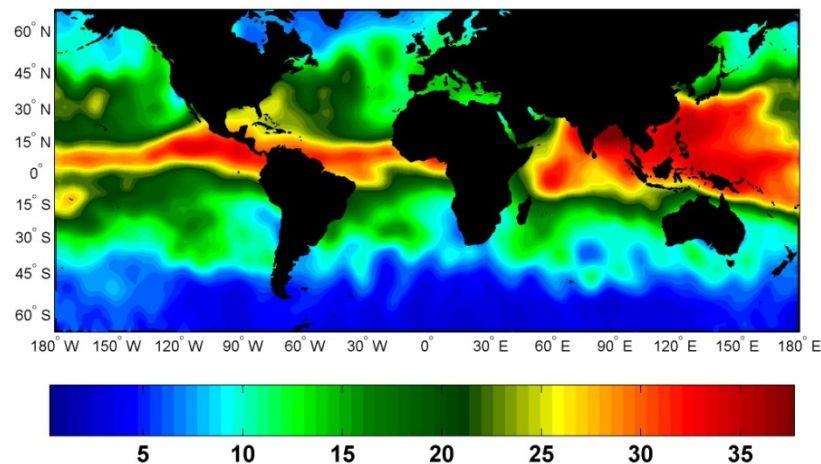


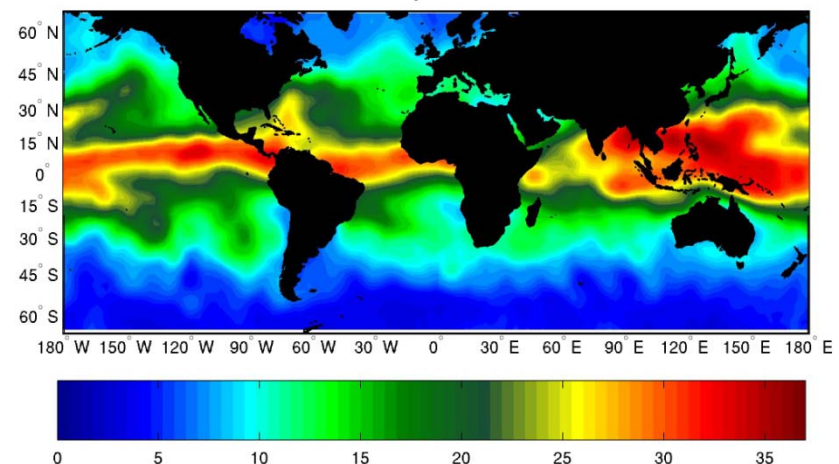
## Performance Assessment of the Advanced Microwave Radiometer after 1 Year in Orbit

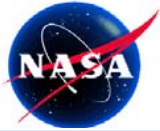
Shannon Brown, Shailen Desai, Wenwen  
Lu and Ant Sibthorpe  
Jet Propulsion Laboratory, California Institute of  
Technology

### AMR First PD Map 6/22 – 6/29 2008



### AMR PD Map 1 year later 6/1 – 6/15 2009

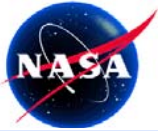




# Introduction



- **New AMR data products (available on PO.DAAC – restricted access)**
  - AMR sea ice flag
  - AMR rain flag
  - AMR coastal path delay
- **AMR **A**utonomous **R**adiometer **C**alibration **S**ystem (ARCS)**
  - System overview
  - Performance evaluation
- **AMR performance to date**
- **JMR replacement product**



# AMR Rain Flag

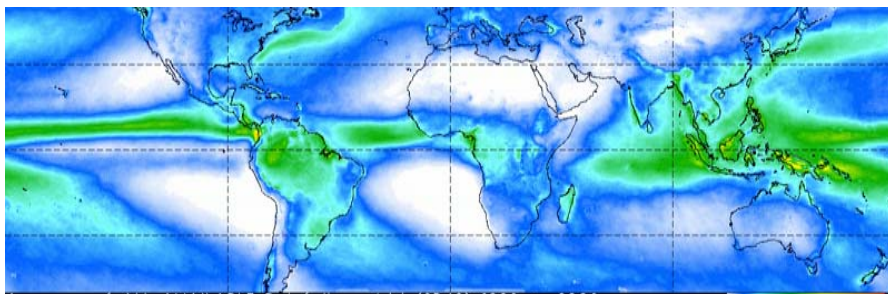


- Rain flag developed for AMR
- Will appear in future GDR release
  - Can be easily implemented by users using products on GDR

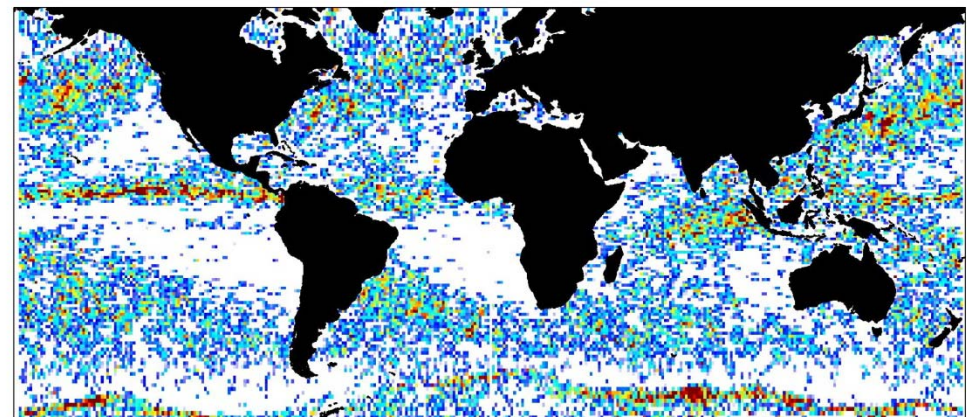
```
Rain Flag true if  
Land_flag == ocean & Sea_Ice_flag == no ice &  
[  $T_B(18.7) > 200\text{K}$  OR  
Radiometer_Cloud_Liquid_Water > 0.75 kg/m2 ]
```

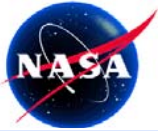
- Based on threshold of AMR derived cloud liquid water and 18 GHz TB
- Observed to statistically reflect TRMM rainfall climatology

Rainfall climatology from TRMM



200-day average of AMR rain flag





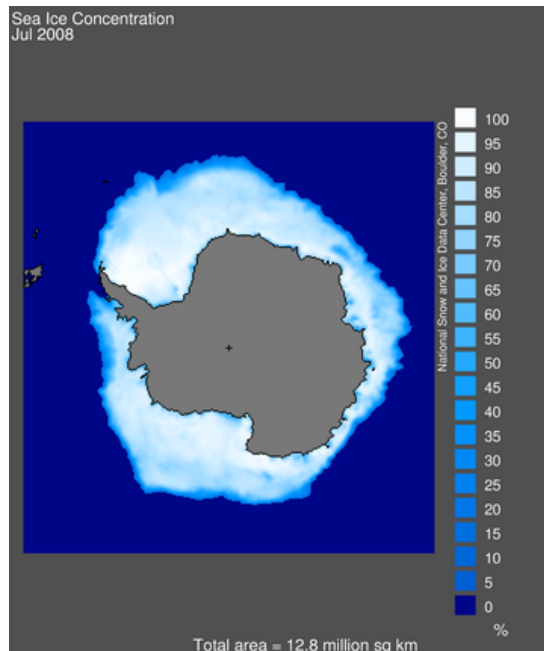
# AMR Sea Ice Flag

- **Sea Ice Flag developed for AMR**
- **Will appear in future GDR release**
  - **Can be easily implemented by users using products on GDR**
- **Based on threshold of 34-18.7 GHz TB difference**

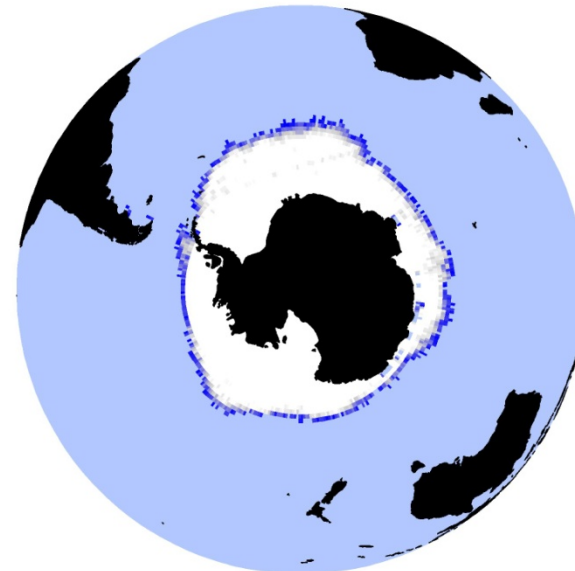
Ice Flag true if

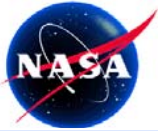
$$(T_B(34.0) - T_B(18.7)) < 10K \ \& \ |Latitude| > 47^\circ$$

July 2008 Sea Ice From NSIDC



Cycle 1-5 average of AMR sea ice flag

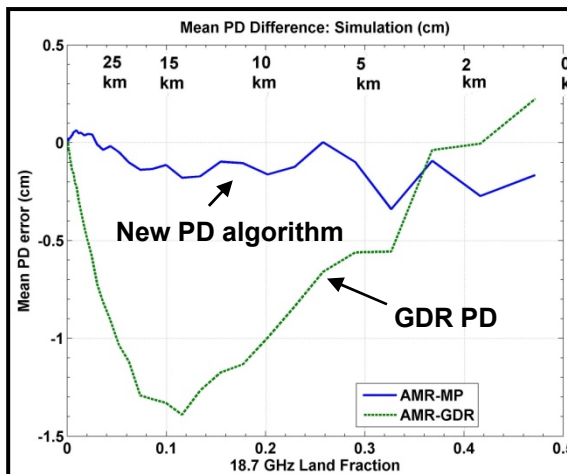




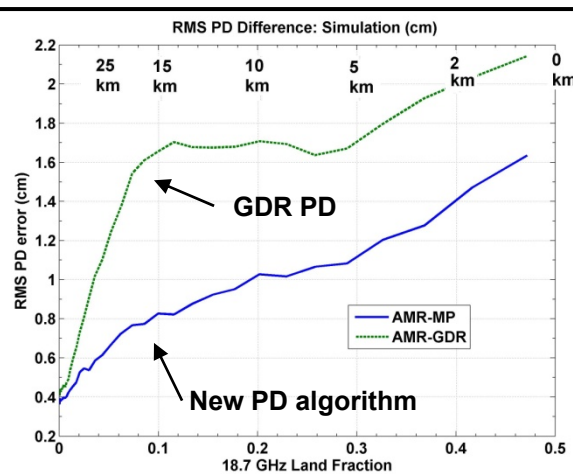
# New Coastal Path Delay Algorithm for AMR



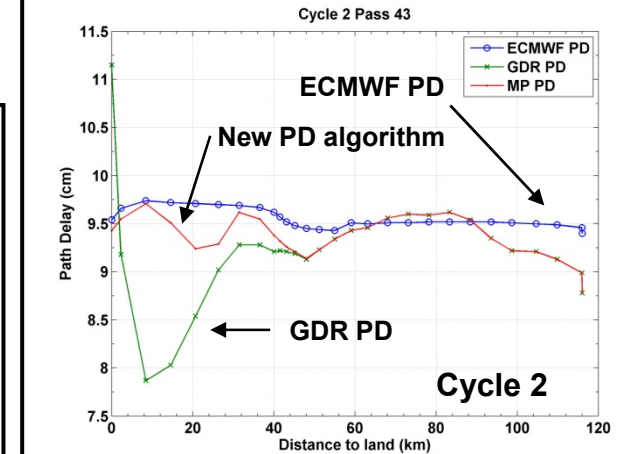
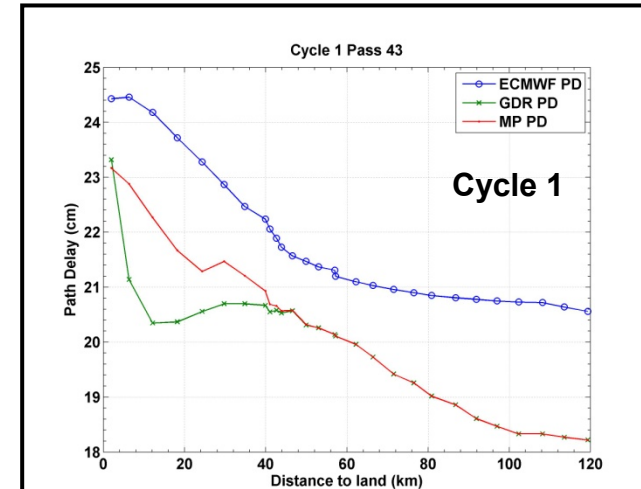
- Developed new PD algorithm valid for both open-ocean and mixed land/ocean scenes
- Performance estimated with detailed simulations and application to measured AMR data
- New algorithm is unbiased near land with error less than 1.2 cm up to roughly a 5 km from land
  - Algorithm will next be applied to JMR and TMR



Mean PD error approaching land for GDR algorithm and new algorithm

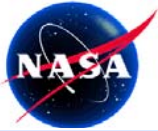


RMS PD error approaching land for GDR algorithm and new algorithm



Comparison of new near-land algorithm, GDR algorithm and ECMWF PD approaching California coast (pass 43 over Harvest, cycles 1 and 2)



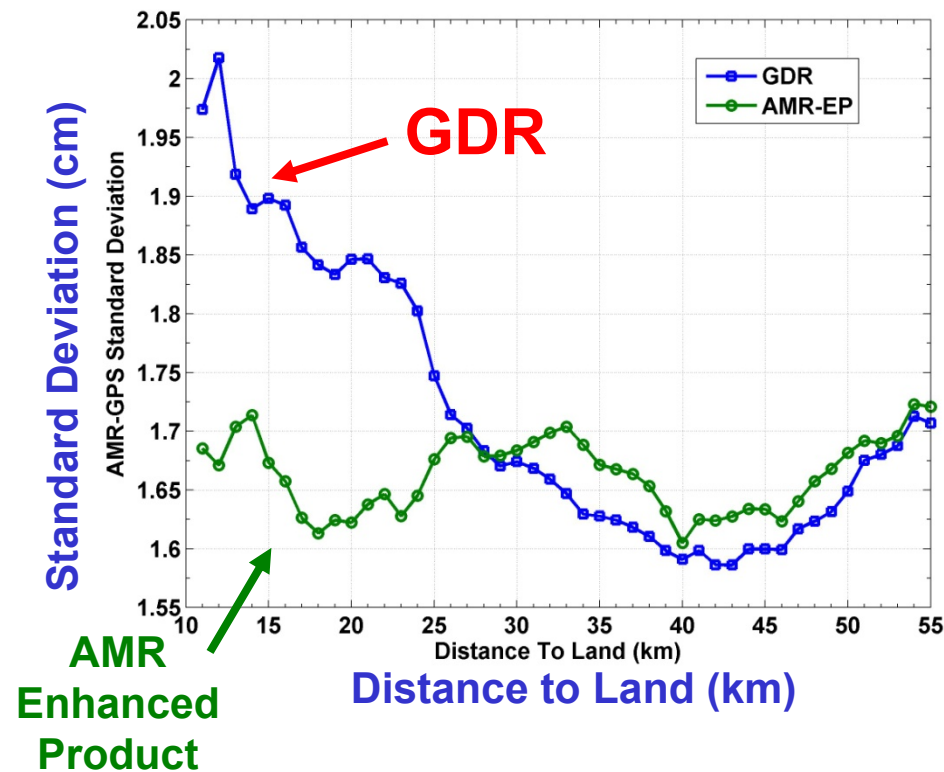


# GPS Validation of New Coastal PDs

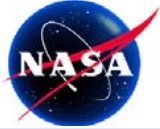


- Coastal GPS sites used to validate new coastal PD algorithm
- Coastal PD algorithm shows little excess variance from GPS up to coastline

## GPS-AMR Standard Deviation Approaching Coast



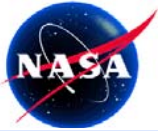
–“A Novel Near-Land Radiometer Wet Path Delay Retrieval Algorithm: Application to the Jason-2/OSTM Advanced Microwave Radiometer” in review TGARS



## AMR - ARCS



- **Autonomous Radiometer Calibration System (ARCS) performs end-to-end on-orbit system calibration for AMR**
  - Implemented in ground processing system at JPL
  - Used to operationally monitor calibration and detect and correct changes prior to GDR production
  - IGDR will be different from GDR if calibration is performed

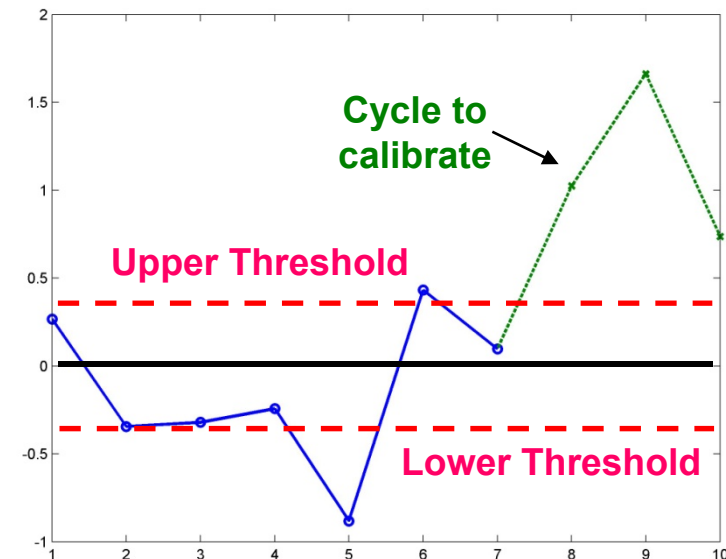


# ARCS Recalibration Decision Algorithm

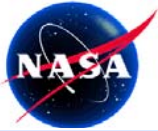


- ARCS uses a combination of path delay and TB residuals to determine if recalibration is needed
  - Uses current GDR processing cycle + future data
- Checks if TB or PD biases from the current cycle + 2 future cycles ALL exceed either upper or lower threshold or if current cycle  $> 3\sigma$
- Re-calibrates if either TB or PD threshold check fails
  - Only uses TBs to recalibrate
  - PD comparisons used for detection and validation only
- Validates by performing threshold check after-recalibration
  - Error if thresholds still exceeded

Change detection example

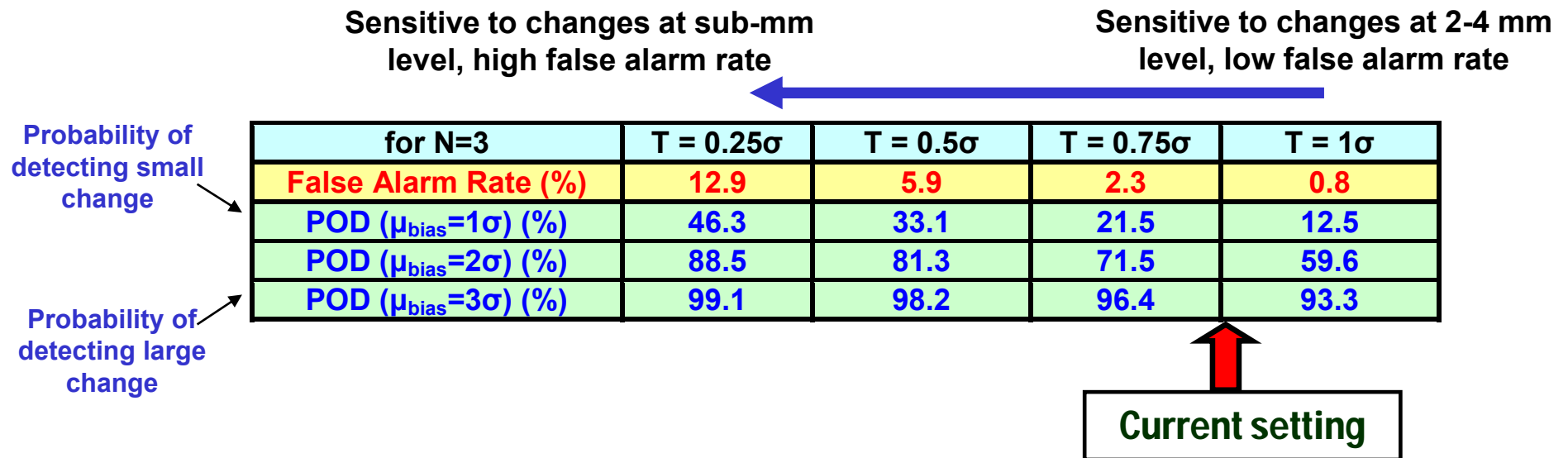




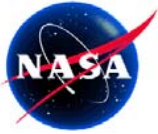


# False Alarm Rate/Probability of Detection

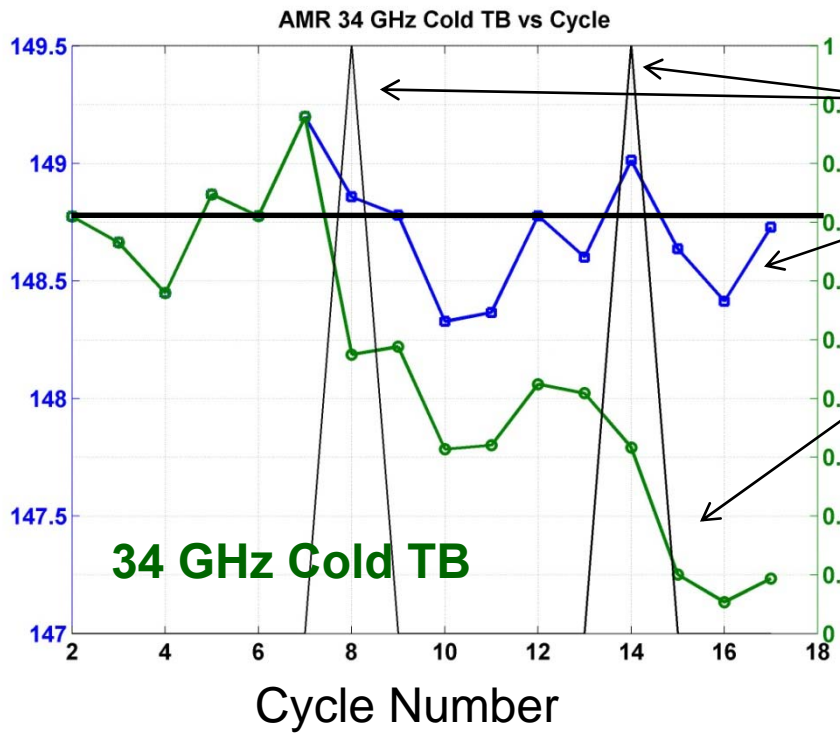
- Threshold setting allows ARCS to be aggressive or conservative
  - Balance False Alarm Rate (FAR) and Probability of Detection (POD)



- ARCS currently set to be conservative to minimize unnecessary recalibration at the expense of missing potential small changes



# OSTM ARCS Performance Assessment



Decision to recalibrate 34 GHz channel

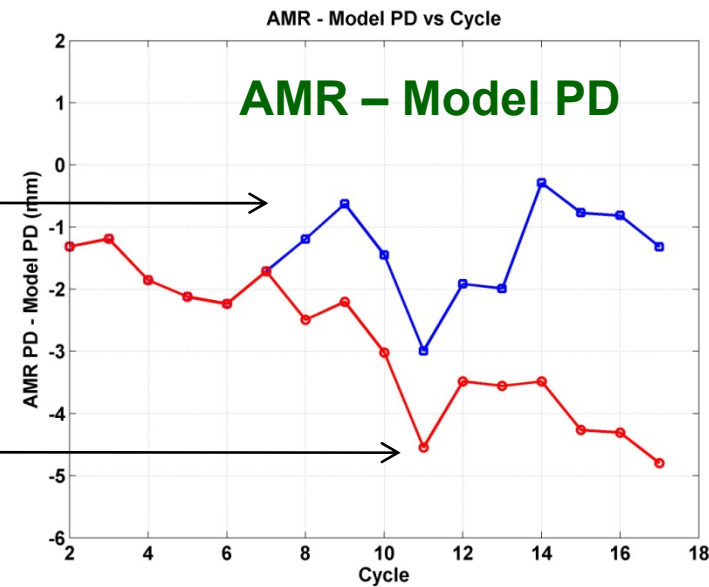
Measured Cold TB with ARCS

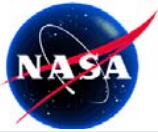
Measured Cold TB without ARCS

2 jumps in 34 GHz channel detected and corrected early in mission

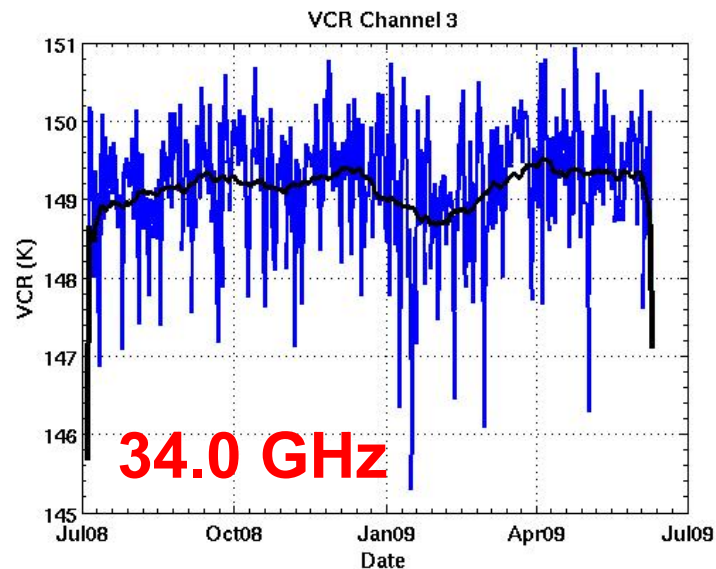
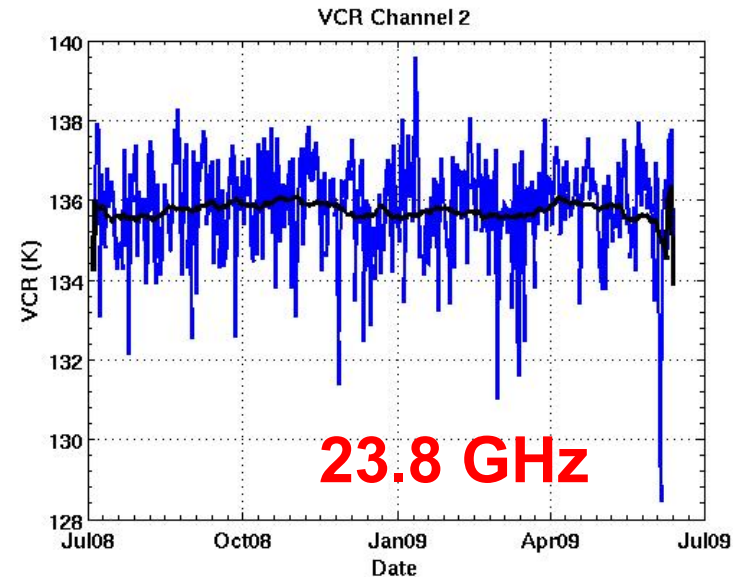
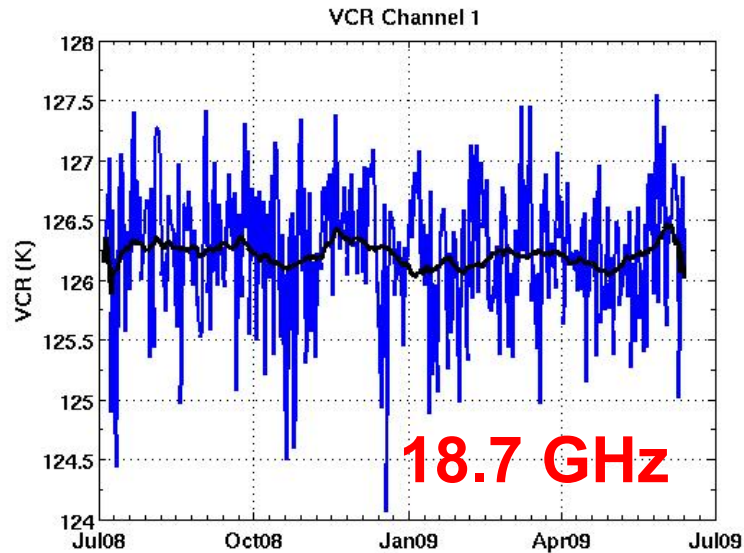
AMR-Model PD with ARCS

AMR-Model PD without ARCS:  
apparent 6mm/yr drift

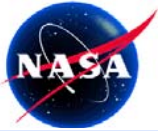




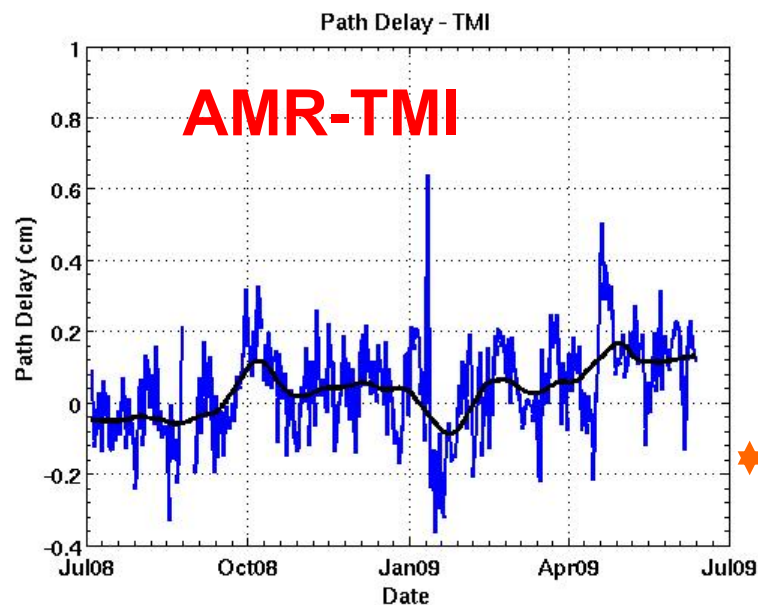
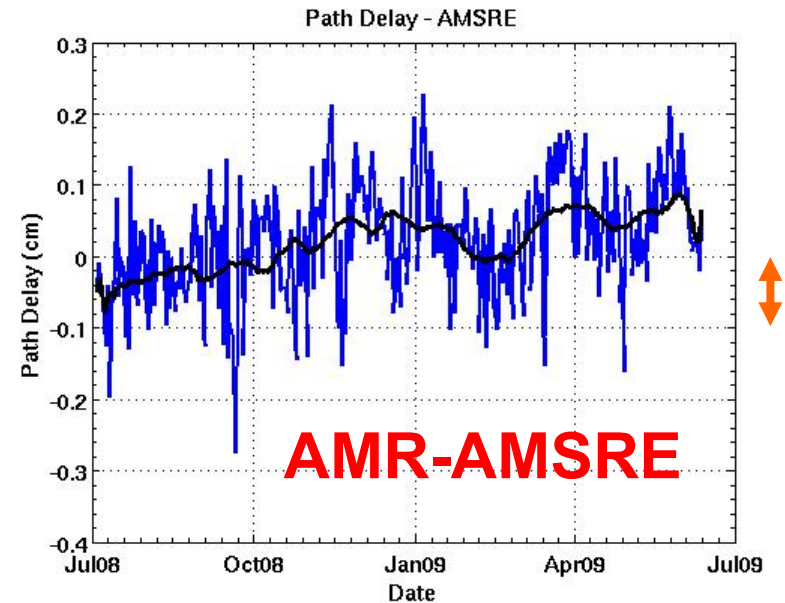
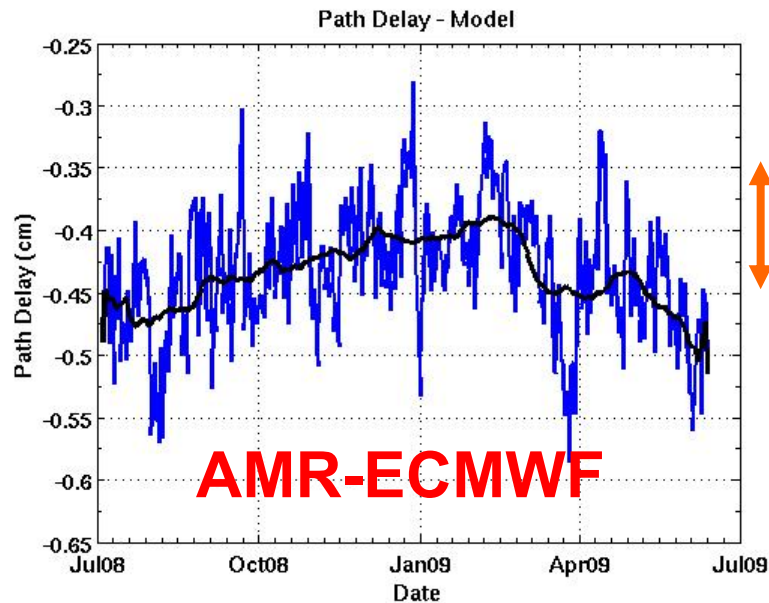
# AMR Long Term TB Stability Assessment



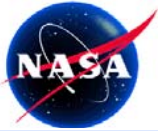
- AMR TBs appear to be stable compared to cold reference
- No residual dependence on instrument temperature (e.g. yaw state bias)
- Re-calibration for GDR only performed on 34 GHz channel
  - 0.5 K jump – September 19, 2008
  - 1 K jump – November 28, 2008



# AMR PD Stability Assessment



- Comparisons between AMR and model and other radiometers
- No conclusive evidence of long term PD instability or drift



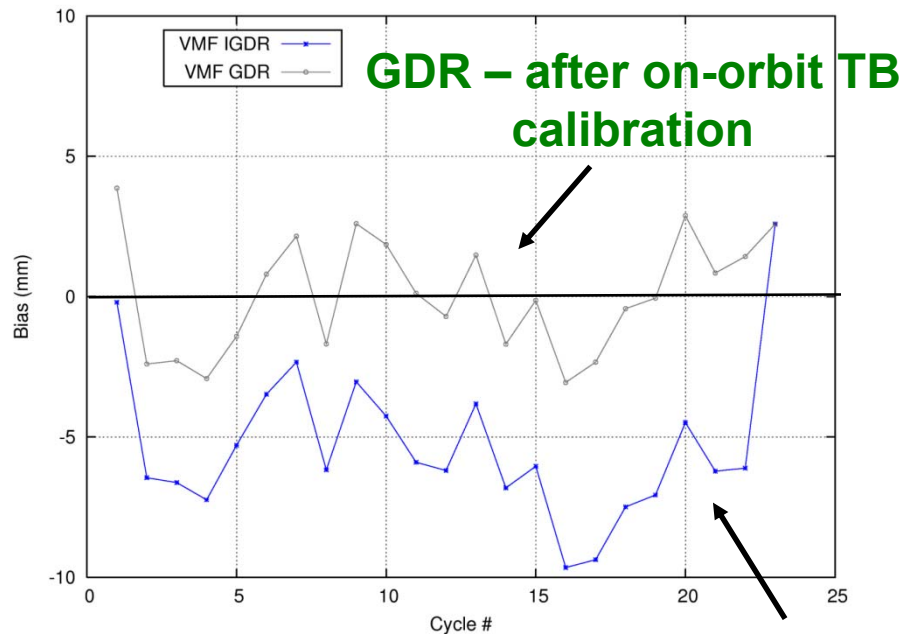
# GPS Wet PD Comparisons



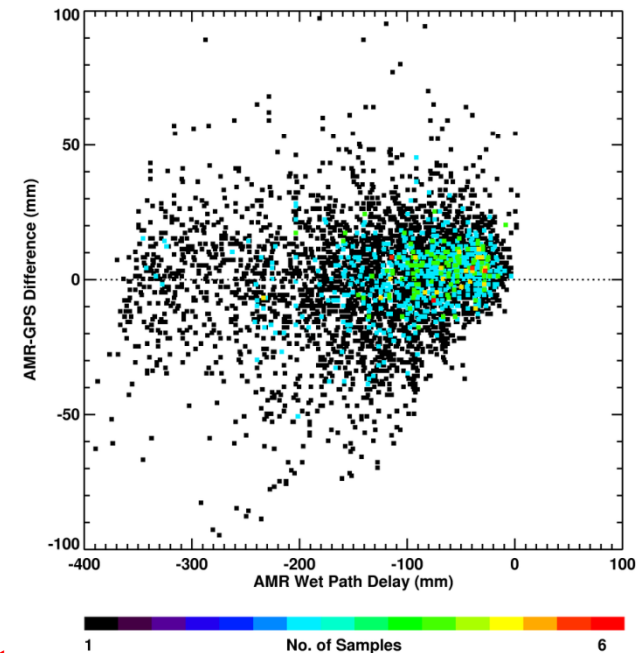
- AMR unbiased compared to GPS PD estimates
  - Independent validation of on-orbit TB calibration performed for GDRs
- No observed PD scale error

## AMR – GPS PD vs Cycle

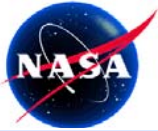
40Km land contamination threshold : all stations



## AMR – GPS PD vs PD



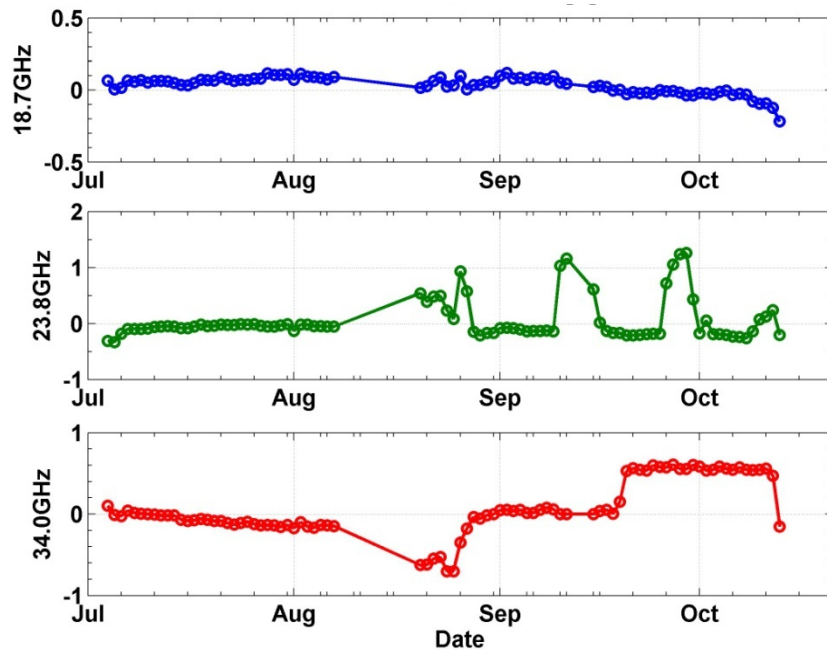




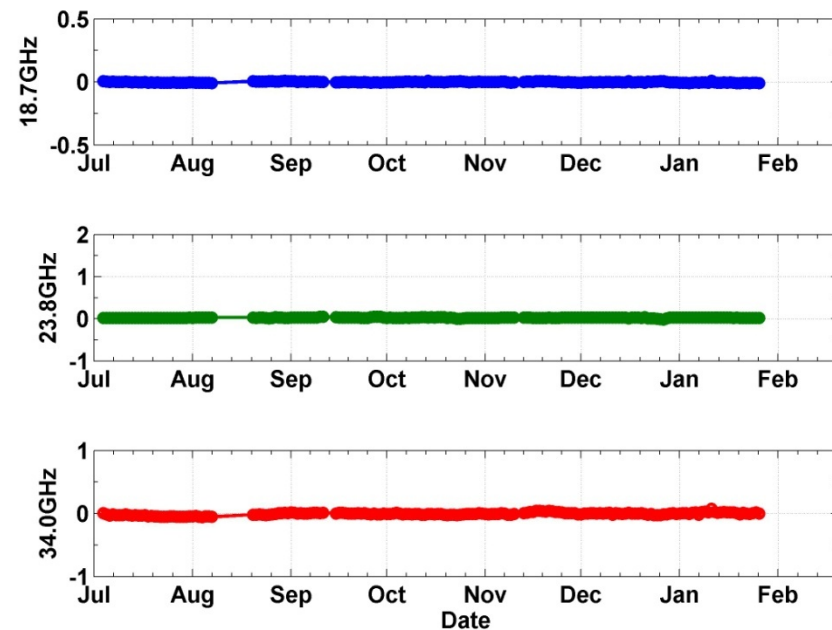
# JMR Replacement Product - TBs

- JMR replacement product corrects instabilities in JMR observed after August 2008 safehold
  - Periodic 1K shifts in JMR 23.8 GHz cold  $T_B$ s (GDR-C data)
  - 34 GHz jumps in AMR TBs corrected on OSTM GDRs

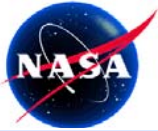
## JMR – AMR Ocean $T_B$ s JMR GDR-C



## JMR – AMR Ocean $T_B$ s JMR Replacement Product



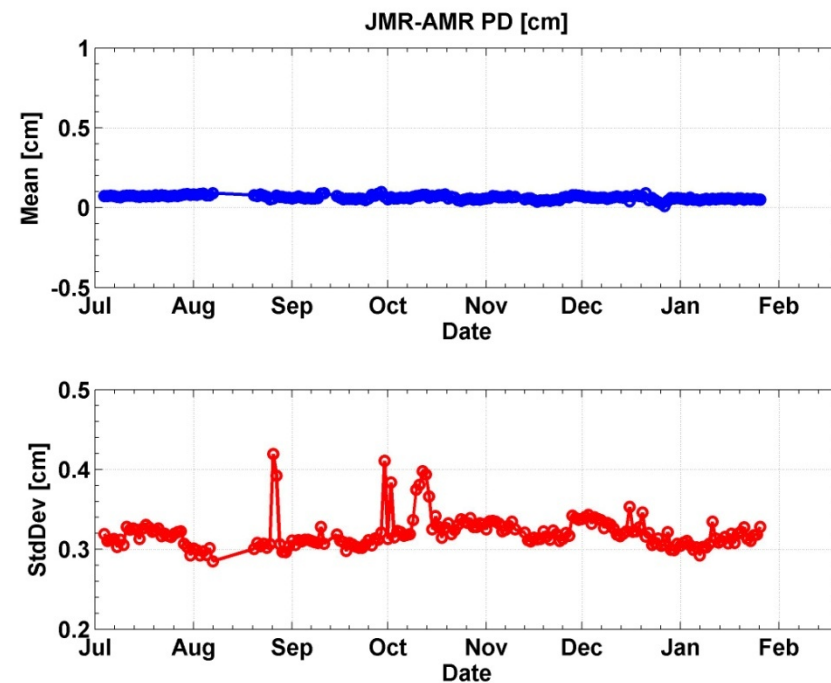
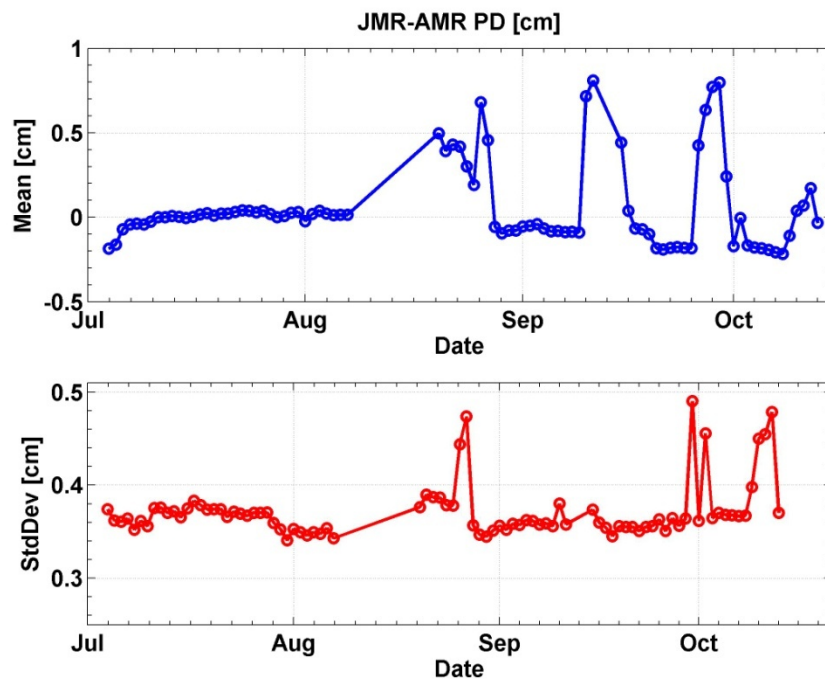


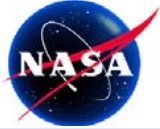


# JMR Replacement Product - PDs



- Periodic 5mm shifts in JMR PDs after August 2008 safehold
- JMR replacement product shows negligible residual bias from AMR and lower variance compared to JMR on GDR-C





## Conclusions



- **New AMR coastal PD available via PO.DAAC**
  - Product compares well with coastal GPS sites
  - Product also included new sea ice and rain flag
  
- **AMR ARCS system operational and maintaining AMR long term calibration**
  - No indication of PD drift over first year of mission
  - PDs unbiased with respect to GPS with no scale error
  
- **JMR replacement product available, removing instability after Aug. 2008 safehold**