Validation of Jason and Topex Microwave Radiometer Wet Path Delay Measurements Using GPS, SSM/I, and TMI

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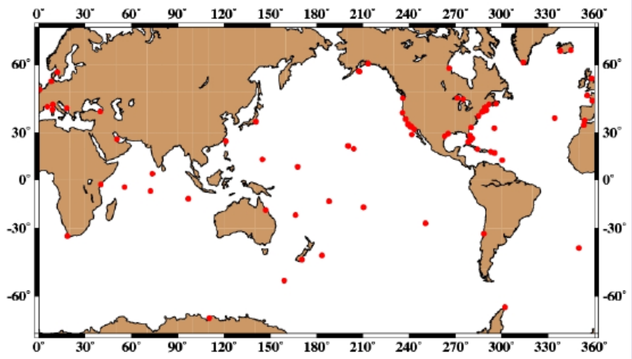
Abstract

Recalibration of the Jason and Topex Microwave Radiometers (JMR and TMR) has been performed over the last year by S. Brown et al. The recalibrated JMR and TMR wet path delay measurements are validated through comparisons to respective measurements from terrestrial Global Positioning System sites, the Special Sensor Microwave Imager onboard the Defense Meteorological Satellite Program satellites, and the Tropical Rainfall Measuring Mission's Microwave Imager. Intercomparisons of the TMR and JMR data during the tandem phase and collinear phases are also performed. From these various comparisons we provide estimates of any remaining errors in the recalibrated data such as scale errors, geographically correlated errors, and temporal errors such as drift or yaw state effects.

Independent Wet Path Delay Measurements

Four independent measurements of wet path delay are used to validate those from the Topex and Jason Microwave Radiometers (TMR and JMR):

- **ECMWF Model**
  - Adopt model as provided on the respective GDRs.
- **Coastal Global Positioning System Sites**
  - 1-87 sites per cycle available for Topex/Poseidon mission.
  - Only use TMR-GPS when T/P on original ground track.
  - 87 sites per cycle available for duration of Jason-1 mission.
  - Some sites have more than one nearby overflight.

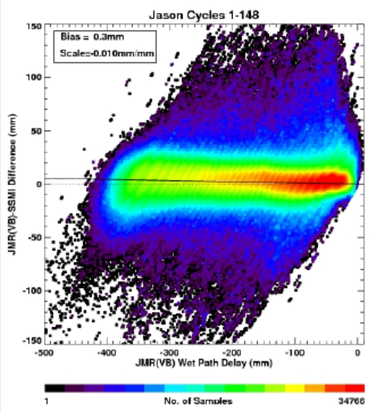


- **Special Sensor Microwave Imager (SSMI) on Defense Meteorological Satellite Program (DMSP)**
  Available for duration of Topex/Poseidon and Jason-1 mission.
- **Tropical Rainfall Measuring Mission's Microwave Imager (TMI)**
  Launched November 1997.
  Available from Topex/Poseidon cycle 193 and for duration of Jason-1 mission.

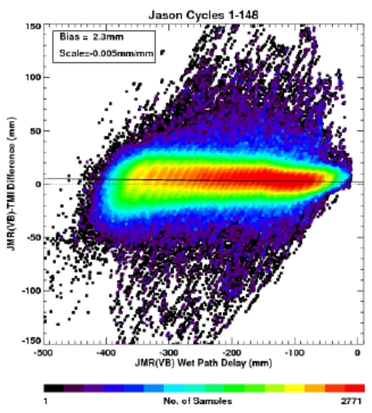
- **TMR data used in this study are as provided on the MGDRs.**
- **No corrections are applied for the known drift and dependence on satellite attitude regime.**

Scale of JMR Measurements

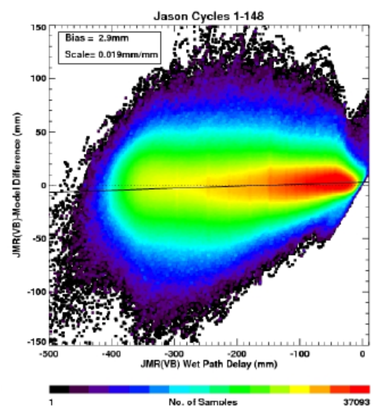
JMR-SSMI



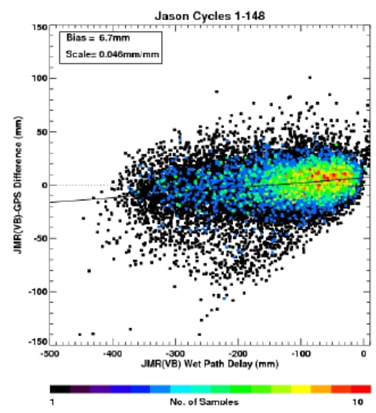
JMR-TMI



JMR-Model



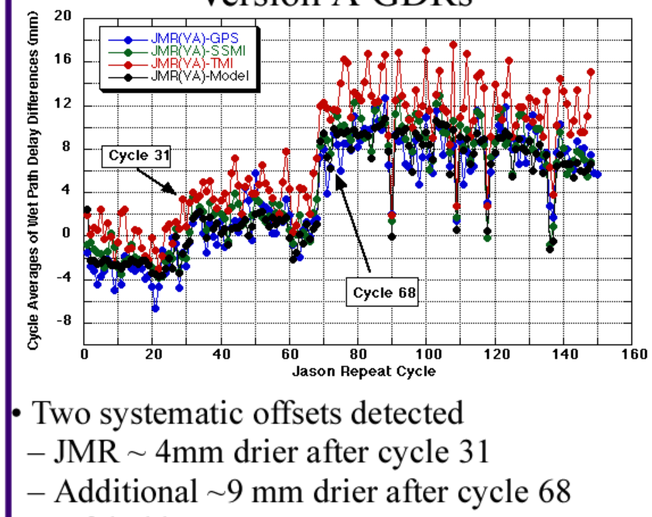
JMR-GPS



- JMR-SSMI, JMR-TMI, and JMRModel all have bias of < 3mm.
- JMR-SSMI and JMR-TMI indicate scale differences of < 5mm (JMR drier) over full wet path delay range, 0-500m.
- JMR-ECMWF and JMR-GPS indicate scale differences of 10-20 mm (JMR wetter) over full wet path delay range.
- Plans to introduce comparisons to radiosondes to determine if scale error exists in JMR.

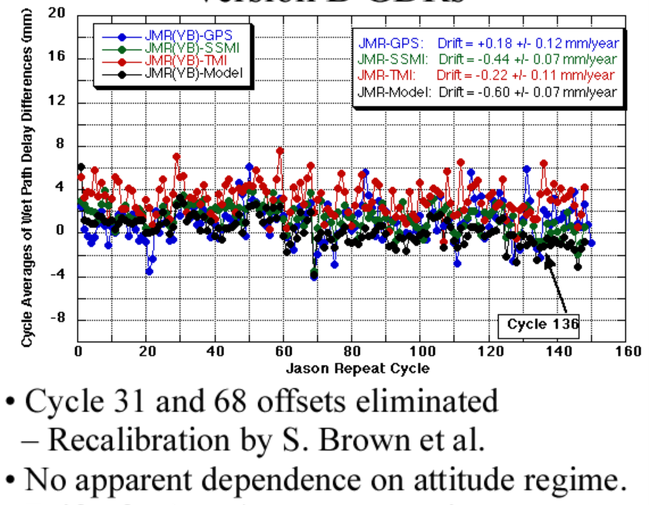
Temporal Variations in JMR

Version A GDRs



- Two systematic offsets detected
  - JMR ~ 4mm drier after cycle 31
  - Additional ~9 mm drier after cycle 68 safehold event.
- Dependence on satellite attitude regime (sinusoidal vs. fixed) appears after cycle 68.

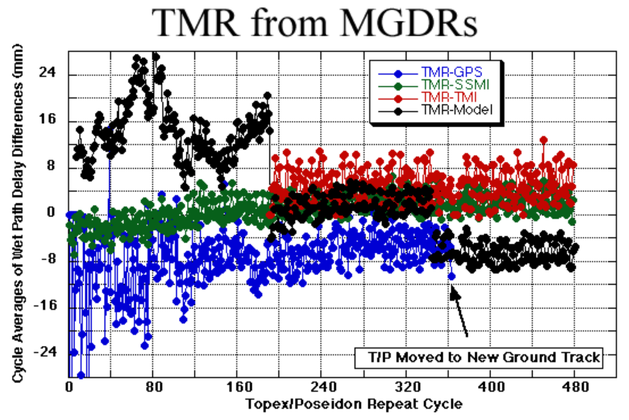
Version B GDRs



- Cycle 31 and 68 offsets eliminated
  - Recalibration by S. Brown et al.
- No apparent dependence on attitude regime.
- Drift of < 1mm/year may remain.
  - Distinct in JMR wind speeds.
- Offsets in brightness temperatures detected after cycle 136 safehold event.
  - Effect on wet path delay < 2mm.

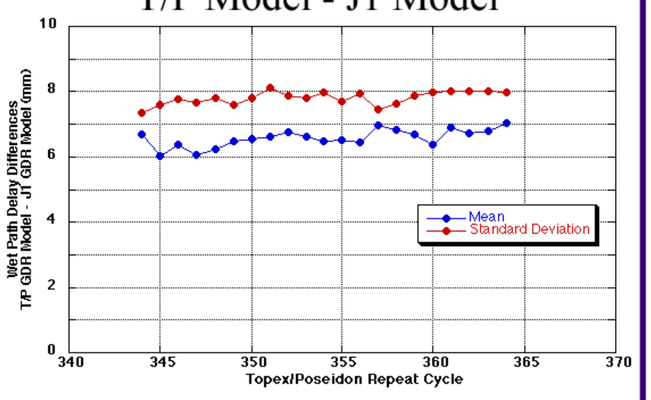
Temporal Variations in TMR

TMR from MGDRs

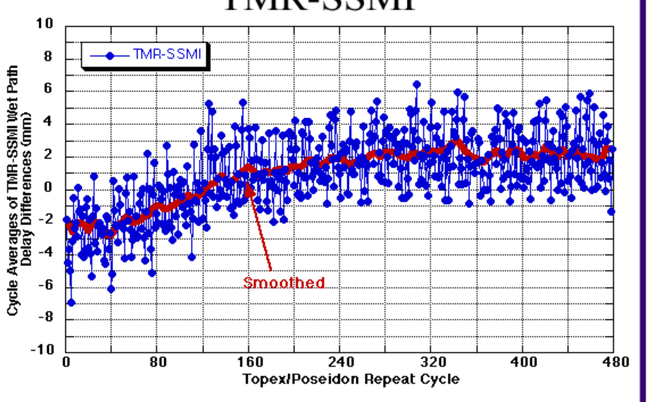


- Steps in differences w.r.t. model caused by changes to model.
- TMR-Model biased -8.2 mm w.r.t. TMR-SSMI after cycle 344.
  - In contrast, JMR-Model is biased -1.2 mm w.r.t. JMR-SSMI during same period.
  - Caused by bias between models provided on T/P and J1 GDRs of 6.6 mm (T/P drier).
- TMR drift of 0.7-0.9 mm/year to ~cycle 280 clear in TMR-SSMI.
  - Known cause is drift in all 3 brightness temperatures, primarily 18 GHz channel.
- Dependence on satellite attitude regime clear in all four differences.
  - ~ 4 mm peak to peak.
- TMR-JMR has mean of ~ 1 mm, and standard deviation of 3-4 mm.
- TMR-GPS biased by ~-8 mm with respect to TMR-SSMI
  - Inconsistent with JMR-GPS vs. JMR-SSMI during same period where bias is < 1mm.

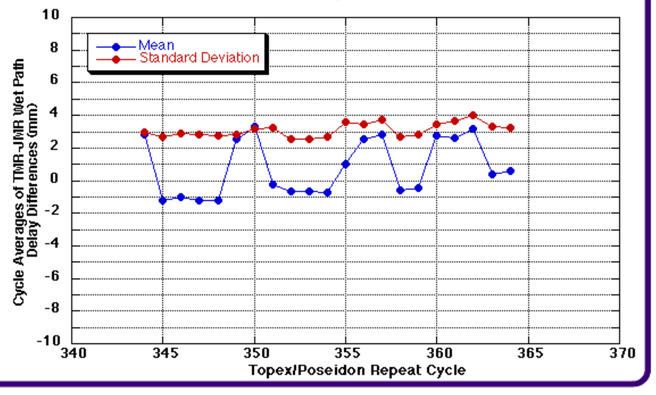
T/P Model - J1 Model



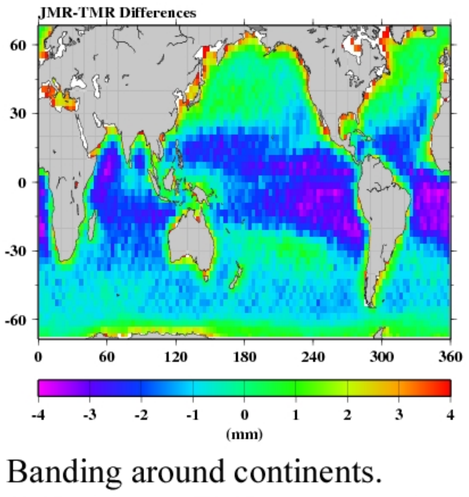
TMR-SSMI



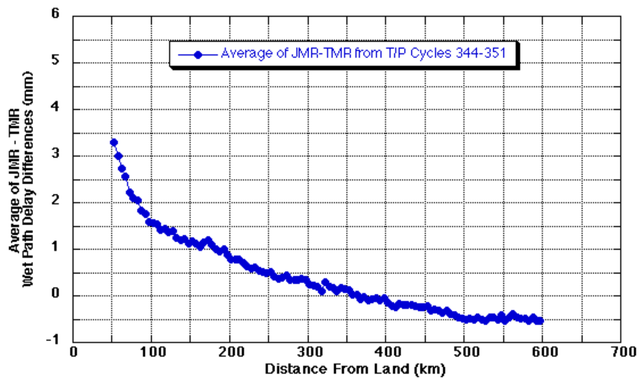
TMR-JMR



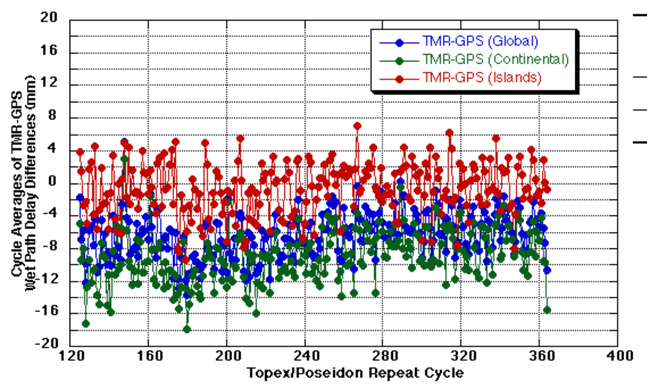
Geographically Correlated Errors in JMR or TMR



- Banding around continents.
- JMR drier or TMR wetter, or both.



- JMR-TMR differences progressively decrease by 4 mm from land to 600 km away from land.



- Offset between TMR-island GPS and TMR-continental GPS suggest error is with TMR.

Average of Differences Between Radiometer and Independent Measurements (mm)

Radiometer	Repeat Cycles	SSMI	TMI	Global GPS	Island GPS	Continental GPS
JMR	1-148	1.5	3.2	1.0	-1.2	1.7
TMR	240-364	2.2	4.6	-5.4	0.0	-7.7

- JMR-island GPS and JMR-continental GPS are statistically identical.
  - Standard deviations are 3 and 2 mm.
- Difference between TMR-island GPS and TMR-continental GPS is significant.
- Suggests geographically correlated errors exist in TMR, and not in JMR.
- Expected to be removed when applying JMR APC algorithm (e.g., Obligis et al.) to TMR.