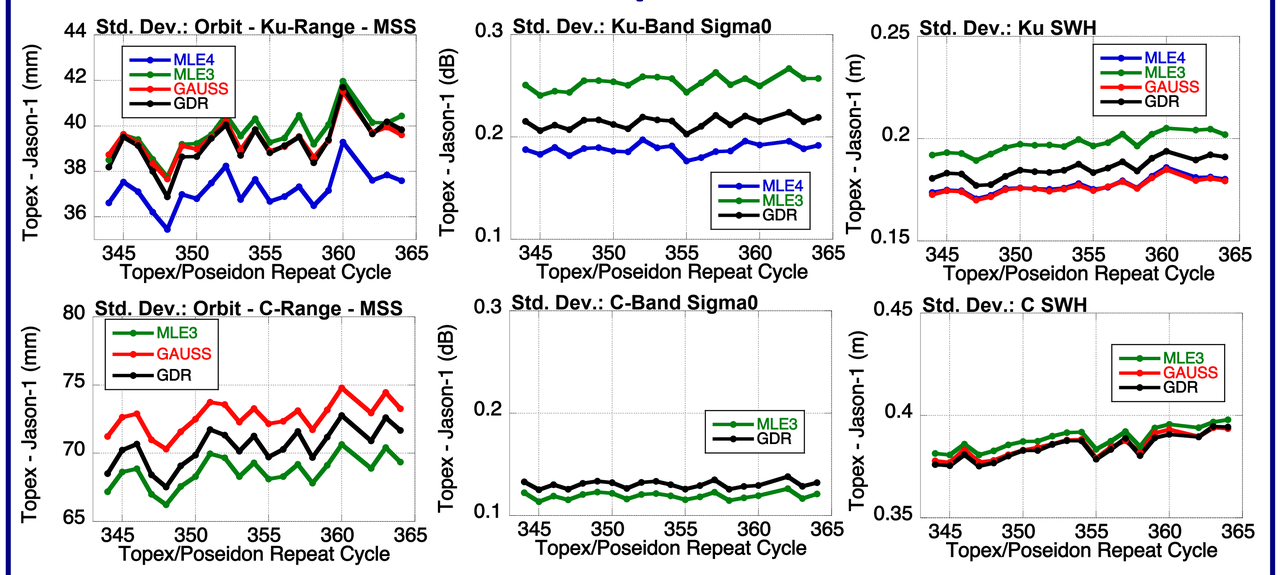


Relative Bias Between Topex and Jason-1



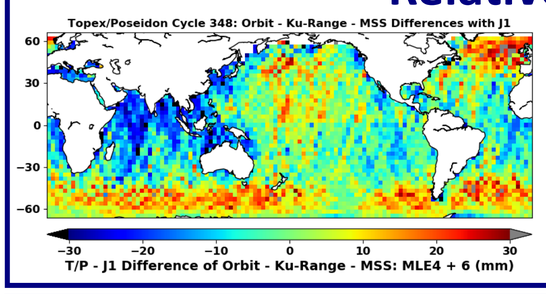
- Similar temporal variations from all four options.
- Smallest relative Ku-band range bias with MLE4 retracking (-6 mm).
- MLE4 Sigma0 intentionally "calibrated" to GDR Sigma0 at cycle 344.
  - No sigma0 generated by GAUSS retracking.
- Smallest relative Ku-band SWH bias from MLE4 retracking (-1.5 cm)

Standard Deviation of Topex – Jason-1 Differences



- MLE4 provides best consistency with Jason-1 for Ku-band range and sigma0.
  - MLE4 and GAUSS perform similarly for SWH.
- MLE3 provides best consistency with Jason-1 in C-band range and sigma0.
  - Slightly worst in C-band SWH.
- MLE3 and MLE4 benefit from waveform alignment (shift).

Relative Sea State Bias



- Relative sea state bias apparent in Topex/Jason-1 range differences.
  - Remaining dependence on wave conditions.
  - Larger than any remaining orbit error.

Conclusion

- Retracking of TOPEX waveforms demonstrates promise for improvement to TOPEX data record.
- Proper alignment of waveforms in frame with reported ranges has significant impact on Ku- and C-band ranges in particular.
  - GAUSS retracking likely to benefit from similar alignment.