Global Cross Calibration and Validation of the Jason-1 and Jason-2/OSTM Data Products

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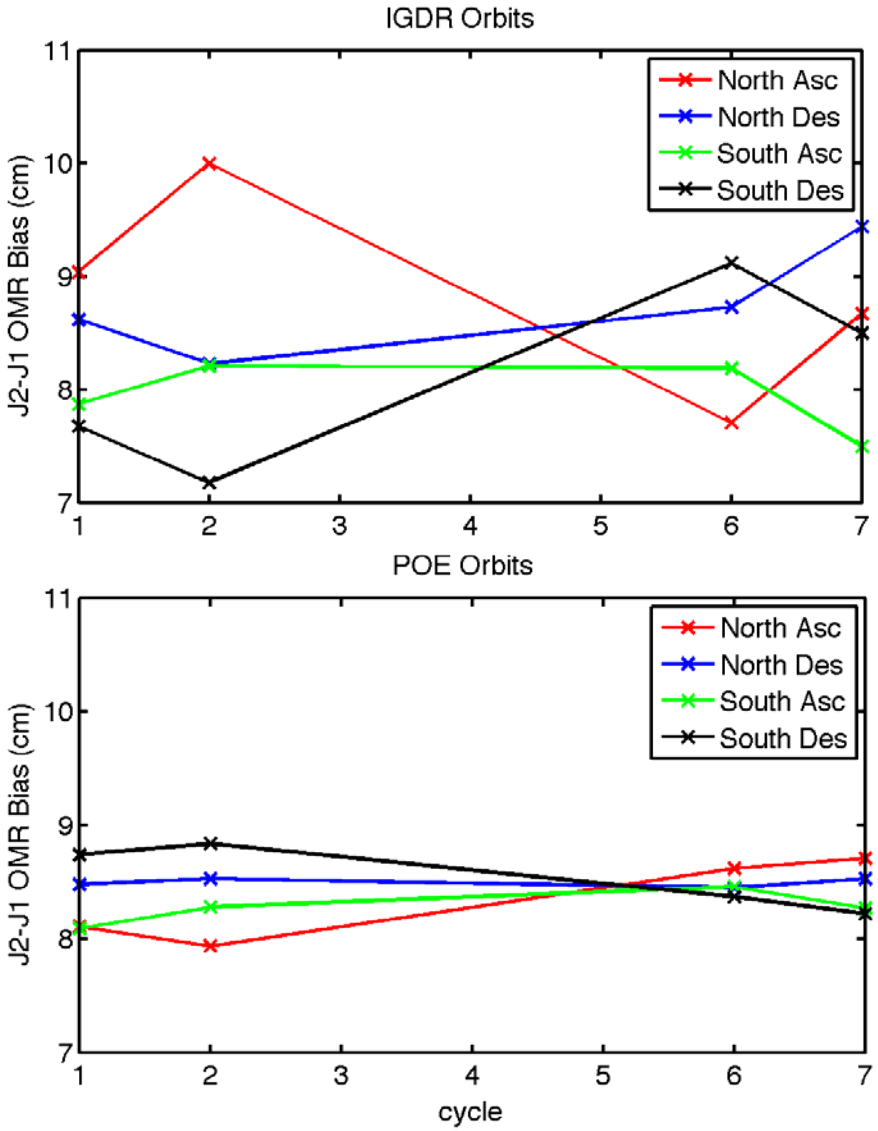
Introduction

- Cross-calibrate and validate measurements from Jason-1 (J1) and Jason-2/OSTM (J2) measurement systems. Evaluate:
  - Biases and temporal stability.
  - Systematic differences.
    - E.g.Scale
  - Geographically correlated differences.
    - E.g. Separate statistical analysis by quadrant
    - Ascending and descending tracks in the northern and southern hemispheres.
- Leverage from Jason-1 and Jason-2/OSTM flying ~54 seconds apart on identical (+/- 1 km) ground track.
  - Effectively observing the same environmental and oceanic conditions.
  - Ignore any change in conditions over 1 minute.
- Co-locate J1 and J2 measurements and evaluate differences.

Orbit - Range - MSS

- Use J1/J2 differences of (Orbit - Range - MSS to evaluate relative range measurements.
  - Use of MSS removes contributions of cross- and along-track MSS gradients.
  - Cycles 3 and 4 excluded because of Jason-1 safehold.
- Consider two orbit solutions:
  - IGDR orbits.
  - POE for J1 and J2 from GSFC.
    - Available for J2 Cycles 1-7 only.
- Relative range bias:
  - **Ku-Band: 84 +/- 2.2 mm when using POE. (J2 measuring short.)**
  - **C-Band: 132 +/- 2.6 mm when using POE. (J2 measuring short)**
- Cycle to cycle scatter reduced when using POE.



Orbit - Range - MSS versus SWH Example

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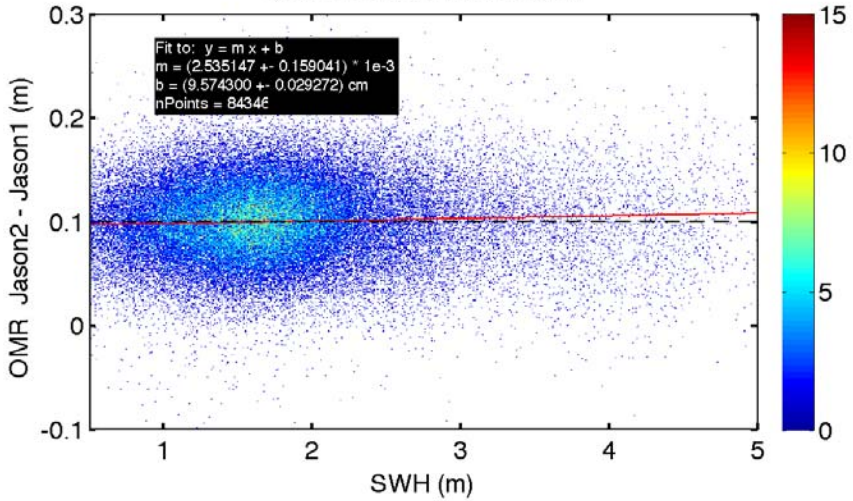
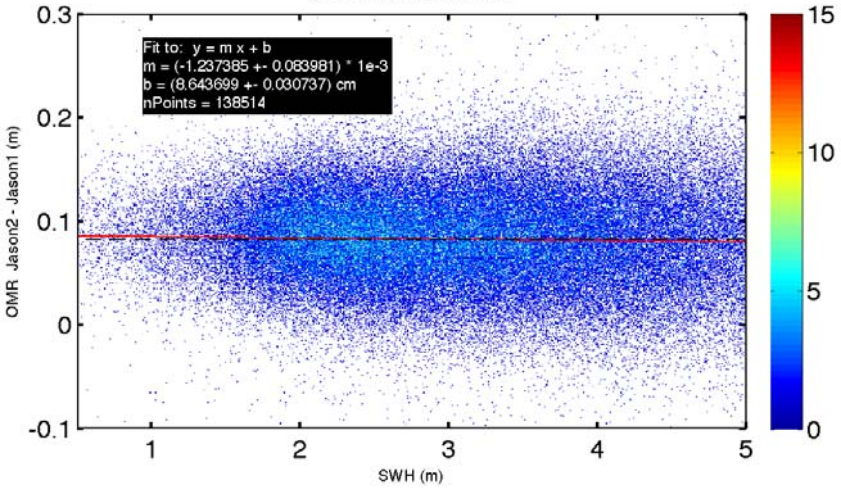
Northern Hemisphere: Ascending

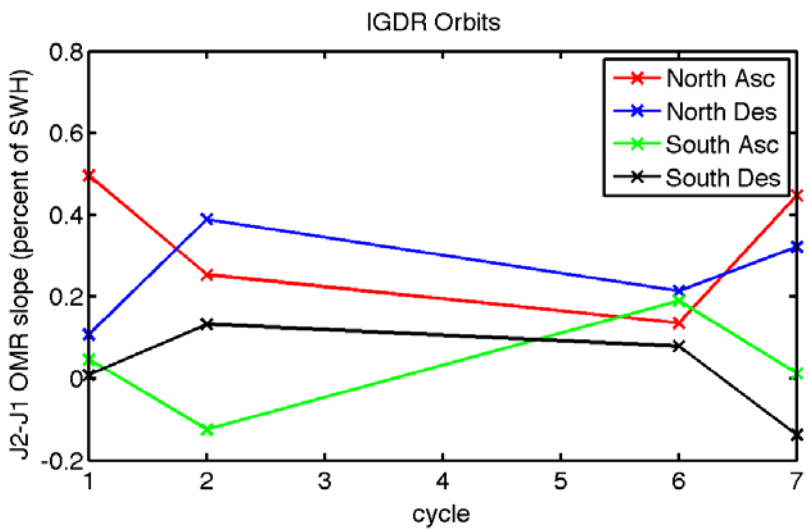


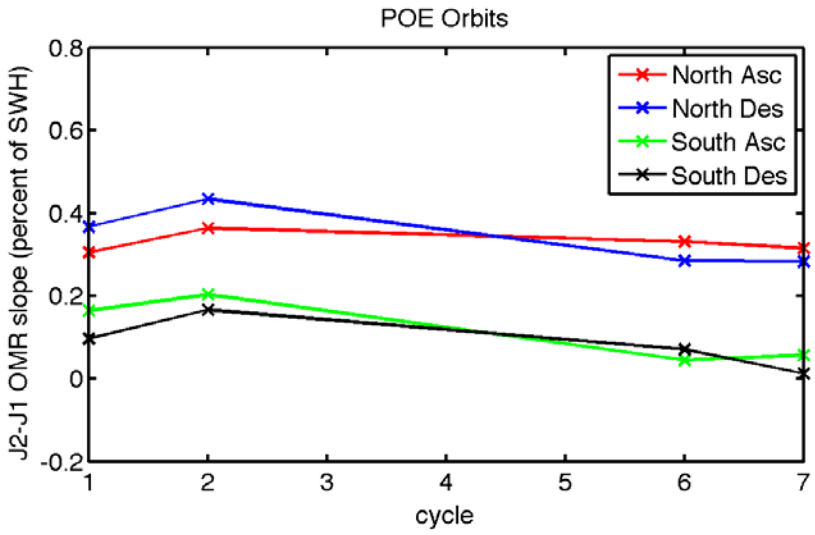
Southern Hemisphere: Ascending



- Example uses cycle 2 IGDR data.
- Consider intercept and slope of linear fit to (Orbit - Range - MSS) differences as function of SWH.
- Orbit-Range-MSS differences have small (0.1 - 0.4%) apparent dependence on SWH.
  - Orbit error and/or MSS gradient error may be contributing.

POE Orbit - Range - MSS versus SWH Slope





- Use of consistent POE for J1 and J2:
  - Reveals relative 0.25%*SWH between northern and southern hemisphere.
  - Consistent for cycles 1, 2, 6 and 7.
- Will redo with other POE's (e.g. CNES) when available.
  - Goal is to use consistent POEs for J1 and J2 so that common geographically correlated orbit error is removed in differences.

Ionosphere Correction Bias from Relative Ku/C Range Biases

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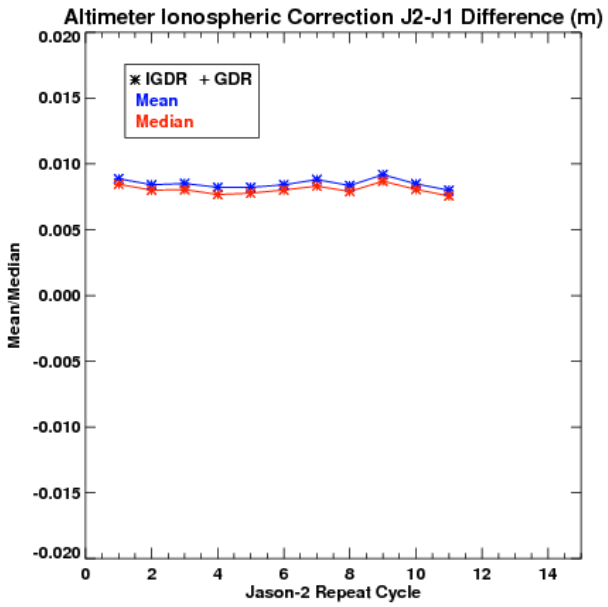
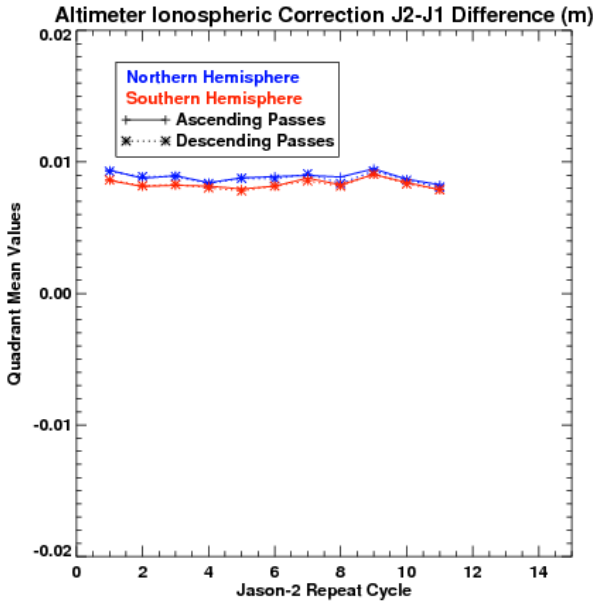
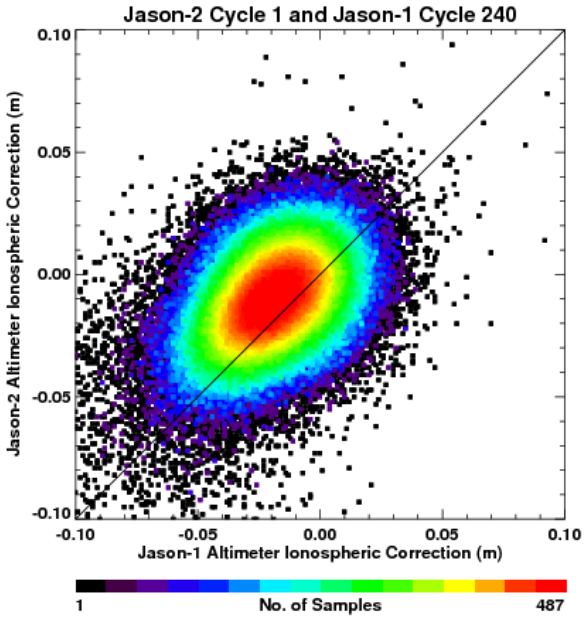
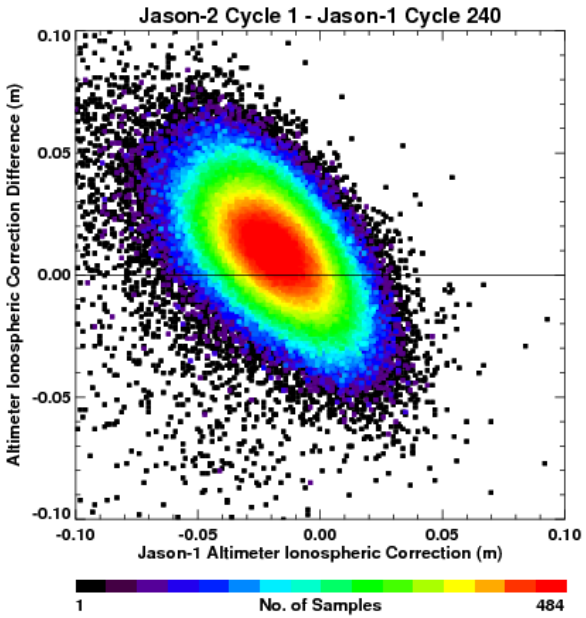


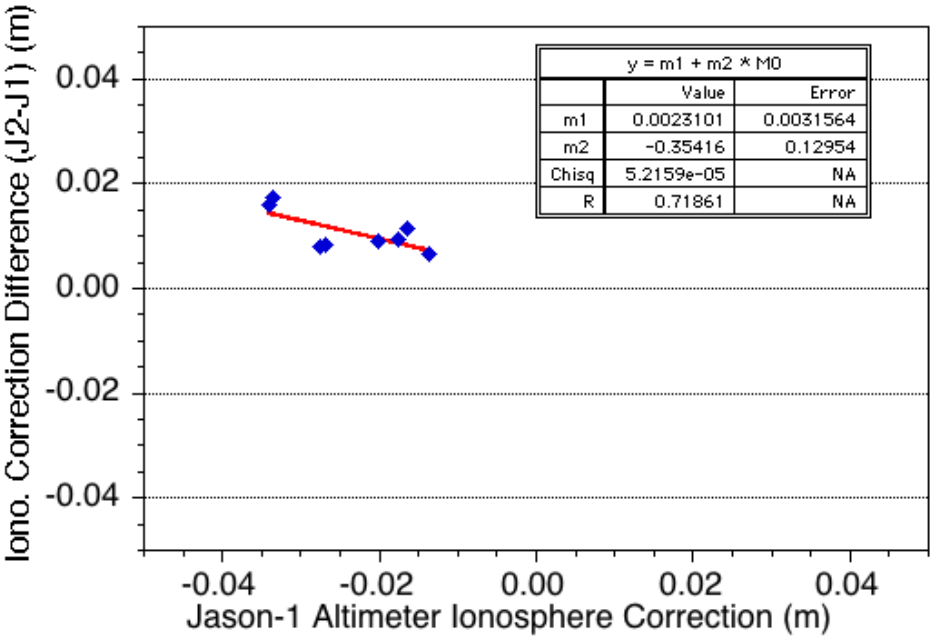




- Relative range biases of 84 and 132 mm in Ku- and C- bands causes +8.6 mm bias to J2 ionosphere correction relative to J1, e.g.
  - Ku-Band Iono = $0.1798*(R_{Ku}-R_C)$
  - J2 Ku-Band Iono = $0.1798*((R_{Ku}- 84) - (R_C-132))$
  - J2 Ku-Band Iono = $0.1798*(R_{Ku}-R_C) + 0.1798*(132-84)$ mm
  - J2 Ku-Band Iono = J1 Ku-Band Iono + 8.6 mm

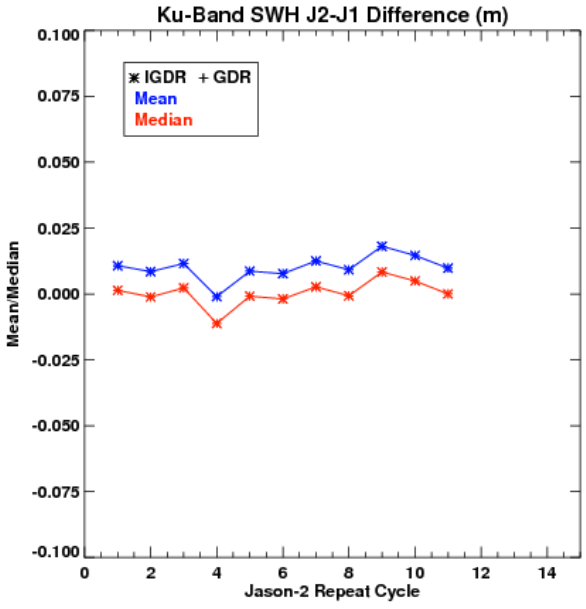
Ionosphere Correction Scale Error?

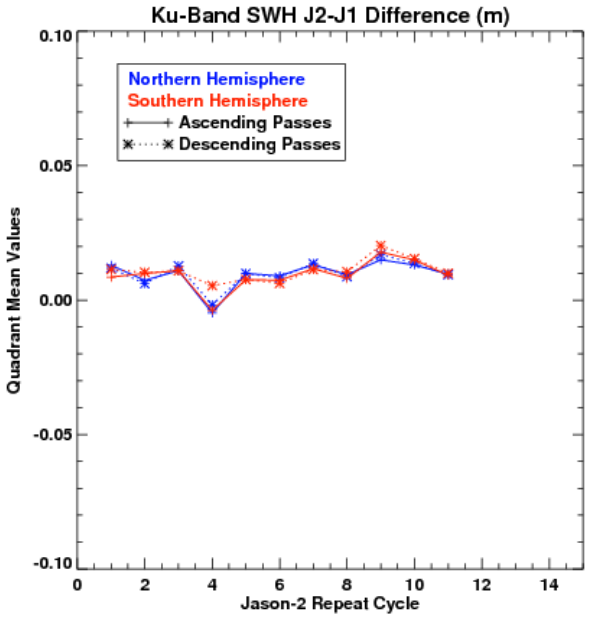


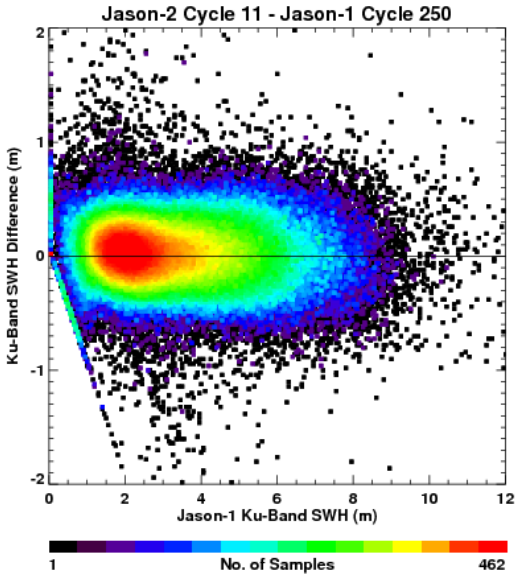


- Apparent scale error in J2-J1 ionosphere corrections.
  - ~40% +/- 10% depending on cycle and how scale is fit to data.
  - Narrow range of current ionosphere corrections (< 8 cm) from solar minimum perhaps limiting accurate determination.
  - Also observed by few coincident measurements at Harvest calibration site.
- Lengthier data set may help to identify root cause, especially as ionosphere conditions begin to intensify.

Significant Wave Height

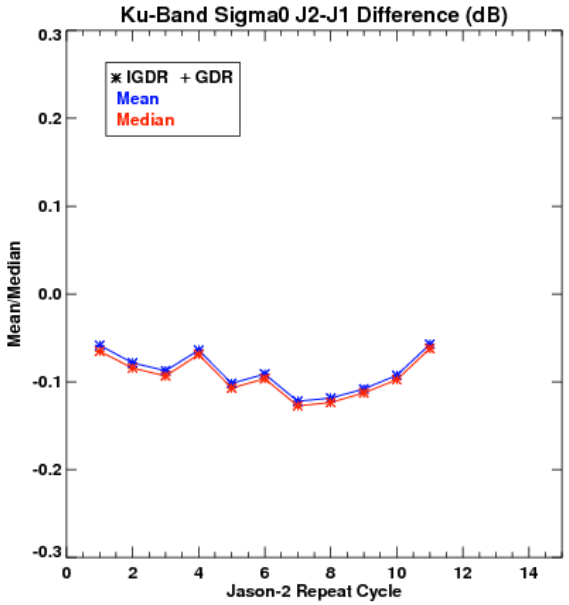


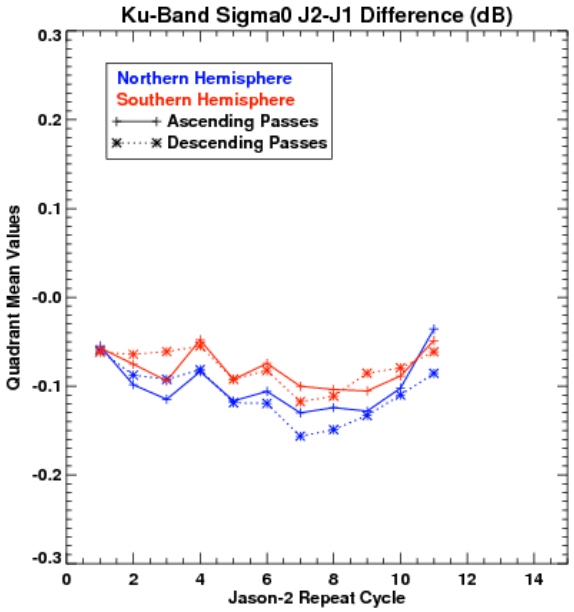


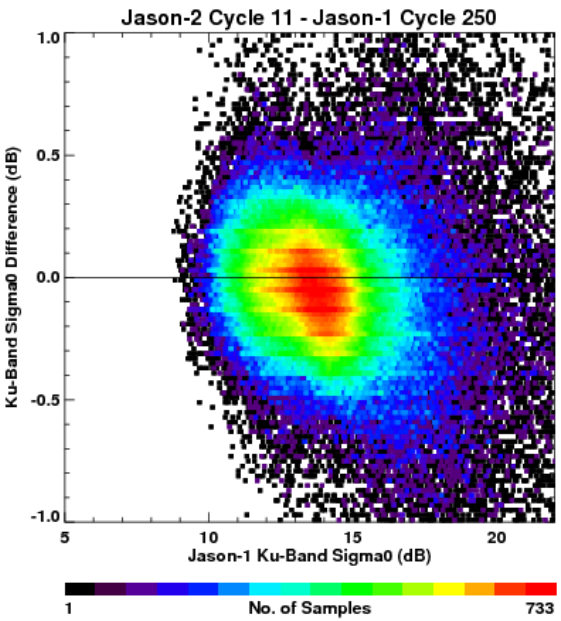


- Relatively stable bias of 1.0 +/- 0.5 cm.
  - Median of differences 0.0 cm.
- Consistent with J2/J1 differences of 1.0 cm in all quadrants.
- No apparent scale error in differences.

Sigma0

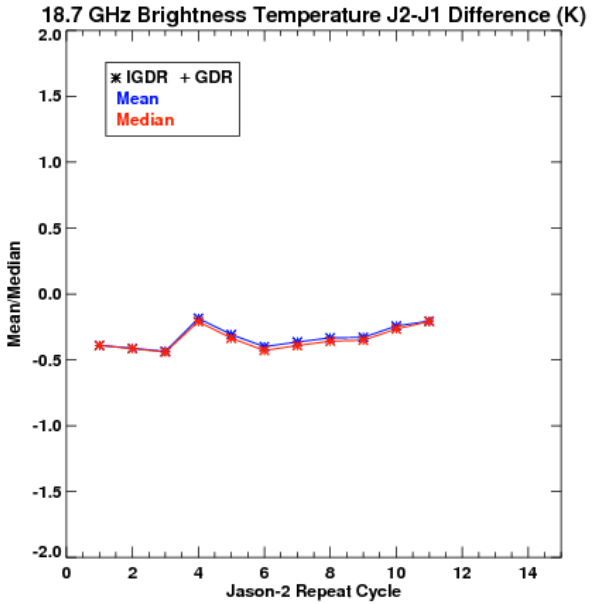


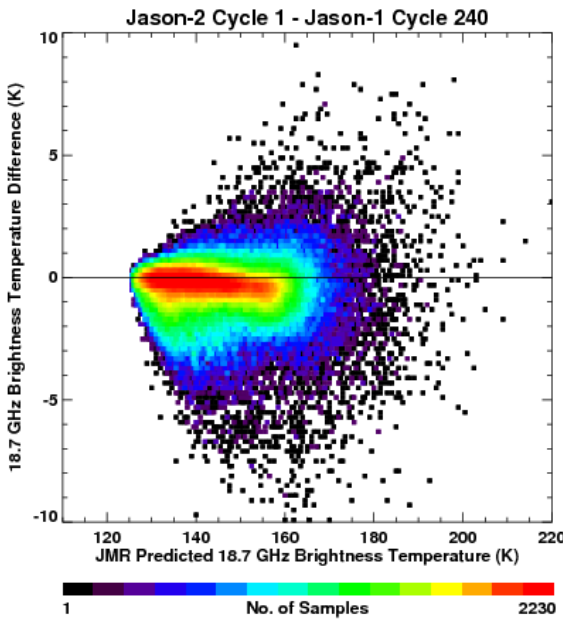


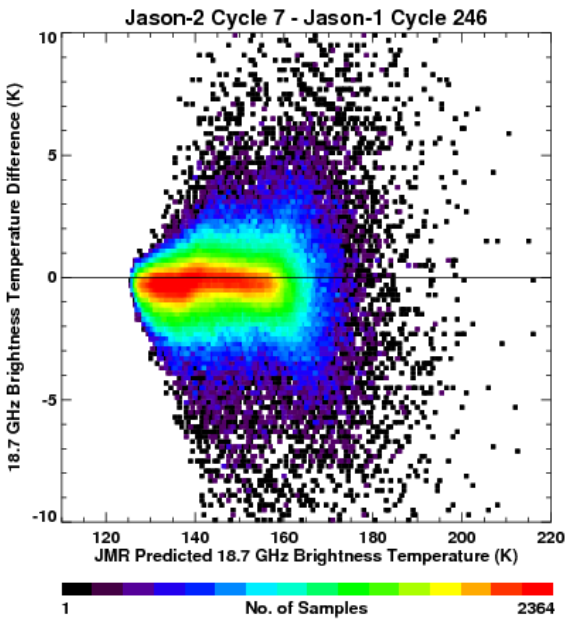


- Relatively stable bias of -0.09 +/- 0.02 dB.
  - Consistent with median of differences.
- Perhaps a north/south bias of < 0.03 dB (?)
  - Need longer duration of comparisons to confirm.
- No apparent scale difference.

18.7 GHz Brightness Temperatures

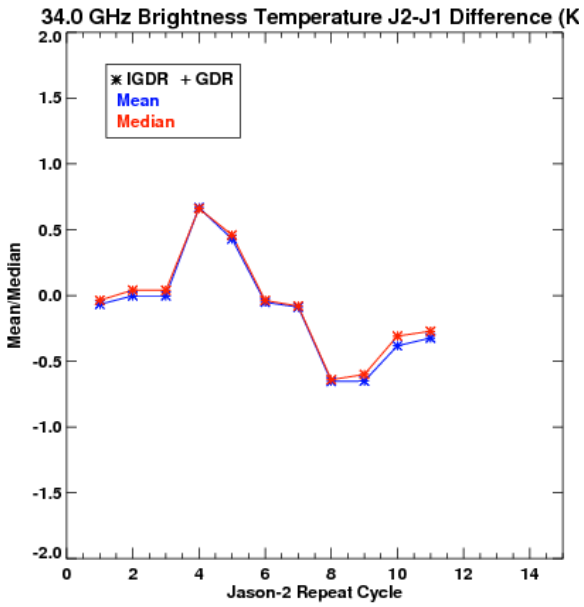


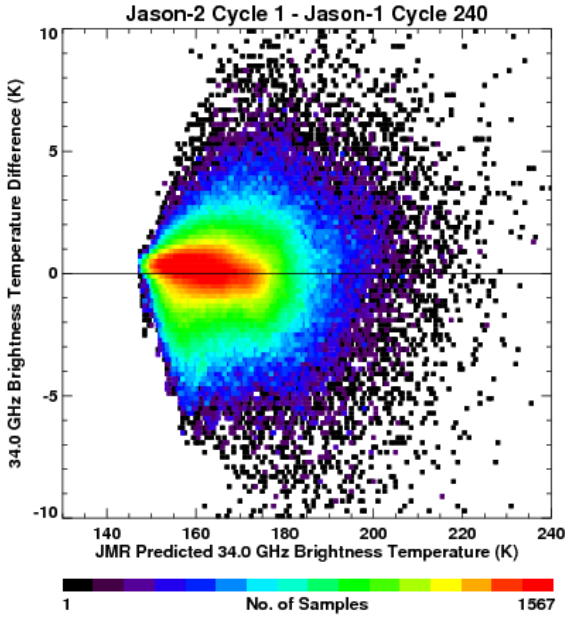


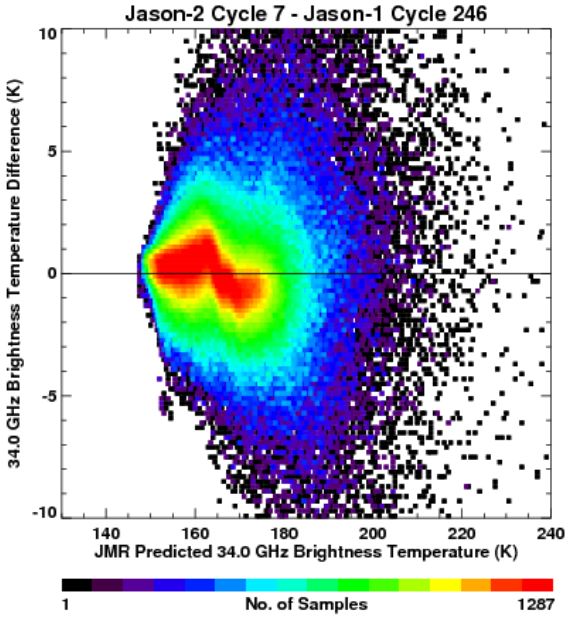


- Bias of -0.3 +/- 0.1 K.
- Instability after Cycle 242/243 Jason-1 safehold. (Cycle 3/4 J2).
  - Introduces < 1K systematic structure to J1/J2 differences.
  - Hint of feature immediately before safehold.

34.0 GHz Brightness Temperatures

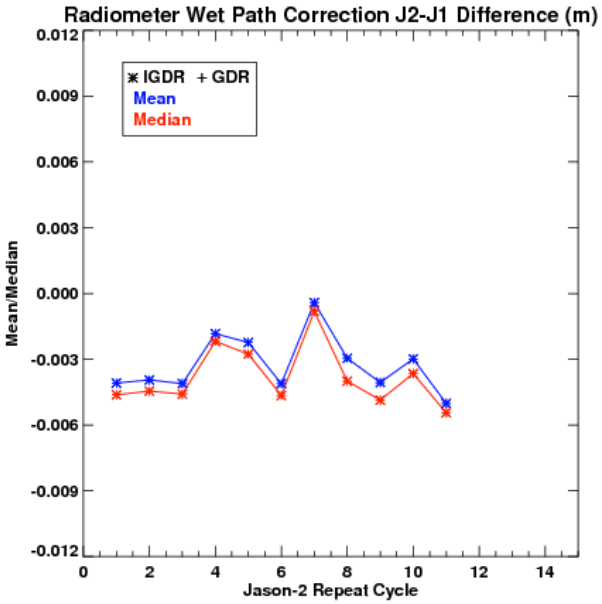


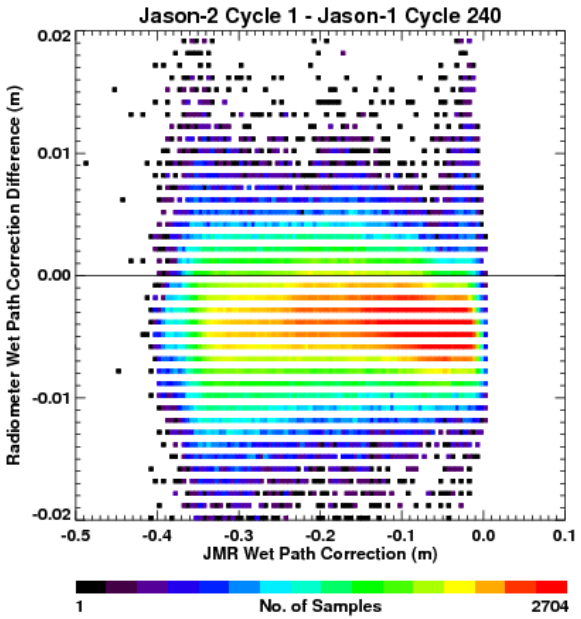


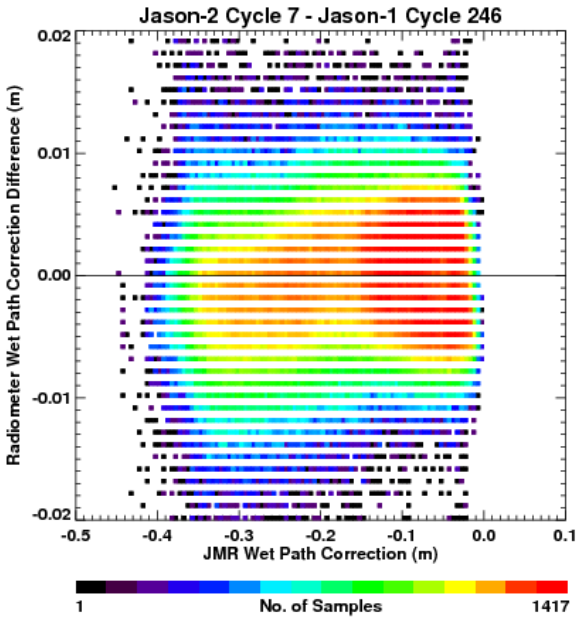


- Bias of -0.1 +/- 0.4 K.
- Instability after Cycle 242/243 Jason-1 safehold (Cycle 3/4 J2)
  - Introduces ~3K peak-to-peak systematic structure to J1/J2 differences.
  - Dissipates slightly at cycle 11.

Wet Troposphere Correction







- Bias of -3.2 +/- 1.3 mm.
- Std. Dev. of 23.8 GHz brightness temperatures increases from 0.6 to 0.9 K immediately after safehold, returning to 0.6K in cycle 10.
- Similarly, scatter of wet path delays increases from 3 to 4 mm and back to 3 mm during same period.

Summary and Conclusions

- J2 Range measurements short relative to J1.
  - Ku-Band: 84 mm
  - C-Band: 131 mm
- Causes J2 ionosphere correction to be biased +8.4 mm relative to J1 ionosphere correction.
- Ku-Band range differences have apparent 0.25%*SWH relative scale between northern and southern hemispheres.
  - Requires further investigation to consider:
    - Orbit error as source e.g. use other POEs,
    - MSS errors.
- Differences of J2/J1 ionosphere corrections suggest a scale error in the differences of 30-50%.
  - Requires further investigation.
- Systematic “structure” (< 3K) in brightness temperatures (especially 34GHz) after Jason-1 cycle 242/243 safehold.
  - Being investigated.
  - Wet troposphere delay differences have standard deviation of 3-4 mm.