Global Calibration and Validation of the Jason-2 GDR-D Products

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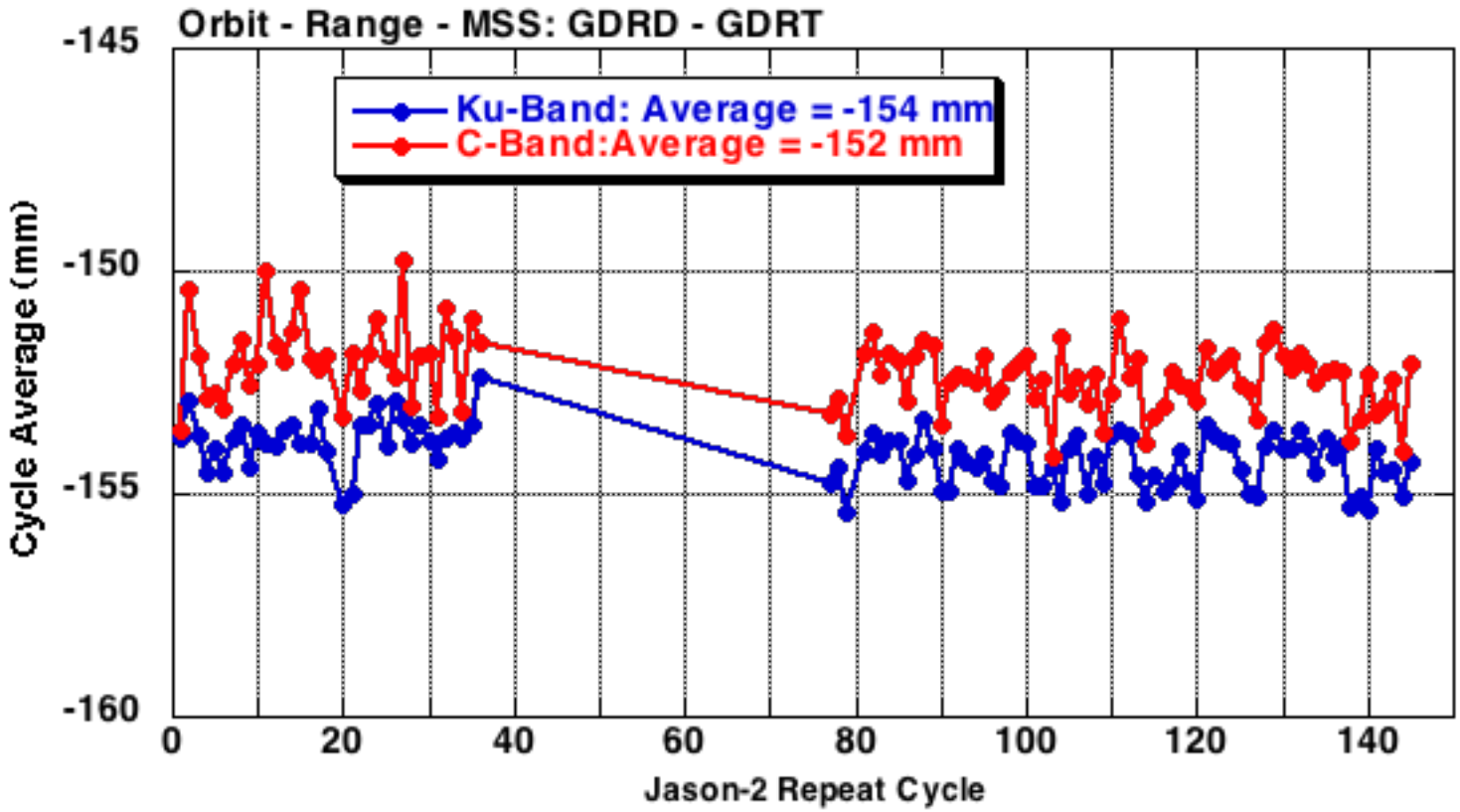
Introduction

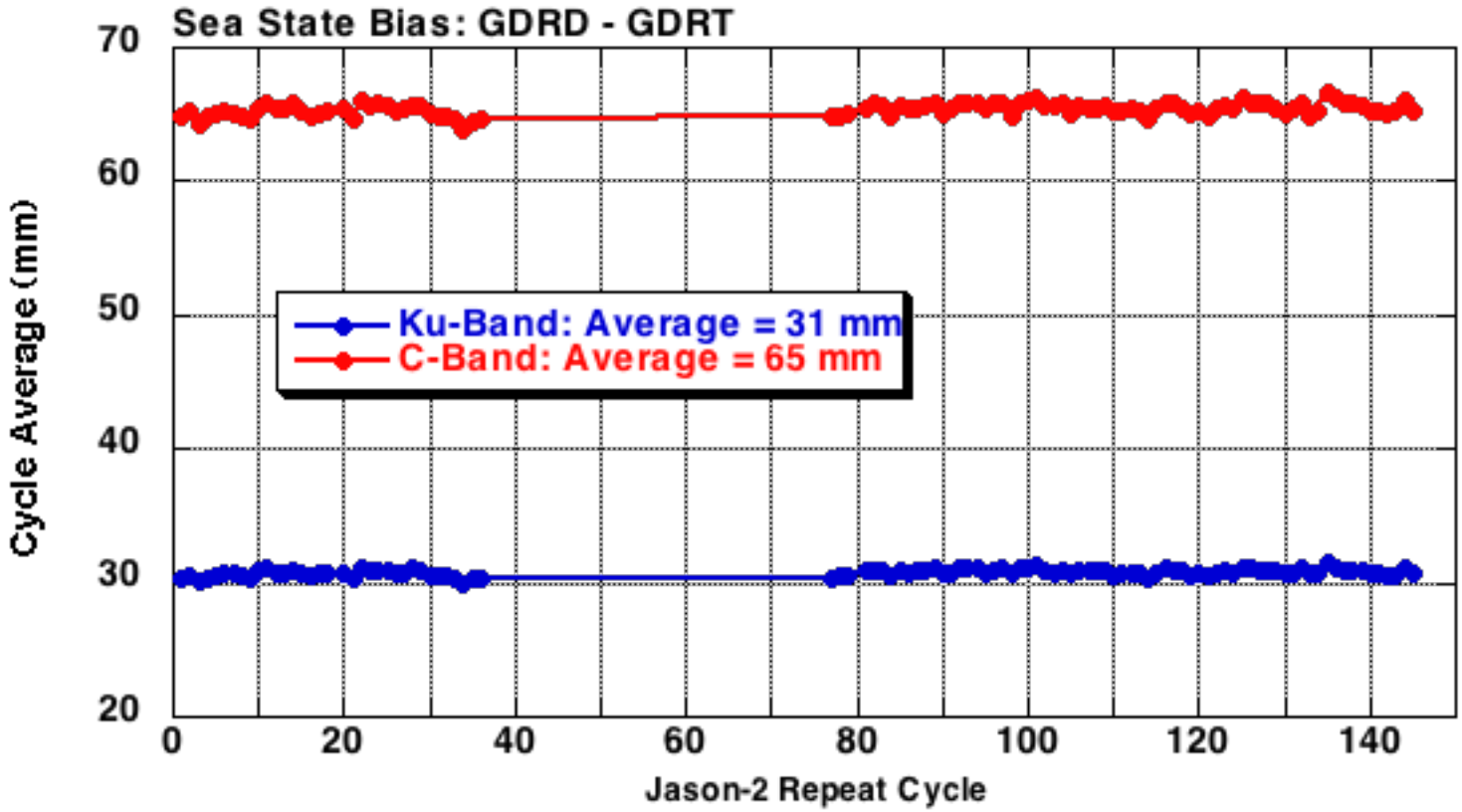
- Comparisons between version “D” and “T” Jason-2 GDR products.
  - What changed?
- Comparisons between MLE-4 and MLE-3 altimeter parameters on GDRD.
- Emphasis on sea surface height component measurements.
  - Characterize temporal and spatial differences.
  - Consider 103 repeat cycles, 1-18, 20-36, 77-79, 81-145.
  - Use sea surface height crossover differences to evaluate relative accuracy.

Orbit – Range – MSS Differences: GDRD - GDRT



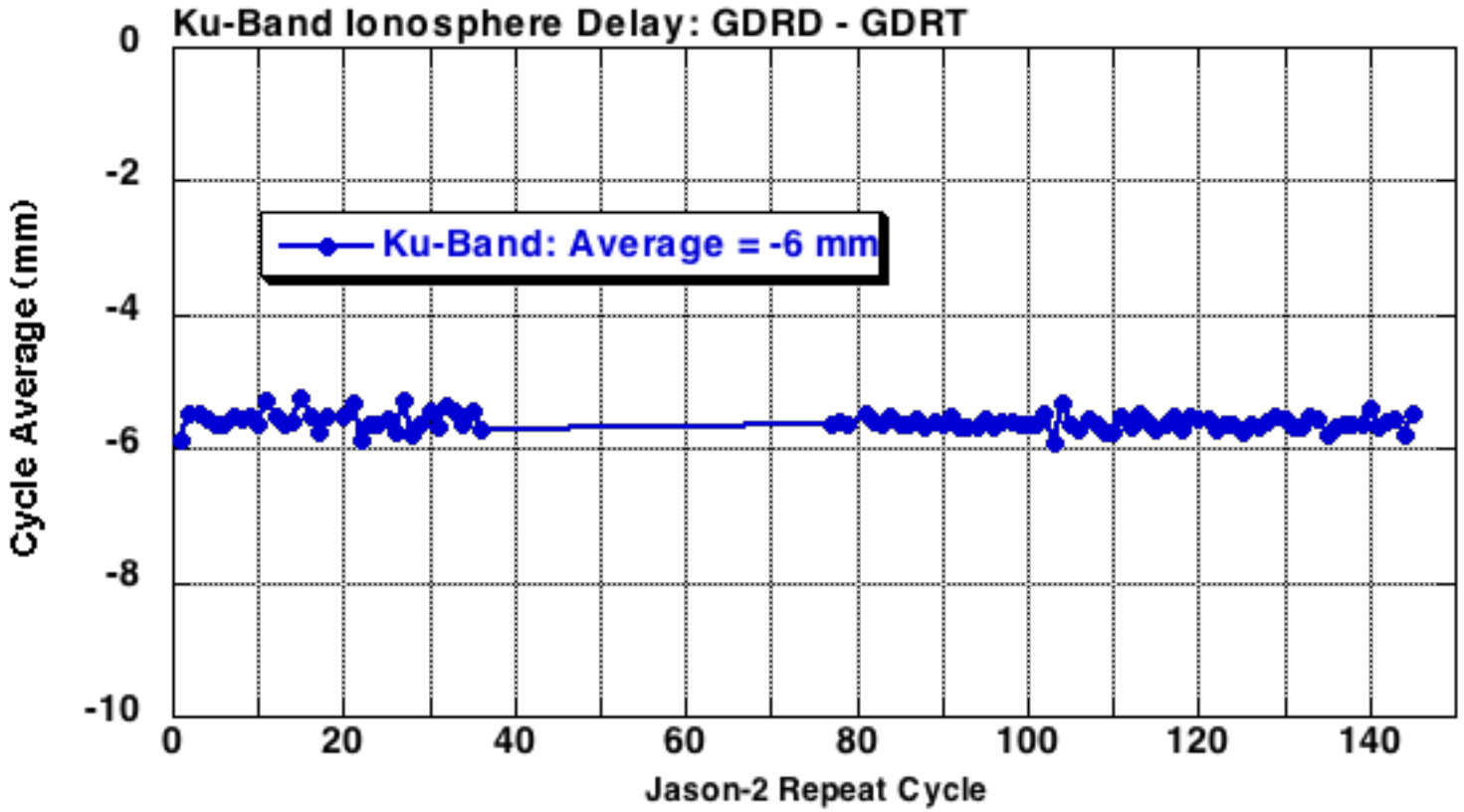
- GDRD applies corrections that lengthen range by ~156 mm:
  - Antenna reference point (Desjonquères): Lengthen range by 181 mm.
  - Truncation of Pulse Repetition Frequency (CNES): Shorten range by 25 mm

Sea State Bias Differences: GDRD - GDRT



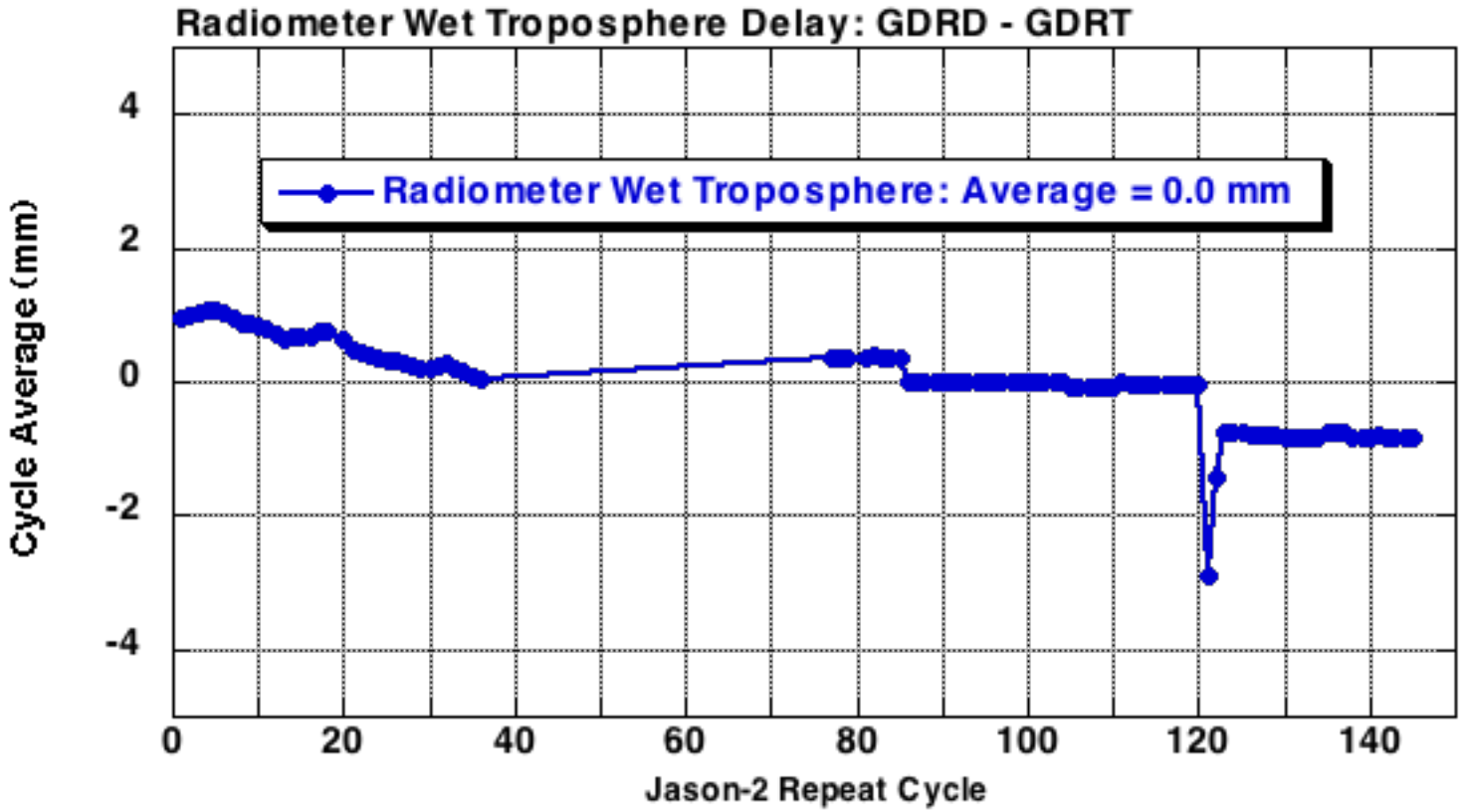
- Sea state bias model derived from GDRD altimeter data (N. Tran).
  - Using "correct" wind speeds after 0.32 dB calibration bias applied to sigma0.
    - Calibration bias to level to Jason-1 sigma0 for optimal use of Jason-1 wind speed model.
    - GDRD-GDRT Sigma0 = -0.15dB. (Jason-2 GDRT-Jason-1 Sigma0 = -0.16 dB).
  - GDRT used SSB model derived from Jason-1 data.

Ku-Band Dual Frequency Ionosphere Delay: GDRD - GDRT



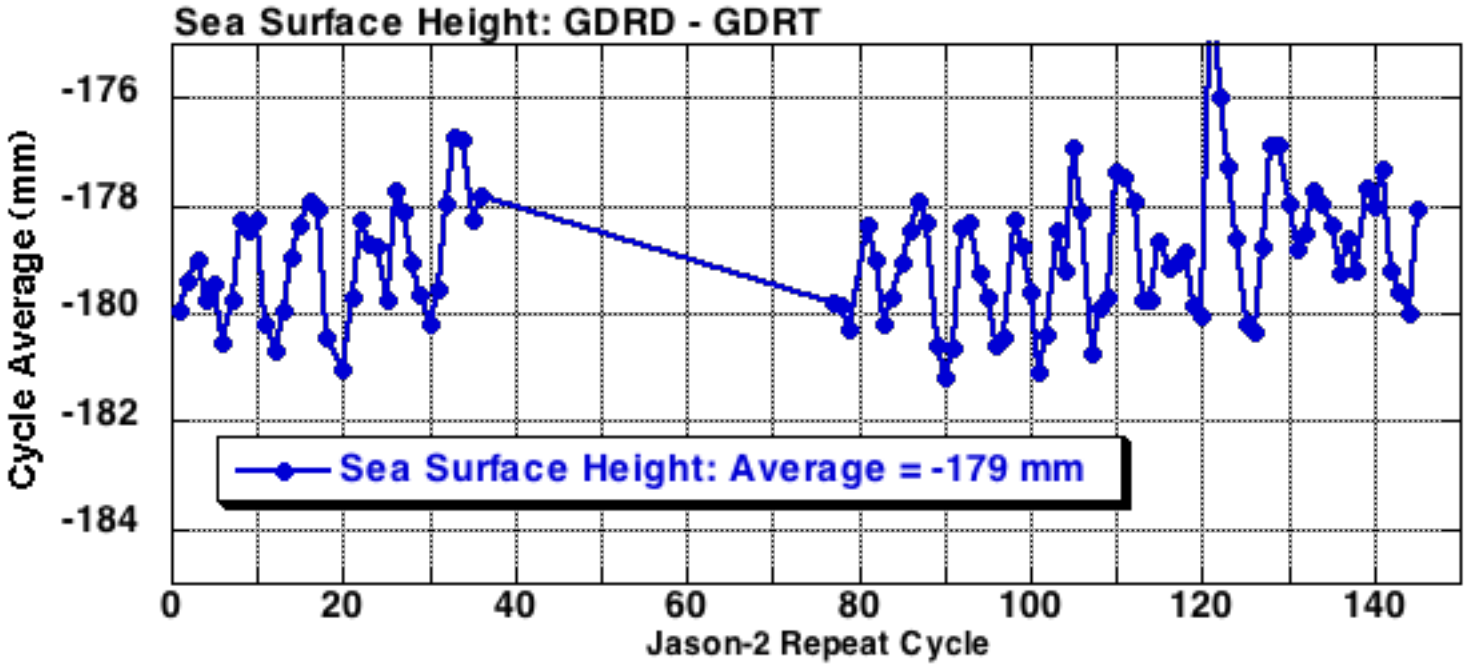
- Bias results from relative biases in Sea State Bias models.
  - Ku-Band Iono = $0.1798*[(R_{Ku}+SSB_{Ku}) - (R_C+SSB_C)]$
  - GDRD Iono. = GDRT Iono. + $0.1798*[(-154+31) - (-152+65)]$ = -6.4 mm
  - Reduces Jason2 – Jason1 ionosphere bias to +2.4 mm.
    - Jason2(GDRT)-Jason1(GDRC) = +8.8mm

Radiometer Wet Troposphere Delay: GDRD - GDRT



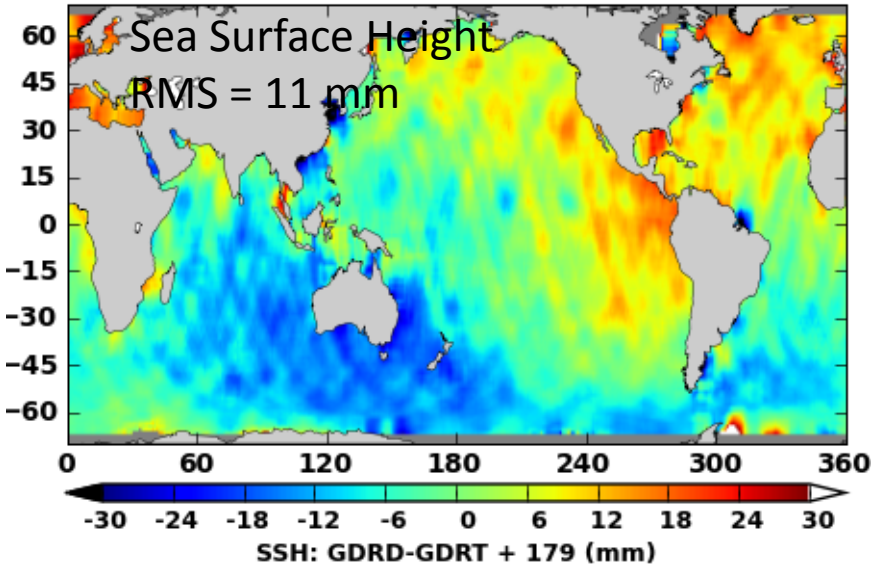
- Climate-quality recalibration for cycle 1-113 (S. Brown).
  - ARCS-quality recalibration for cycles 114-140.
- Operational calibration by "ARCS" for cycle 141 onward.
- Drift between GDRD and GDRT for cycles 1-145 = -0.4 mm/yr.

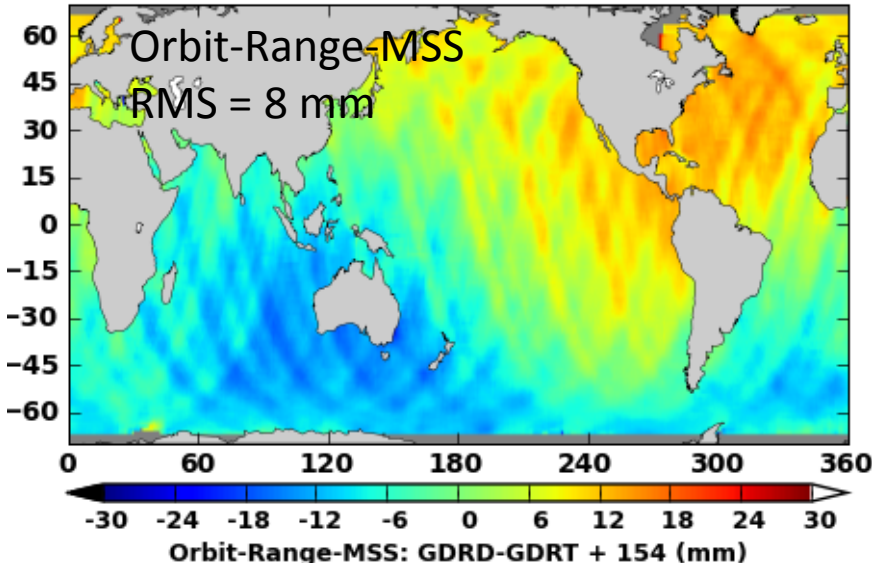
Sea Surface Height: GDRD - GDRT

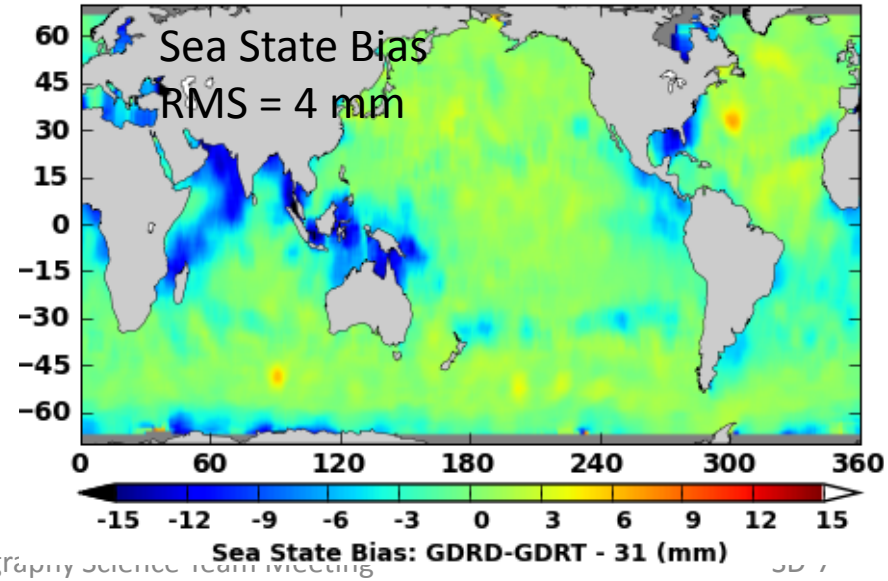


Quantity	Bias (mm)	Drift (mm/yr)
Orbit-Ku Range – MSS	-154	-0.20 +/- 0.04
-Sea State Bias	-31	-0.07 +/- 0.02
-Ionosphere	6	0.01 +/- 0.01
-Radiometer Wet Troposphere	0	0.39 +/- 0.02
-Dry Troposphere	0	0
=Sea Surface Height	**-179**	**0.13 +/- 0.09**

Geographical Differences, GDRD-GDRT: Cycle 91



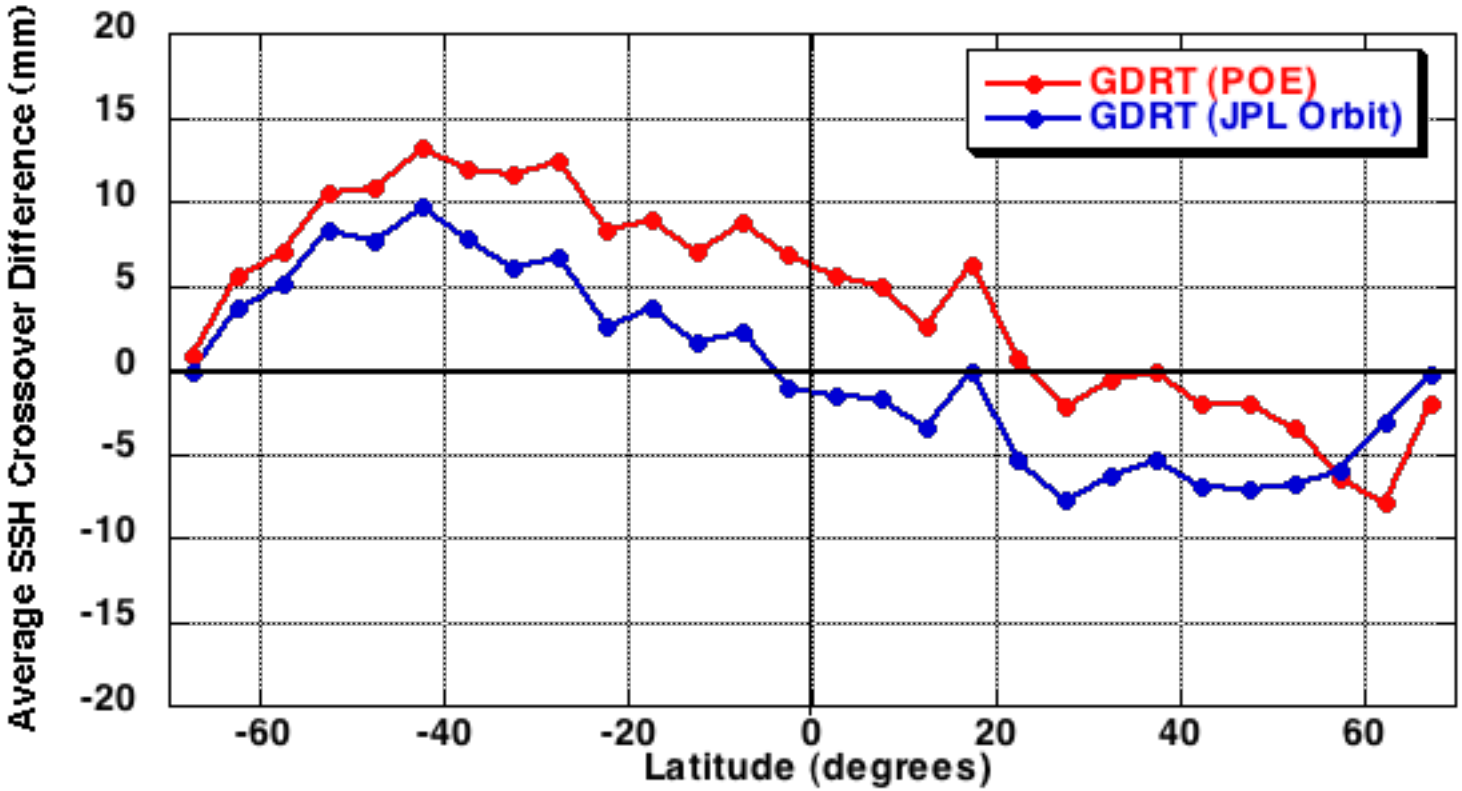




- Spatial and differences dominated by changes to POE.
  - Geographically correlated orbit error.
  - Range differences primarily biases.

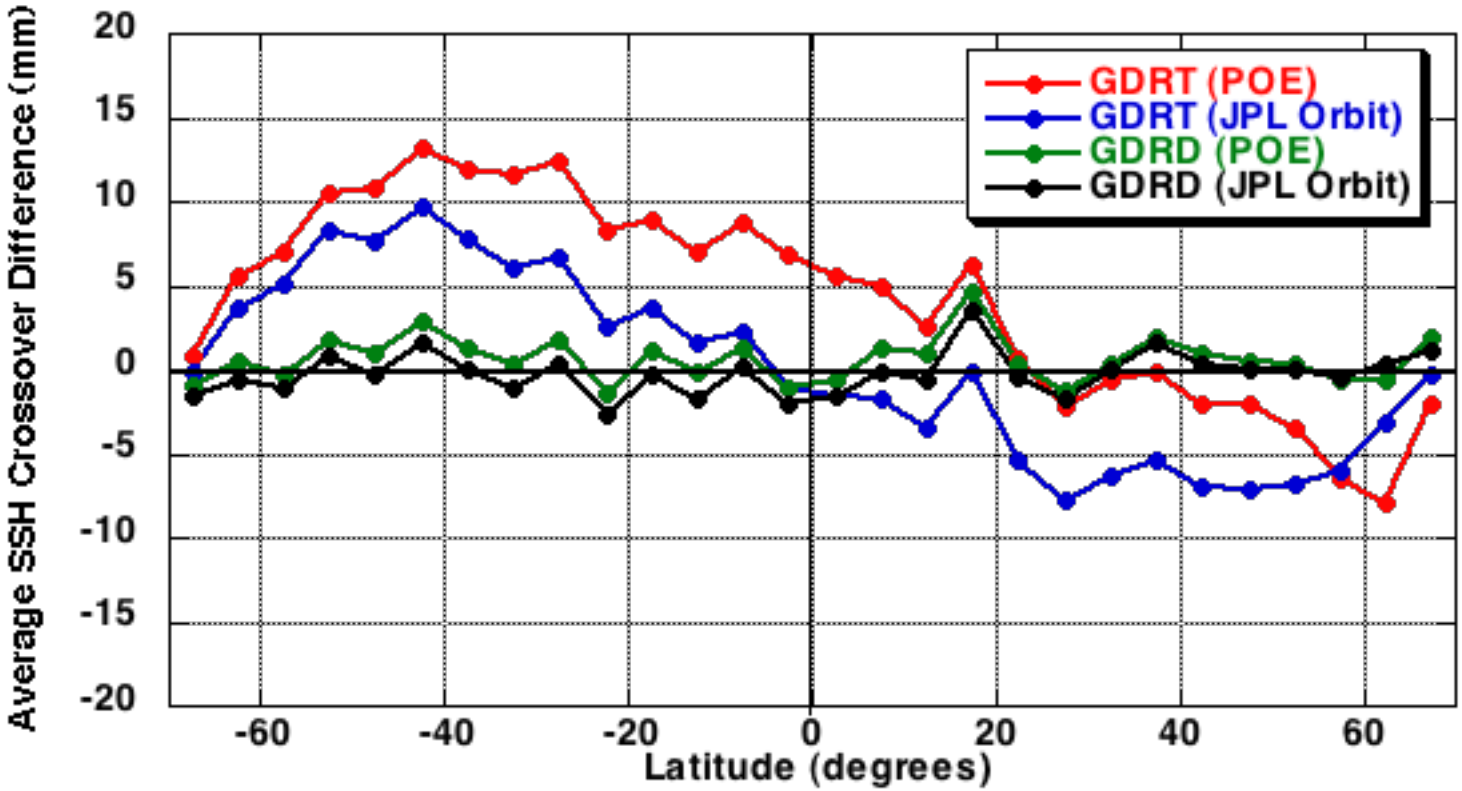
- Sea state bias differences correlated with differences in SWH.

Time Tag Bias in GDRT



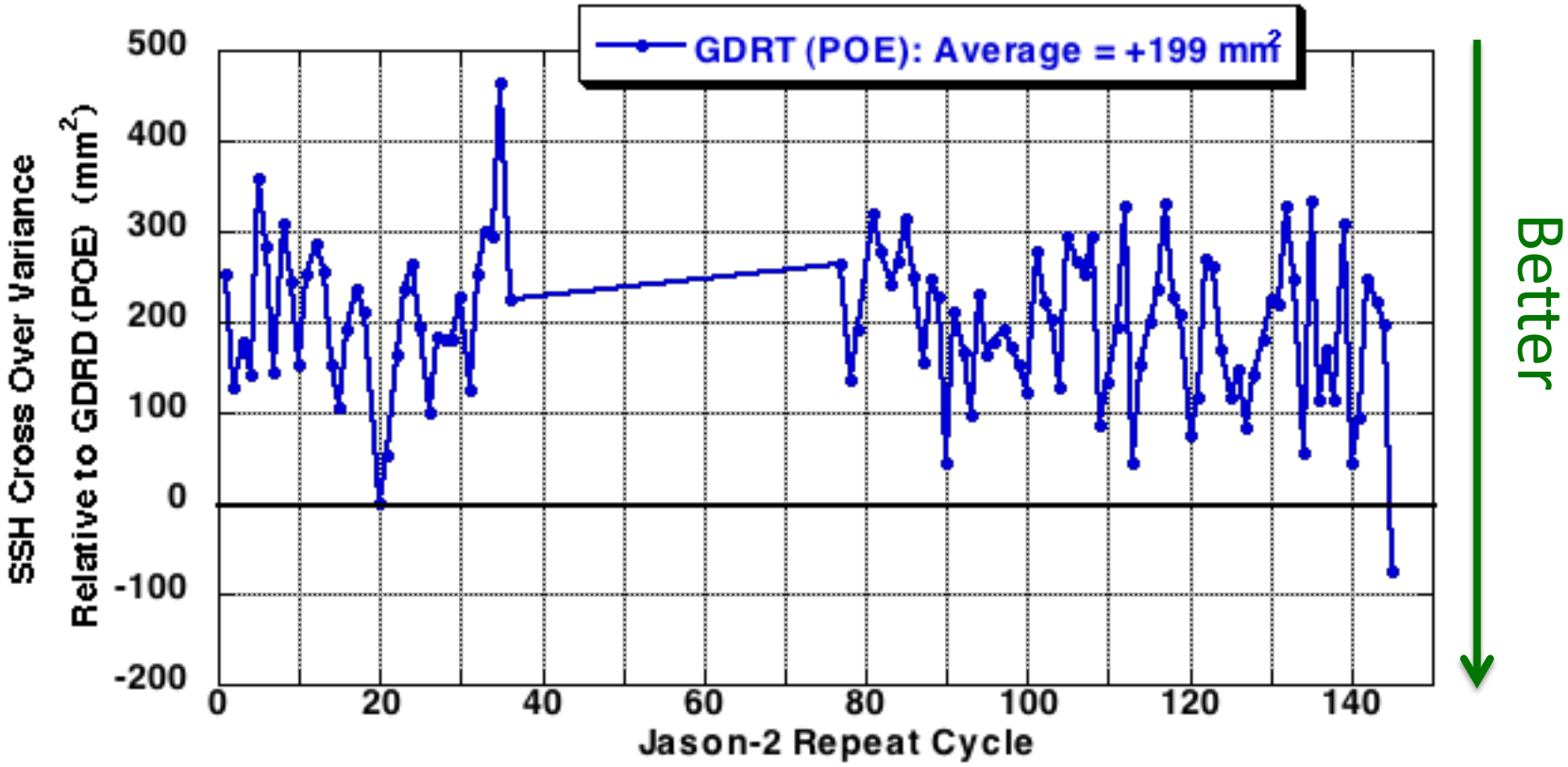
- Time tag bias in GDRT ranges (250 microsec) clearly observed when using JPL's orbit (CNES).
  - Clear hemispherical dependence in average SSH crossover differences.
  - Masked by geographically correlated orbit error in GDRT POE.

Time Tag Bias Resolved in GDRD



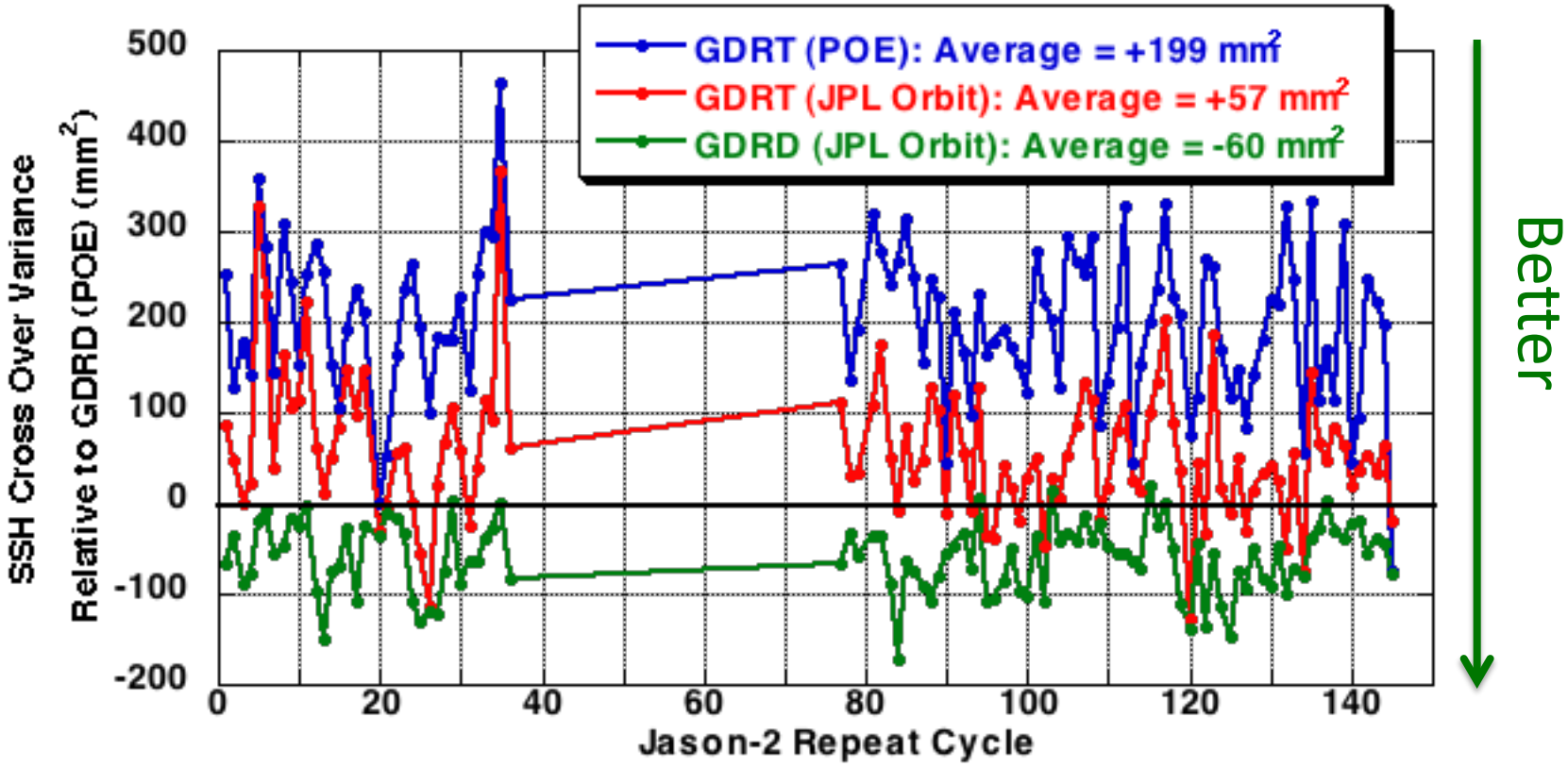
- Time tag bias explained by difference between time of emitted and received echo (CNES).
  - Also affects Jason-1 GDRC (corrected with “pseudo-datation bias”).
- Correct time tags used in GDRD.

SSH Crossover Variance: GDRT Relative to GDRD



- GDRD significantly reduces SSH crossover variance.
  - Average variance reduction = 199 mm^2.

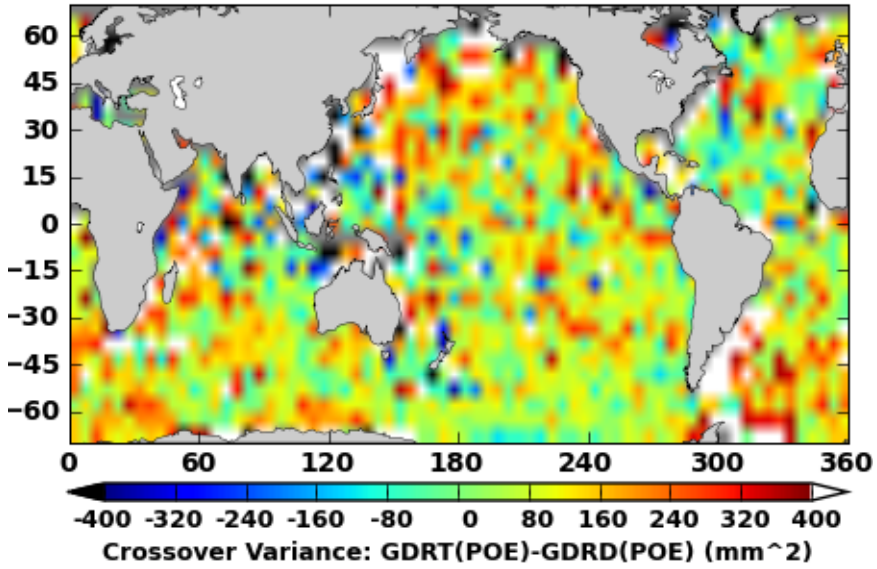
SSH Crossover Variance Relative to GDRD (POE)



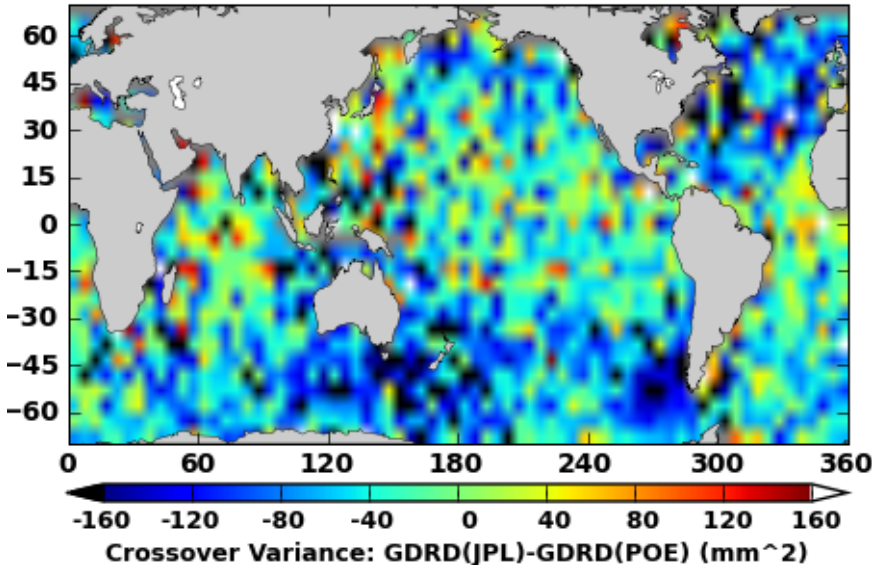
- JPL GPS Orbit provides lower crossover variance than POE (GDRT or GDRD)
  - 142 mm² lower for GDRT, and 60 mm² lower for GDRD.
  - GDRD POE has better agreement with JPL orbit, than GDRT POE.
- ~40% of variance reduction (GDRT to GDRD) from improvements to POE.

SSH Crossover Variance Relative to GDRD(POE)

GDRT(POE) – GDRD(POE)
Average = 215 mm^2



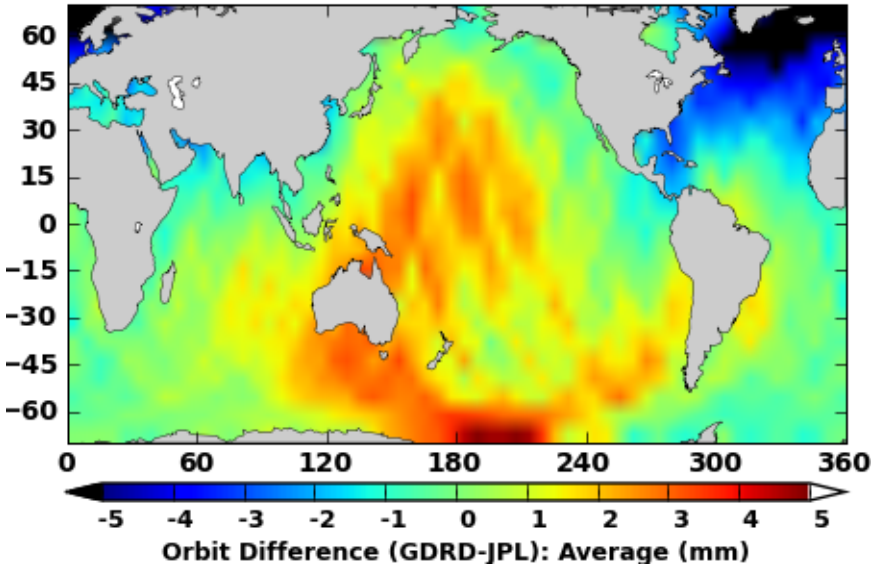
GDRD(JPL Orbit) – GDRD (POE)
Average = -45 mm^2



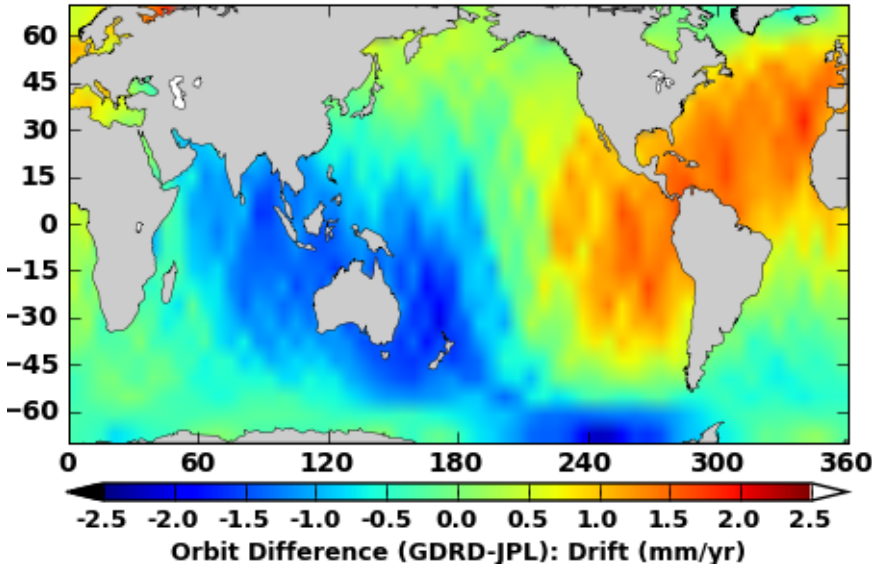
- GDRD reduces crossover variance globally.
- GDRD with JPL orbit provides additional crossover variance reduction globally.
  - Remaining orbit error in GDRD POE.

Orbit Differences: GDRD - JPL GPS

Average from 103 cycles
Mean = 0.2 mm, RMS = 1.9 mm

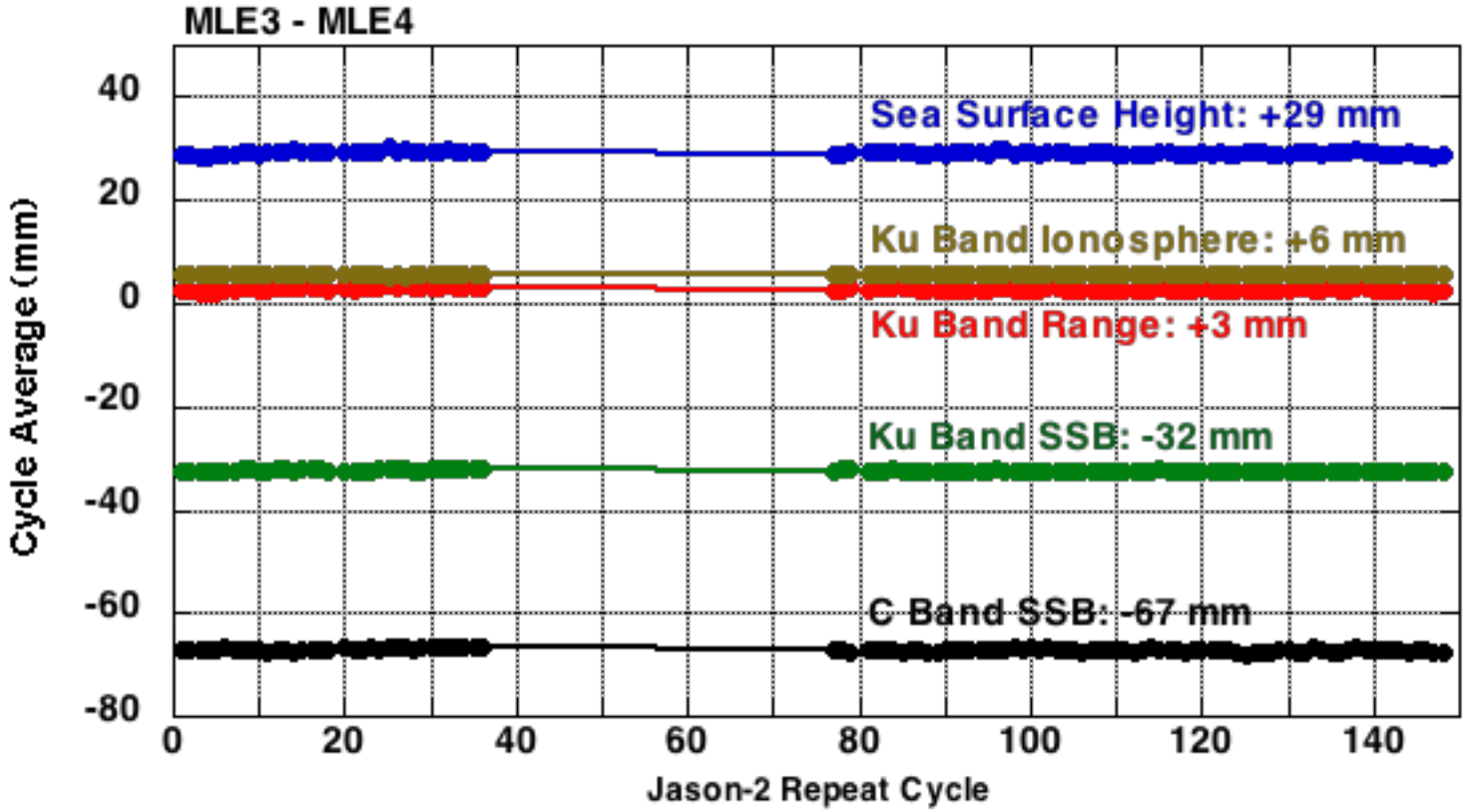


Relative Drift from 103 cycles
Mean = -0.1 mm/yr, RMS = 0.8 mm/yr



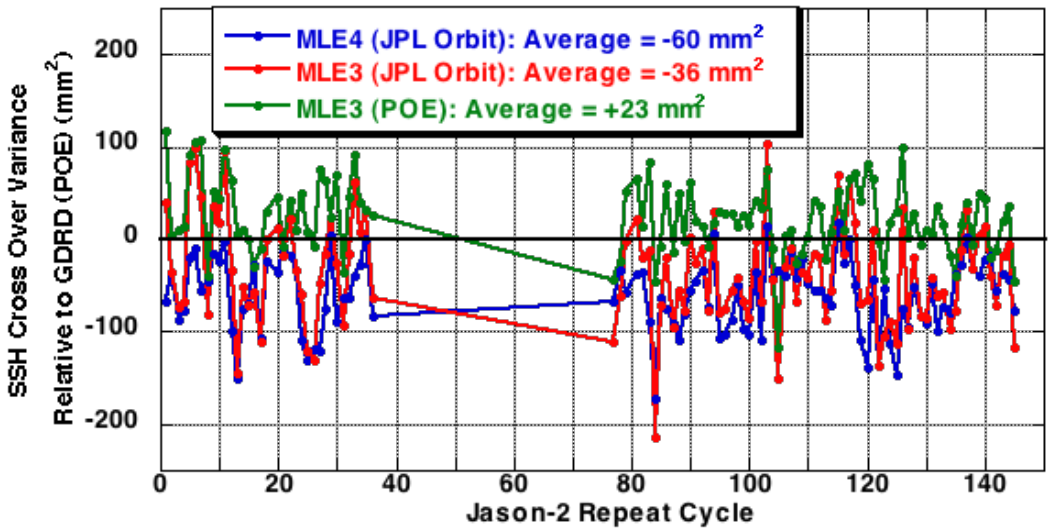
- Simultaneously fit average, drift, and annual to orbit differences between GDRD POD and JPL GPS orbit using 103 repeat cycles.
- Peak-to-peak orbit differences +/- 1 cm.
- Geographically correlated drift (+/- 2.5 mm/yr).

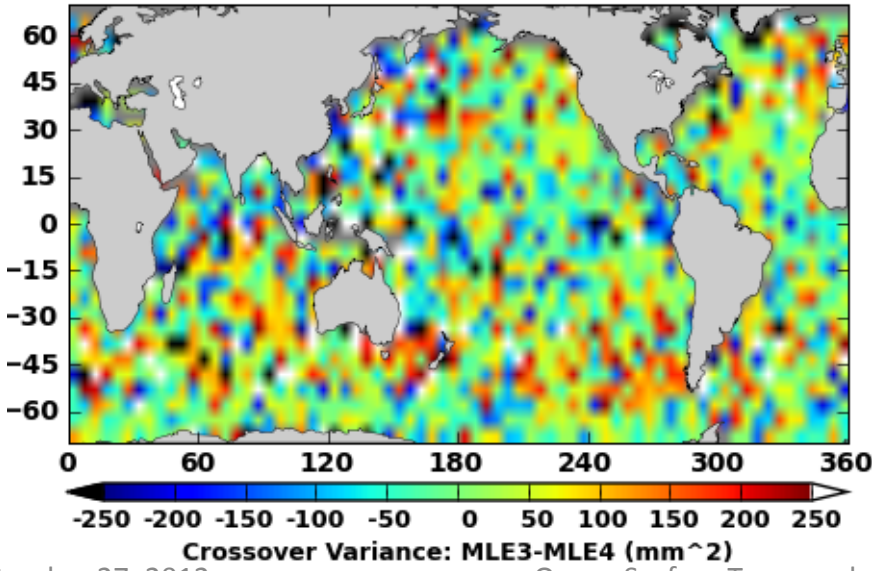
Cycle Averages of MLE3 – MLE4



- MLE-3 sea state bias models (Ku and C) appear to be at same absolute level as GDR-T MLE-4.
  - E.g. GDRD MLE3 SSB - GDRT MLE4 SSB Level ≈ 0
  - Results with MLE-3 ionosphere also being at GDR-T Level.
- SSH variability is primarily from differences in Ku-band range.
  - Standard deviation = 2 cm.

MLE-3 versus MLE4: SSH with JPL Orbit





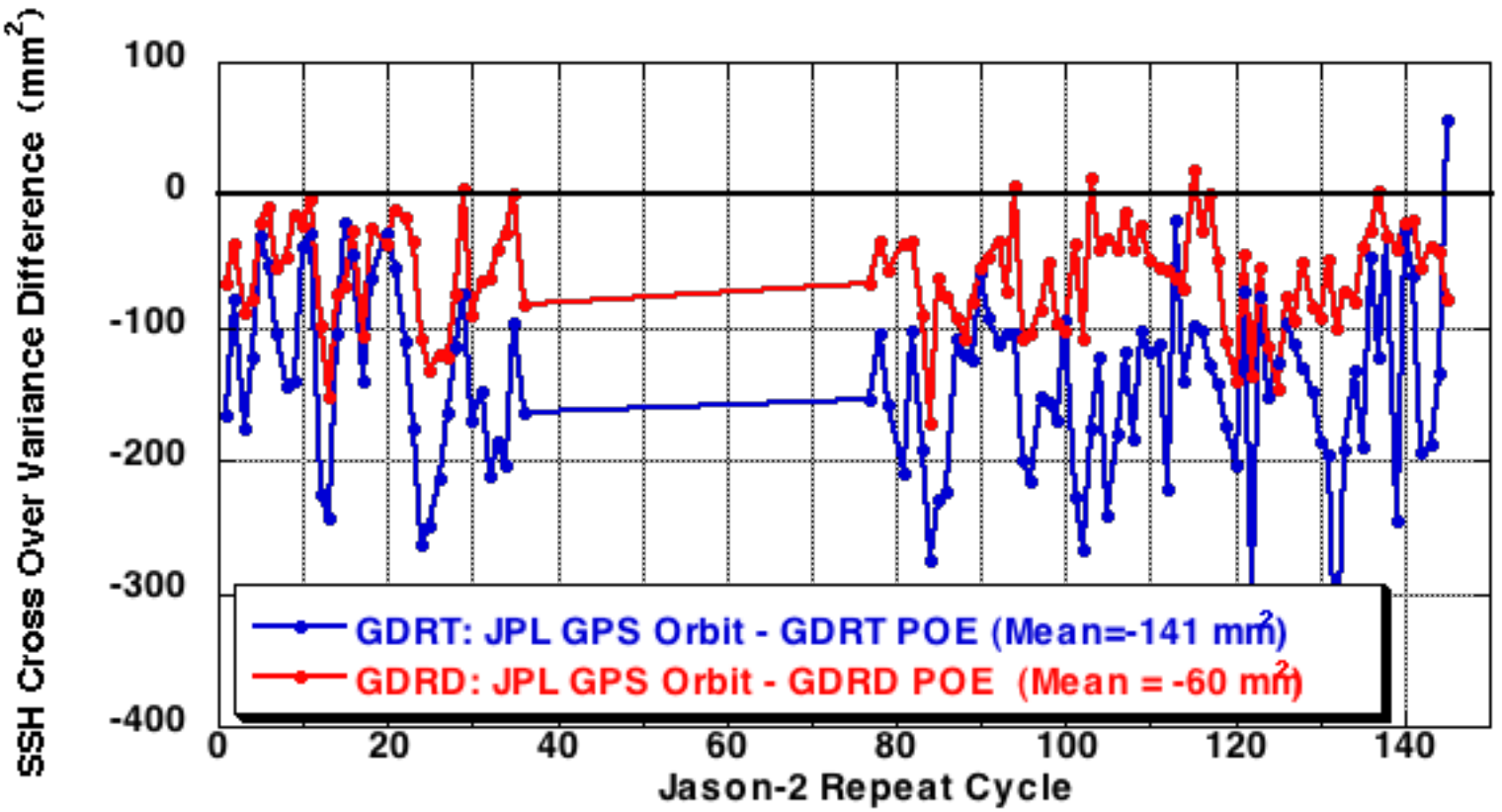
- On average:
  - MLE3 > MLE4 crossover variance. (+23 mm^2)
- JPL Orbit: MLE3 – MLE4
  - Global average: +16 mm^2

Summary

- GDRD is significant improvement over GDRT.
  - 200 mm^2 in SSH crossover variance reduction.
  - Biases in range and SSH resolved.
  - Margin for improving the POE.
    - 60 mm^2 additional SSH crossover variance reduction when using JPL GPS orbit with GDRD.
  - Geographically correlated relative drift between GDRD POE and JPL GPS orbit.
    - Global average of -0.1 mm/yr.
- On average, GDRD MLE3 data have slightly higher SSH crossover variance (16 mm^2)
  - MLE3 sea state bias models at the same absolute level of GDR-T products.
    - Causes MLE3 SSH to be biased +3 cm from MLE4 SSH.

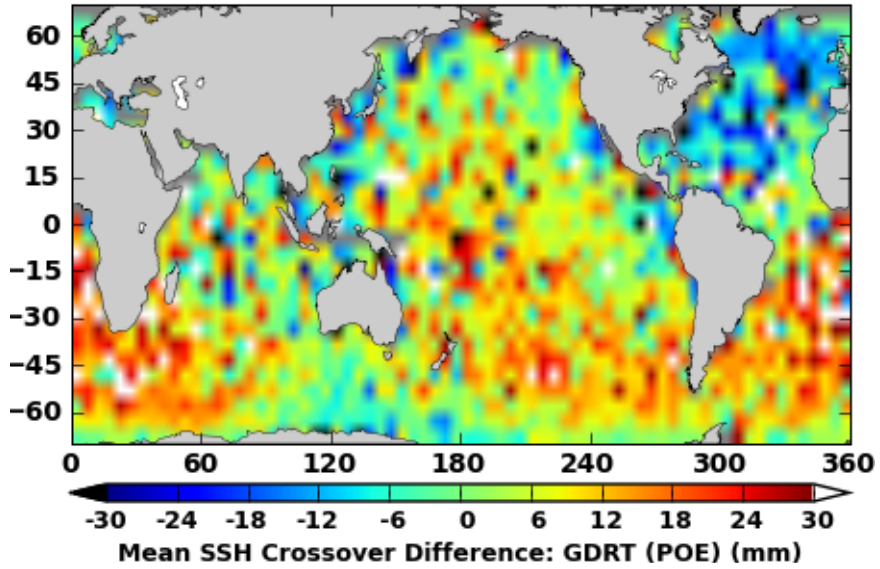
Back-Up Slides

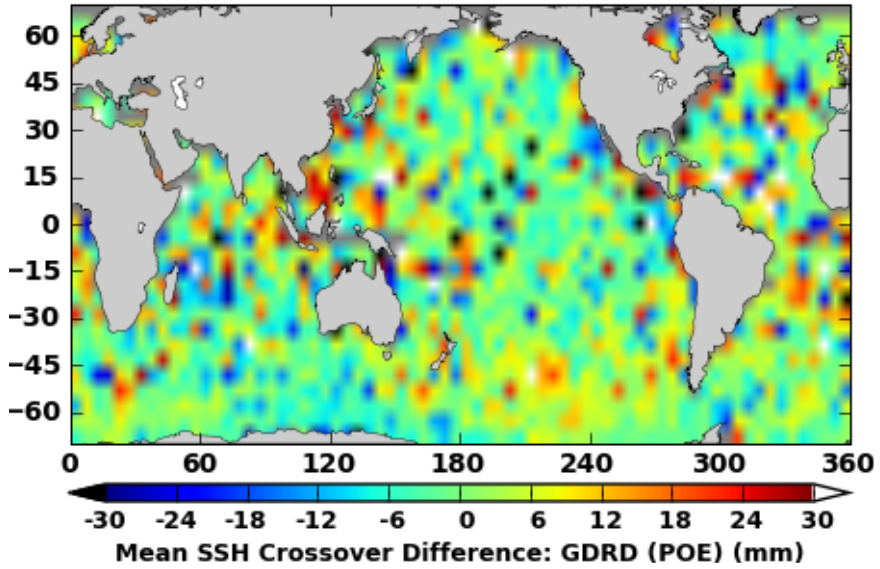
SSH Crossover Variance: POE Versus JPL Orbit

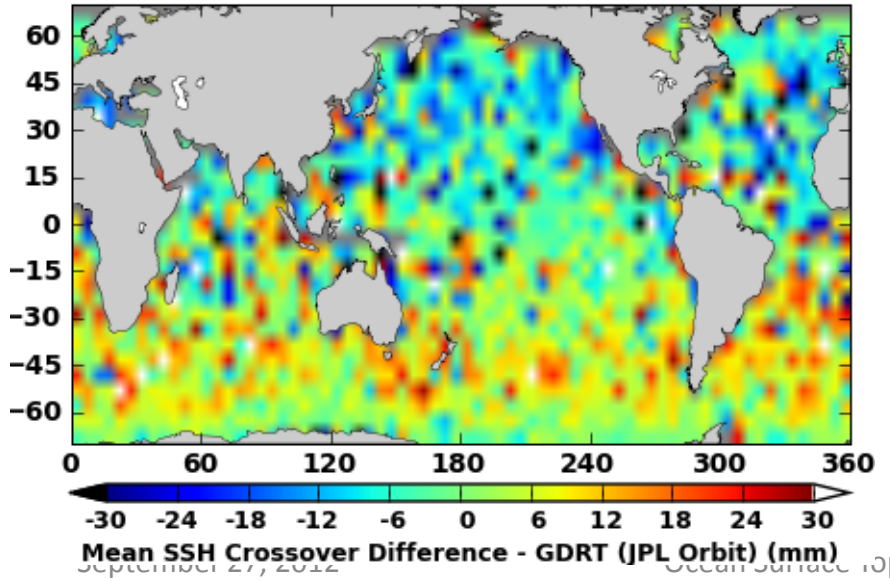


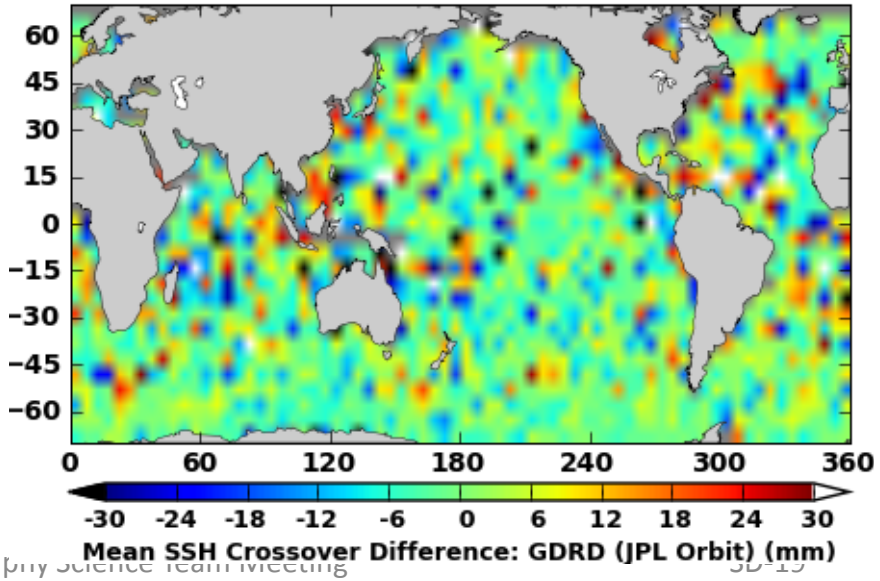
- GDRD POE agrees closer to JPL's GPS orbit.

Mean of SSH Crossovers Differences

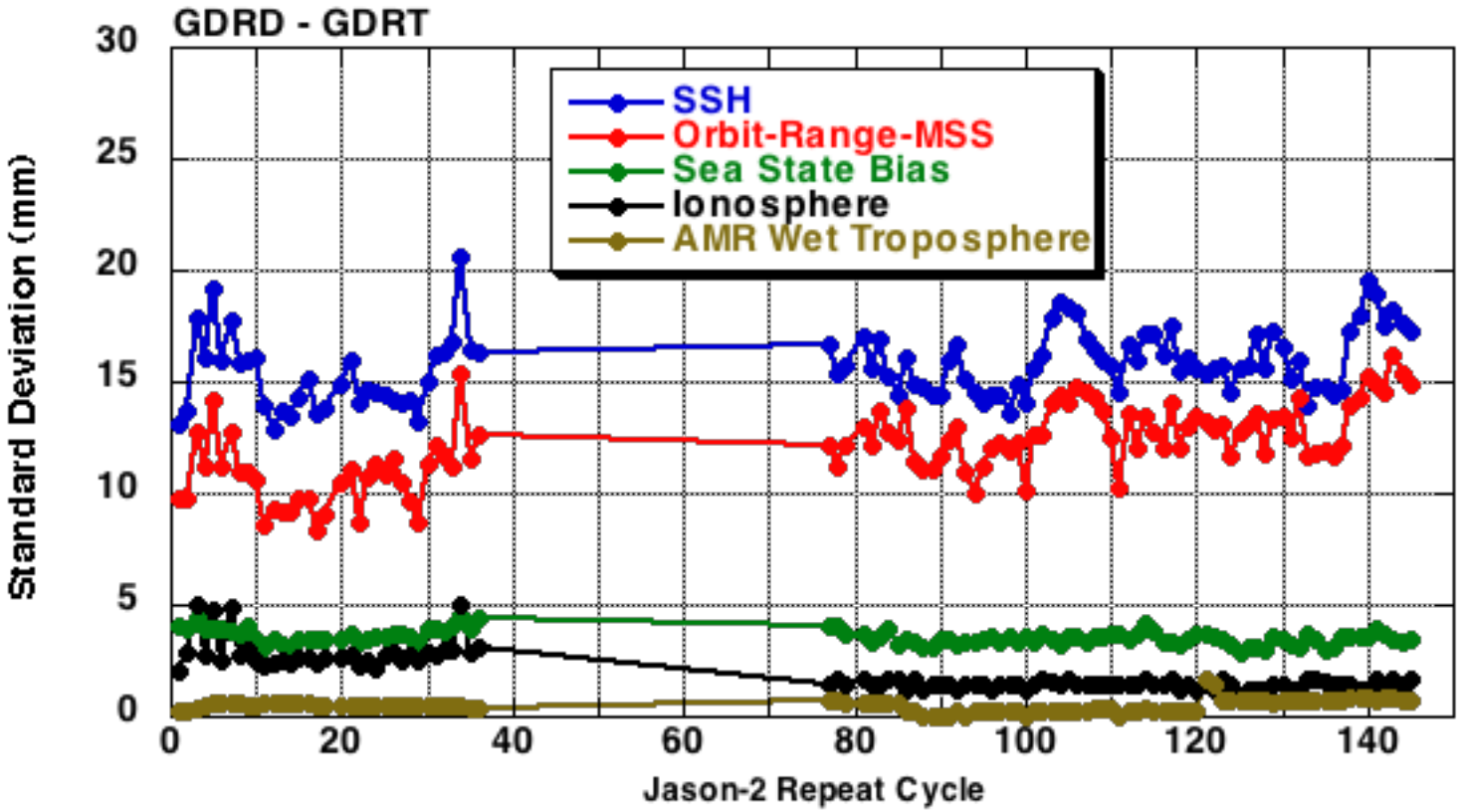






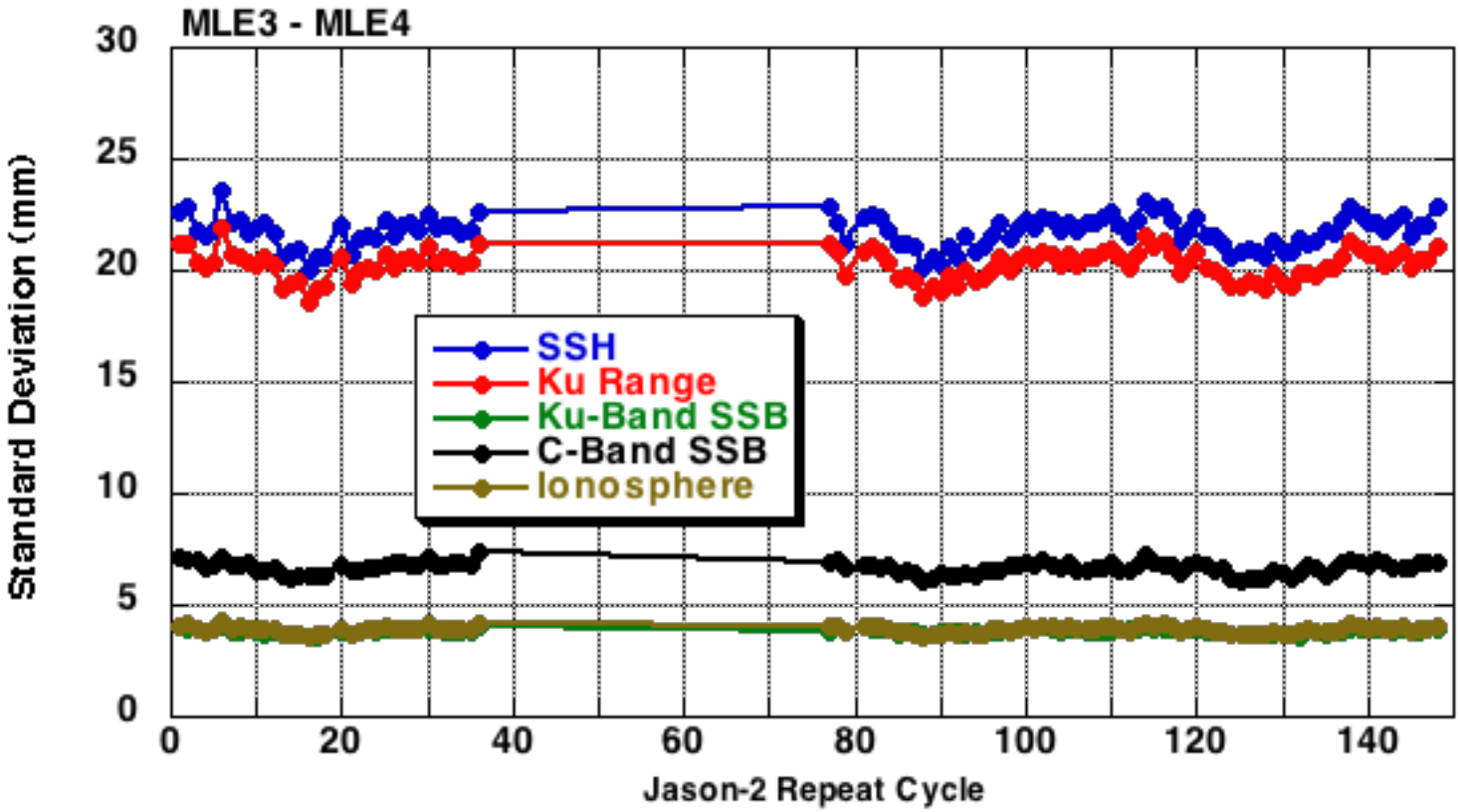


Standard Deviation of Differences: GDRD - GDRT



- Primary variability from orbit and/or range differences.
  - Range differences are primarily biases.
  - Orbit differences are larger contributor.

Standard Deviation of MLE3-MLE4



- SSH variability between MLE3 and MLE4 SSH primarily from Ku-Band range.