Results from the NOAA-14 Microwave Sounding Unit Pitch Test

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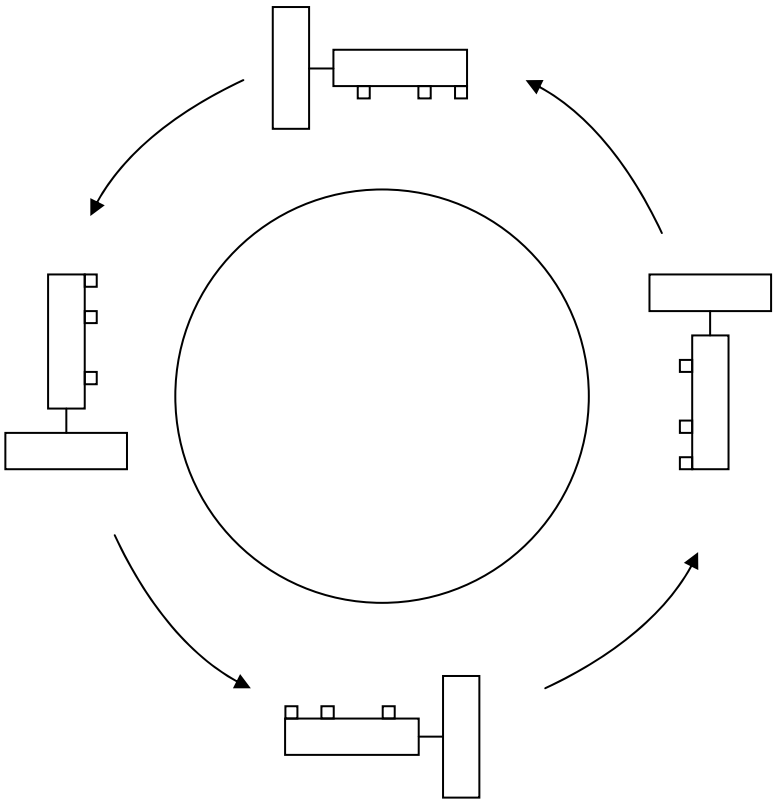
Motivation

- Numerous investigators have used the 28 year MSU time series to estimate decadal tropospheric temperature trends
- NOAA-14 is the last satellite to carry this instrument. It is almost 12 years old and in fairly good health.
- It was vital to perform a final characterization test* on the MSU before processing is terminated on 6 October 2006 (Tomorrow)

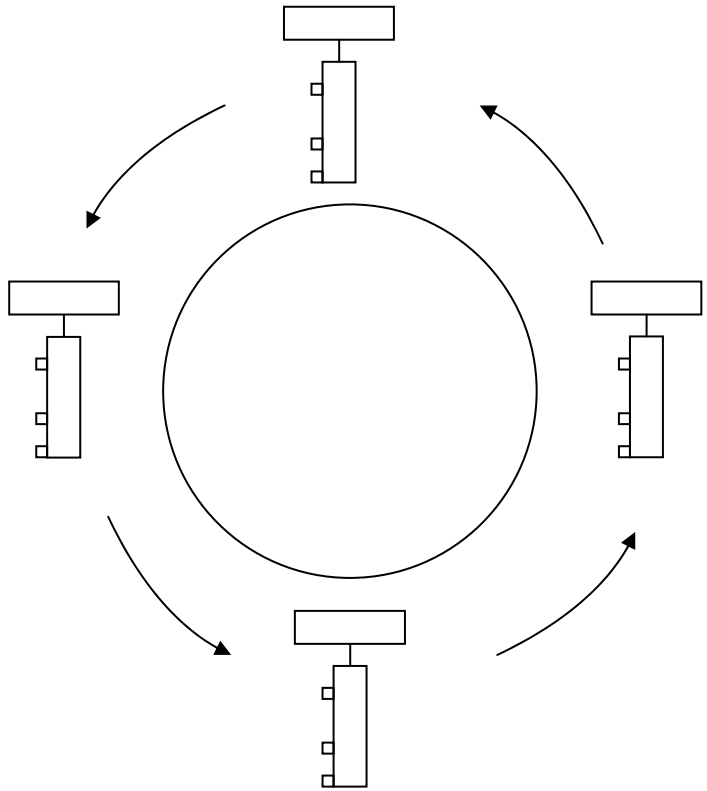
*test, or analysis- we do not perform experiments on our S/C

Pitch Over Maneuver

Normal Orbit



Pitch Maneuver



Planning

- I first approached Cindy Hampton 24 Aug 05
- First team meeting 22 Sep
- Team met irregularly through winter/spring 2006
- Team members worked through issues on a time available basis. No resources allocated to this effort.
- Maneuver planned for 19 July 2006
- Anomaly postponed it indefinitely
- Maneuver finally took place 10 August 2006

Pre-Maneuver Planning

- Orbit and timing selected so that
  - Descending pass over Wallops shortly after maneuver initiation for abort option
  - STK modeling to ensure no sunlight in instrument aperture or radiators
  - Activated McMurdo for SP monitoring
  - Received NASA approval of TDRSS support
  - Extensive contingency planning
  - Commanding only available through CDAs

Pre-Maneuver Anomaly

- N2 pressure slowly and inexplicitly increasing such that release valve may crack during maneuver, affecting attitude
- Switch from TIP-A to TIP-B to verify problem
- Solution: ‘Burped’ N2 tank by simultaneously firing opposite thrusters

Contingency Rehearsal

Worst Case Scenario

- NOAA-9 type of satellite death (zombie)
- Spacecraft Kill macro written just in case

Maneuver Initialization

- Normal spacecraft redundancy disabled
- Solar array disabled
- Earth Sensor Array disabled
- Thrusters enabled
- Spacecraft put into pitch axis inertial drift
- All of this done by stored macro when NOAA-14 was out of CDA range (over Siberia)

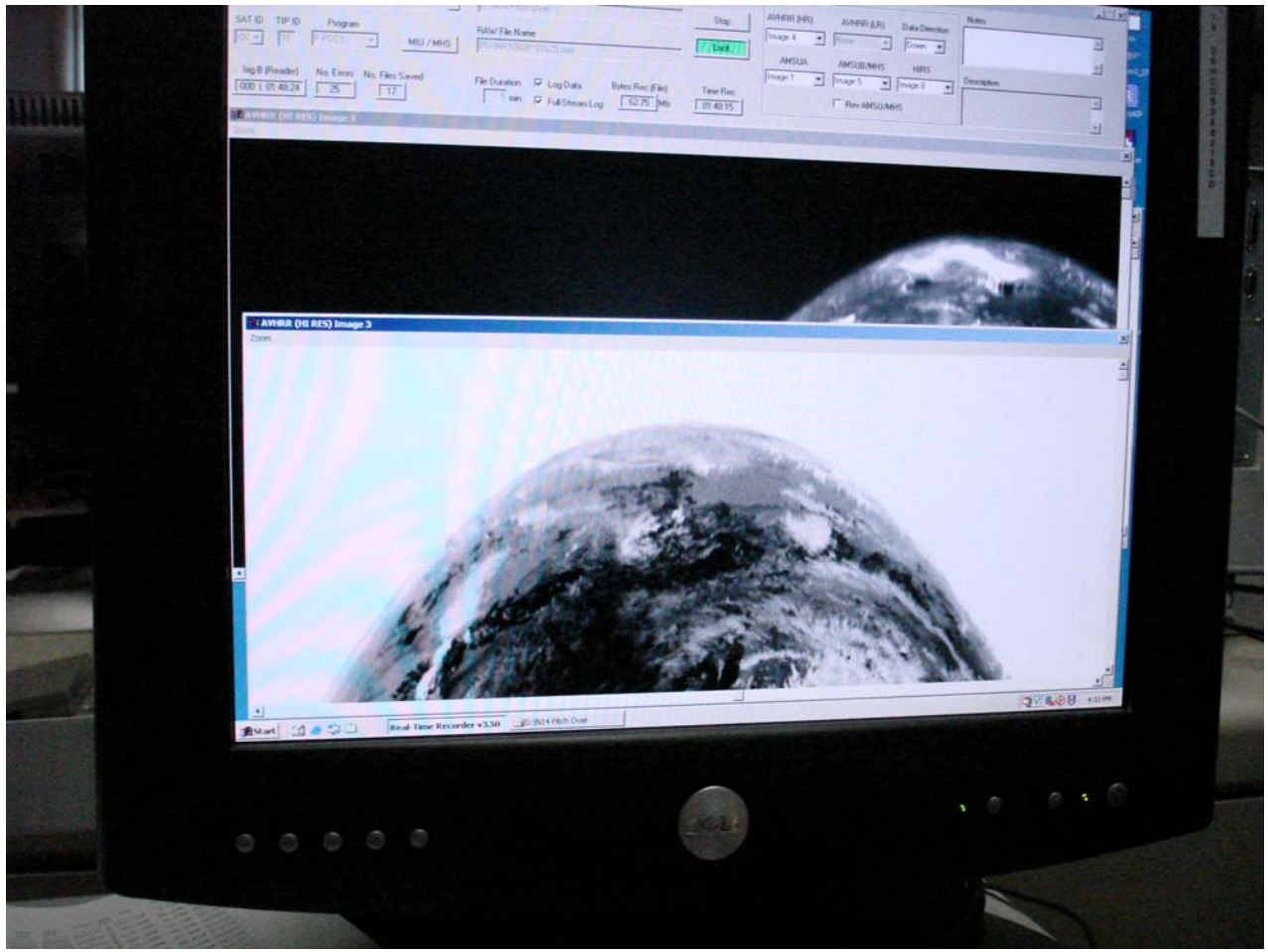
Day of the Maneuver

NOAA Satellite Operations Facility

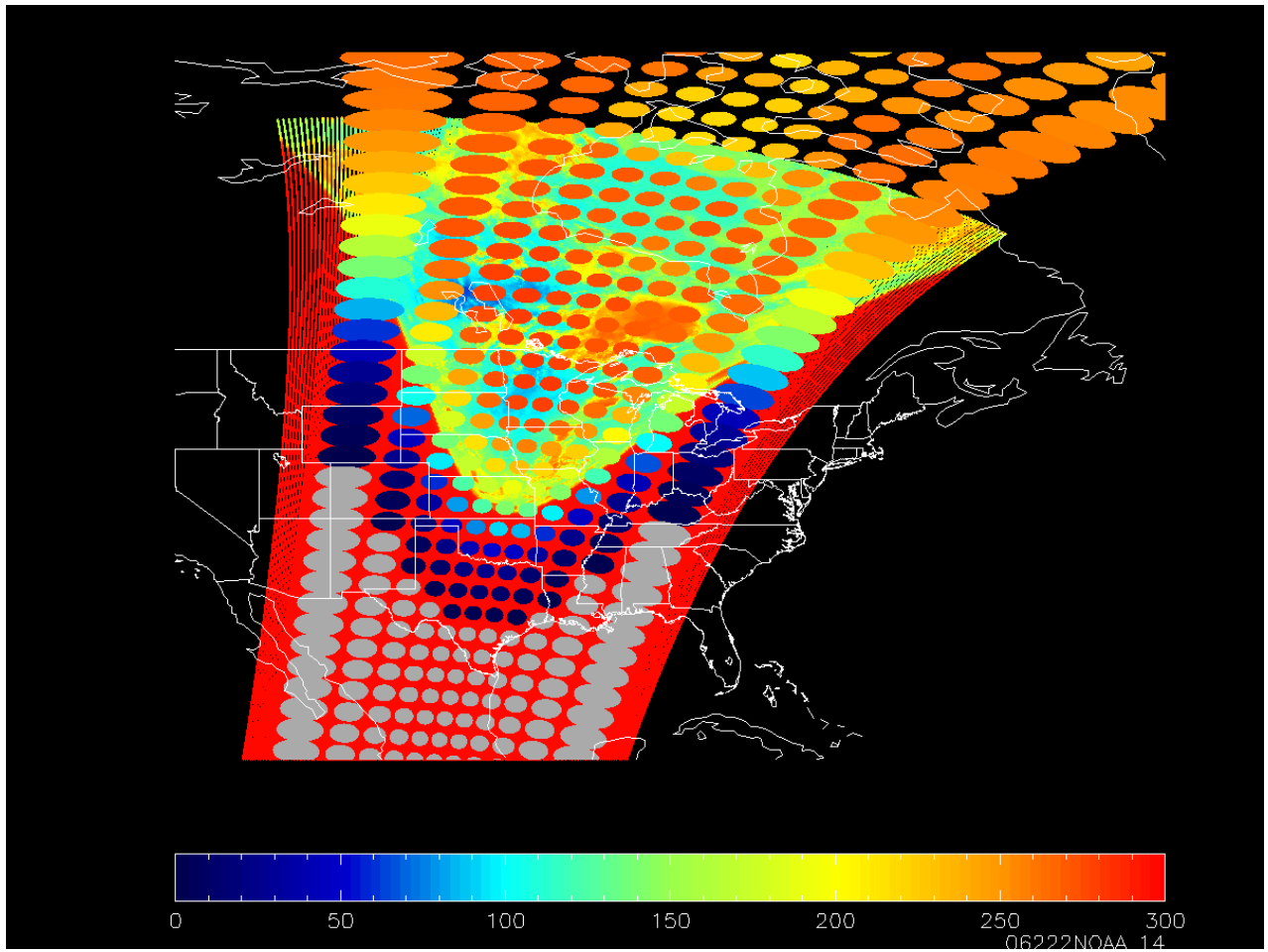
Day of the Maneuver

Day of the Maneuver

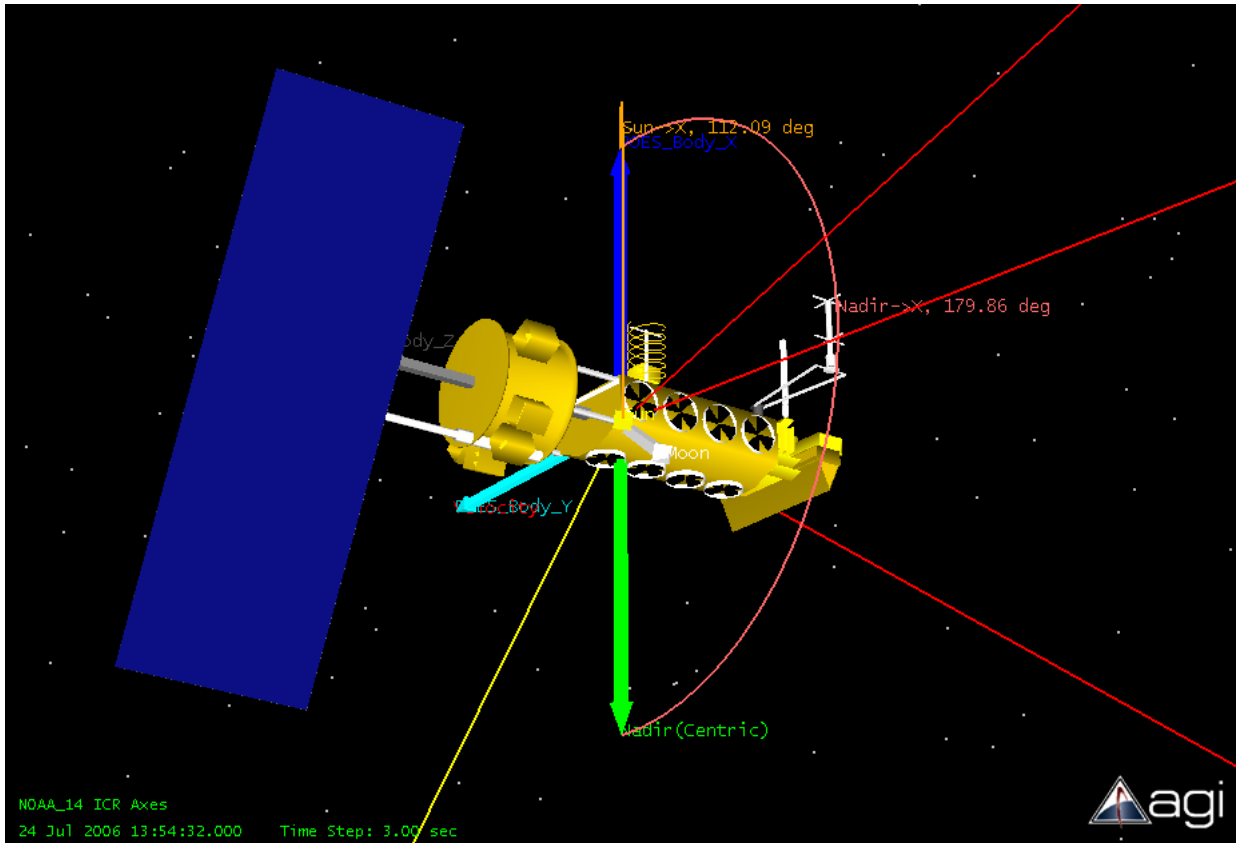
Real Time



AVHRR & MSU Clearing Earth Limb



180 Degrees into POM

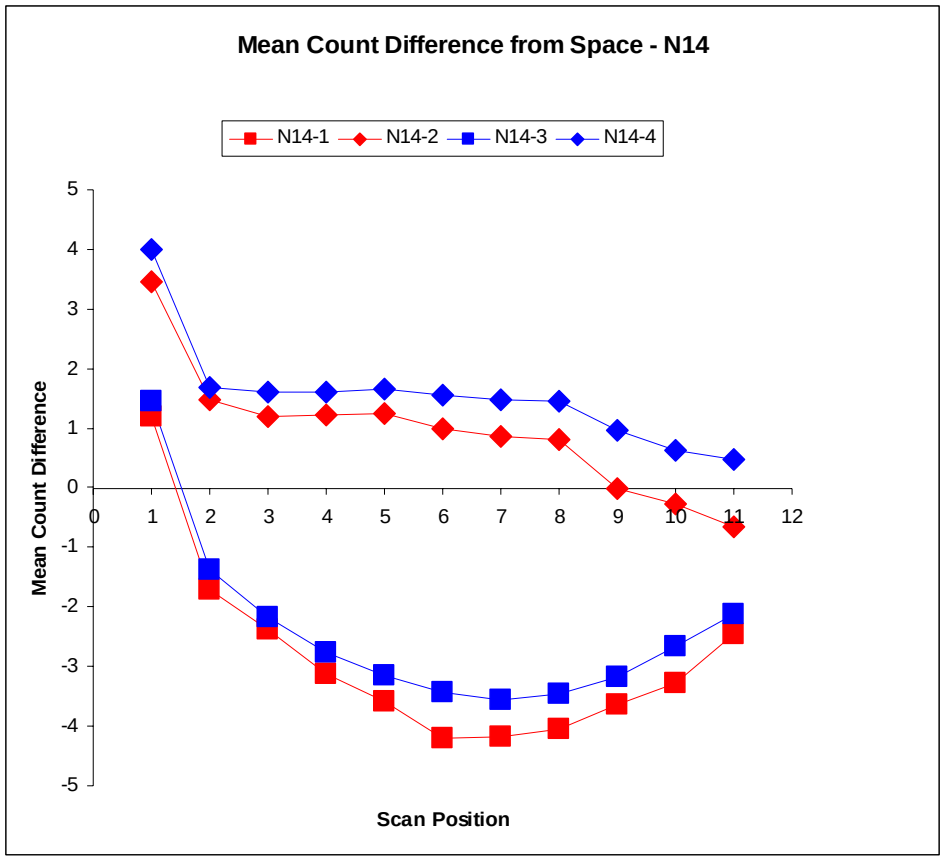


- At 80 Deg south latitude descending towards McMurdo
- MSU looking at deep Space

Results

Mean difference of ‘earth scene’ from 139 space calibration looks

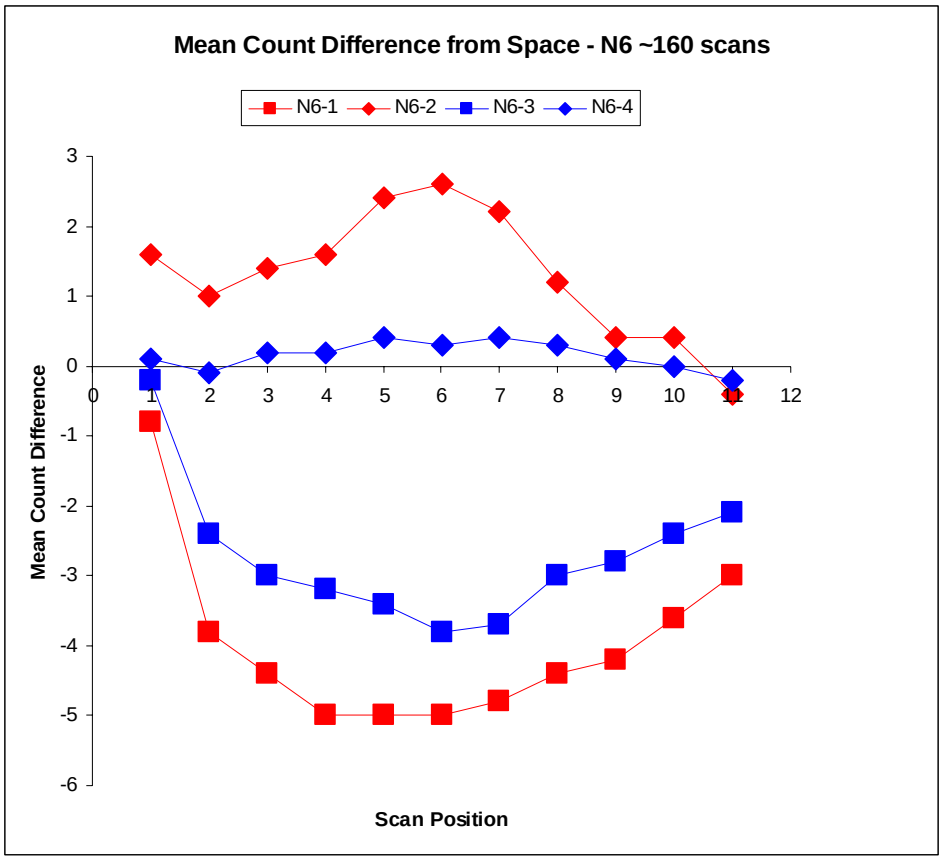
0.12 K / count



1. Space look sees different counts than earth scene
2. Asymmetry in earth scene
   - Different for different polarizations (1&3V)
3. Posn 1 noticeably warmer than posn 2

Special Surprise Results from NOAA-6 (courtesy Crone memo, 1984)

0.12 K / count



1. Channels 1&3 similar behavior to N14
2. Channel 4 has almost no asymmetry
3. Channel 3 deviates most from Space Cal at nadir position (similar but opposite sense to ch 1&3)
4. Ch 1&3 warmer at posn 1 than 2 (like N14)

Anomalies

- Momentum built up more than expected. Thrusters fired as designed to bleed momentum
- HIRS and AVHRR radiators no longer protected by earth shield. Patch temperature up 70K (from 100K). IR data useless fairly early into maneuver. Instruments recovered a few orbits later.
- N2 pressure increased further but relief valve held, reinforcing the decision to ‘burp’ the N2 tank.

Summary

- NOAA successfully executed a pitch over maneuver on NOAA-14
- The MSU exhibits scan asymmetry, and the space calibration look deviates from the earth scene when viewing cold space
- The MSU on NOAA-6 exhibited similar and different behavior to NOAA-14, depending on the channel
- This asymmetry may just be a bias, and may not effect temperature trends
- Hopefully we can do this maneuver on NOAA-15 for the AMSU-A/B.