Sentinel-6 AMR-C Instrument Performance/Status and Calibration

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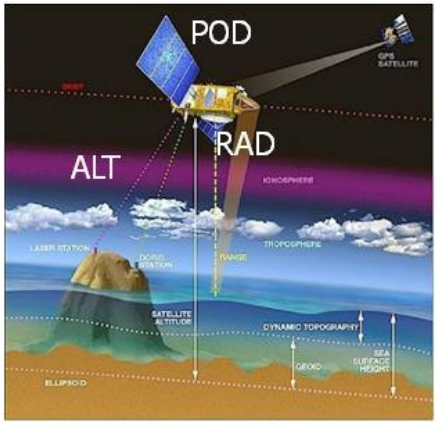
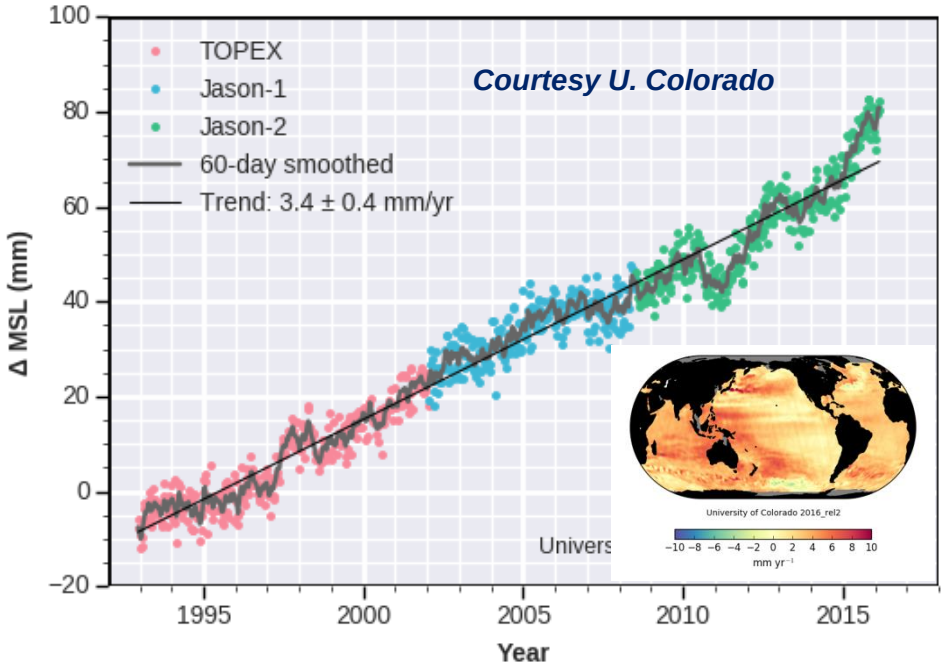
Sentinel-6 AMR-C

- Sentinel-6 is the first climate focused ocean altimeter system
- Two 5-year design life measurement systems provide a decade of precise global mean sea level observations

  - Two key measurements system requirements
    - Single sample error (1Hz): 3.2 cm
    - GMSL Stability: ± 1mm per year
  - AMR-C microwave radiometer provides correction for radar propagation delay from tropospheric water vapor



Global Mean Sea Level (GMSL) Trend Recovered from Jason Series



AMR-C Instrument Overview

- Measures single polarization, radiometric brightness temperatures to provide “wet” tropospheric path delay correction for the Altimeter range measurement which is critical to meet science requirements.

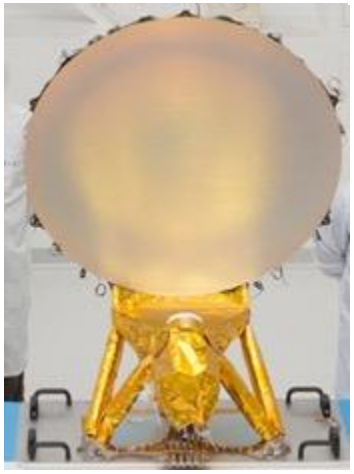
- Same basic functional and radiometric performance requirements as OSTM, Jason-3, and SWOT AMR with some mission-unique enhancements.

  - Traditional (Jason-2/3) three frequency (18.7, 23.8, 34 GHz) radiometer (heritage architecture).

  - Enhanced science objective to measure path delay with absolute stability of 1mm/year (was goal on Jason-3 to a requirement). This drives the addition of a on-board Supplemental Calibration System (SCS).

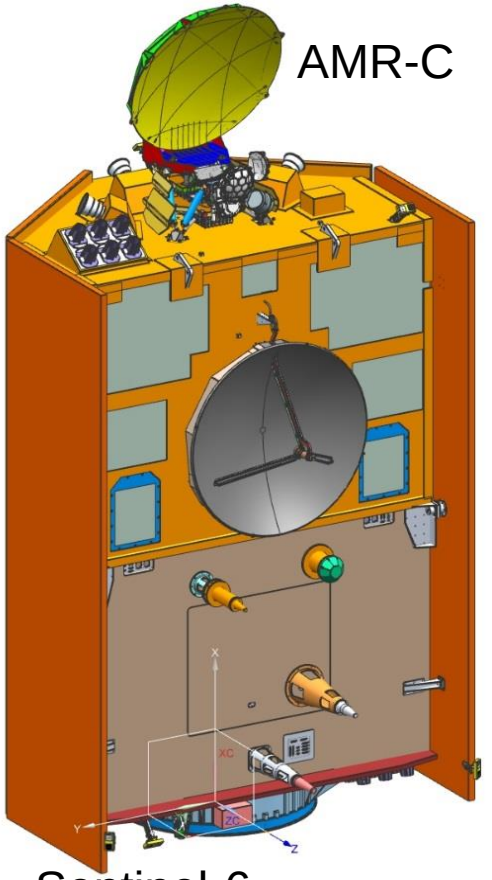
  - Experimental addition of three high-frequency (90, 130, and 168 GHz) channels (as tech demo, non-mission critical). This High Resolution Microwave Radiometer (HRMR) provides high resolution path delay correction in coastal regions where heritage AMR measurements are degraded by land contamination.

Jason-3 AMR

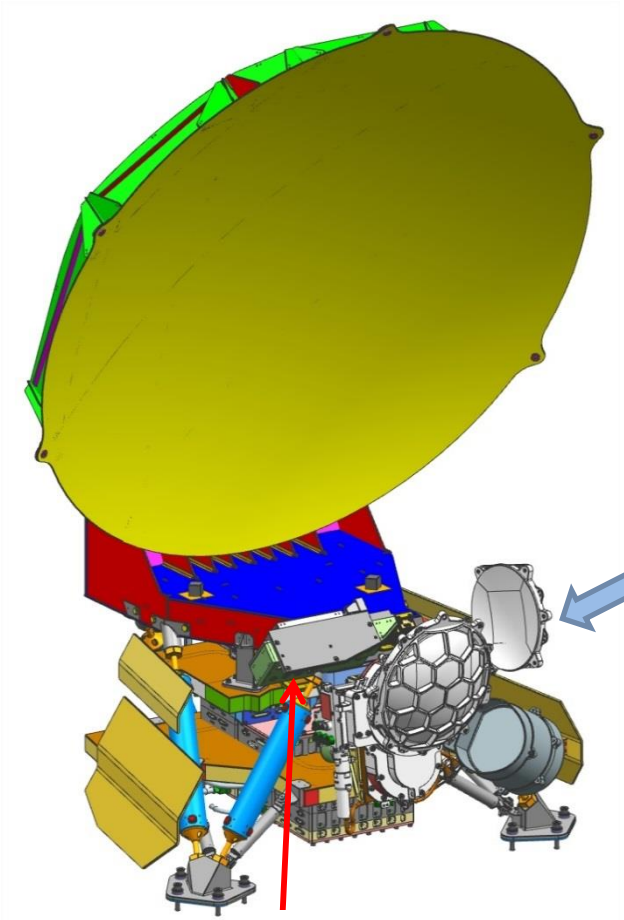


Sentinel-6 AMR-C

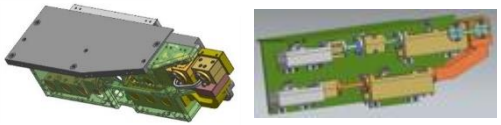
AMR-C Instrument Overview

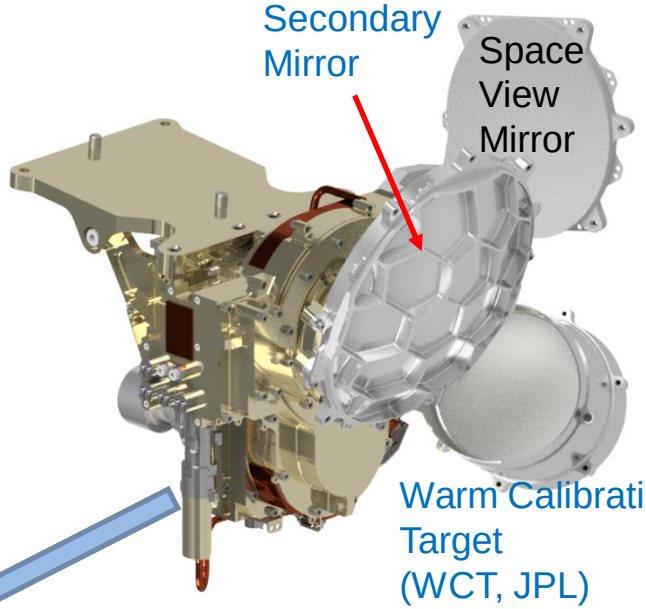


Sentinel-6
Spacecraft



HRMR-RF Electronics

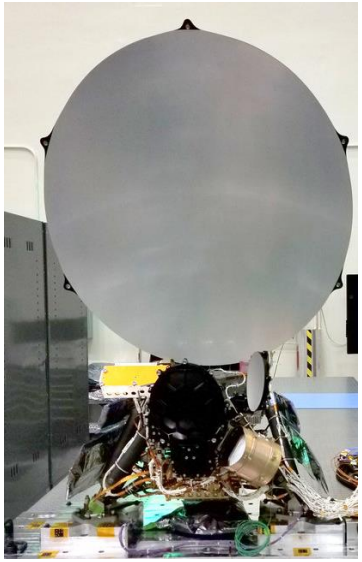




SCS (Supplemental
Calibration System)

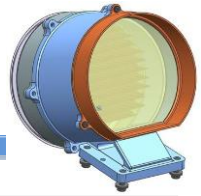
AMR-C Performance (1Hz Path Delay Error)

- Sentinel-6 AMR-C completed all pre-launch testing and met its performance requirements with significant margin
- Global RMS wet path delay error as good as or better than Jason-3
- Formal uncertainty estimate from the instrument and algorithm contribution is 6mm RMS

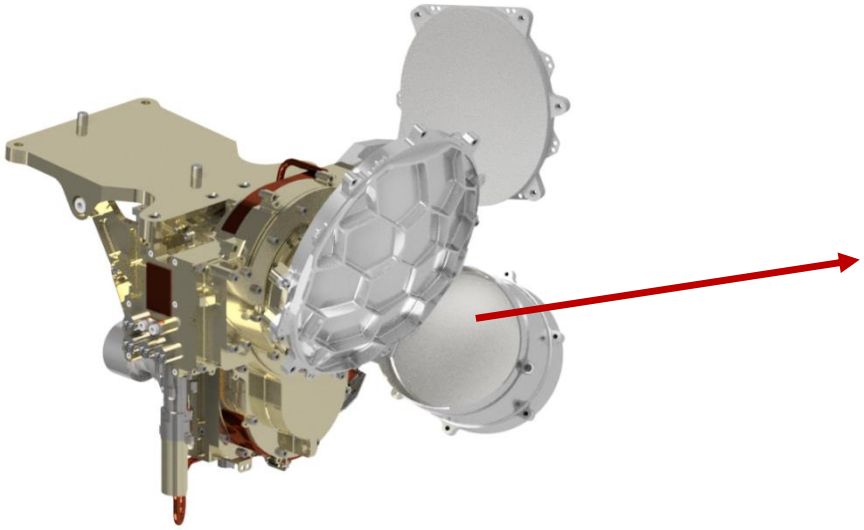


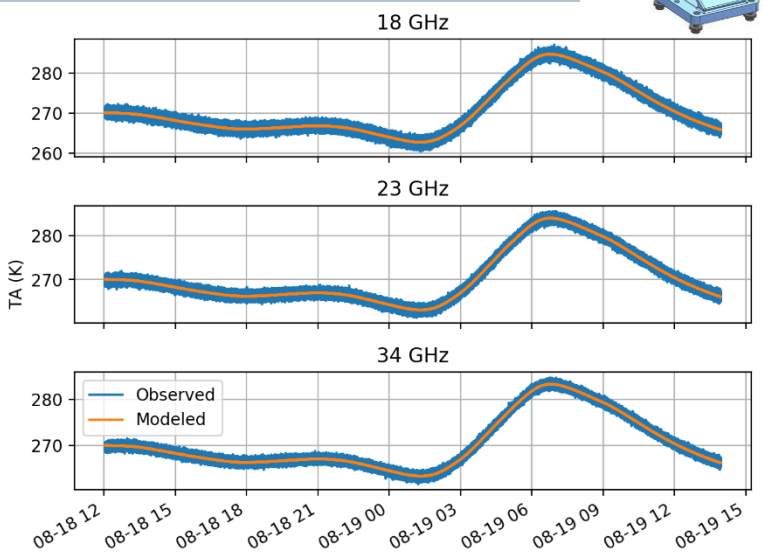
Component	Error Allocation	AMR-C FM-A Actuals
Instrument Performance	0.55 cm	0.17cm
Science processing algorithms	0.6 cm	0.6cm
Total RSS	0.8 cm	0.62cm

AMR-C Performance (Long-Term Stability)



Supplemental calibration system (SCS)





Measured and modeled warm target brightness temperature during testing characterization test

- AMR-C includes blackbody calibration system (SCS) that eliminates need for ancillary or vicarious radiometer calibration on-orbit to support measurement of GMSL trends
- System was tested extensively pre-launch to characterize performance of the warm load and the cold sky reflector
- SCS predicted to provide long term stability to 0.7 mm/yr or better

AMR Post-Launch Characterization/Calibration Plans

- AMR-C performance and calibration on-orbit will be monitored using heritage approaches developed over past decades of altimetry with additional efforts specific to characterize SCS
  - Ocean vicarious calibration, Amazon hot reference, inter-satellite comparison
  - Model PD and WS comparison

- **Cold sky spacecraft pitch maneuvers**
  - Calibrates AMR-C and HRMR through main reflector
  - Cross-compare to SCS cold sky reflector
- **AMR-C SCS warm target calibration**
  - View warm load for long period (>24hrs) to verify TB model using internal calibration sources
  - Verify Earth spill-over contribution
- **AMR-C SCS cold sky mirror calibration**
  - Scan across cold sky mirror over land then ocean to verify Earth spill-over contribution

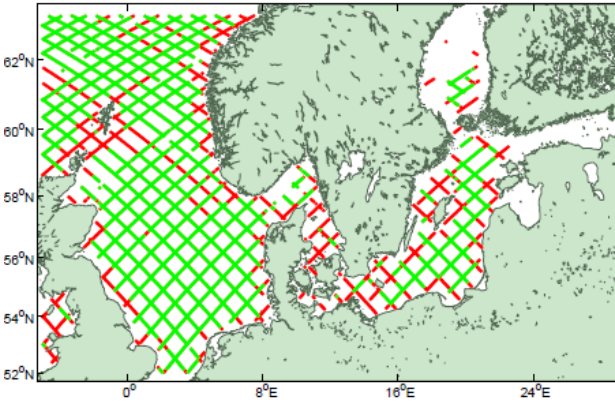
Radiometer (AMR-C) Calibration Approach

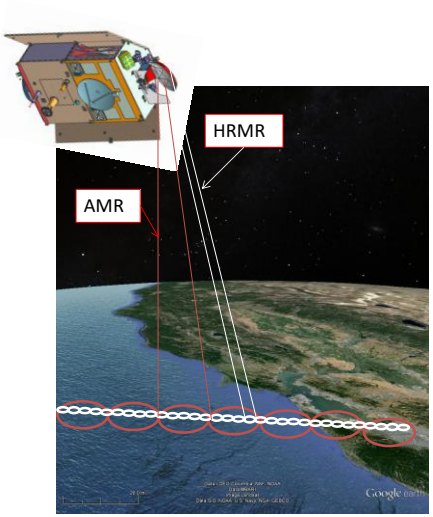
- Cal/Val Phase: Calibration parameters generated by instrument scientists.
  - Initially use Jason-3 heritage approaches.
    - Cold-sky pitch maneuvers (<30-day intervals), vicarious cold and Amazon hot references.
  - Include measurements from onboard Supplemental Calibration System (SCS) after completing in-flight calibration and validation.
    - SCS baselined to provide cold and hot calibration measurements every 5 days.
  - Validate ARCS through shadow off-line operations.

- Operational Phase: Automatic generation of calibration parameters by AMR Radiometer Calibration System (ARCS)
  - Operational implementation within JPL Ground Data System after shadow off-line operations validated against manually generated calibration parameters.
  - Uses calibrated SCS measurements together with heritage approaches.

HRMR - Coastal Altimetry

- Altimetry data flagged in the coastal zone due to inadequacy wet path delay measurements from the low-frequency microwave radiometer
  - Research in this area has led to some data recovery, but errors are still larger
- HRMR demonstrates capability of high-frequency radiometer channels for extending the wet path delay measurement into the coastal zone
  - Similar measurement improvements in radar system for coastal altimetry (e.g. SAR processing)





Performance Goal:

Measure the wet tropospheric path delay of the nadir altimeter signal over ocean with an objective uncertainty of 1.0 cm within 5-50km of the coast

Measure the relative change in brightness temperature at 90, 130 and 168 GHz over 60s with an uncertainty of 0.2K

Summary

- We’re about to begin a new era for monitoring GMSL and coastal altimetry
- AMR-C expected to reduce the wet path delay component of the GMSL trend uncertainty to a negligible level
- HRMR will demonstrate new capability for increasing the accuracy of PD up to the coast line