Global Calibration and Validation of the Jason-1 Version E GDRs

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Introduction

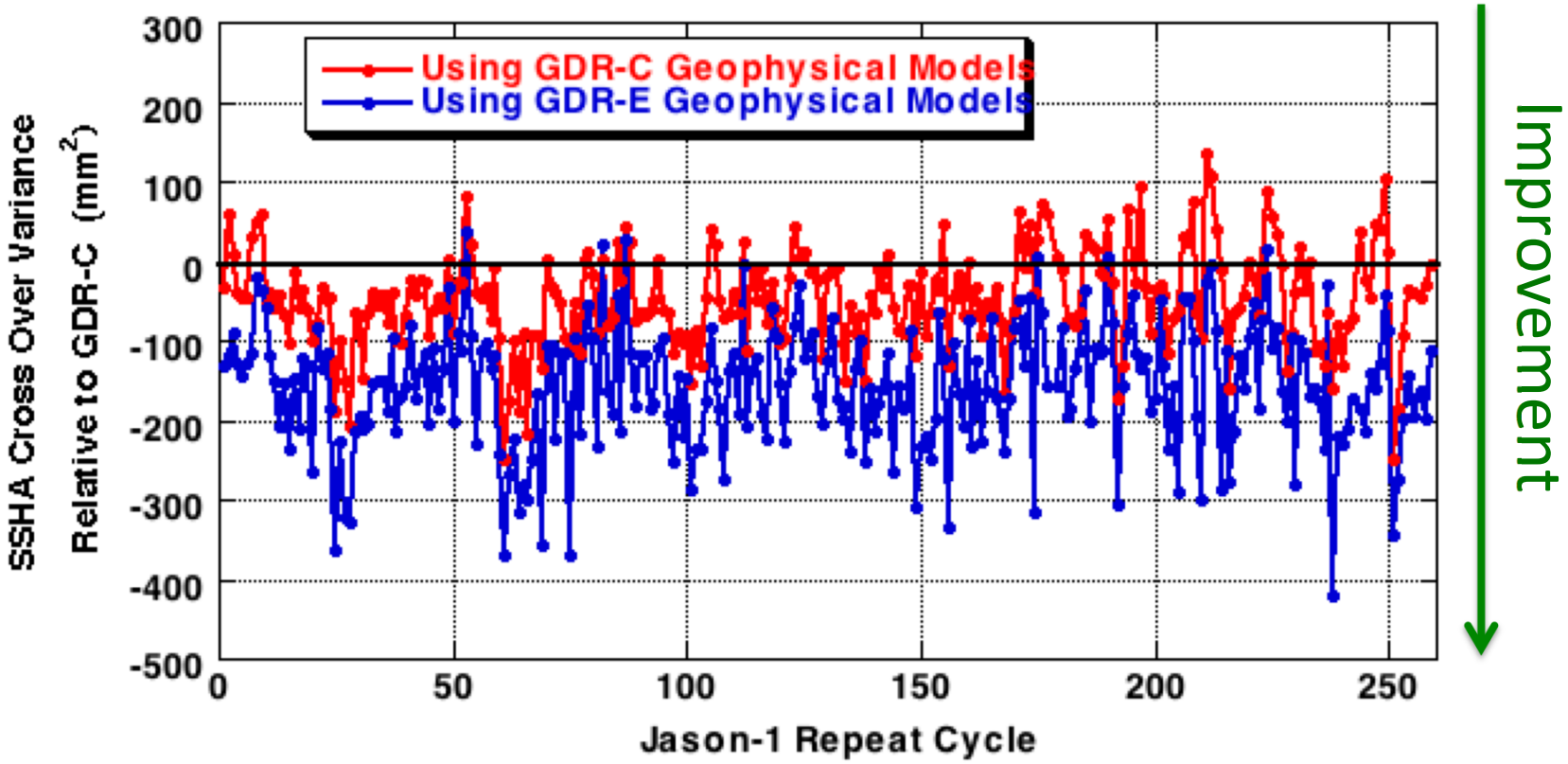
- Jason-1 Version E GDRs currently being generated by CNES and JPL.
  - GDR-E production resulted from close-up review by CNES and NASA.
  - Complementary perspectives invaluable to development and cal/val.
  - Expected completion by end of November, 2015.
  - Previous version C.
- Calibration and Validation performed for 2002-2008.
  - 2002-2004 are released.
  - 2005-2008 data are partially validated.
  - Summarize impact from changes versus GDR-C.

Version E versus Version C

Parameter	Description
Format	NetCDF instead of binary. Closely follows Jason-2 products.
Time tag	Difference between time of emitted and received echo.
Orbit	Version E POD standards
Range	+63.9 mm in Ku- and C-band to account for internal path delay.
Radiometer	Re-calibrated data with near-land algorithm applied.
Sea State Bias	Updated for Ku- and C-band (computed from GDR-C data).
Ionosphere	From updated range and sea state bias.
Met. Models.	ECMWF Re-Analysis (ERA) in addition to ECMWF operational. (Dry and wet troposphere, Inverse Barometer, High Frequency Fluctuations, Wind Speed)
Ocean Tides	Modern FES(2014) and GOT (4.8) models.
Other Models	New for MSS, MDT, Geoid

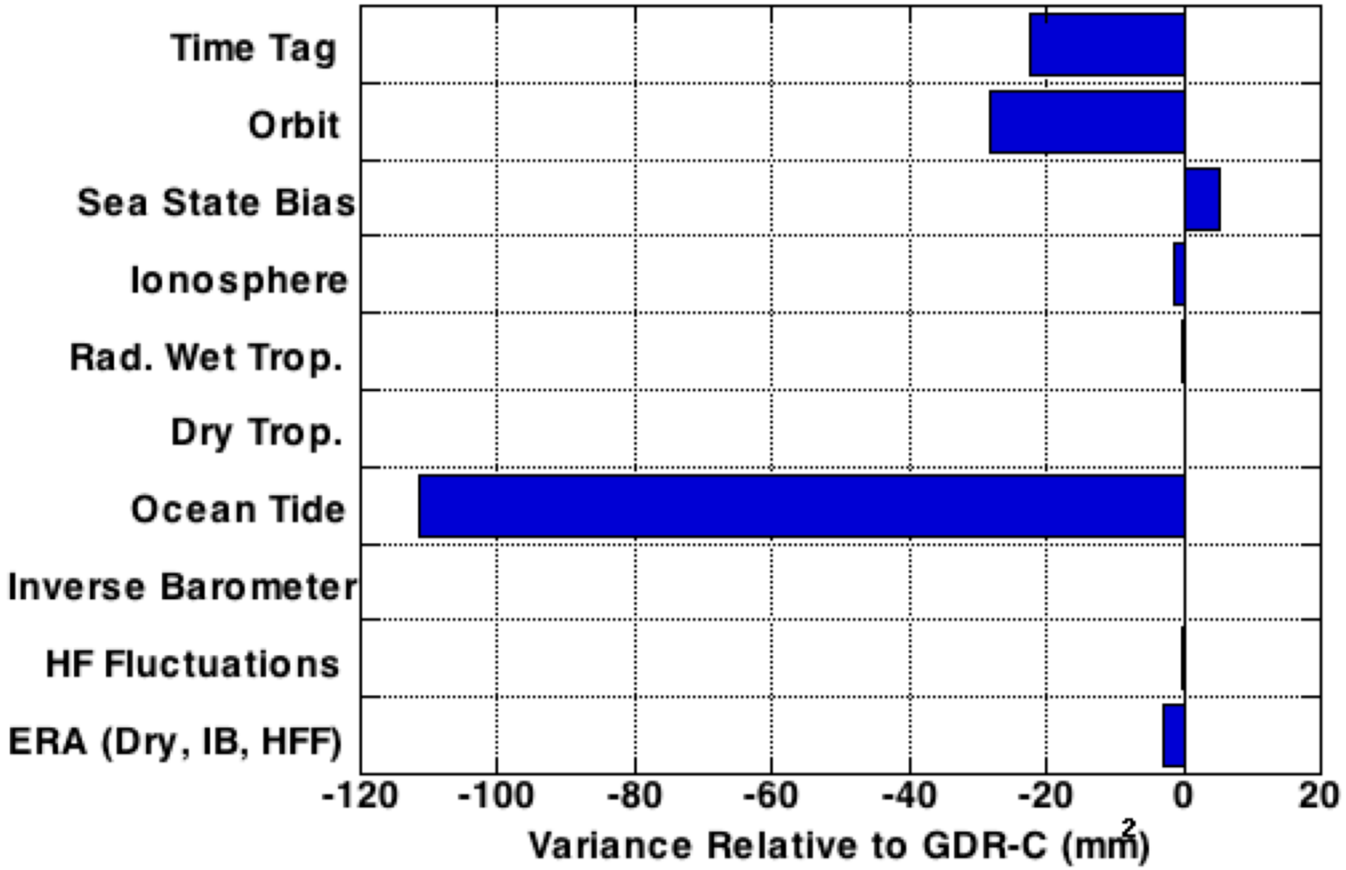
- **NOTE: Waveforms are not retracked.**
  - **Ranges are identical except for bias and time tag.**

GDR-E Improves SSHA Crossover Variance



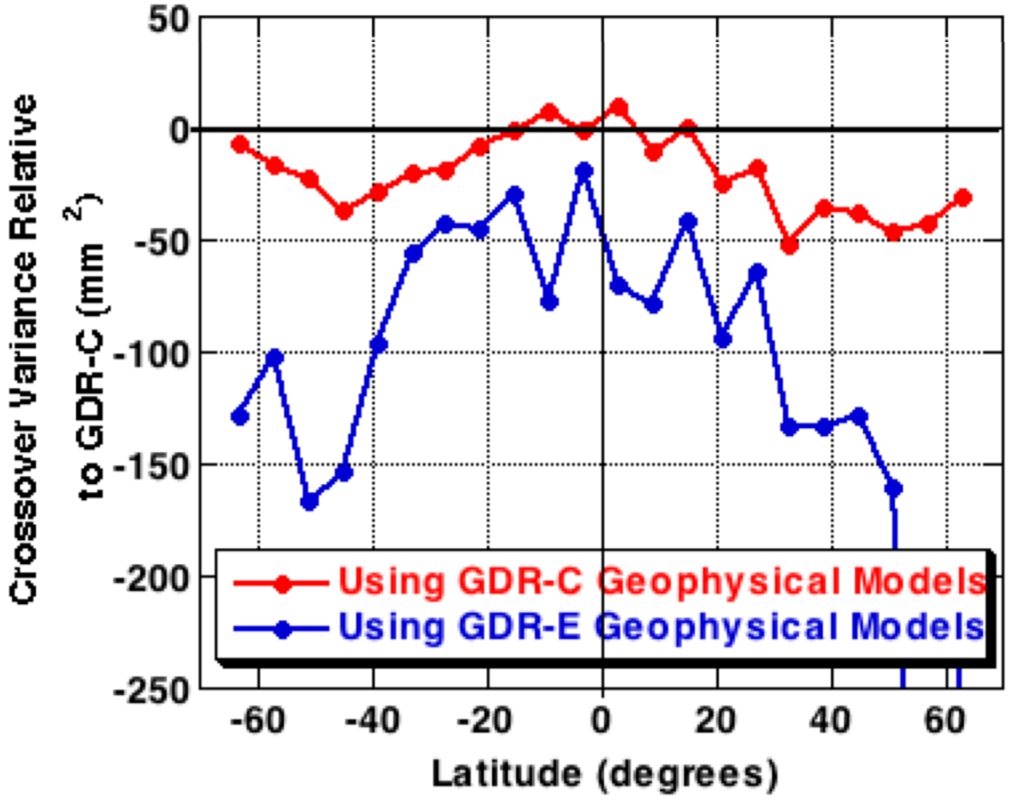
- GDR-E significantly reduces SSHA crossover variance.
  - Time tag adjustment, orbit and environmental corrections: -47 mm^2
  - Modern ocean tide models: Additional -110 mm^2
  - Total: -157 mm^2

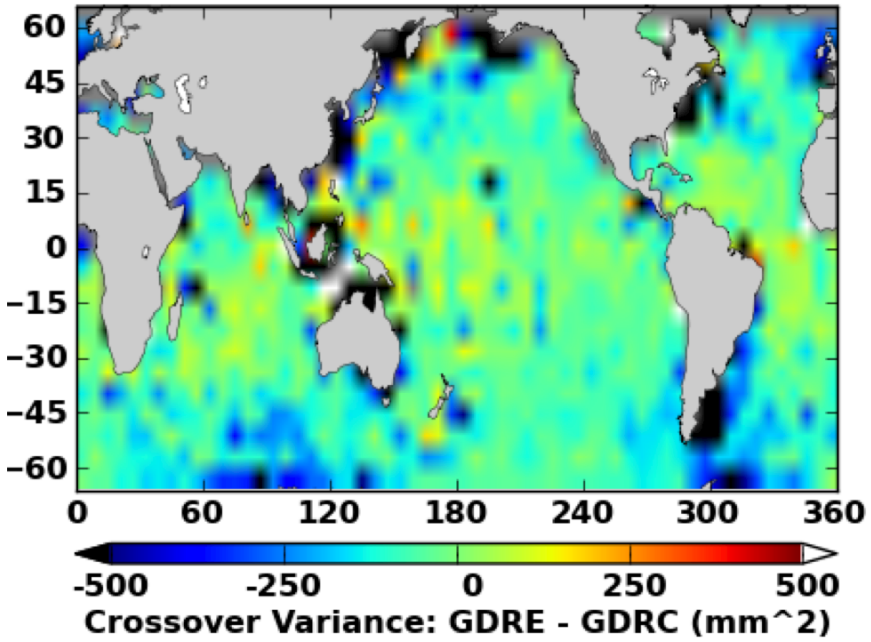
Sources of Crossover Variance Reduction



- Time tag and new orbit are primary source of SSH variance reduction.
- Modern ocean tide models are primary source of SSH Anomaly variance reduction.

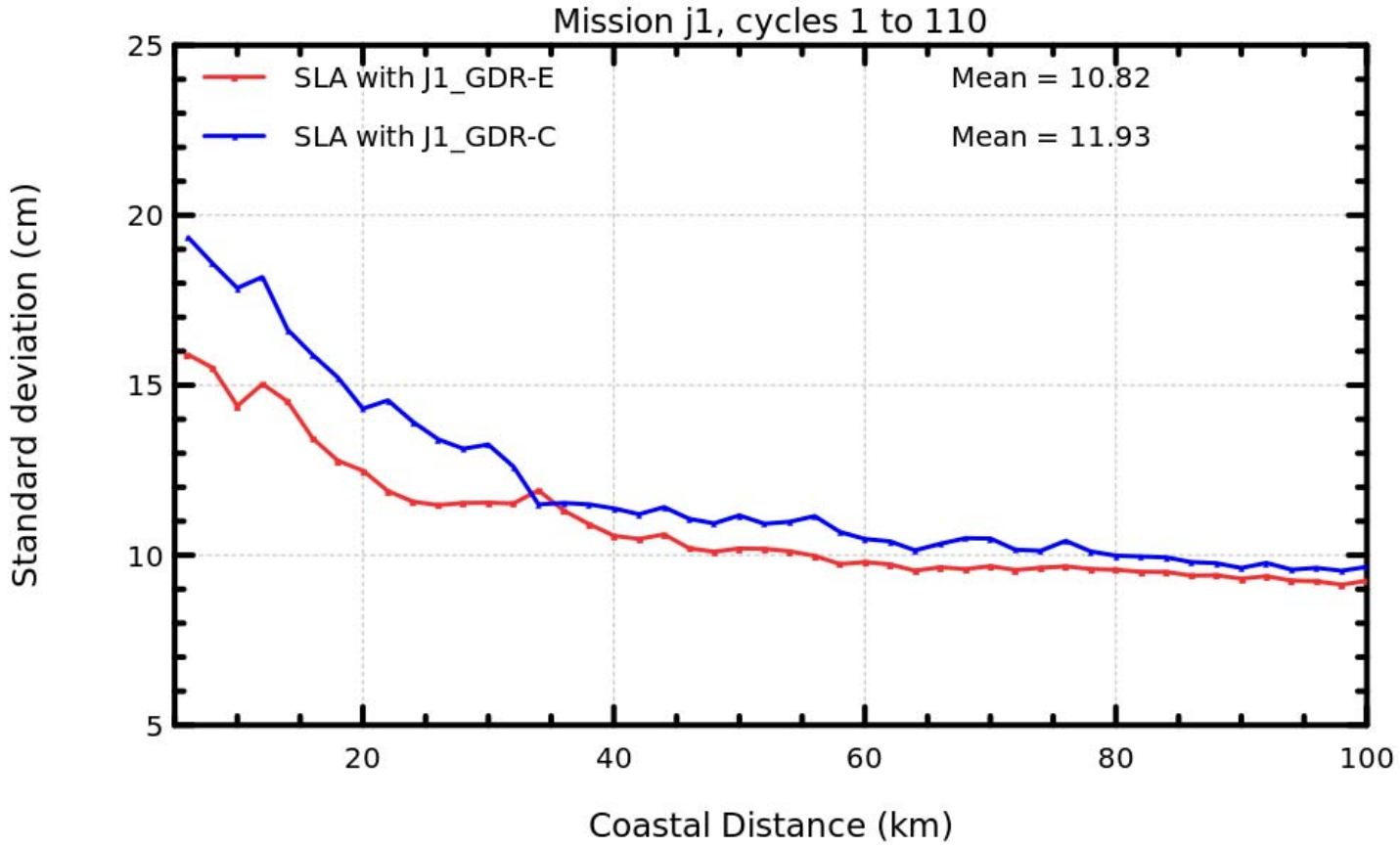
Spatially Dependent Improvements to Crossover Variance





- GDR-E has lower crossover variance over most regions.
  - Most significant improvements at latitudes > 40 degrees.
  - Dominated by improvements from new tide models.

Improved SSHA Near Coasts



- Jason-1 GDR-E reduces variance of sea surface height anomaly near coasts.
  - Most likely from improved tidal models and JMR coastal algorithm.

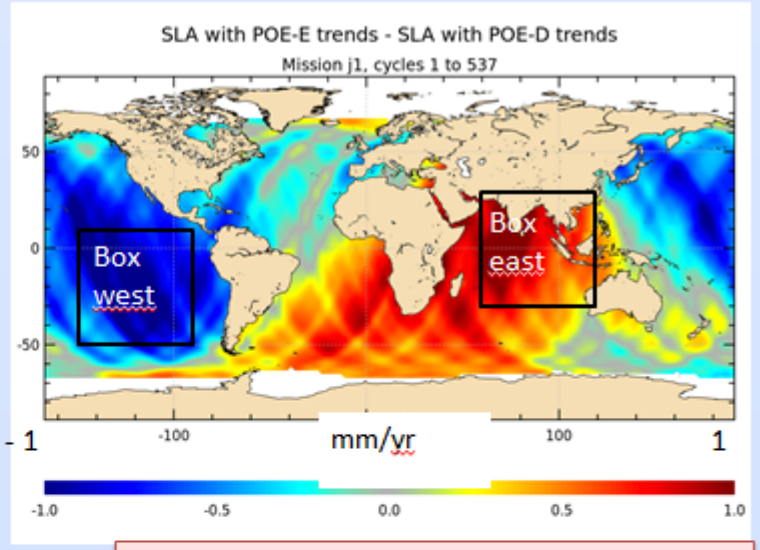
MSL Regional impacts related to POE

- POE-E orbit is close of POE-D orbit in terms of quality.
- Concerning the Mean Sea Level (MSL) evolution:

⇒ Low impact for the global MSL

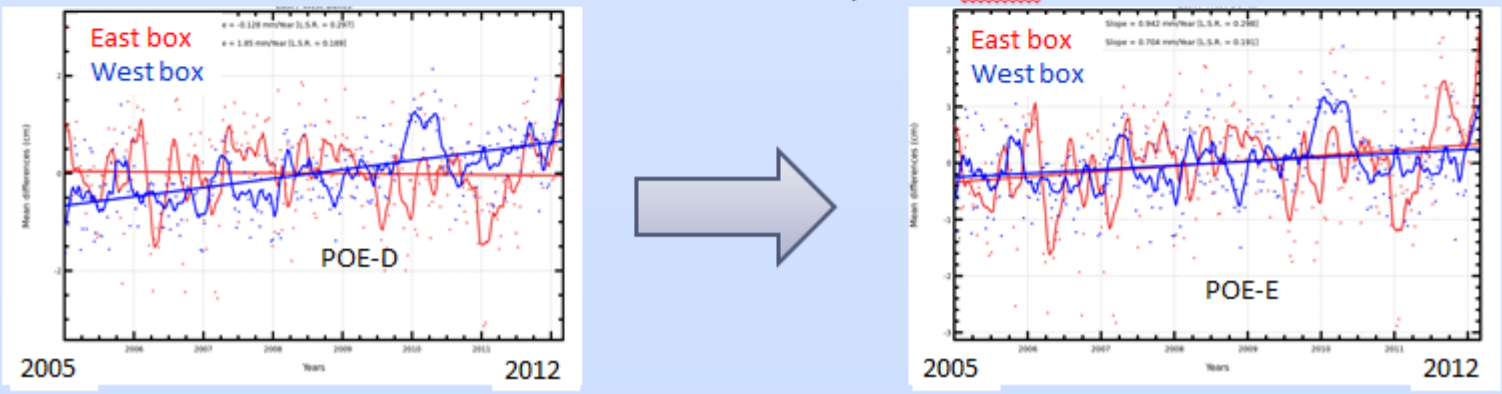
⇒ Strong impact for the regional MSL trends (+/- 1 mm/yr) East/West patterns on geographical trends is highlighted.

⇒Comparison between altimeter data and temperature/salinity profiles show that regional MSL trends discrepancies between Jason-1 and T/S are reduced with POE-E CNES orbit solution

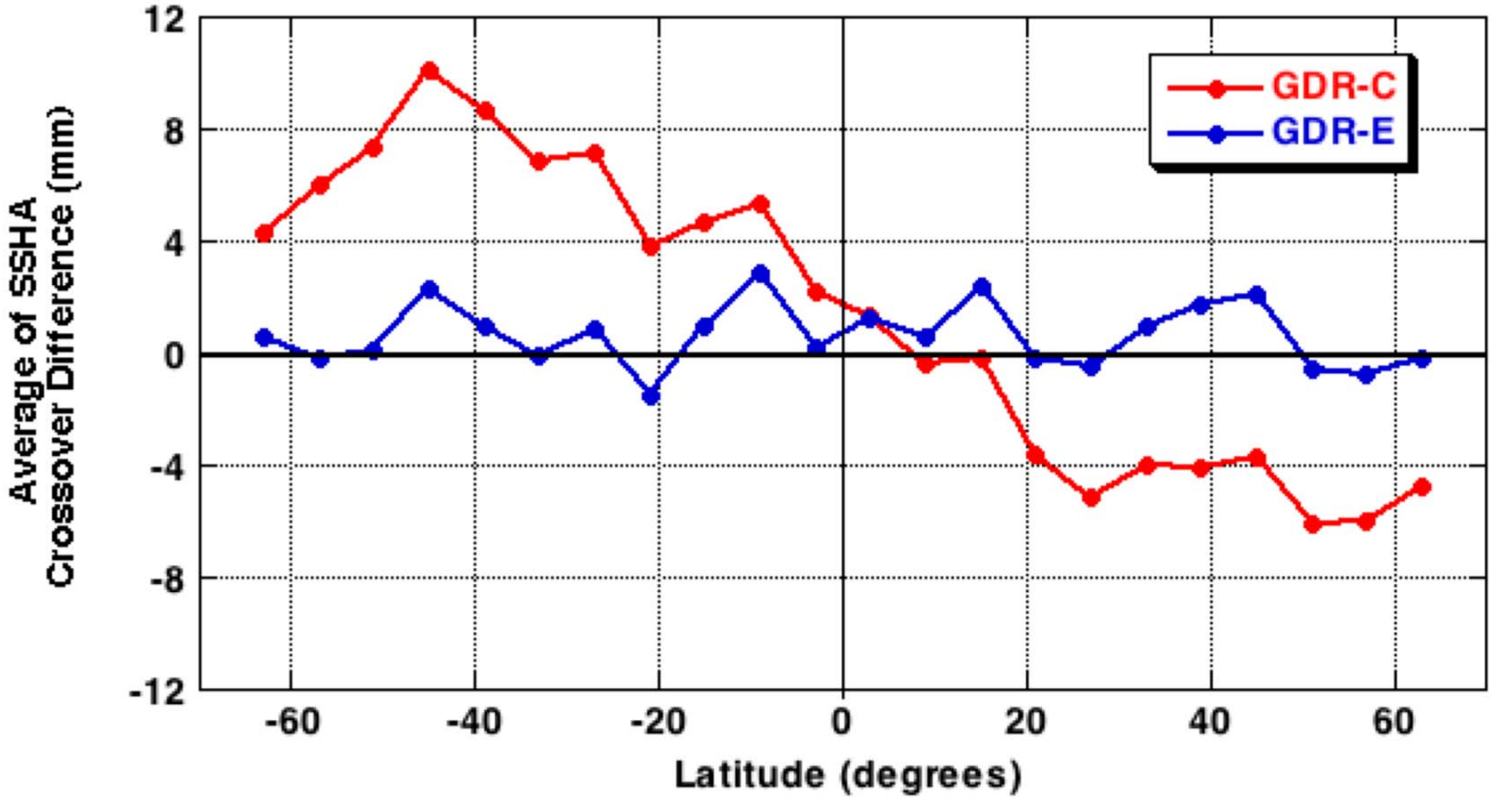


Significant impact detected on Regional Mean Sea Level trends

Differences between altimetry and T/S profils

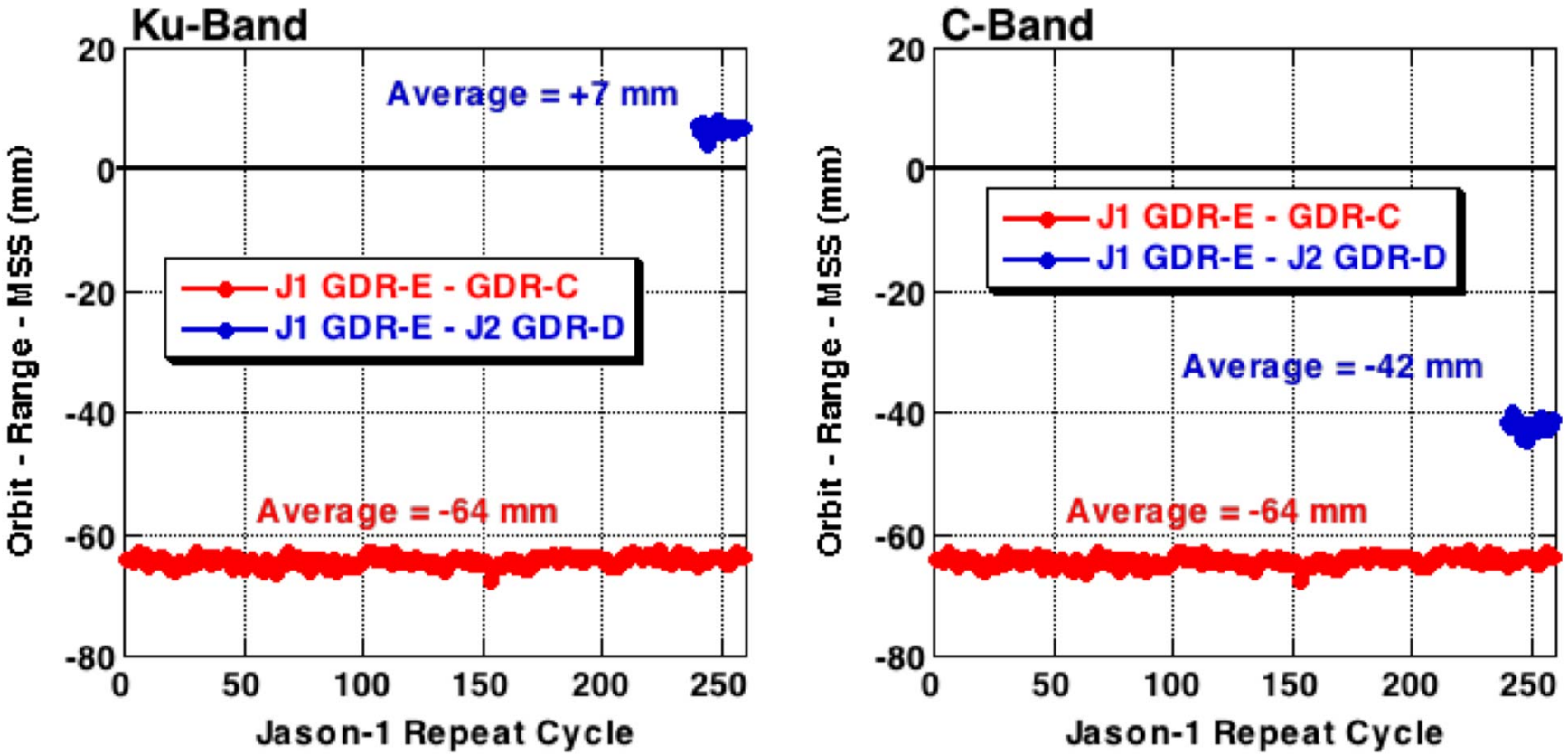


Time Tag Bias Resolved in GDR-E



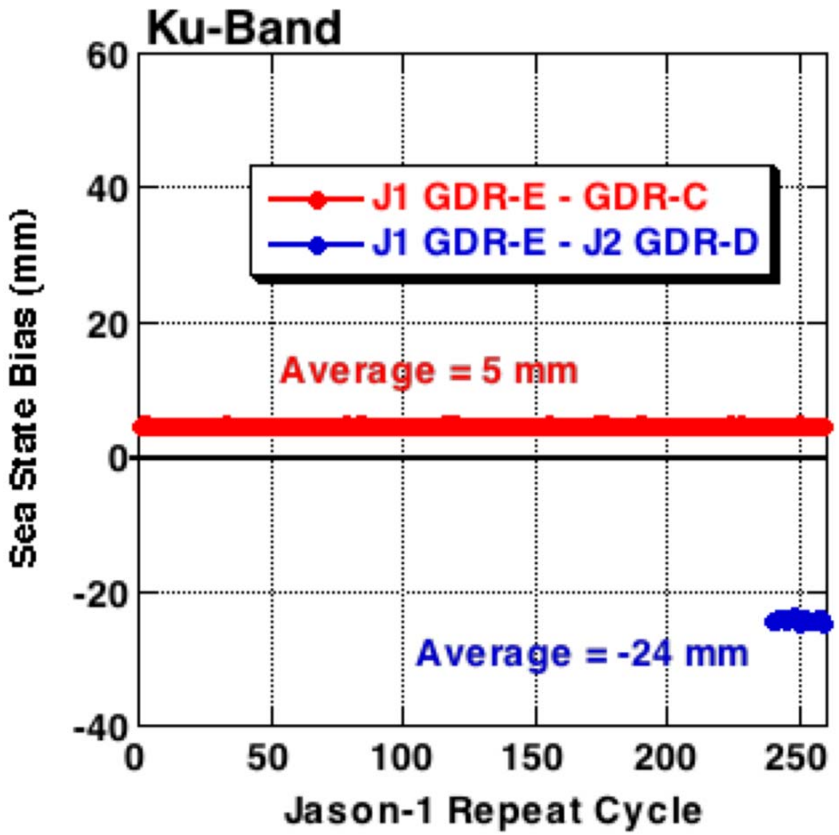
- Adjustment of time tags removes latitude dependence of average crossovers.
  - Error discovered by CNES in early Jason-2 products and also applies to Jason-1.
  - Explained by difference between time of emitted and received echo.
    - Correction was available on GDR-C (pseudo_datation_bias).

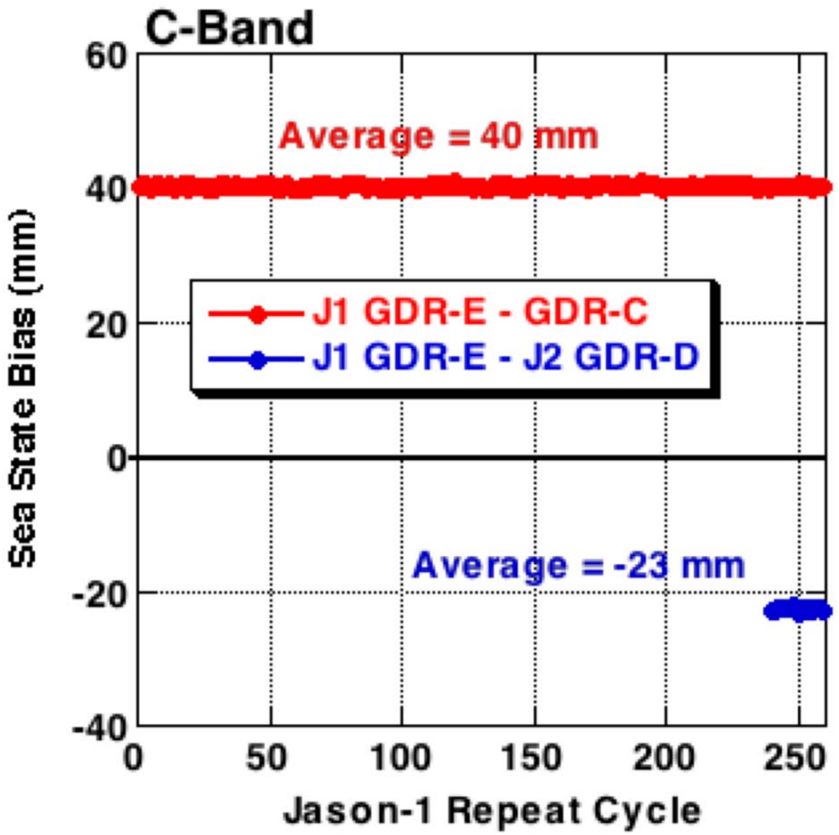
Ku- and C-Band Range



- GDR-E incorporates update to Ku- and C-band range instrument correction of +63.9 mm.
- **GDR-E should have applied +60.74 mm to Ku-band, and -3.16 mm to C-band.**
  - **Relative bias with J2 GDR-D would then be: 10 mm in Ku-band, and 25 mm in C-band.**

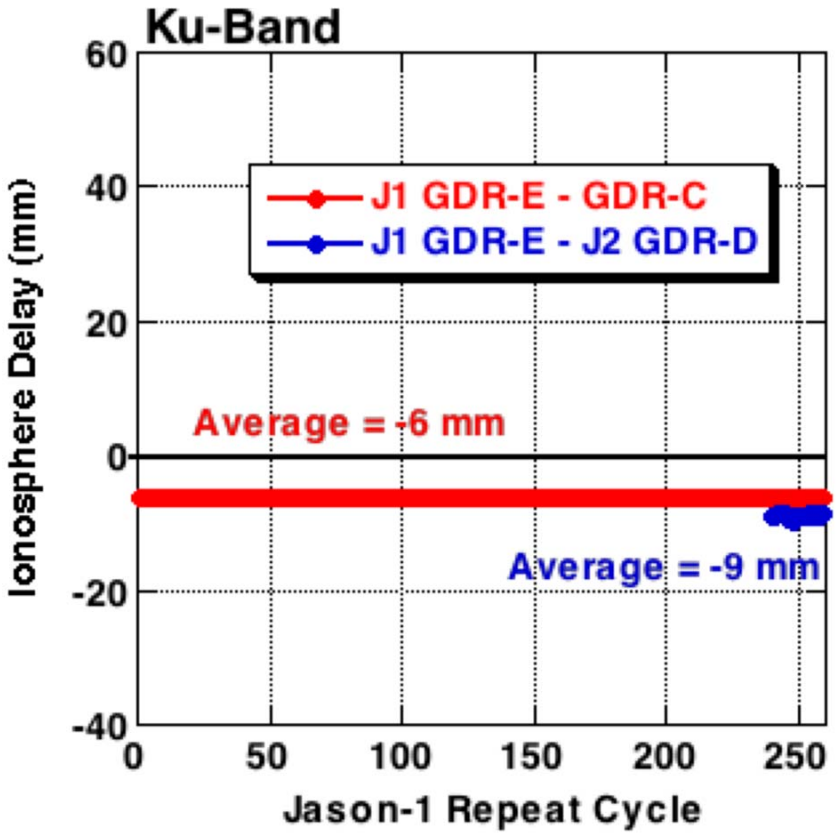
Ku- and C-Band Sea State Bias





- Improved consistency of leveling of Ku- and C- band SSB for Jason-1 and Jason-2.
  - Relative bias of ~2.3 cm remains, but consistent for Ku- and C-band.
  - **Reduced to < 2 mm in Ku and < 10 mm in C when using most recent Jason-2 SSB model (N. Tran, 2012).**

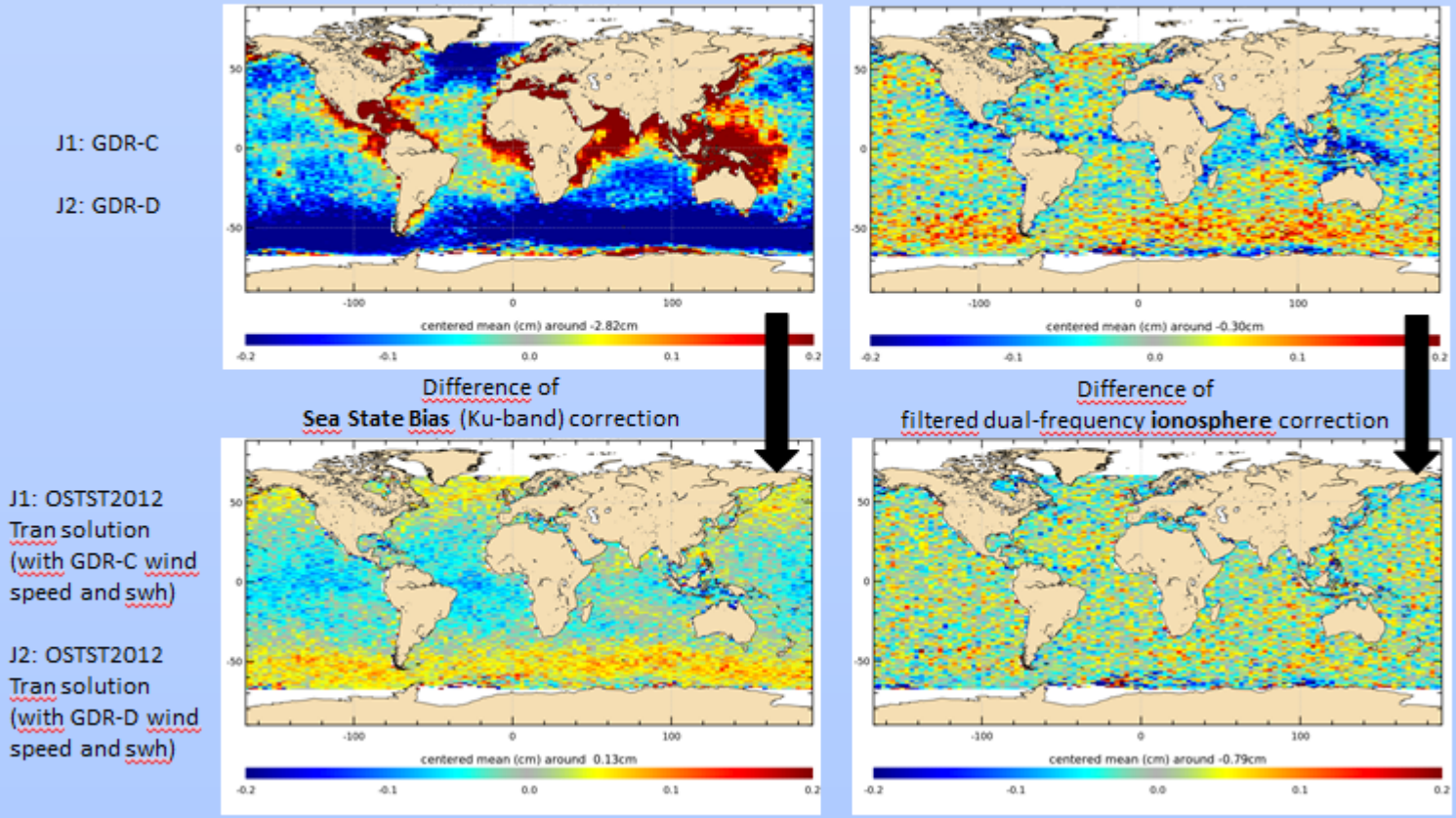
Ku-Band Ionosphere Delay



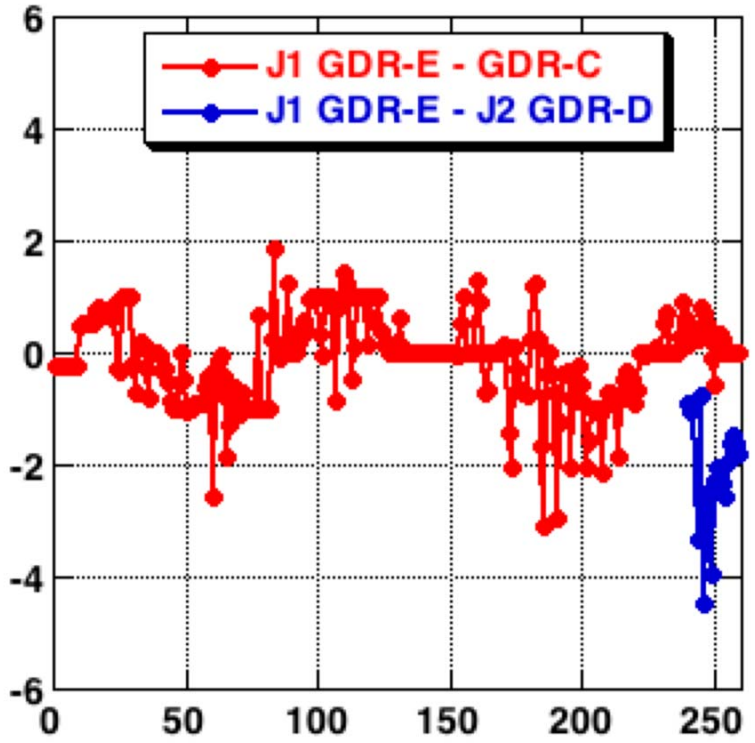
- Ionosphere difference: ΔIono
- ΔIono = $0.1798*(\Delta R_{Ku}+\Delta SSB_{Ku} - \Delta R_C - \Delta SSB_C)$
- Expect J1 GDR-E – GDR-C:
  - 0.1798*(+64 + 5 -64 -40) = -6 mm
  - **Primarily from changes to Ku/C relative SSB bias.**
- Expect J1 GDR-E – J2 GDR-D:
  - 0.1798*(-7 -24 -42 +23) = -9 mm
  - **Primarily from remaining Ku/C relative range bias.**
  - **If correct range instrument corrections were applied:**
    - **0.1798*(-10-24+25+23)=+3 mm.**

Jason-1 / Jason-2 improved consistency

Using OSTST2012 Sea State Bias (i.e. Jason-1 GDR-E algorithm solution) and corresponding ionospheric corrections will significantly improve the consistency between the two missions

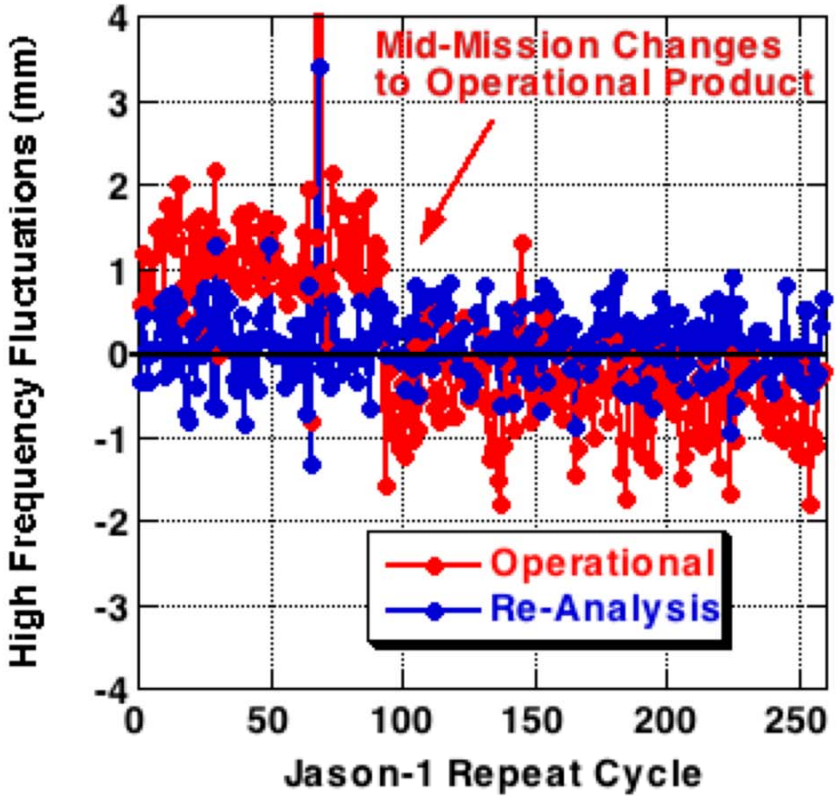


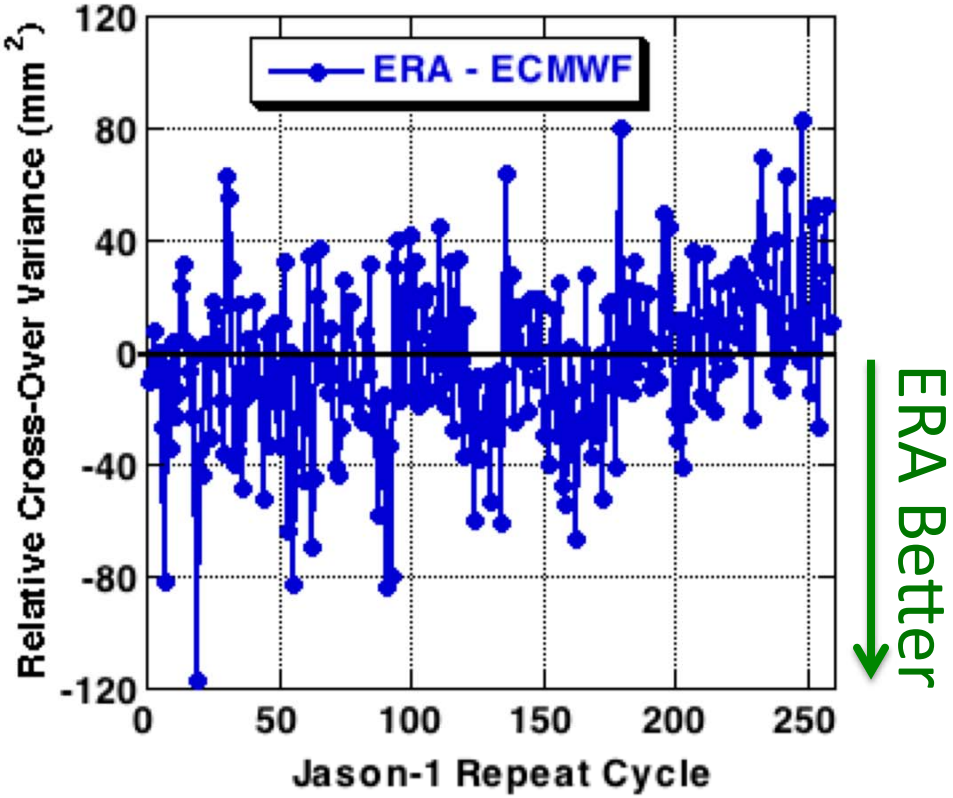
Radiometer Wet Delay



- Radiometer wet delay on GDR-E very similar to GDR-C.
- On going calibration to reduce high-frequency fluctuations in JMR calibration during Jason-1/ Jason-2 tandem period.
  - Will be improved in release version of cycles 240-259.

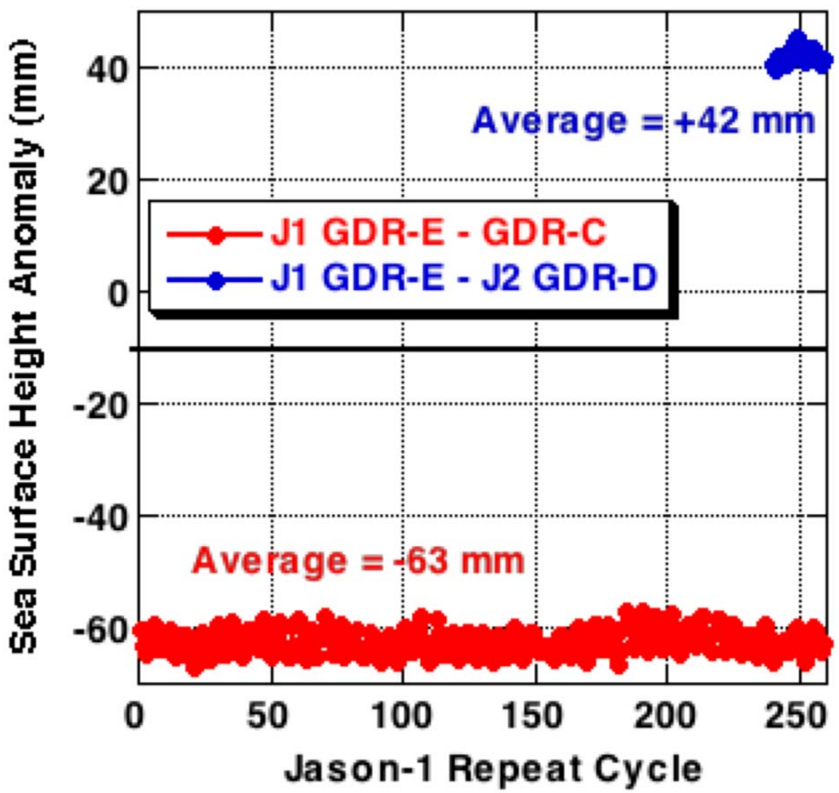
Dry Troposphere Delay, IB, High Frequency Fluctuations

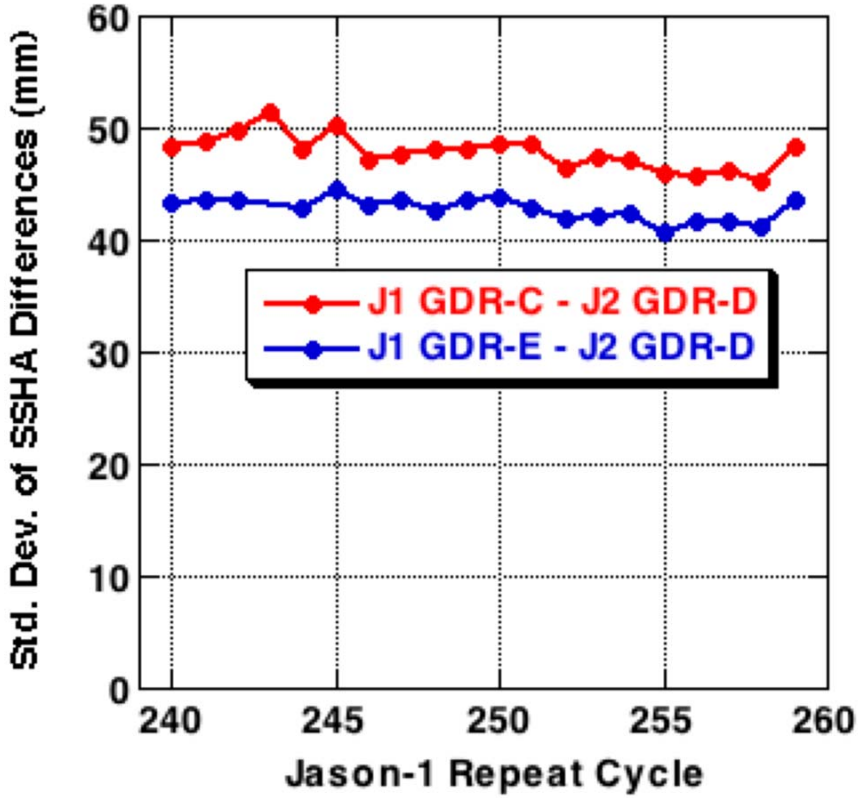




- No change to dry delay, IB, and HFF from ECMWF operational model.
- Addition of ECMWF Re-Analysis model for dry delay, IB, and HFF model.
  - Provides better long-term consistency. (Eliminates mid-mission biases).
  - Also improves SSH cross-over variance for earlier years.
    - -10 mm^2 for 2002-2006 vs +12mm^2 for 2007-2008

Sea Level Anomaly





- Bias and 60-day (tidal) variations dominate Jason-1 GDR-E – GDR-C.
- Jason-1 – Jason-2 relative bias reduced to +42 mm from +115 mm.
  - **With correct range instrument correction, relative bias would be +33 mm.**
  - **With most recent Jason-2 SSB model (N. Tran, 2012), relative bias would be reduced to < 10 mm.**
- 20% improvement in variance of differences with Jason-2 GDR-D.

Conclusion

- Jason-1 GDR-E products are significant improvement over GDR-C.
  - Improved SSHA cross-over variance.
    - Primarily from time tag adjustment, orbit solution, and modern tide models.
  - Improved consistency with Jason-2 GDR-D products.
    - Reduction of relative bias, and reduction in variance of SSHA differences.
- Additional GDR-E Cal/Val results in poster:
  - H. Roinard et al., *Jason-1 GDR-E Reprocessing*
- Known issues:
  - Documentation currently states GOT4.10 ocean tide model.
    - Should say GOT4.8 for all tidal components, except S2 from GOT4.10.
  - Error in range instrument corrections.
    - Ku-band: Should have been +60.74 mm instead of +63.9 mm.
    - C-band: Should have been -3.16 mm instead of +63.9 mm.
      - Causes 12 mm bias in ionosphere correction.
    - Relative SSH bias with Jason-2 GDR-D would then be +33 mm instead of +42 mm.
- **Jason-1/Jason-2 relative SSH bias would be reduced to < +10 mm when using correct range corrections and most recent Jason-2 SSB model (N. Tran, 2012)**

Acknowledgement

- Thanks to CNES developers and JPL operators of the Jason-1 GDR-E Reprocessing Software.

Back-Up Slides