THE ADVANCED TECHNOLOGY MICROWAVE SOUNDER (ATMS): A NEW OPERATIONAL SENSOR SERIES

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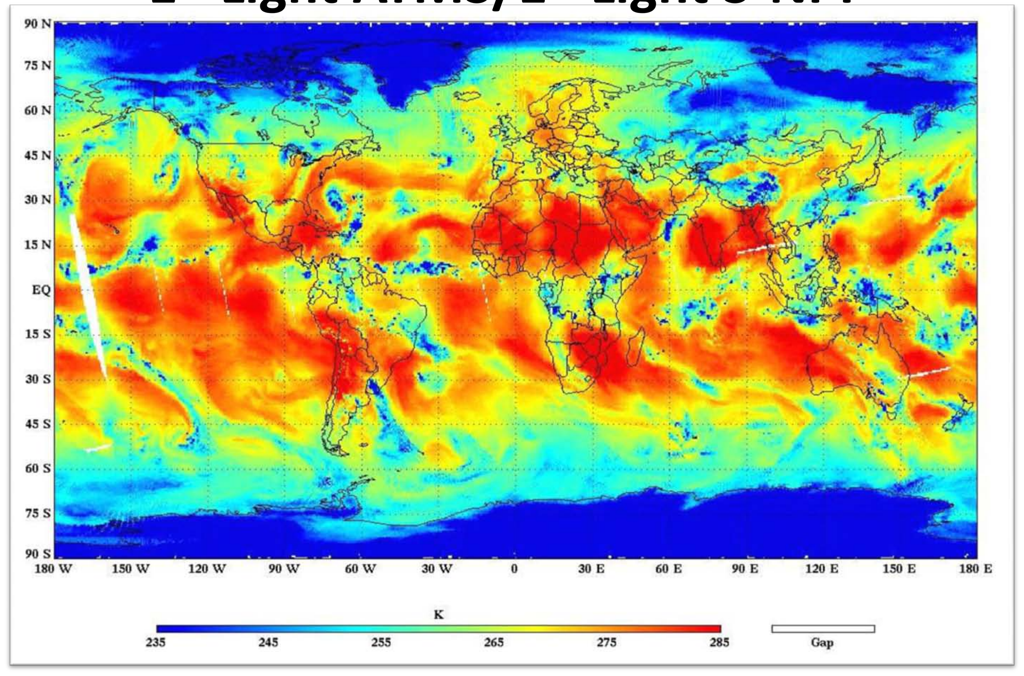
ABSTRACT:

ATMS is a new satellite microwave sounding sensor designed to provide operational weather agencies with atmospheric temperature and moisture profile information for global weather forecasting and climate applications. ATMS will continue the microwave sounding capabilities first provided by its predecessors, the Microwave Sounding Unit (MSU) and Advanced Microwave Sounding Unit (AMSU). The first ATMS was launched October 28, 2011 on board the Suomi National Polar-orbiting Partnership (S-NPP) satellite. Microwave soundings by themselves are the highest-impact input data used by Numerical Weather Prediction (NWP) models; and ATMS, when combined with the Cross-track Infrared Sounder (CrIS), forms the Cross-track Infrared and Microwave Sounding Suite (CrIMSS). The microwave soundings help meet NWP sounding requirements under cloudy sky conditions and provide key profile information near the surface.

SCAN PROFILE SELECTION AND SCAN BIAS:

After activating ATMS on orbit, the primary task is to determine the optimal Scan Profile (SP). This selects the least obstructed space view profile among 4 Space View sectors (SPs 1 – 4) centered at 6.66°, 8.33°, 10.0° & 13.33° (below NPP+Y axis). The goal of this task is to assess the impact either of spacecraft/or Earth limb infringements, to implement performance evaluation. SP1 was selected because it has the lowest impact . To date, ATMS has demonstrated great on-orbit performance. Like all previous microwave sensors/sounders, ATMS has scan bias. Scan Bias correction is important, both for operations and for atmospheric research, and the ATMS SDR Team is actively analyzing these data.

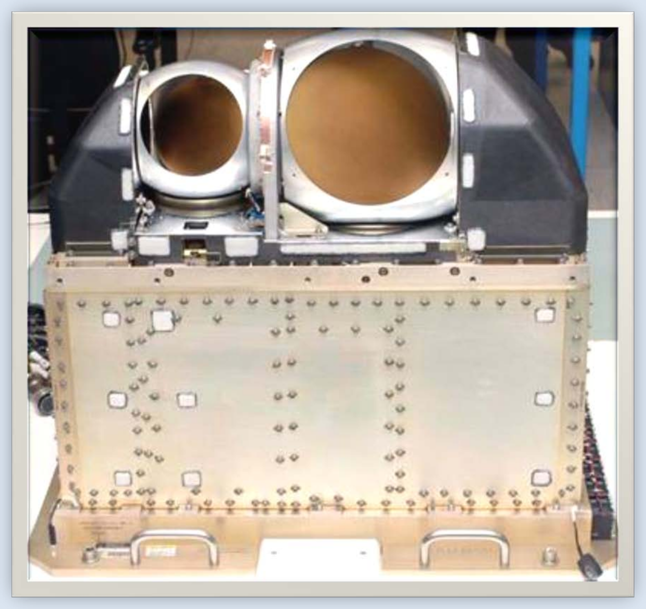
1st Light ATMS/1st Light S-NPP



LEFT: This is the 1st light image from ATMS, acquired on November 8, 2011. This is also the 1st light image for the entire S-NPP mission, since ATMS was the 1st instrument turned on.

The image shows the ATMS channel 18 data, which measures water vapor in the lower atmosphere. Tropical Storm Sean is visible in the data, as the patch of blue, in the Atlantic off the coast of the Southeastern United States. These data were processed by NOAA's National Environmental Satellite, Data, and Information Service.

S-NPP/ATMS Instrument Specs

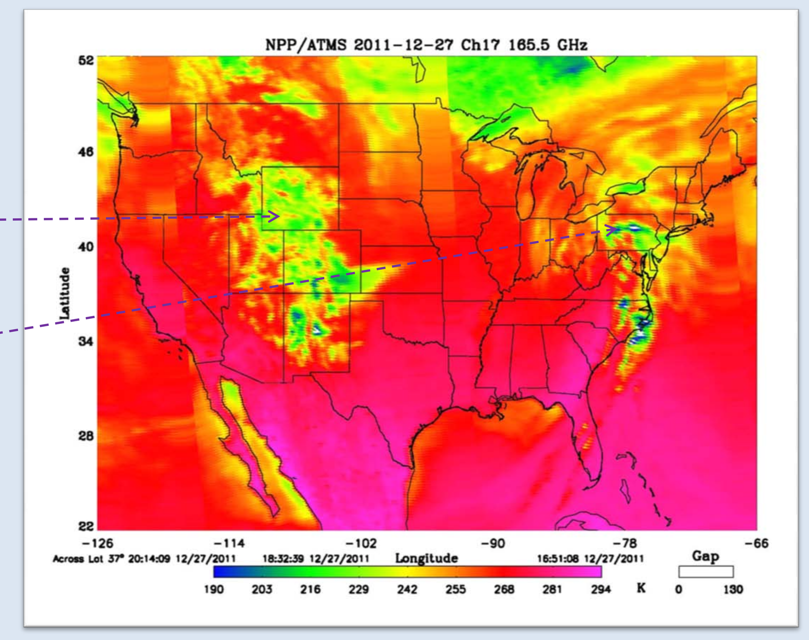


Parameter	PFM value
Envelope dimensions	70x60x40 cm
Mass	75 kg
Operational peak power	200 W
Data rate	30 kbps
Absolute calibration accuracy	0.6 K
Pointing knowledge	0.03 degrees
NEDT	0.3--2.0 K
Orbit altitude	824 km (NPP)
Reliability	0.87

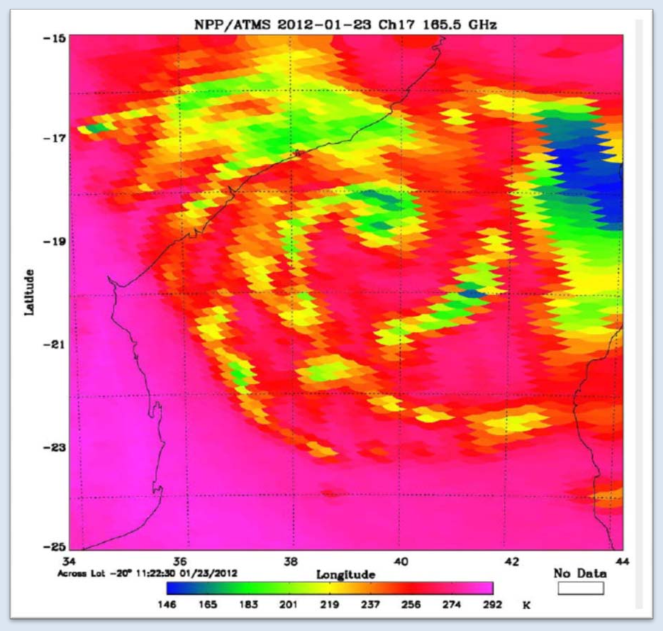
ATMS Example Images

ATMS has a wider swath than previous MW sounders yielding more ground coverage. Here we show some amazing ATMS weather related snow, rain, and ice images for the US. Super Tropical Cyclone Funso – ATMS Brightness Temperature images of super typhoon Funso showed that Funso brought flooding rain to the coastal regions of Mozambique and Madagascar. It reached Category 4 -- powerful storm.

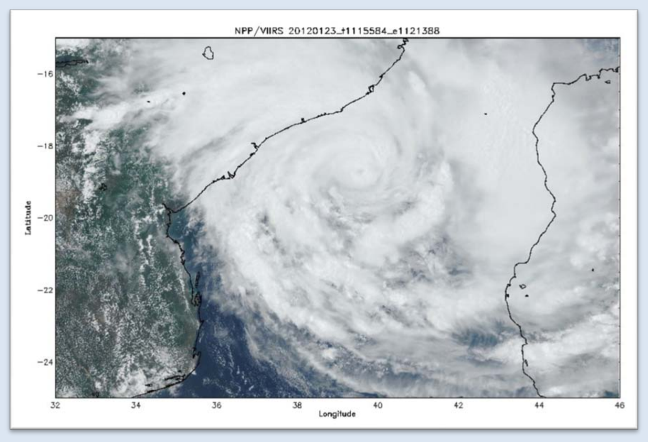
Companion S-NPP sensors like VIIRS can provide high-resolution views of Funso, however visible and IR sensors cannot penetrate clouds. On the other hand, microwave sensors such as ATMS provide forecasters and scientists the ability to see inside storms like Funso, providing quantitative data on the internal structure and state that are vital to predict its strength, development, and direction.



LEFT: Blizzard Storm in USA Mid-West & Rains (18 *mm* H_2O) in the NW/NE coast. Ch 17 sees a combination of the surface plus water vapor and ice crystals in the atmosphere.

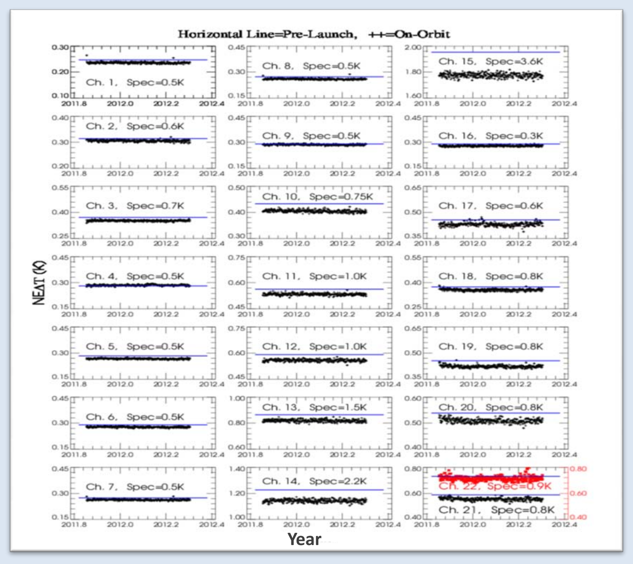


LEFT: On 1/23/2012, at 11:22:30 UTC, Funso built up near -19° latitude. Note how microwaves are able to see through the clouds that dominate the visible/IR images. In all the ATMS Images, yellows, greens, and blues indicate progressively colder brightness temperatures in the 165.5 GHz channel, corresponding to hydrometeors in the towering cloud features within the cyclone.

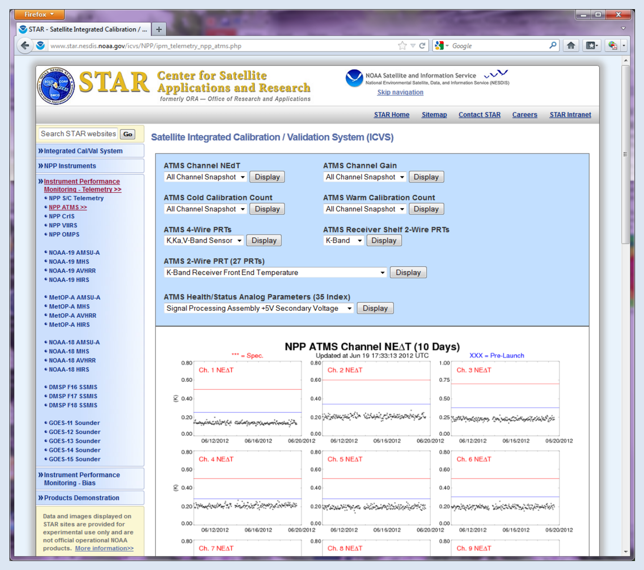


Similar Cyclone Funso true color image from S-NPP/VIIRS.

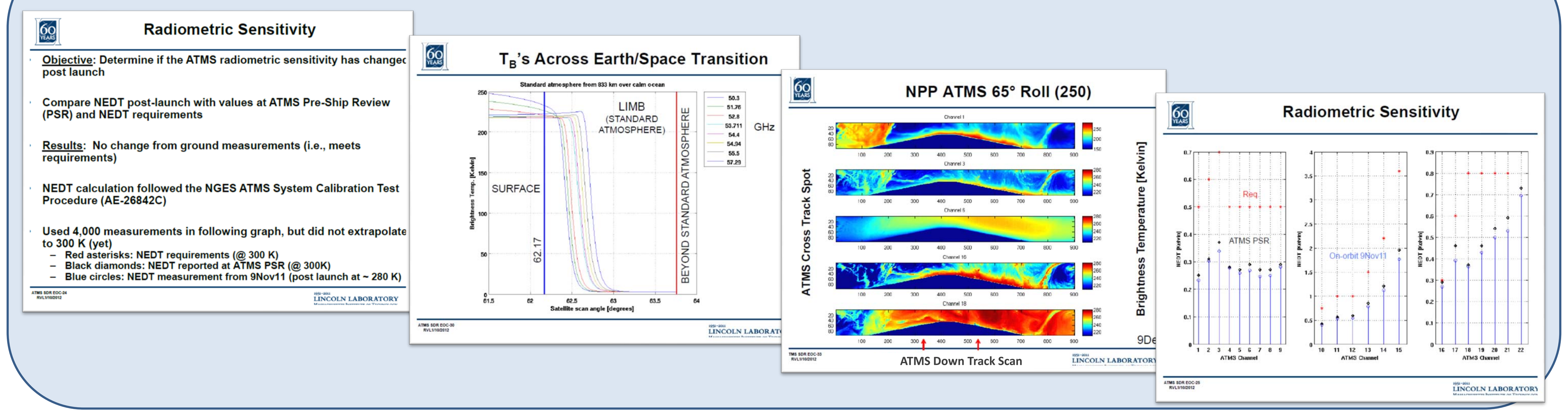
NOAA NESDIS Integrated Cal/Val System



ATMS on-orbit NEΔTs from the launch operational day (Nov. 8, 2011) to April 20, 2012 are calculated from the RDR warm load radiometric calibration counts. For comparison, NEΔT values from the pre-launch TV calibration test data are shown by the blue horizontal lines at individual channels. Also listed are the ATMS NEΔT specifications (Spec) for individual channels. The results demonstrate that the on-orbit NEΔTs agree well with the pre-launch results as expected. The NEΔTs of channel 22 are plotted in red color (using the right-hand side scale) at the right-bottom part and overlap with channel 21.



Radiometric Sensitivity and Spacecraft Maneuvers



On-orbit Performance Verification

Temperature Stabilization:

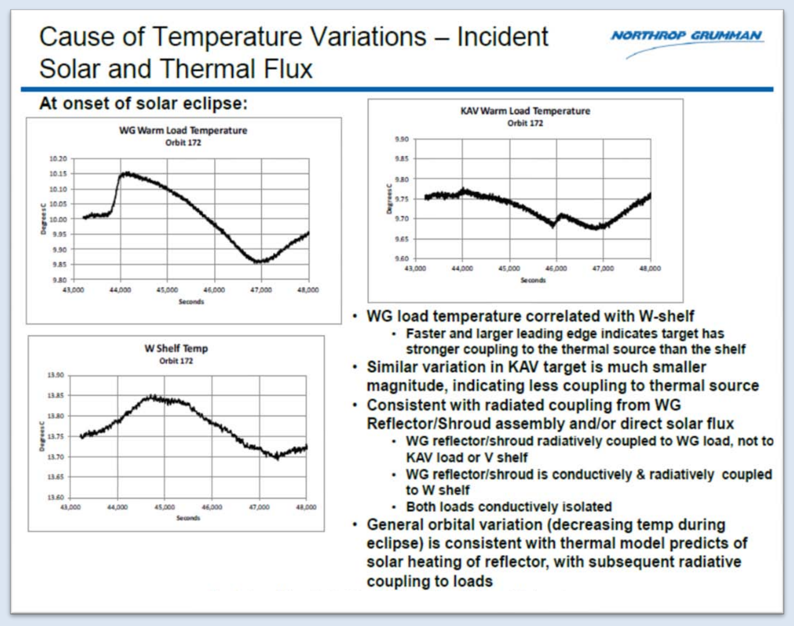
Parameters to be characterized are stability of: Calibration target temperatures, Receiver shelf temperatures, and Radiometric gain

Scope: Data from orbit 164 was used to determine that spec-compliant stabilization was achieved; Data from orbit 182 was used to characterized full stabilization (thermal steady-state)

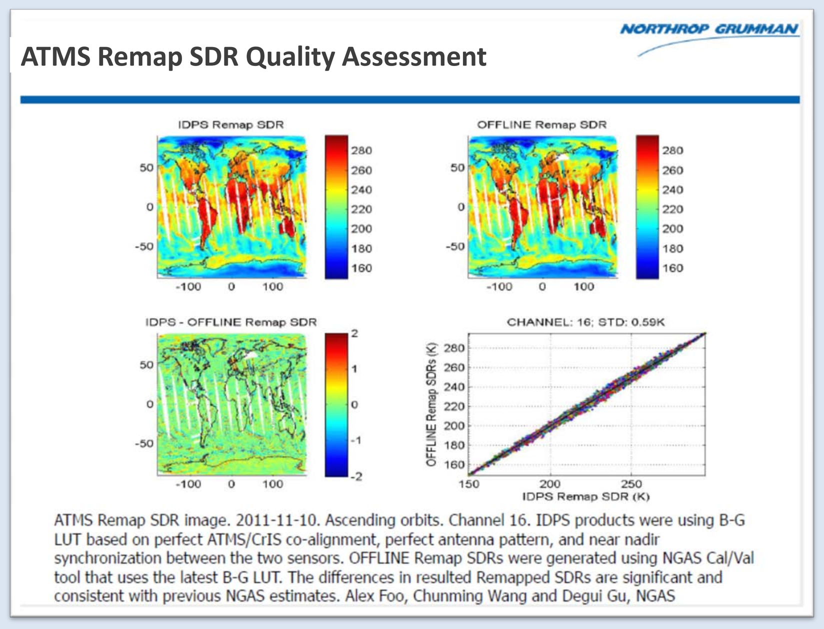
Criteria for spec-compliance assessment:

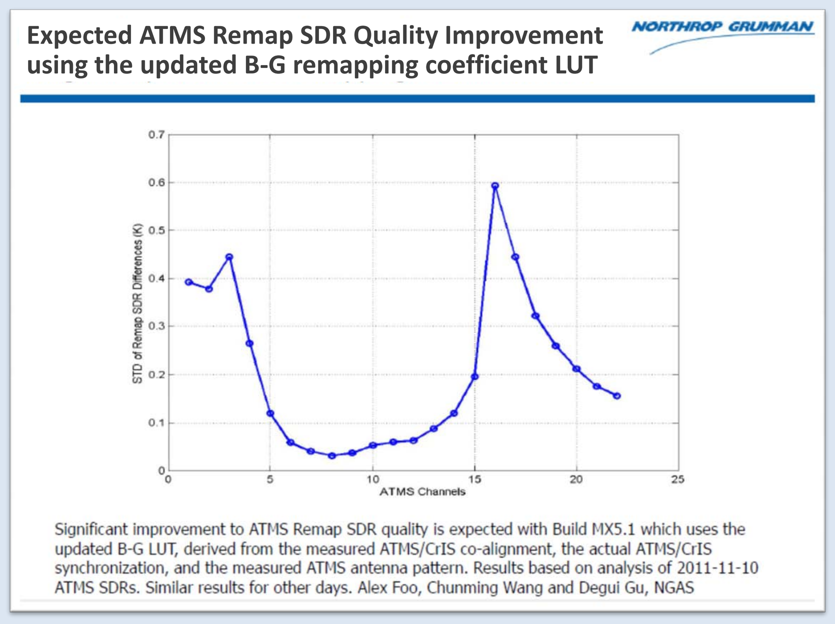
- Drift in calibration target temperatures < 0.001°C / sec
- Drift in receiver shelf temperatures < 0.001°C / sec
- Gain drift: < 0.00008 dB/sec for channels 1-11, 16-2
  < 0.0001 dB / sec for channels 12-15

Example results shown in following charts: Requirements are satisfied by orbit 164, Steady state achieved by orbit 182



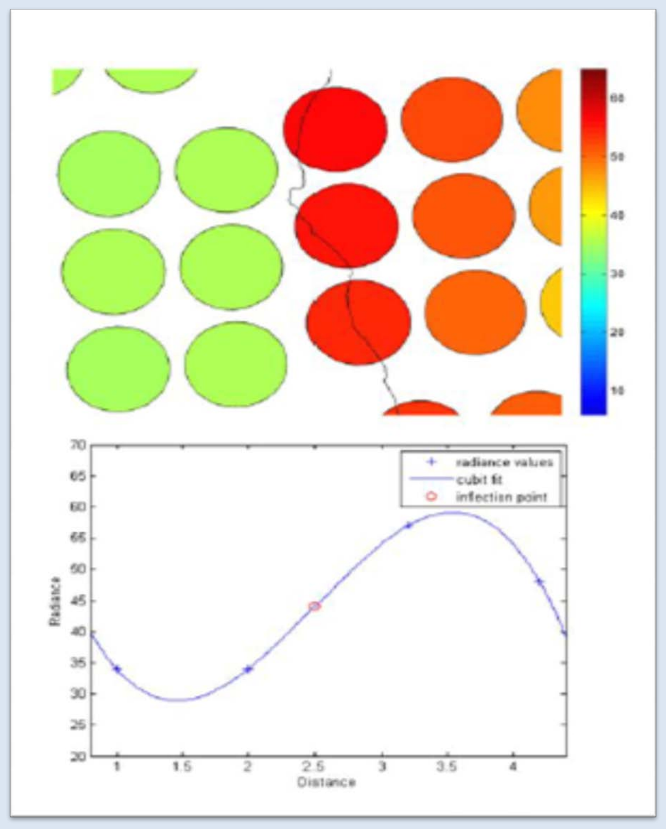
SDR Remapping



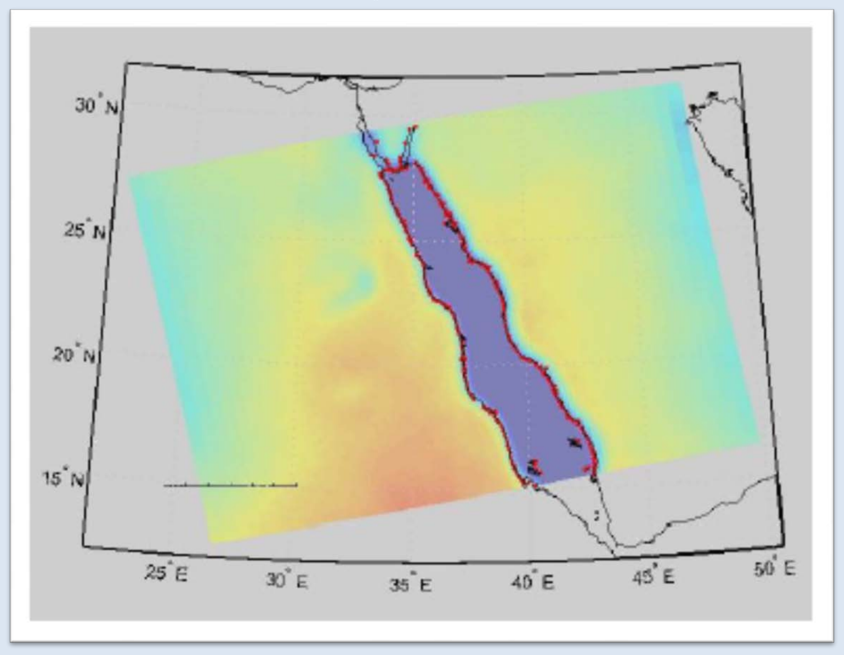


Geolocation Verification Method

- Pick multiple regions with high coastline contract and orbits with costal crossing close to nadir (BP 24-74)
- Fit a cubic polynomial through for points in the in-track or cross-track direction
- The inflection point is taken as the shore crossing point
- Compare points to actual cost (GSHHS fine resolution dataset)
- For each approximate coastline point, the intersection of the perpendicular is found on the actual cost. This distance is separated into a North-South and East-West error.



Example: Red Sea

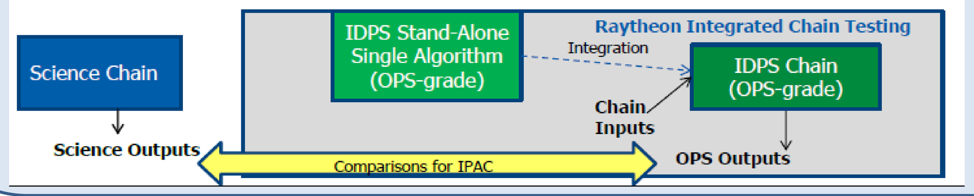


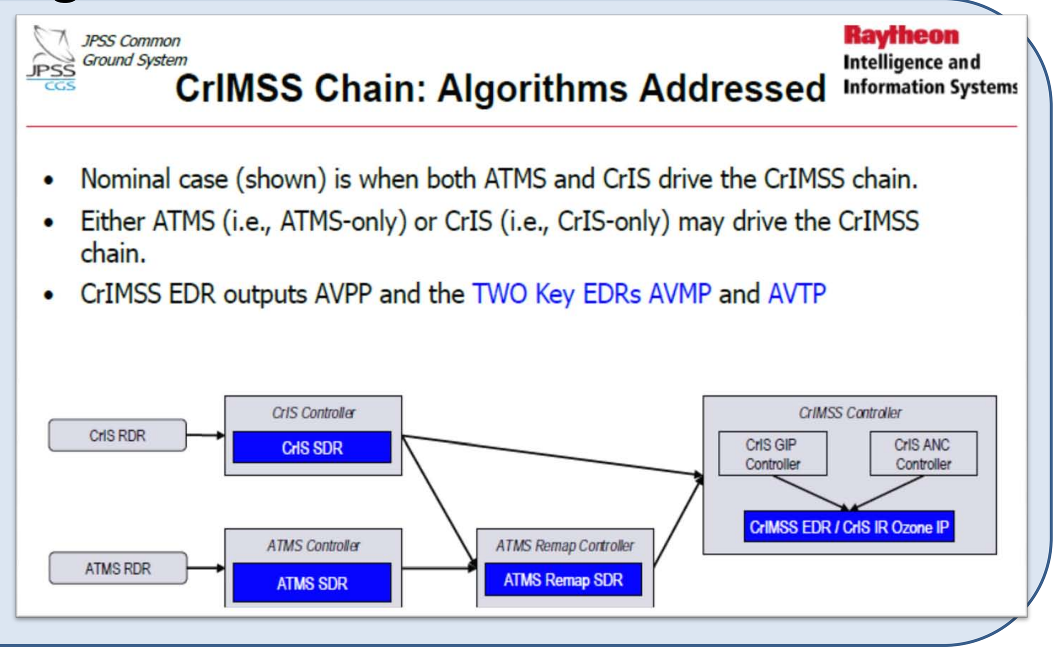
Orbit 668
14 Dec 2011 7 Granules
271 Crossing Pts. (Channel 1)

Data Processing Chain

Operational Algorithm Testing

- Algorithm modules strung together in sequence with proper predecessor/successor interfaces (data/algorithms)
- Data is processed from APs/RDRs to EDRs/IPs
- Chain testing differences include:
  - Differences between Science and OPS (implementation & outputs) propagate through chain (left to right)
  - Differences can invoke different algorithm branching, making downstream result comparisons difficult
  - Science module outputs lack cross-scan and cross-granule processing
  - Differences in ancillary and supplemental data sources
  - Science is scan-based (e.g., ATMS) while OPS is granule-based
    - OPS granule boundaries are determined by time, may contain short granules





SUMMARY:

ATMS on S-NPP is the first of a new series of operational microwave sounders. We have presented a summary of the new microwave sounder ATMS on Suomi-NPP. Early on-orbit performance is good and Cal/Val activities are continuing for this important operational weather and climate sensor.