Initial On-orbit Performance Assessment of the Advanced Microwave Radiometer and Performance of JMR GDR-C

Shannon Brown, Shailen Desai, Wenwen Lu

Jet Propulsion Laboratory

Shannon.T.Brown@jpl.nasa.gov

Introduction

- **Update to JMR GDR-C from GDR-B**
- **AMR Performance Assessment**
  - **Improvements to AMR**
  - **Comparison with JMR GDR-C**
  - **ARCS and plans forward**
    - **A**utonomous **R**adiometer **C**alibration **S**ystem

Updates to JMR on GDR-C

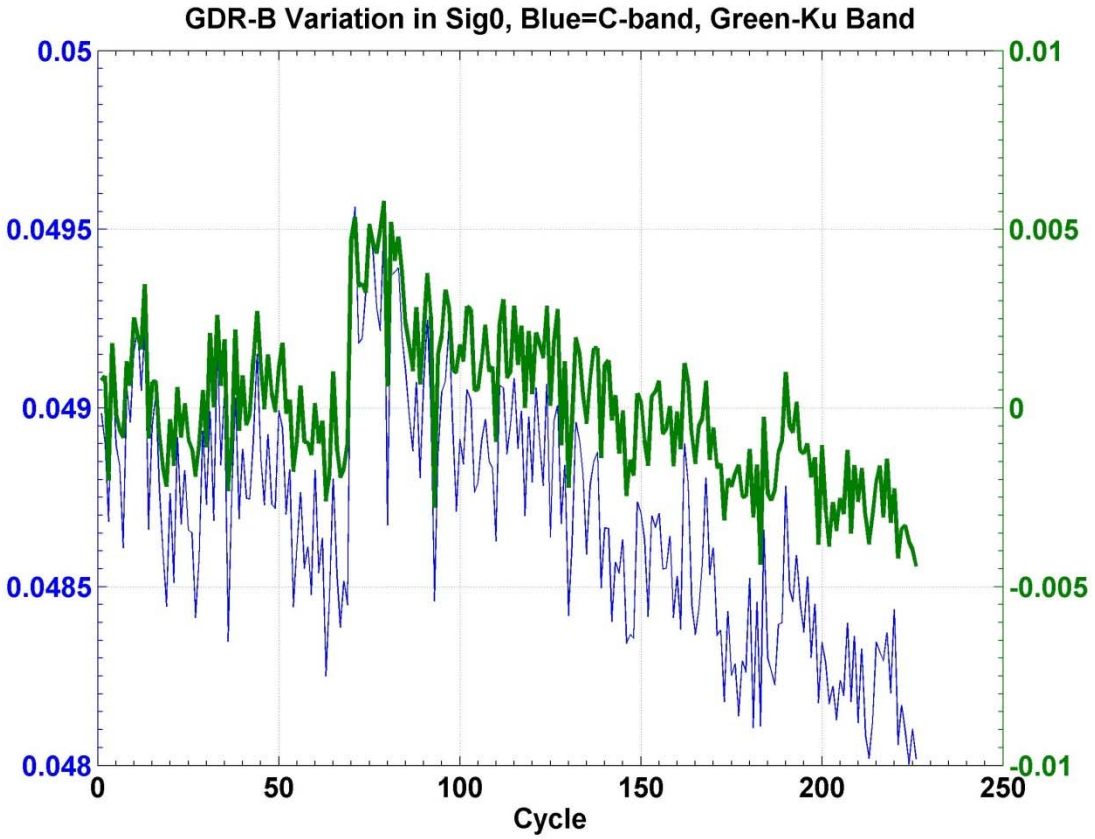
- GDR-C
  - Implemented time-variable calibration coefficients with new coefficients once per cycle
  - Adjusted PD algorithm coefficients to remove scale error
    - error in coefficients carried over from an error in the post-launch calibration of the TMR

- Largest changes in GDR-C are in 34.0 GHz channel, so there is little change in PD time series from GDR-B to GDR-C
  - GDR-C biased by ~4mm drier from GDR-B due to correction of scale error

- Biggest impact of GDR-C is correction of scale error and removal of sigma0 drift

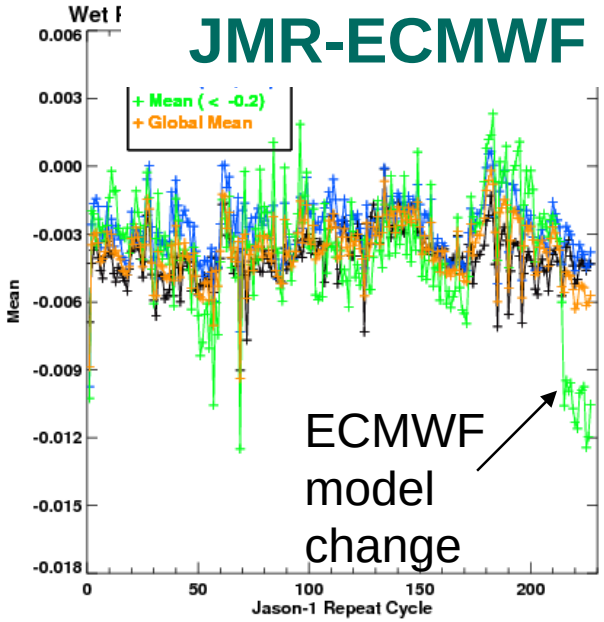
JMR GDR-B (Sigma0)

- Drift in 34.0 GHz channel after cycle 70 not accounted for in GDR-B calibration
  - Minimal effect on PD
- Shows up as drift in JMR derived Sigma0, which results in a SSH drift



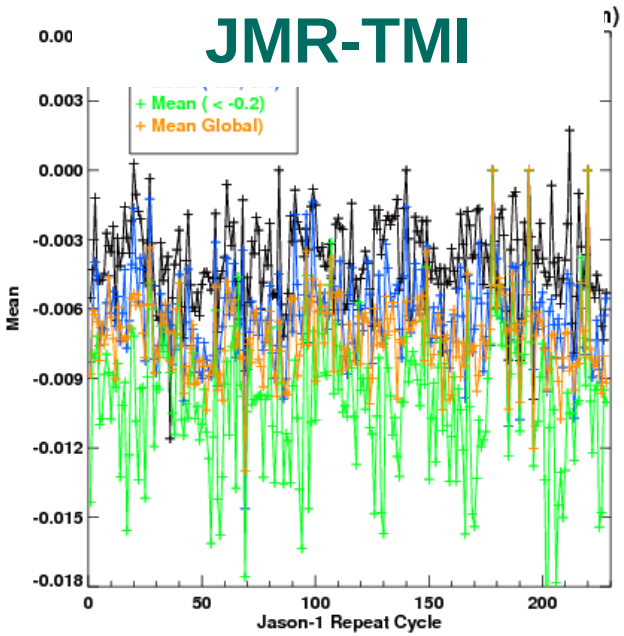
GDR-C Path Delay Comparisons

JMR-ECMWF

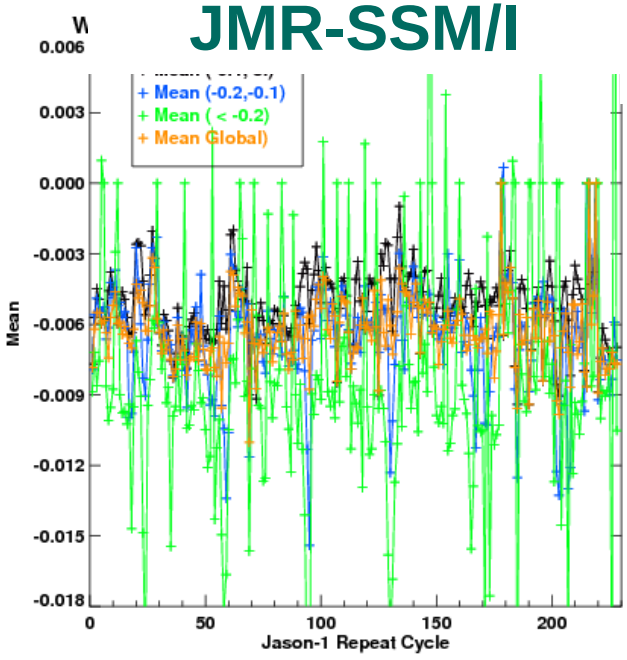


- No change in JMR PD scale error over time (e.g. gain and bias errors properly accounted for)

JMR-TMI



JMR-SSM/I

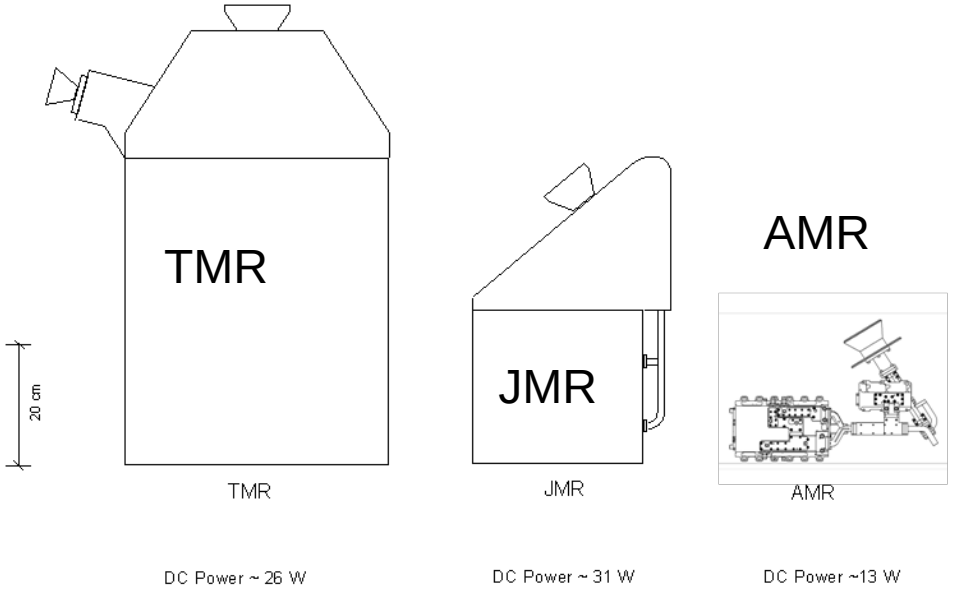


- No significant scale error observed between JMR and Radiosondes and JMR and ECMWF (cycles 1-215)

Jason-2 Radiometer Improvements

Ocean Surface Topography Mission

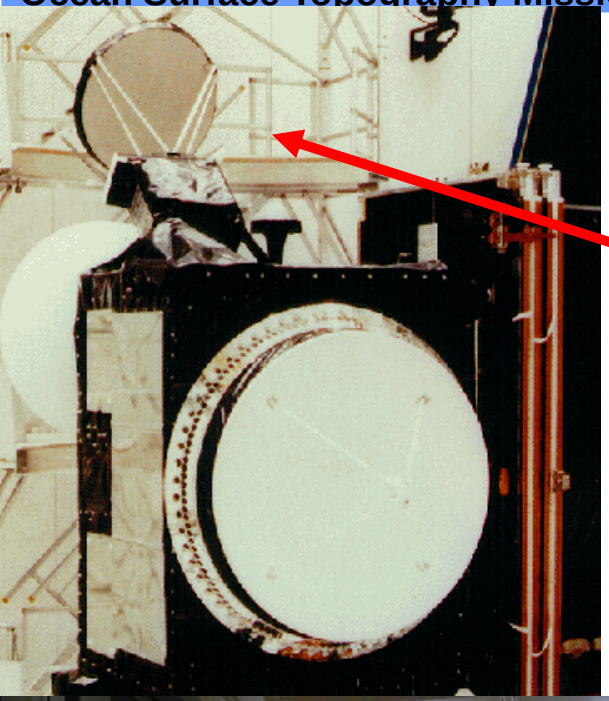
- Several significant improvements made to radiometer on Jason-2
  - AMR - Advanced Microwave Radiometer
- 1 meter, unblocked reflector to improve coastal resolution and reduce geographically correlated errors
  - Compared to partially blocked 0.6 m reflector for JMR/TMR
- Active thermal control to improve calibration stability
- Significant reduction in 1Hz measurement noise
- Improved land flagging algorithm



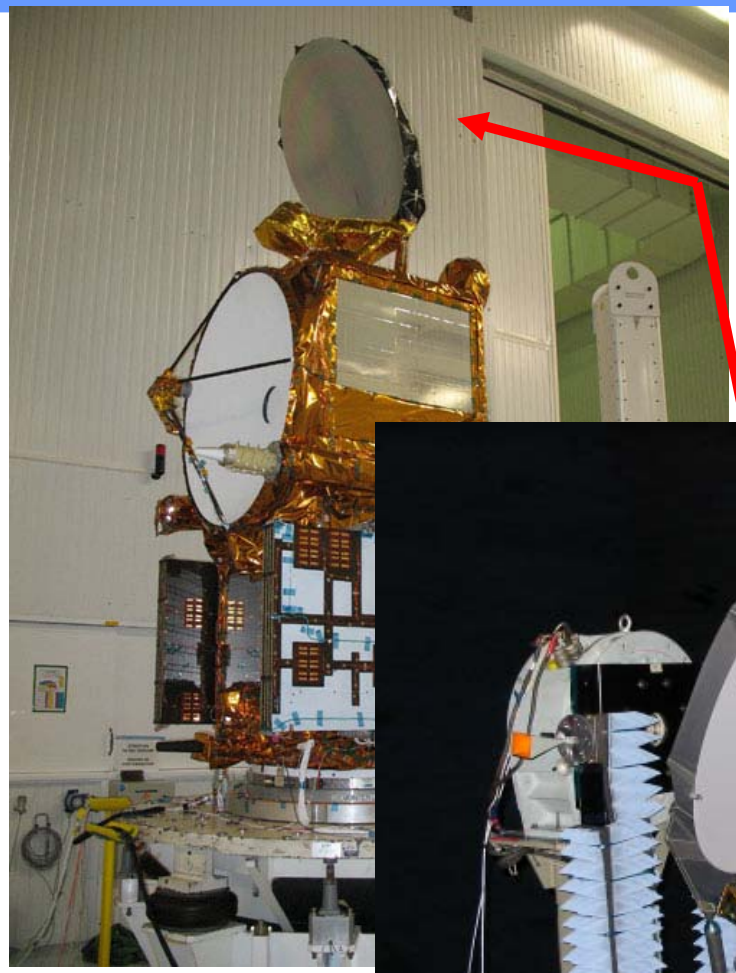
*AMR system fully redundant, JMR data and power redundant, but only one redundant receiver channel (23.8G Hz)

Jason-2 AMR

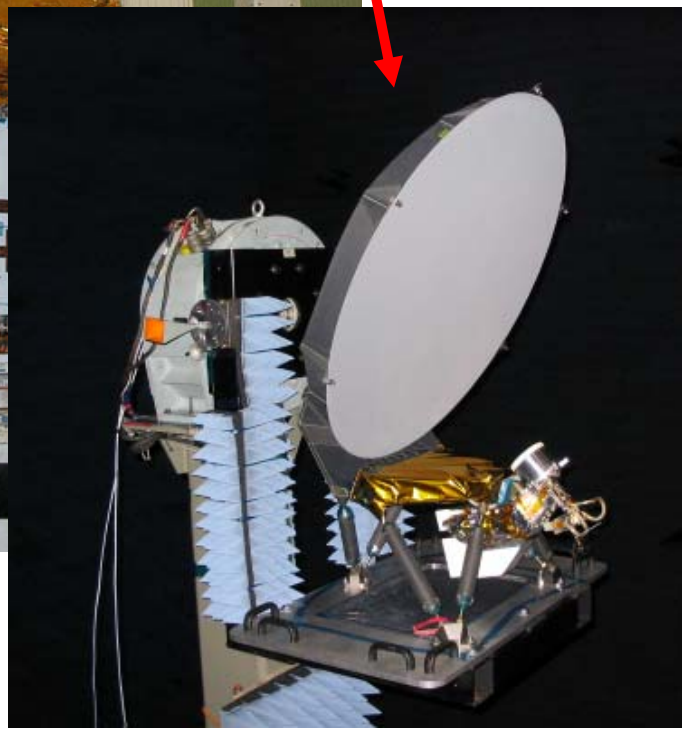
Ocean Surface Topography Mission

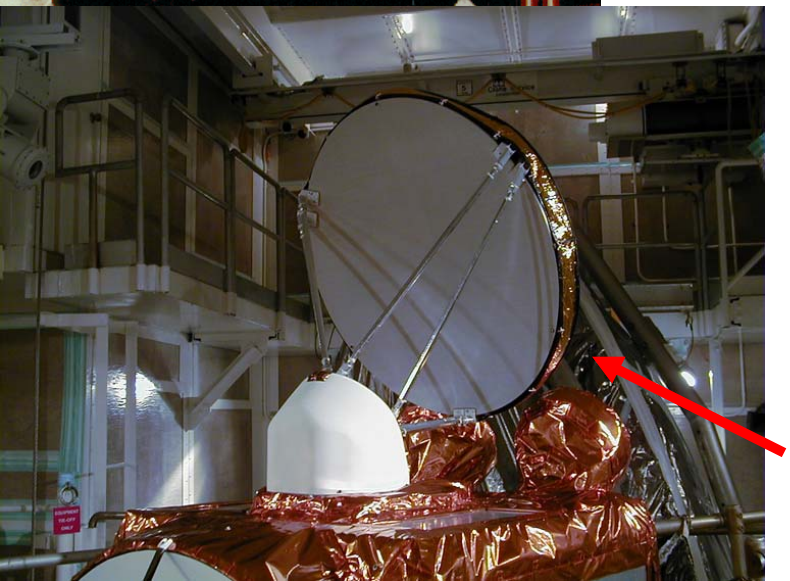


TMR



AMR



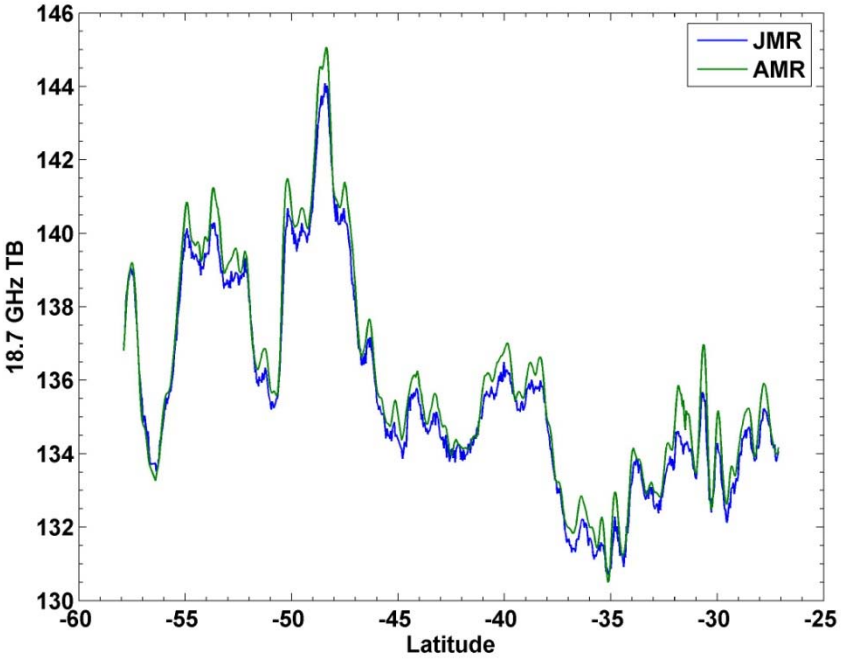


JMR

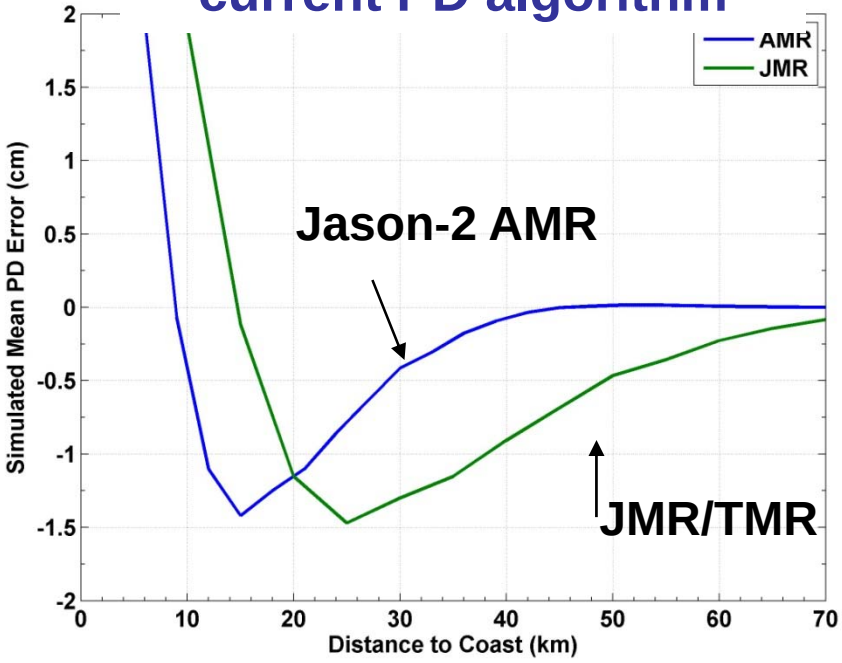
AMR Antenna Improvements

- Spatial resolution nearly doubled from TMR and JMR
  - ~26 km for AMR compared to ~50 km for JMR/TMR
- 98-99% of energy received within 75 km of boresight, compared to about 92-93% for TMR/JMR

AMR & JMR 18.7 GHz TBs



PD Error near coast with current PD algorithm



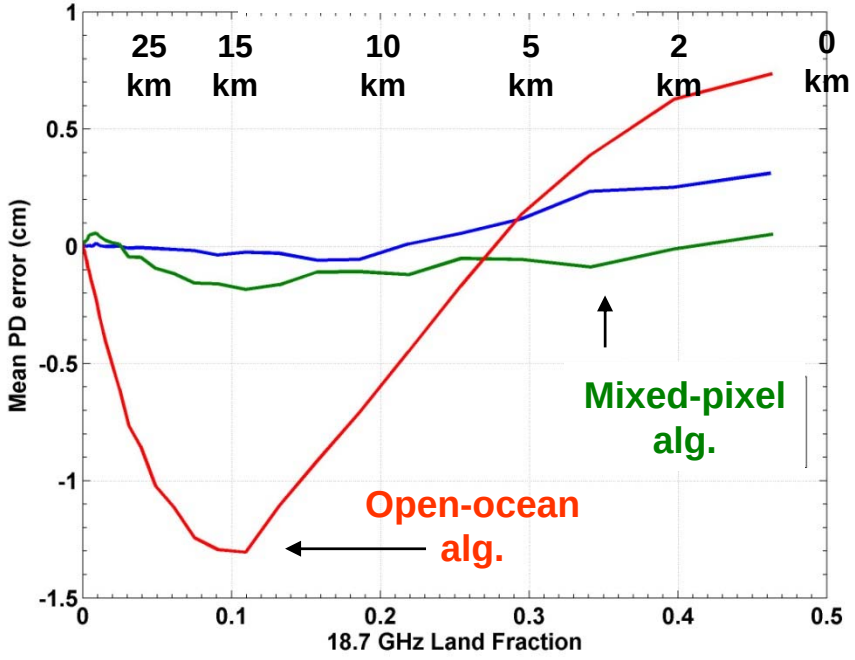
New AMR Coastal PD Algorithm

Ocean Surface Topography Mission

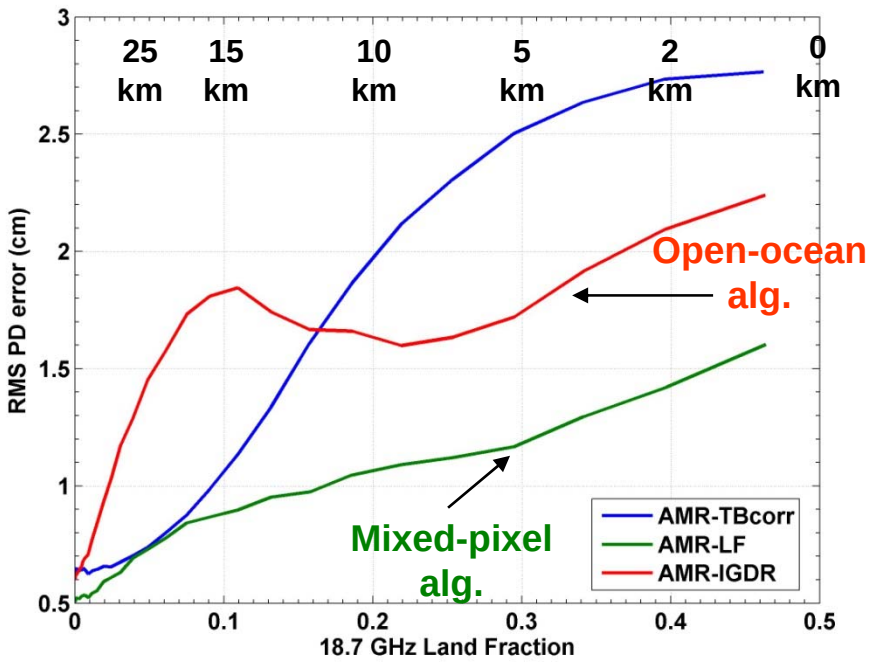
- New mixed pixel path delay algorithm developed for AMR to more accurately retrieve PD in coastal zone
- RMS error below 1.2 cm to within 5km from coast for new algorithm

- See talk and poster in “Instrument Processing” splinter for more information

ΔPD Mean



ΔPD RMS

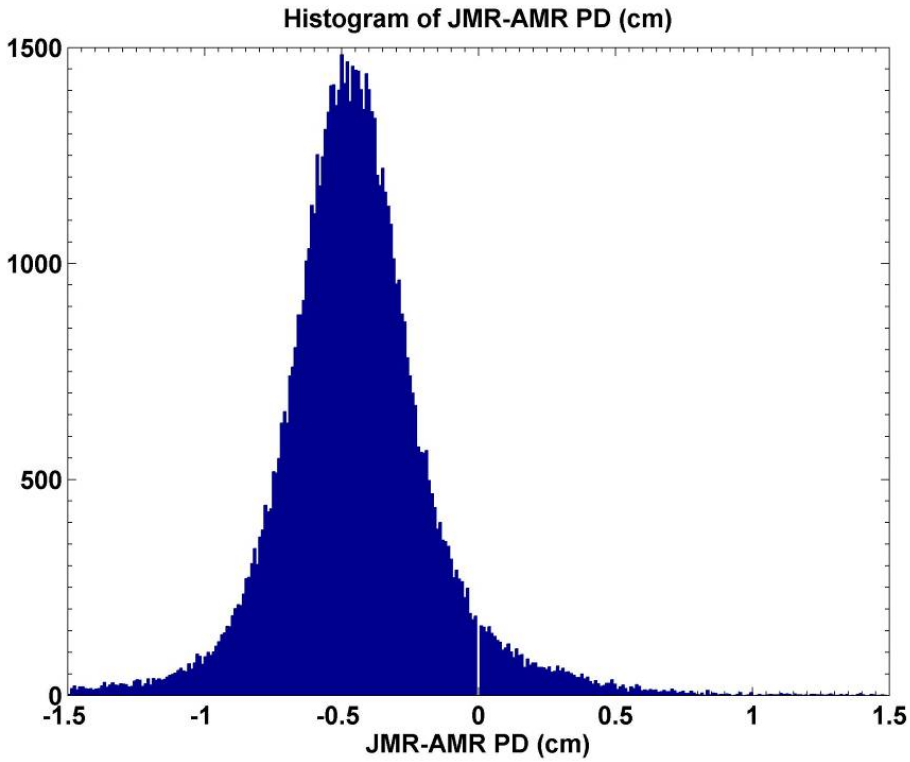


IGDR “Day 1” Calibration JMR-AMR

- AMR “Day 1” calibration had only small residual biases between JMR and AMR TBs
  - +0.4 K at 18.7 GHz
  - - 0.4 K at 23.8 GHz
  - +0.1K at 34.0 GHz

- Translates into 0.45 cm of PD bias between JMR and AMR on current IGDRs (AMR wetter)
  - 3 mm standard deviation between JMR and AMR

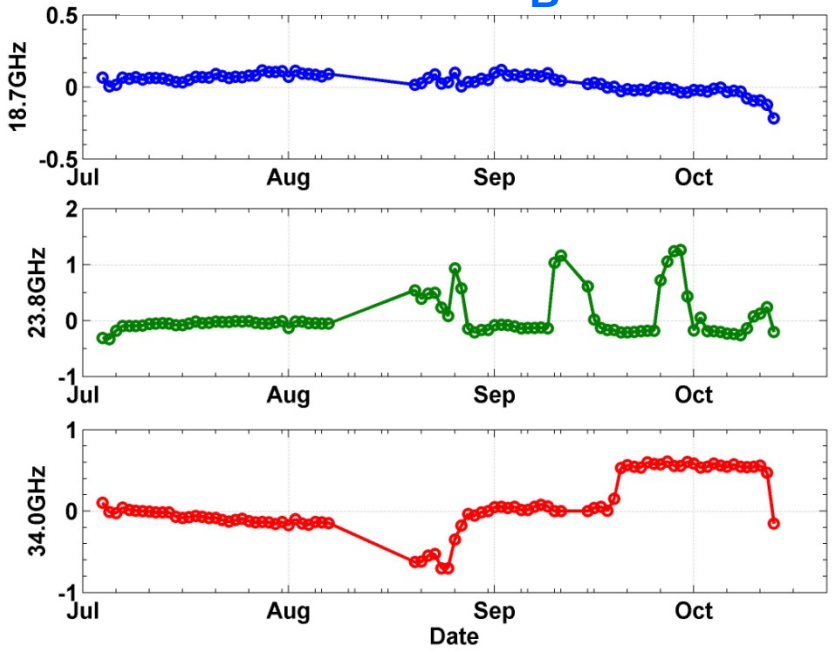
- AMR calibration has been tuned in preparation for GDRs



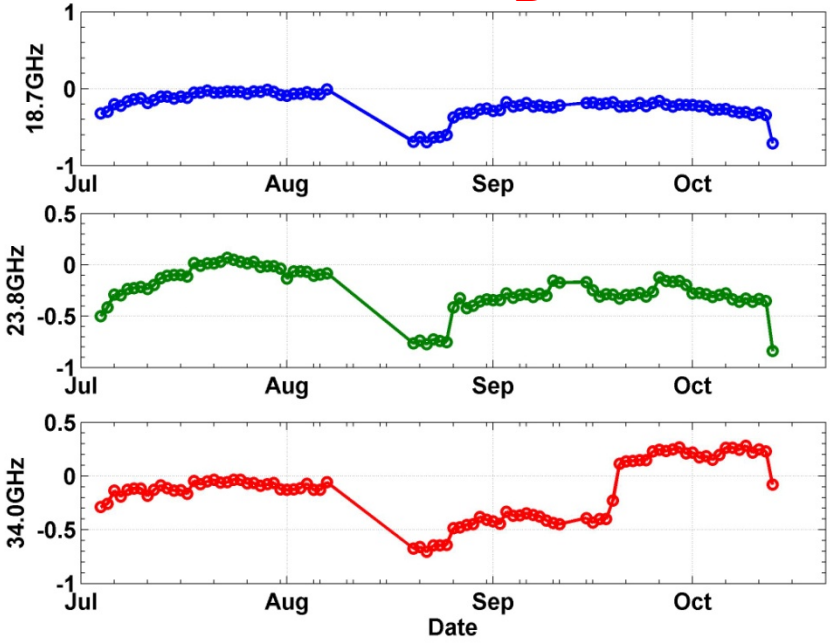
AMR-JMR TB Comparisons

- **Instabilities in JMR observed after safehold**
  - **Periodic 1K shifts in JMR 23.8 GHz cold T_Bs**
- **Small < 0.1K drift in AMR observed over first 2 months of mission**
- **0.5 K offset shift in AMR 34.0 GHz channel mid-way through September – will be accounted for in ARCS processing**

Ocean T_Bs

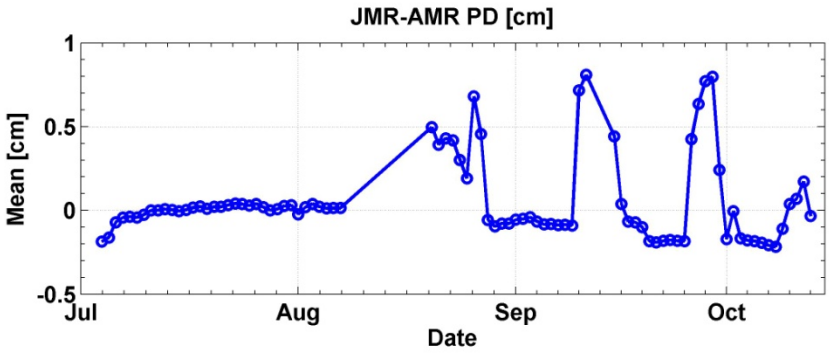


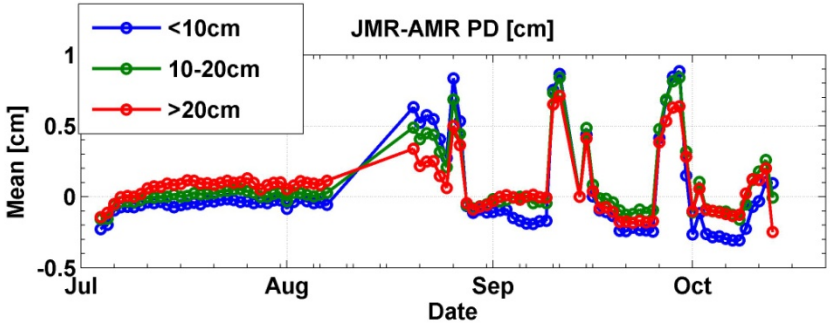
Land T_Bs

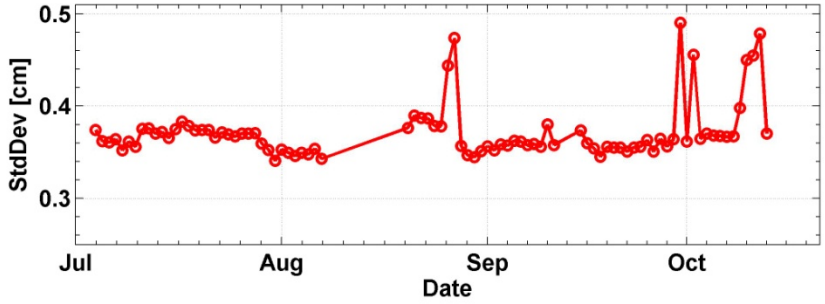


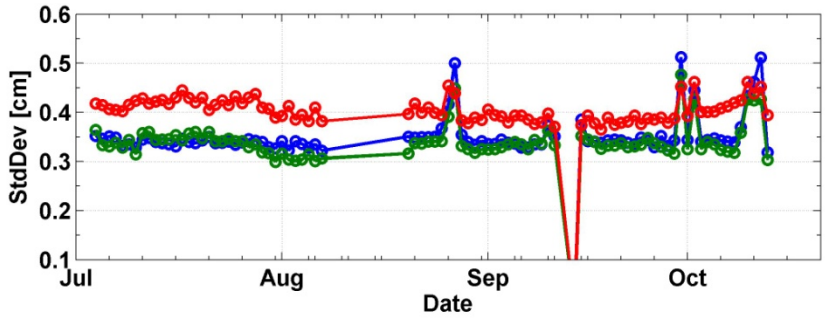
AMR-JMR PD Comparisons

- **Instabilities in JMR observed after safehold**
  - **Periodic 5mm shifts in PD**
- **Small << 1mm drift in AMR observed over first 2 months of mission**
- **Shift in AMR 34.0 GHz channel translates into < 1mm of PD error**
  - **Will be corrected prior to GDR production by ARCS processing**





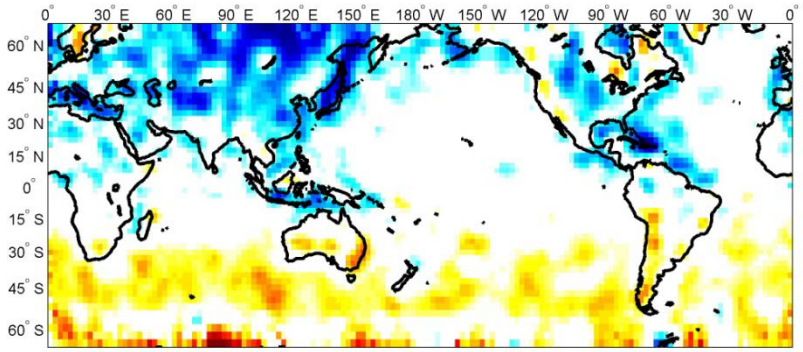




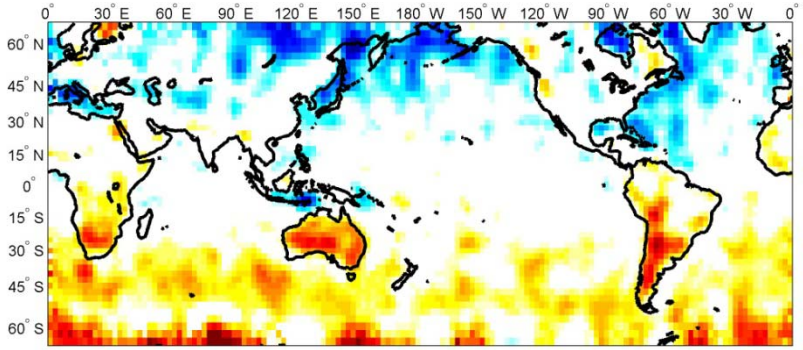
Regional AMR-JMR TB Comparisons

- Regional comparisons show good agreement between JMR and AMR
- Systematic biases arise in part from residual antenna pattern correction errors and from different sensor resolutions
  - Evident in southern hemisphere oceans
  - Also over Antarctic ice sheets and over land
- Plan to use AMR to correct JMR and TMR APC residual errors

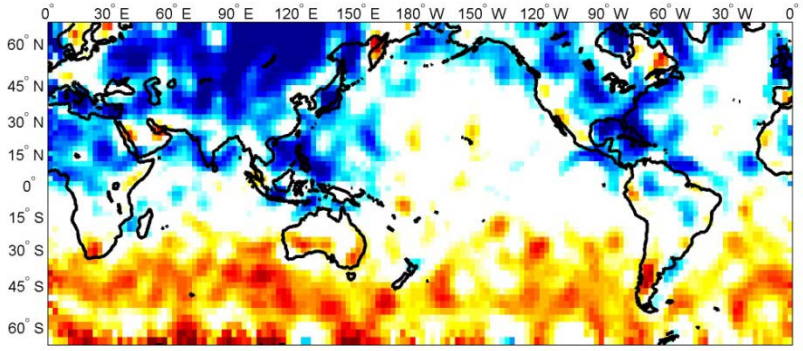
18.7 GHz

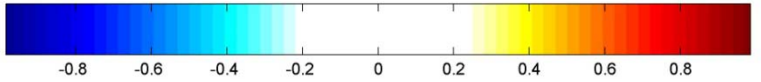


23.8 GHz

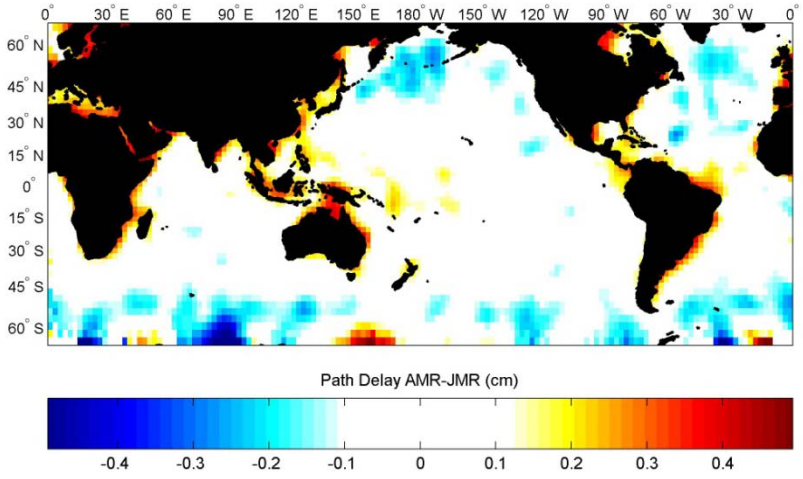


34.0 GHz



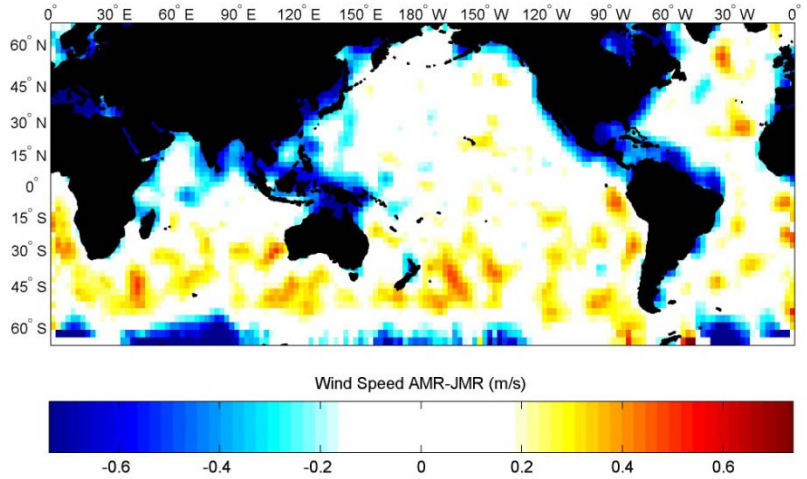


Regional AMR-JMR Geophysical Comparisons



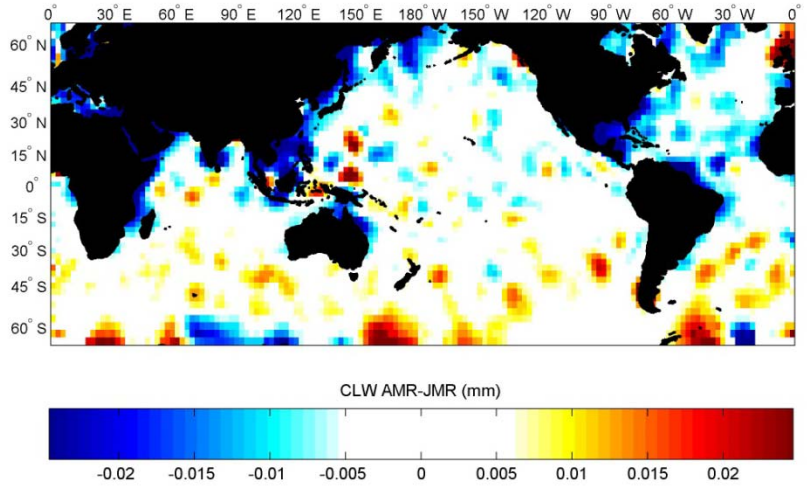
PD

WS



- **No significant regional biases between JMR and AMR**
- **Some residual error due to deficiencies in JMR antenna pattern correction**
  - **JMR APC will be improved using AMR data**

CLW



JPL ARCS

- **A**utonomous **R**adiometer **C**alibration **S**ystem (ARCS) will perform end-to-end system calibration for AMR
  - Implemented at JPL
  - Will be used to operationally monitor calibration and detect and correct changes prior to GDR production
  - Additional functionality will be used for detailed off-line calibration for GDR updates

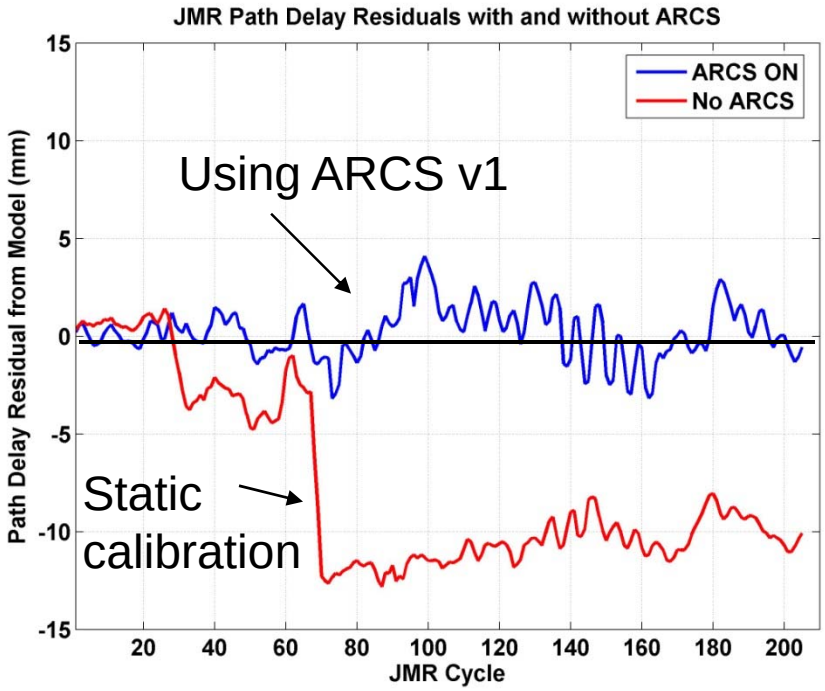
- ARCS v1 uses a weighted combination of path delay and TB residuals to determine is recalibration is needed
  - Uses current GDR processing cycle + future data
  - Only uses TBs to recalibrate
  - PD comparisons used for detection and validation only

- ARCS v1 intelligence tested with JMR data

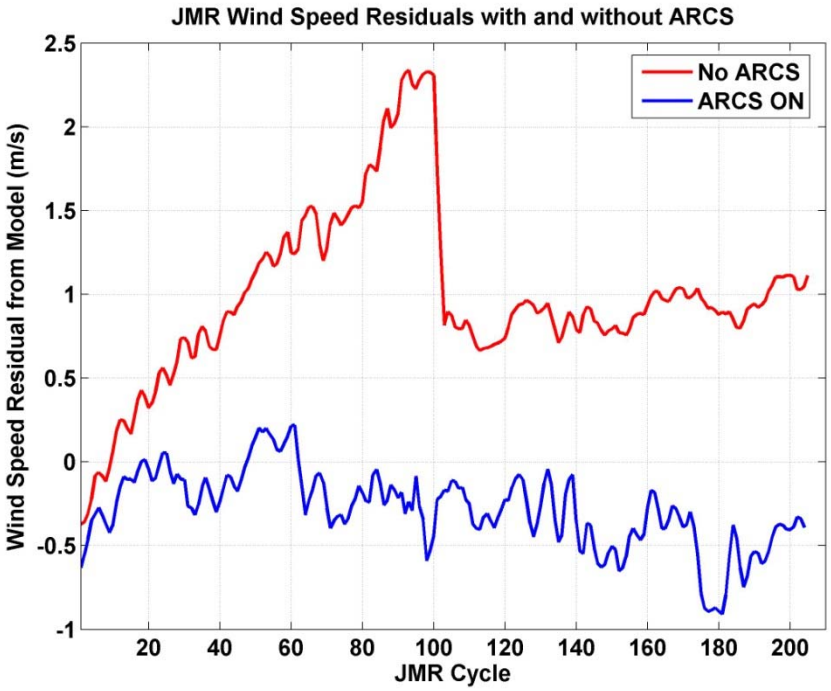
ARCS v1 Testing Result with JMR

- ARCS v1 run on 6 years of JMR data
  - Recalibrated a total of 26 times out of 206 cycles tested
- Significant improvement observed with ARCS turned on (blue line)
  - Long term drift eliminated with ARCS

Path Delay Residuals



Wind Speed Residuals



Summary

- AMR is meeting performance expectations
- JMR GDR-C removes sigma0 drift, but some instability observed after recent safehold
- ARCS implemented for AMR will maintain stable calibration on Jason-2 GDRs
- Future plans and outstanding issues:
  - Add AMR coastal PD product to Jason-2 GDRs
    - Work on applying coastal algorithm to JMR/TMR coastal on-going
  - Use AMR to recalibrate APC for JMR and TMR
  - Potential 1-sec offset in JMR/AMR time tag (pointed out by G. Quartly and R. Scharroo after recent JMR S/C anomaly)
  - Update/Improve radiometer flags (radiometer specific rain/ice flag)
  - Address Jason-1 post-safehold instabilities