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# **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.
    - For example: Scale
  - Geographically correlated differences.
    - Qualitative visual inspection of mapped differences
    - Quantitative analysis of quadrant statistics separated by ascending/descending passes in Northern/Southern Hemisphere.
- Perform analysis using independent algorithm implementations.
  - Confirm consistency within the GDR product.
  - Help explain dependencies/causes of biases and other data features.
  - Assess impact of drifts and/or errors to the various data components.



# Jason-2/Jason-1 Cross Calibration Overview



	Bias (J2 – J1)	Drift	Scale	Geo. Correlated
Sea Level Anomaly	7.5 +/- 0.1 cm	-	-	-
Range Ku	8.3 +/- 0.1cm	-	-	-
Range C	13 +/- 0.2 cm	-	-	-
Significant Wave height	1.1 +/- 0.4 cm	-	-	-
Iono. Correction	0.85 +/- 0.03 cm	-	Interesting Behavior	-
Sigma0	-0.15 +/- 0.2 dB	-	-	-
Sea State Bias	-0.17 +/- 0.03 cm	-	-	-
Wet Trop. Correction	0.17 +/- 0.1 cm	-	-	-
Bright Temp 18.7 GHz	0.16 +/- 0.1 K	-	-	-
Bright Temp 23.8 GHz	-0.072 +/- 0.2 K	-	-	-
Bright Temp 34.0 GHz	0.38 +/- 0.2 K	-	-	-
Altimeter Wind Speed	0.45 +/- 0.06 m/s	-	Yes	-
Radiometer Wind Speed	0.19 +/- 0.19 m/s	Possibly	Yes	-



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Sigma0		-	-	-
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*Range / iono. bias / scale*

*Impact of sigma0 bias*

*Radiometer wind speed drift*

*Focus of this talk*

Yes  
Yes



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Iono. Correction	0.85 +/- 0.03 cm	-	-	-
Sigma0	<i>Impact of sigma0 bias</i>	-	-	-
Sea State Bias		-	-	-
Wet Trop. Correction	0.17 +/- 0.1 cm	-	-	-
Bright Temp 18.7 GHz	0.16 +/- 0.1 K	-	-	-
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Altimeter Wind Speed	0.45 +/- 0.06 m/s	<i>Radiometer wind speed drift</i>	Yes	-
Radiometer Wind Speed	0.19 +/- 0.19 m/s		Yes	-

*Range / iono. bias / scale*

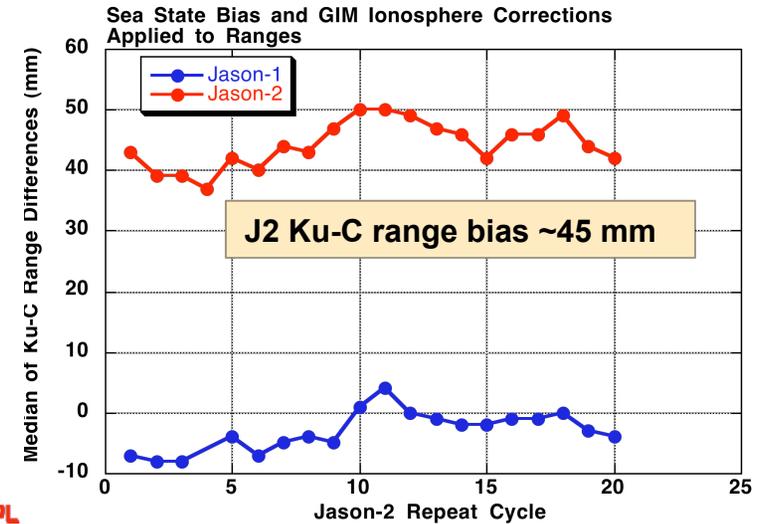
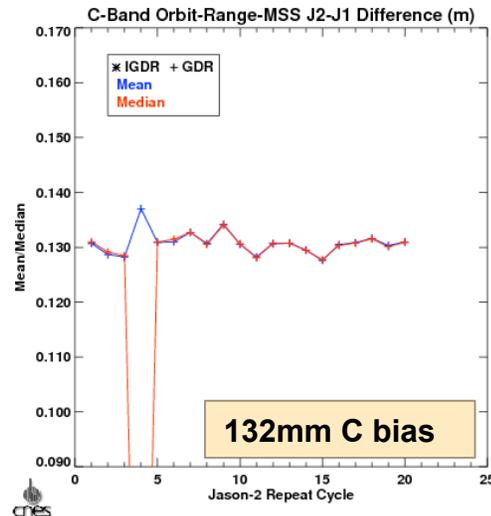
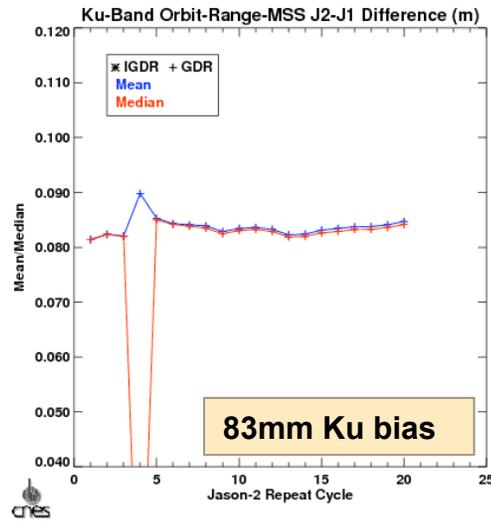
*Focus of this talk*

*Impact of sigma0 bias*

*Radiometer wind speed drift*



# Range Bias

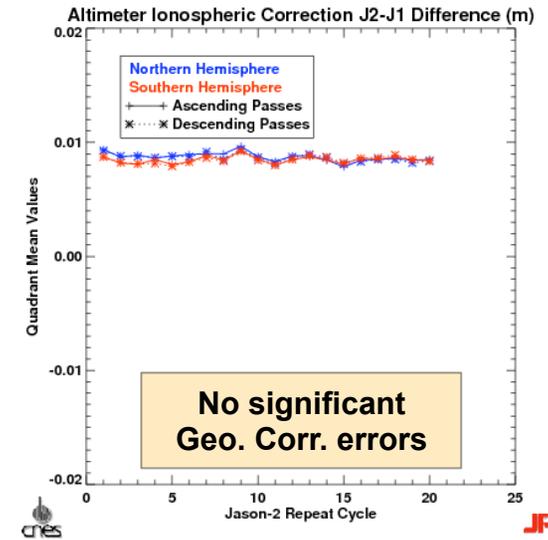
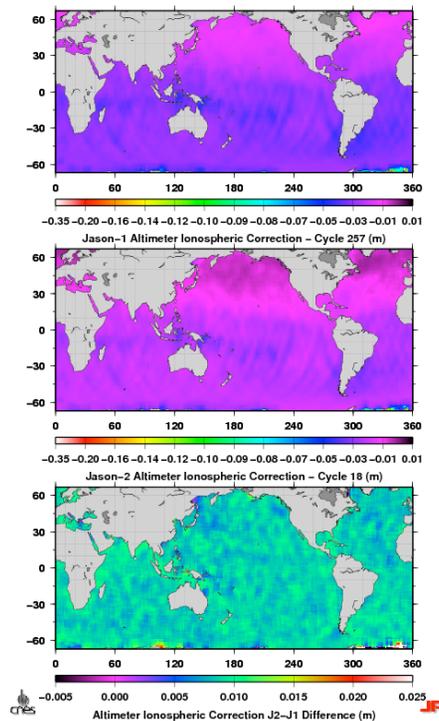
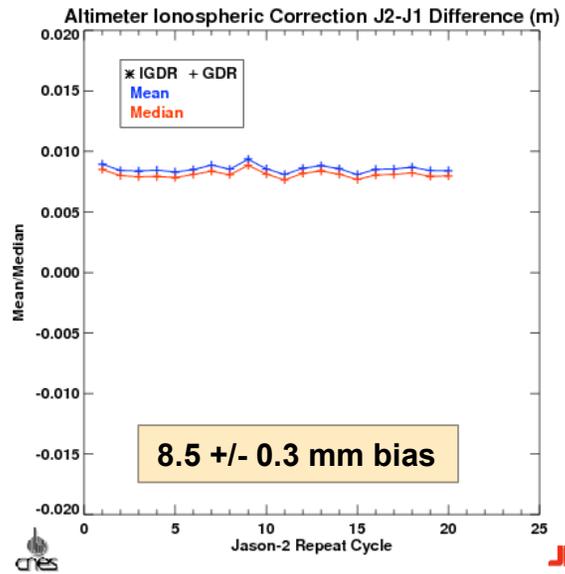


- J2-J1 Ku band range bias is 83 mm. C band range bias is 132 mm.
- Jason-2 has larger Ku – C range bias than does Jason-1

- Jason-2 has ~ 4.5cm Ku – C range bias
- Impacts altimeter ionospheric correction



# Ionosphere Correction Bias



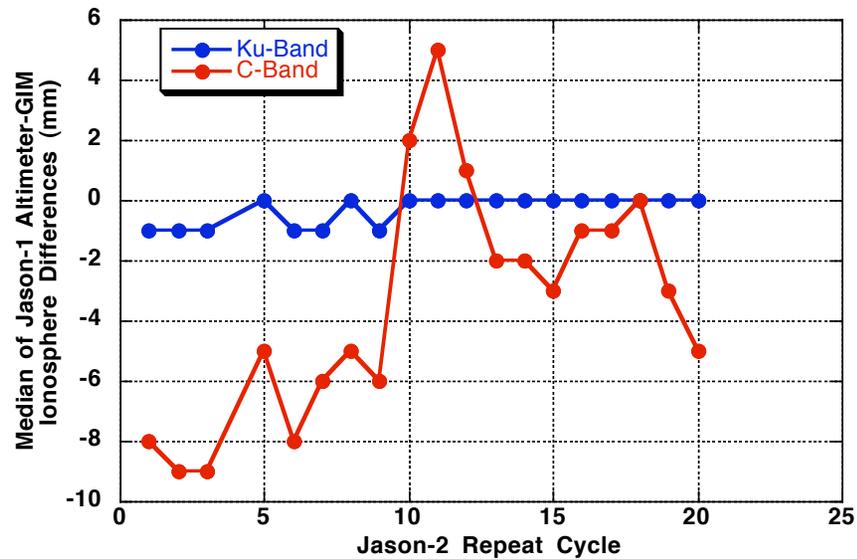
- Relative range biases of 83 mm (Ku band) and 132 mm (C band) cause the J2 ionosphere correction to have 8.5 +/- 0.3 mm bias with respect to J1.
  - $Ku\text{-Band Iono} = 0.1798 \cdot (R_{Ku} - R_C)$
  - $J2\ Ku\text{-Band Iono} = 0.1798 \cdot ((R_{Ku} - 83) - (R_C - 132))$
  - $J2\ Ku\text{-Band Iono} = 0.1798 \cdot (R_{Ku} - R_C) + 0.1798 \cdot (132 - 83)\text{ mm}$
  - $J2\ Ku\text{-Band Iono} = J1\ Ku\text{-Band Iono} + 8.8\text{ mm}$



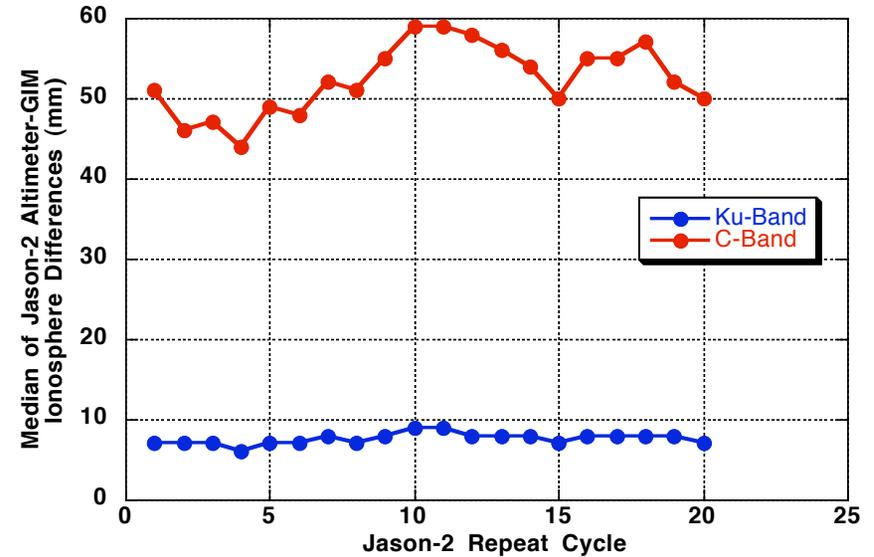
# Ionosphere Correction GIM / Altimeter Comparisons



## Jason 1



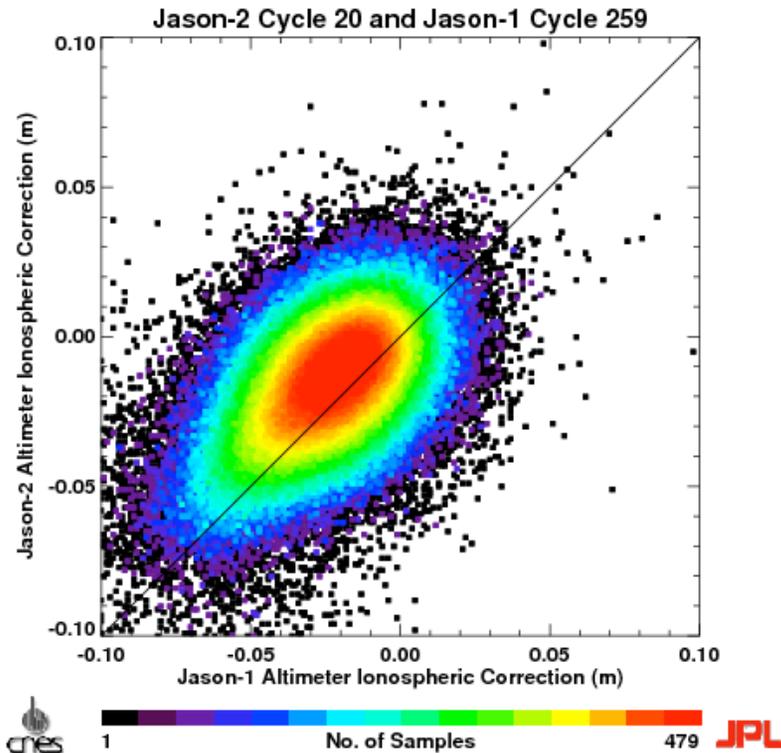
## Jason 2



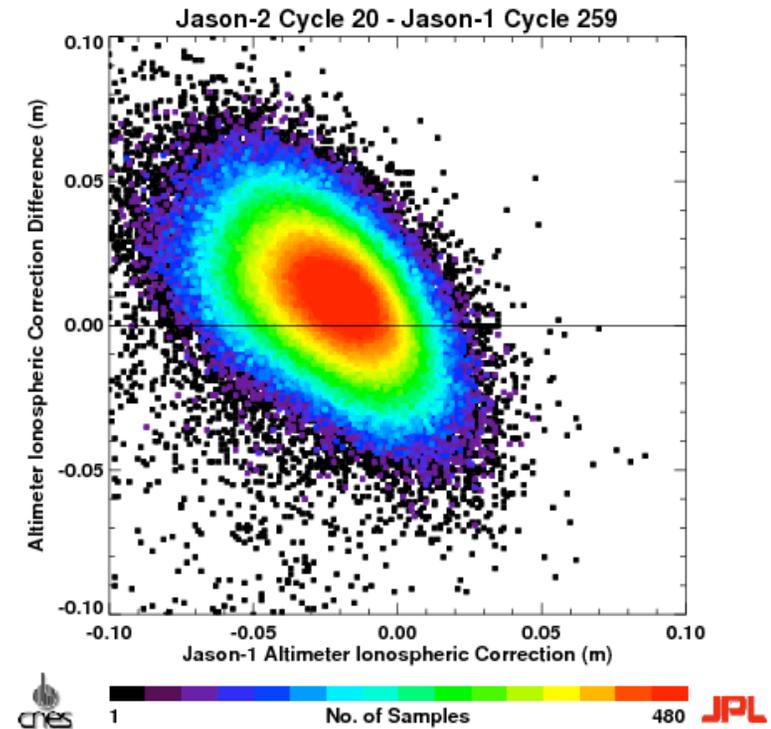
- Altimeter – GIM comparisons show a larger bias for Jason-2 than for Jason-1



# Apparent Scale Error in Ionosphere Correction



- Correlation scatter plot shows 8.5 mm bias
- No evidence of any scale error



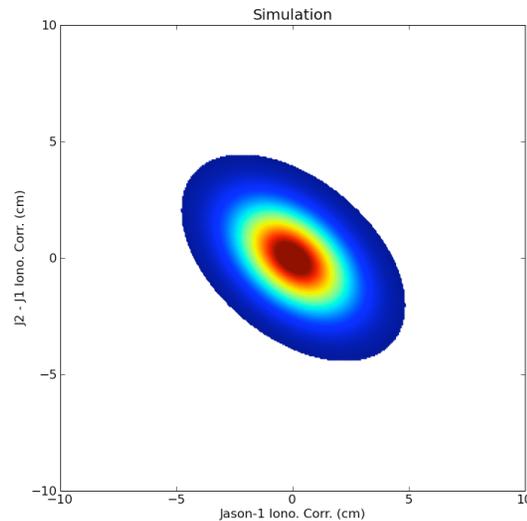
- Difference scatter plot appears to show severe scale error.
- Inconsistent with correlation scatter plot



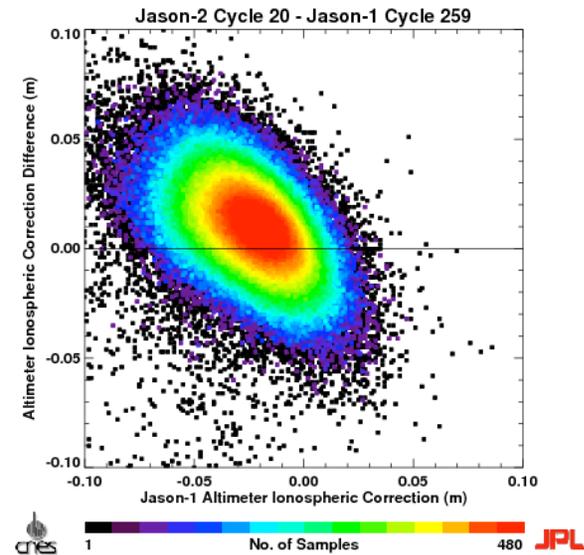
# Ionosphere Correction Statistics



## Simulation



## Data



- Physical and measurement variances estimated from:
  - Jason1/2 iono corr ( $\sigma = 1.57/1.59$  cm)
  - J2-J1 iono. corr. Difference ( $\sigma=1.45$  cm)
- Estimation results
  - Jason-1/2 meas. error: ( $\sigma= 1.01/1.04$  cm)
  - Physical iono. corr. variation: ( $\sigma= 1.20$  cm)

- Data taken during solar minimum
  - Variance mostly due to random, uncorrelated measurement error
- Downward tilt caused by uncorrelated portion of the variances
- Good agreement between simulation and data

- Significant uncorrelated variances in J1/J2 iono corr. during solar minimum cause apparent scale error.



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*Impact of sigma0 bias*

*Range / iono. bias / scale*

*Focus of this talk*

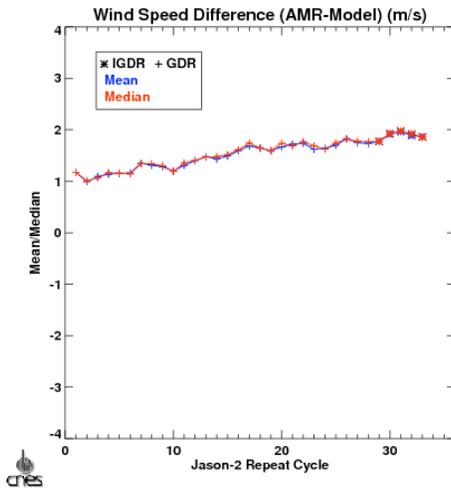
*Radiometer wind speed drift*



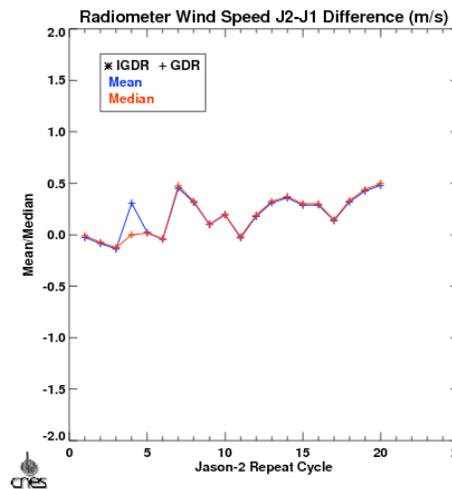


# Radiometer Wind Speed Drift

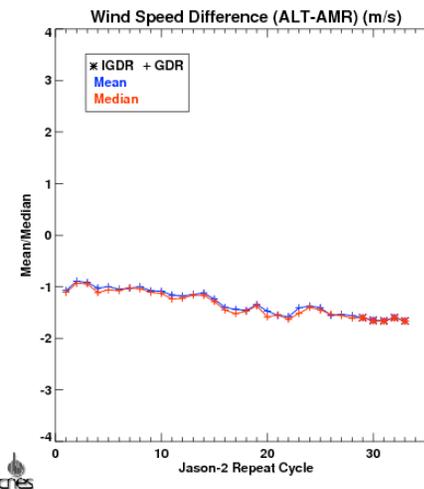
AMR - Model



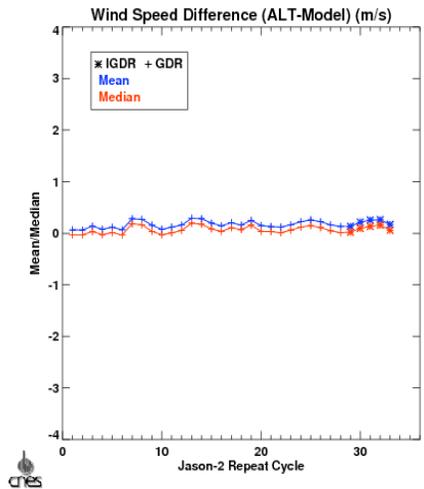
AMR - JMR



ALT - AMR

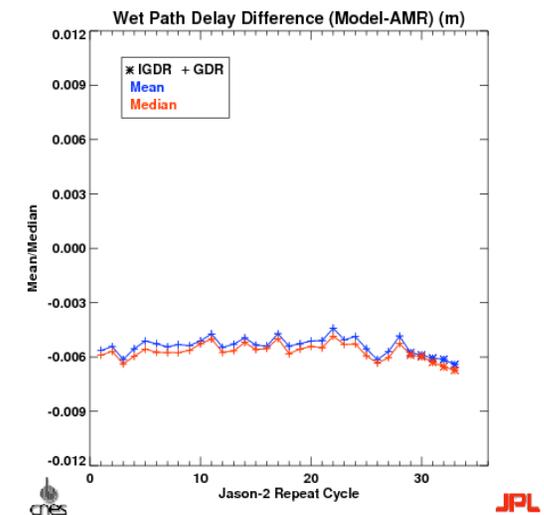


ALT - Model



- AMR wind speed on GDR appears to be drifting with respect to model, altimeter and JMR
- No discernable drift in vicarious cold brightness temperatures or in wet troposphere correction.
- Reason for AMR wind drift under investigation.
  - Retraining wind speed algorithm coefficients reduces drift

Wet Trop. Corr.

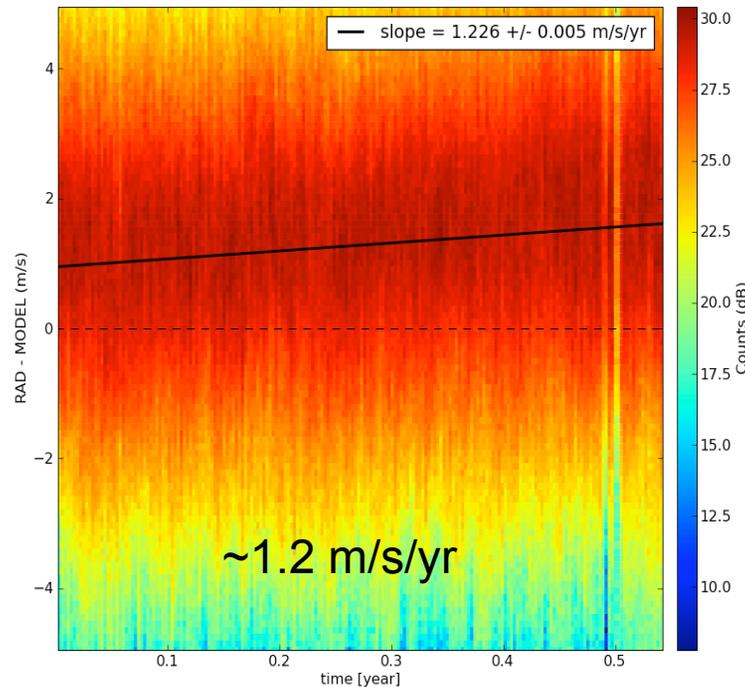




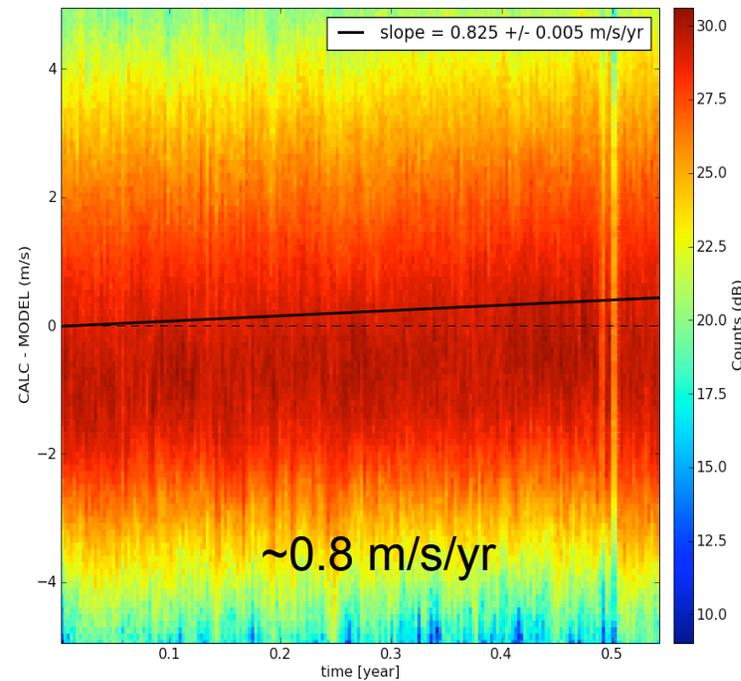
# AMR Wind Speed Drift Quantified



AMR – Model (GDR)



AMR – Model (retrained)



- AMR wind speed on GDR appears to be drifting at  $\sim 1.2$  m/s/yr
- Retrained wind speed algorithm reduces drift to  $\sim 0.8$  m/s/yr
- Radiometer wind speed is used in computing wet path delay.

- Observed radiometer wind speed drift has negligible impact on wet path delay measurement. ( $< 0.05$  mm/yr).



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*Impact of sigma0 bias*

*Range / iono. bias / scale*

*Radiometer wind speed drift*

*Focus of this talk*

Yes

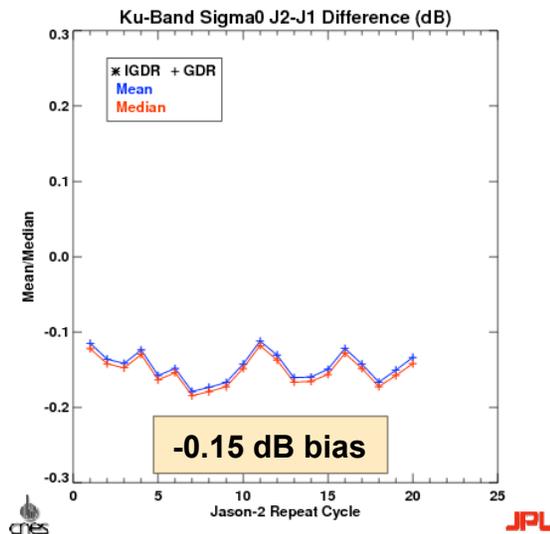
Yes



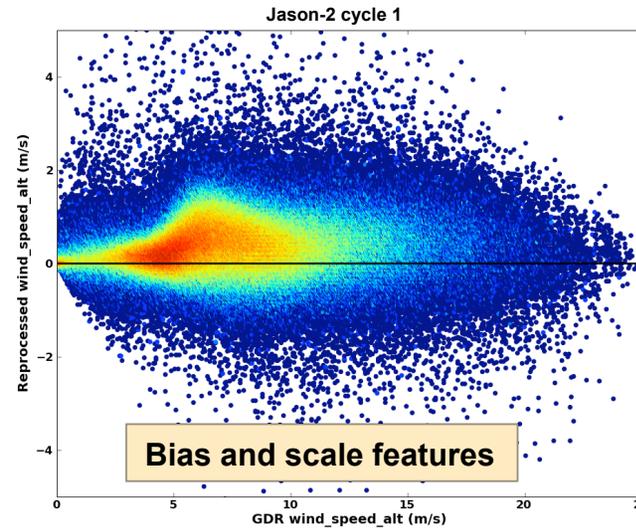
# Impact of Sigma0 Bias



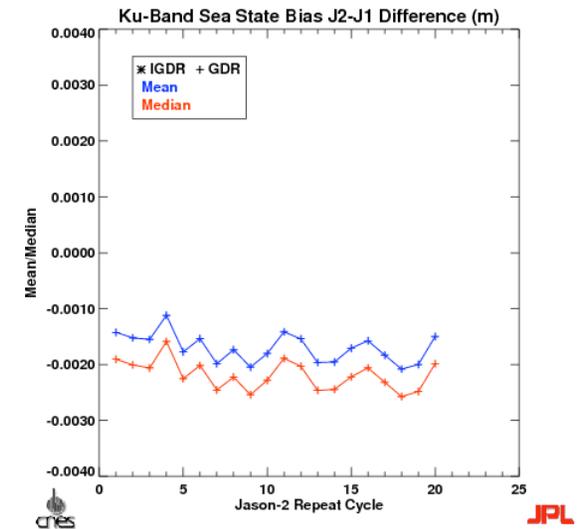
## Sigma0 J2-J1



## Wind Speed J2-J1



## Sea State Bias J2-J1



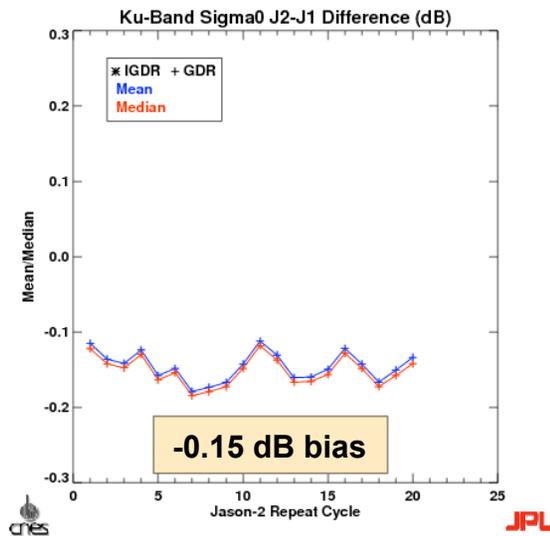
- Observed J2 – J1 sigma0 bias is -0.15 dB
- Expected to impact altimeter wind speed and sea state bias



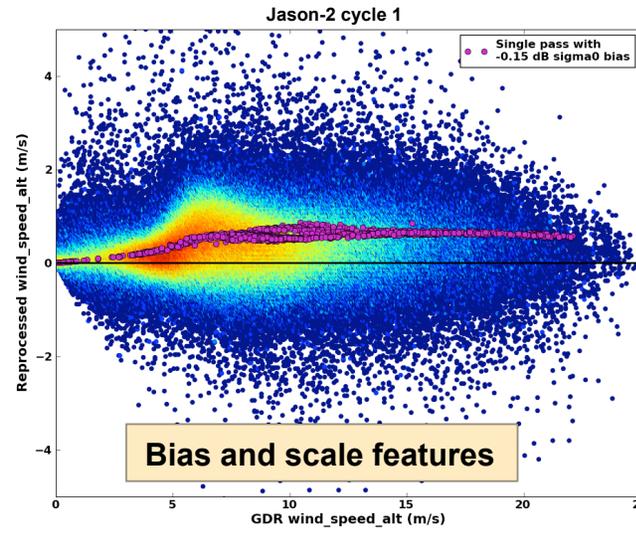
# Impact of Sigma0 Bias



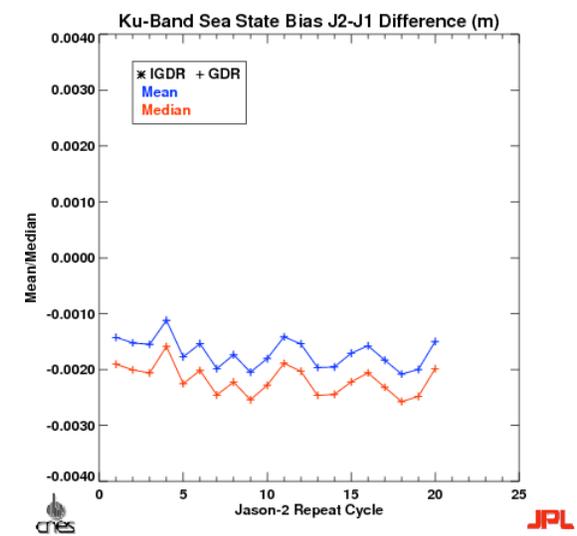
## Sigma0 J2-J1



## Wind Speed J2-J1



## Sea State Bias J2-J1



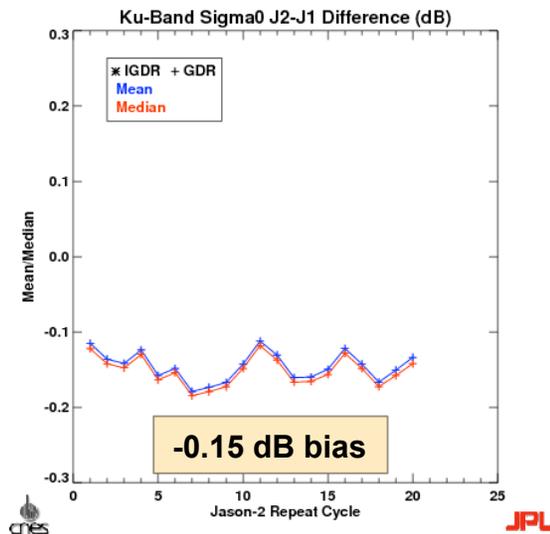
- Observed J2 – J1 sigma0 bias is -0.15 dB
- Expected to impact altimeter wind speed and sea state bias
- Reprocessing J2-cycle1,pass1 with 0.15 dB sigma0 bias replicates features of scatter plot



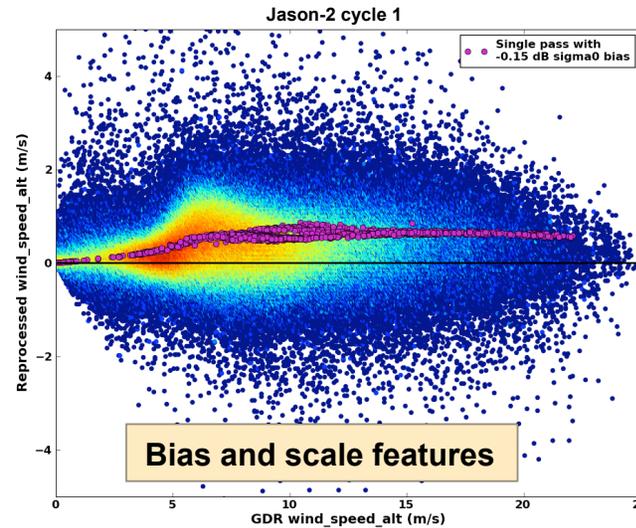
# Impact of Sigma0 Bias



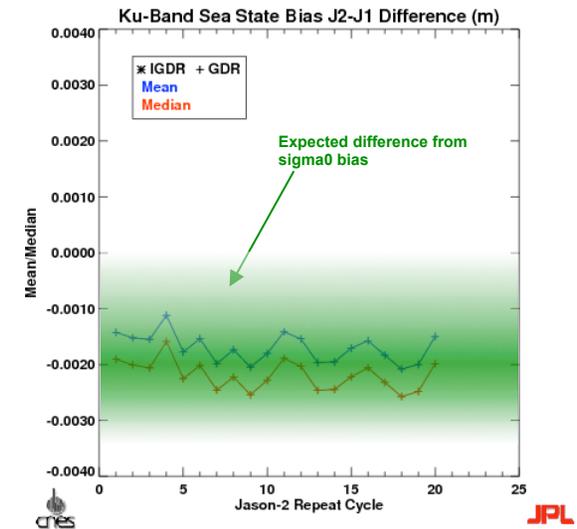
## Sigma0 J2-J1



## Wind Speed J2-J1



## Sea State Bias J2-J1



- Observed J2 – J1 sigma0 bias is -0.15 dB
- Expected to impact altimeter wind speed and sea state bias
- Reprocessing J2-cycle1,pass1 with 0.15 dB sigma0 bias replicates features of scatter plot
- Wind speed spread consistent with observed J1/J2 differences in sea state bias



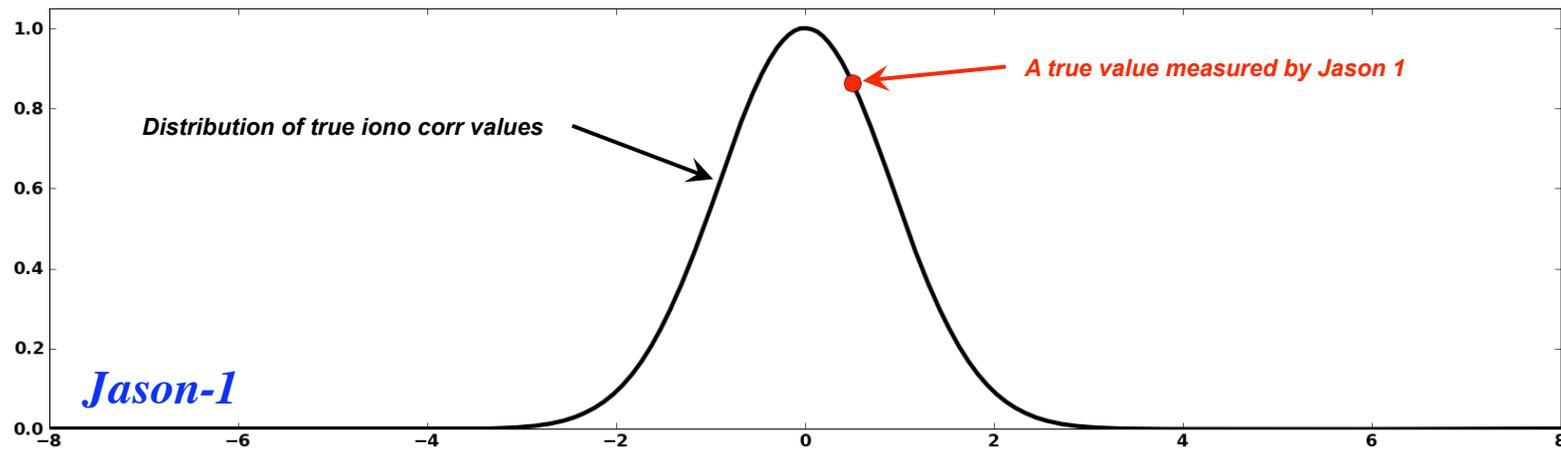
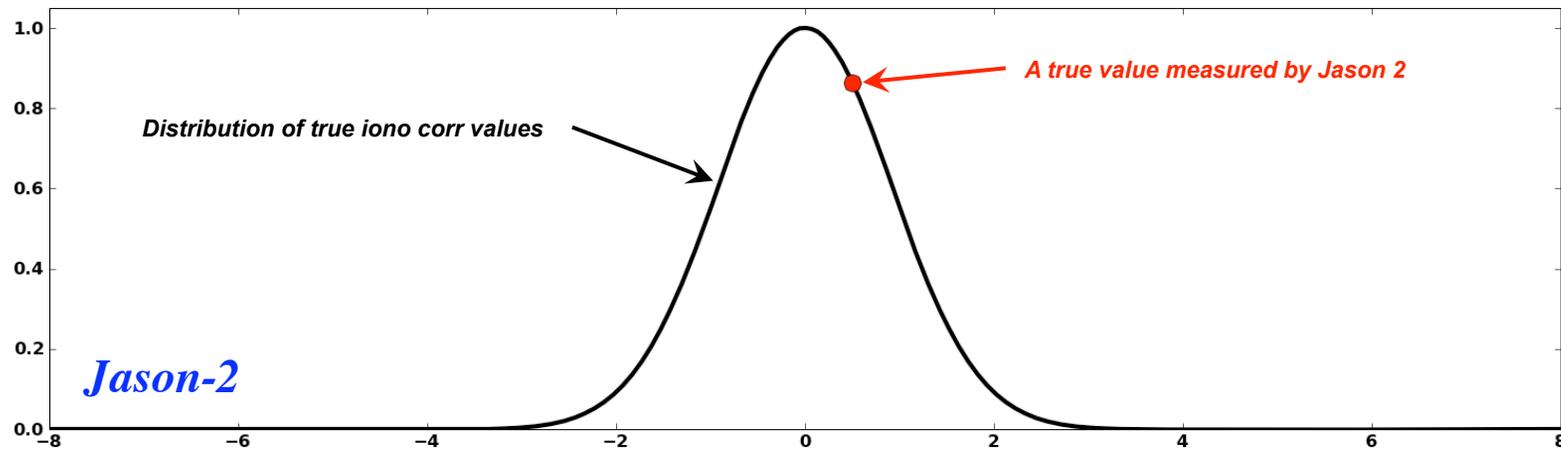
# Summary and Conclusions



- J2-J1 ionosphere correction is biased by 8.5 mm due to different relative biases in Ku and C band ranges.
  - Ku-Band: 84 mm
  - C-Band: 131 mm
- Jason-2 has a ~ 4.5 cm bias between Ku and C band ranges
- Apparent scale error in J2-J1 ionosphere differences is statistical artifact current low ionosphere conditions (solar minimum).
- AMR wind speed appears to be drifting at 1.2 m/s/yr
  - Still under investigation
  - Negligible impact on wet path delay / sea level anomaly
- J2-J1 sigma0 bias observed to be -0.15dB
  - Likely contributing to J2-J1 altimeter wind speed bias/scale peculiarities.
  - Likely contributing to observed J2-J1 differences in the sea state bias.

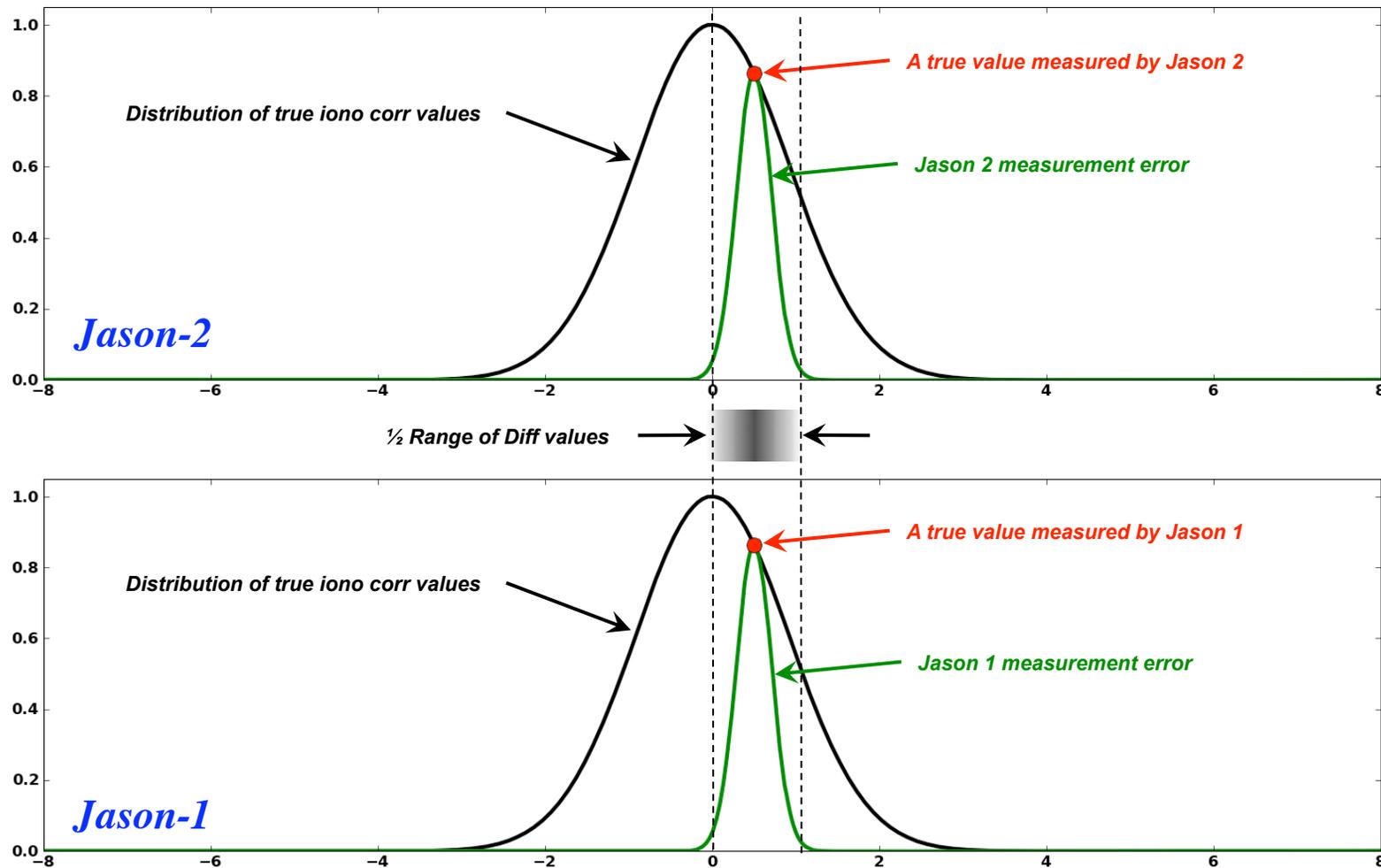


# Differences of Noisy Data





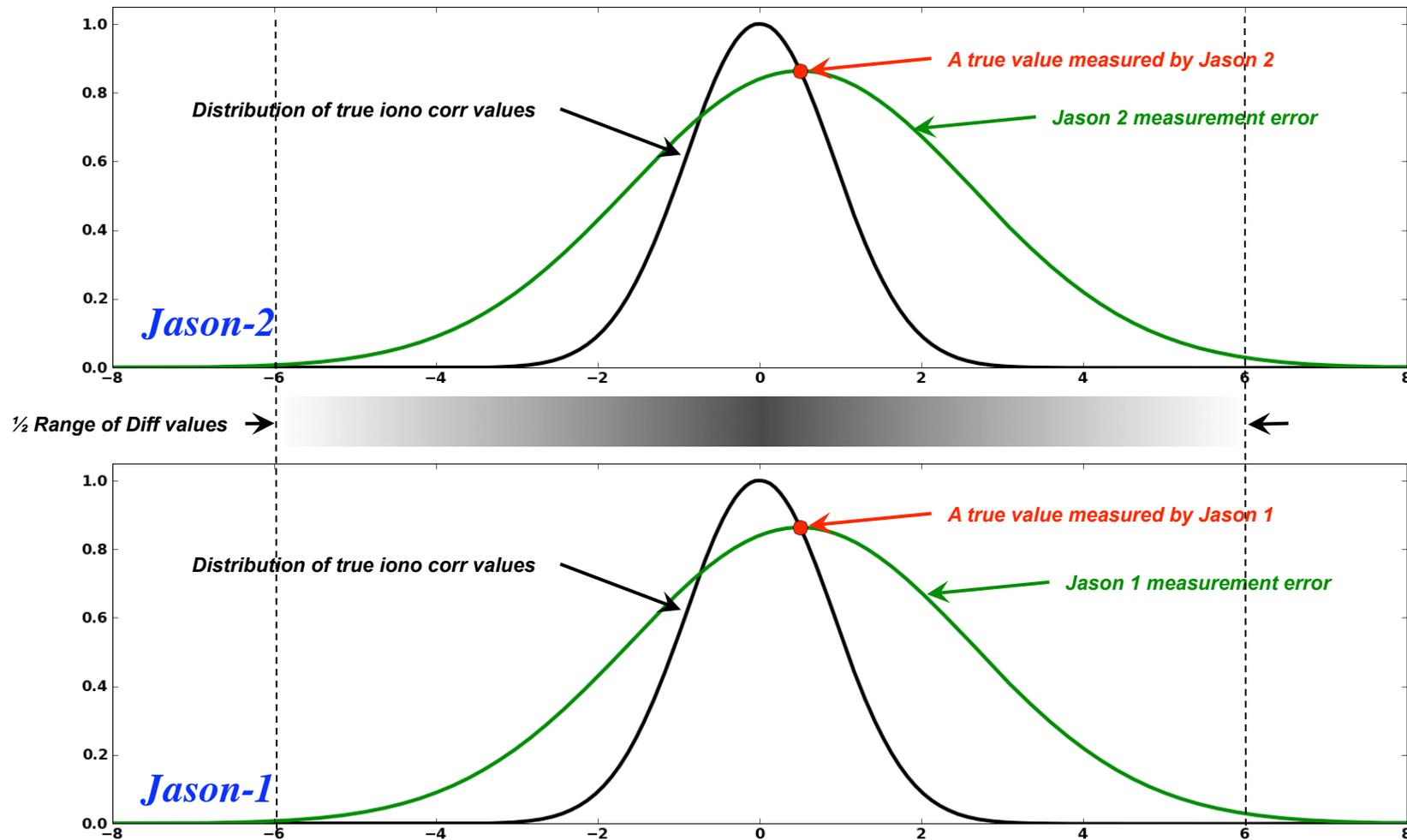
# Differences of Noisy Data



- Difference confined to narrow range independent of true value.



# Differences of Noisy Data



- Difference value driven by distance from mean. Looks like scale error.