The AMSU/MSU FCDR as an in-orbit reference for monitoring ATMS

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  - Existing Methods of Validating Microwave Instruments
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- SATMS - AMSU FCDR SNO bias
  - Temporal
  - Temperature
  - Scan Angle
- Summary and Discussion

Keywords:
- AMSU-A : Advanced Microwave Sounding Unit-A
- ATMS : Advanced Technology Microwave Sounding.
- SATMS : Science Data Record produced by ATMS observations.

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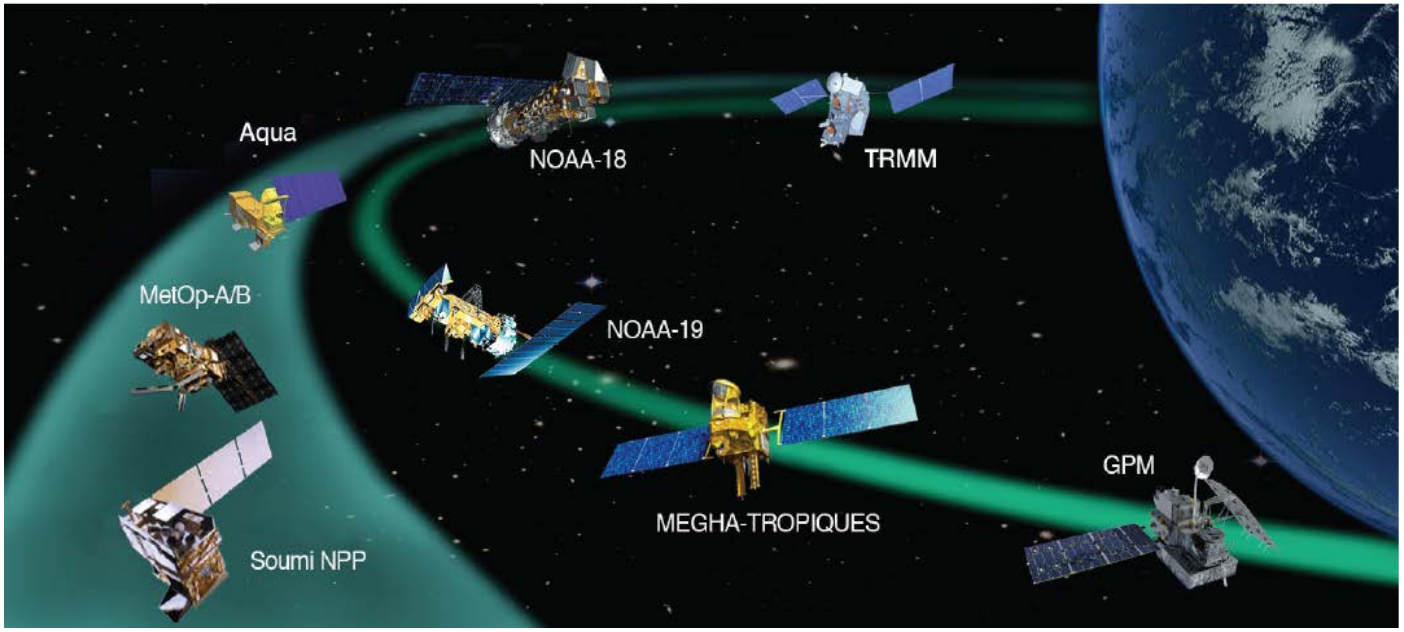
Introduction- Microwave Instruments

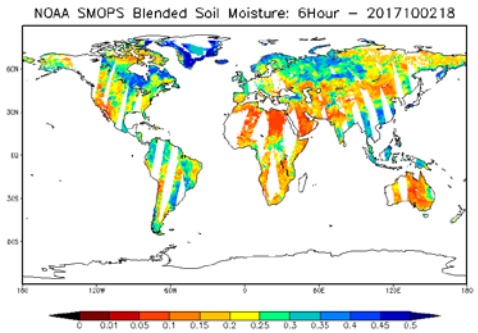


Microwave Instruments

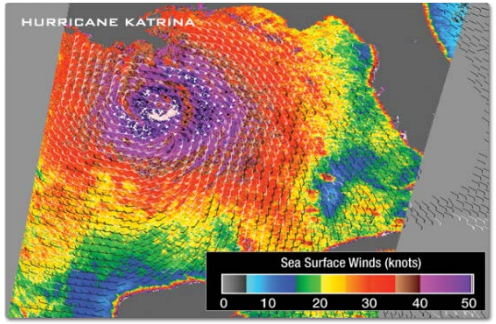
MWTS-2
MTVZA
SSMI
GMI
ATMS
AMSR(2/E)
AMSU/MSU

The WMO OSCAR Data base shows over 65 Microwave instruments launched since 1978

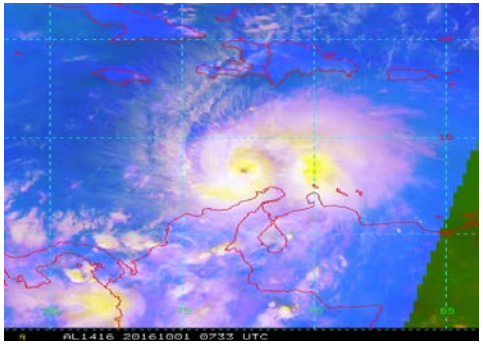
Soil Moisture



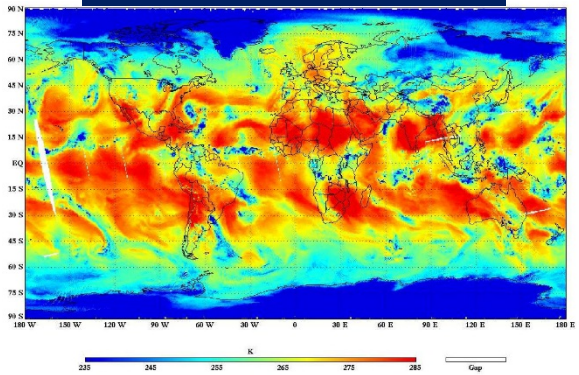
Winds



Hurricanes



Water Vapour



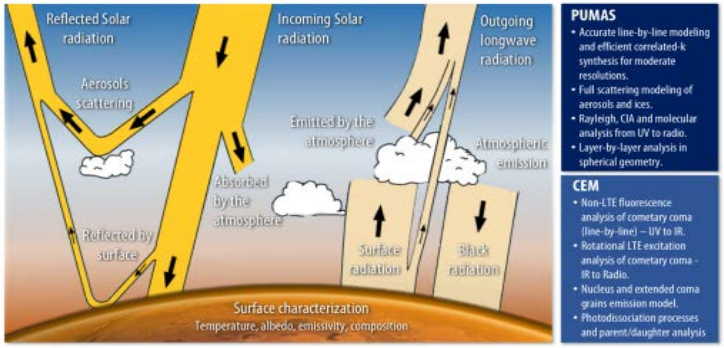
Introduction- Methods for Validating Microwave Instruments

Radiative Transfer Model (RTM)

The Model Simulates the Brightness Temperature at the Central Frequency and Polarization of the Channel at the location of the measurement.

Pros: Direct comparison at the point of interest

Cons: Sensitive to quality or biases in the input and uncertainty in SRF



GPS-RO

The GPSRO data are provided by receivers onboard low Earth

GSICS (SNO) style inter- comparisons with a hi-quality in orbit reference can reveal temporal, scan angle, temperature biases that can aid in re-calibrating the instrument and permanently removing biases.

Cons: Limited Channels/Coverage+ Lower Trop and Mesosphere outside range.

Re-Analysis

Re-analysis data are generated from long-term runs of fixed climate modeling systems with combinations of a comprehensive set of physical parameterizations and assimilation of routine observations from various sources such as satellites, ships, buoys, aircraft, and the radiosonde network, etc.

Pros: Global fields of TOA.

Cons: Model Biases and Differences between Re-Analysis datasets.

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Big Questions

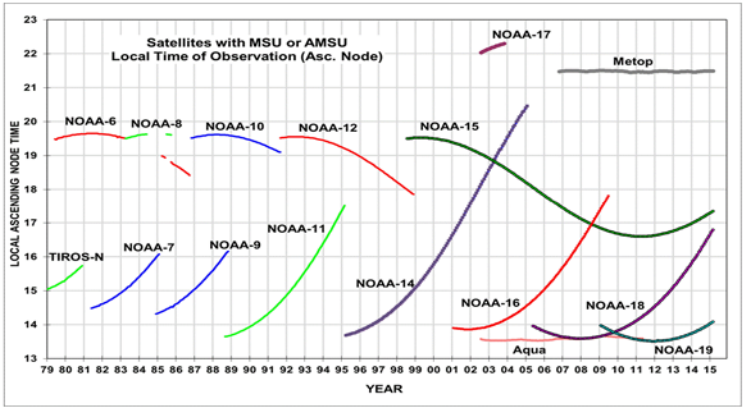
- **Can we come up with a procedure to select an in-orbit reference?**
- **Can we select a reference to which all MW instruments can trace to?**
- **Can the computed biases help in re-calibrating an instrument so as to permanently remove the biases and trends?**

Reference:
Procedure discussed in Tim Hewison Presentation in OSCAR Workshop Discussions from 2015 GSICS Annual Meeting , Delhi India

Big Question-Way Forward

Start with a channels you wish to monitor and then select an in-orbit instrument/channel that is **several times more stable and accurate** than the instruments one wishes to monitor, to serve as reference.

Most of the microwave instruments develop biases and trends post launch in their native measurements of Top of Atmosphere Radiances. (See Zou and Wang 2011 & 2013; sections reporting issues in prelaunch calibration section.)



Accuracy Criterion

~ 0.1K (1 w/m2).

Stability criterion

~0.05 K (0.3 w/m2/dec).

Leroy et al, 2007 , 34 Yrs of continuous observation at this level of accuracy to get climate signal.

L1B Climate Data Records:

- **Are several times more stable than raw measurements of L1B BT and can be a good candidate for a reference**
- **Come close to the climate stability criterion which is much better than an in-orbit instrument performance**

An FCDR can be a good candidate for acting as In-orbit references

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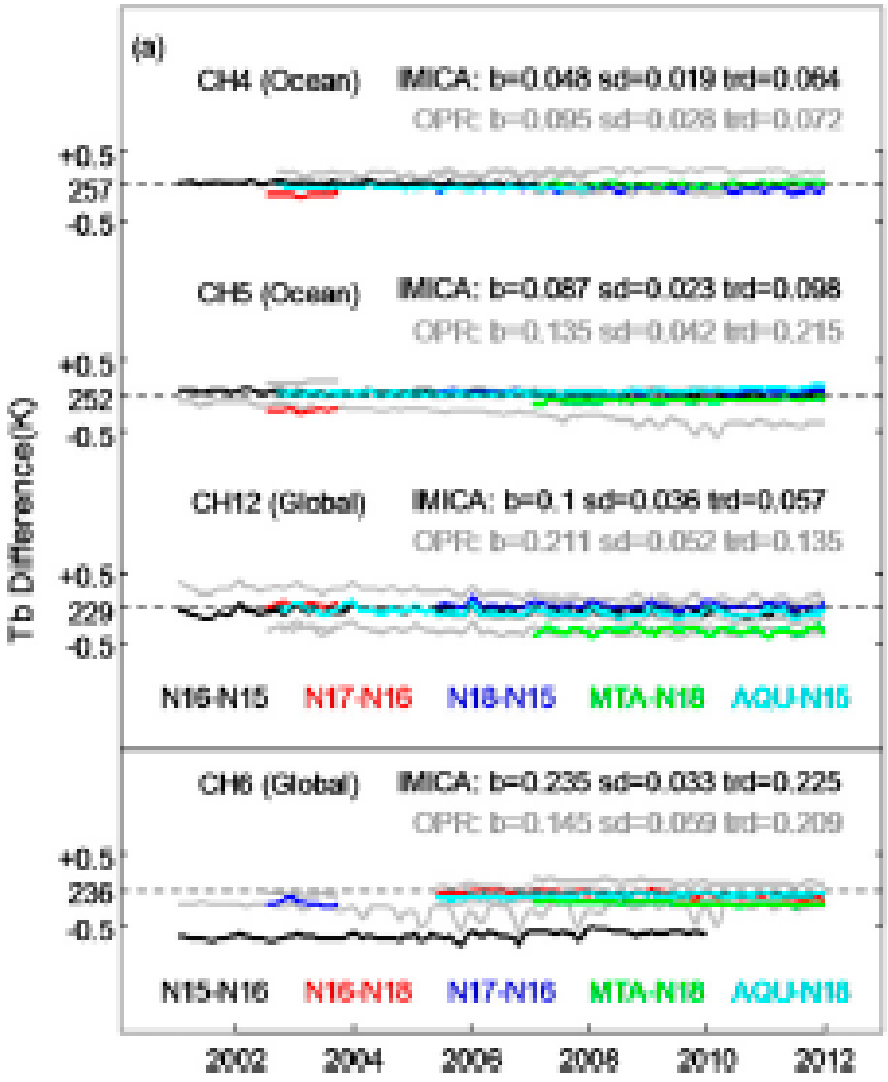
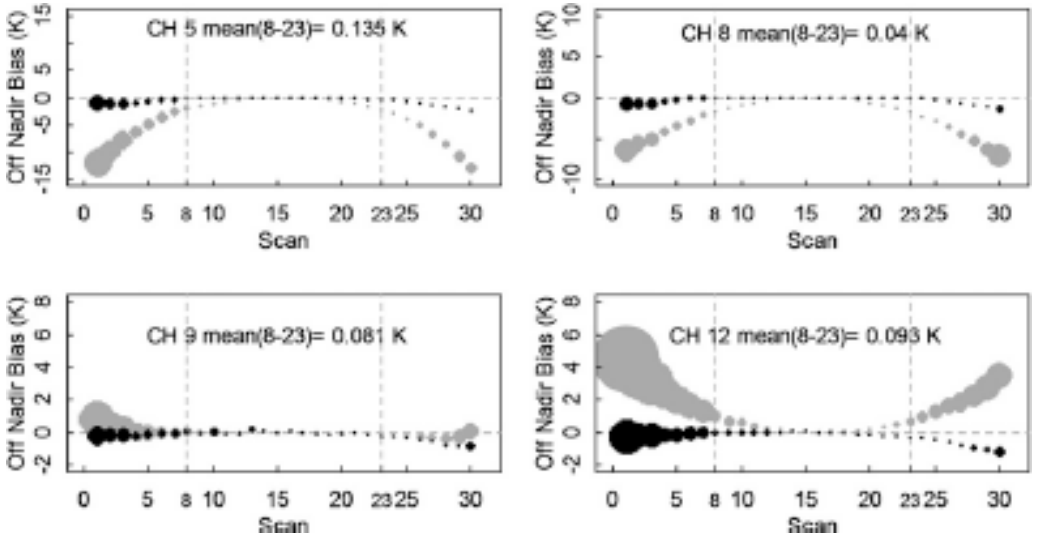
Stability of AMSU/MSU FCDR





- (Advanced Microwave Sounding Unit) AMSU-A onboard six POES satellites were inter-calibrated using the Integrated Microwave Inter-Calibration Approach (IMICA)

- Five calibration errors were removed/reduced: nonlinearity, bias drift, frequency shift, sun-heating induced temperature variability in radiances;

- Inter-satellite Biases were reduced to 0.1-0.2K

- 19 years of swath data

- Dataset available from NCEI CDR website

•AMSU-A/MSU FCDR continuously monitored in Real time
•Scan Angle Dependence has been corrected
•Validated with GPSRO and instruments monitored at ICVS
•Typical data file resembles a native L1B data file

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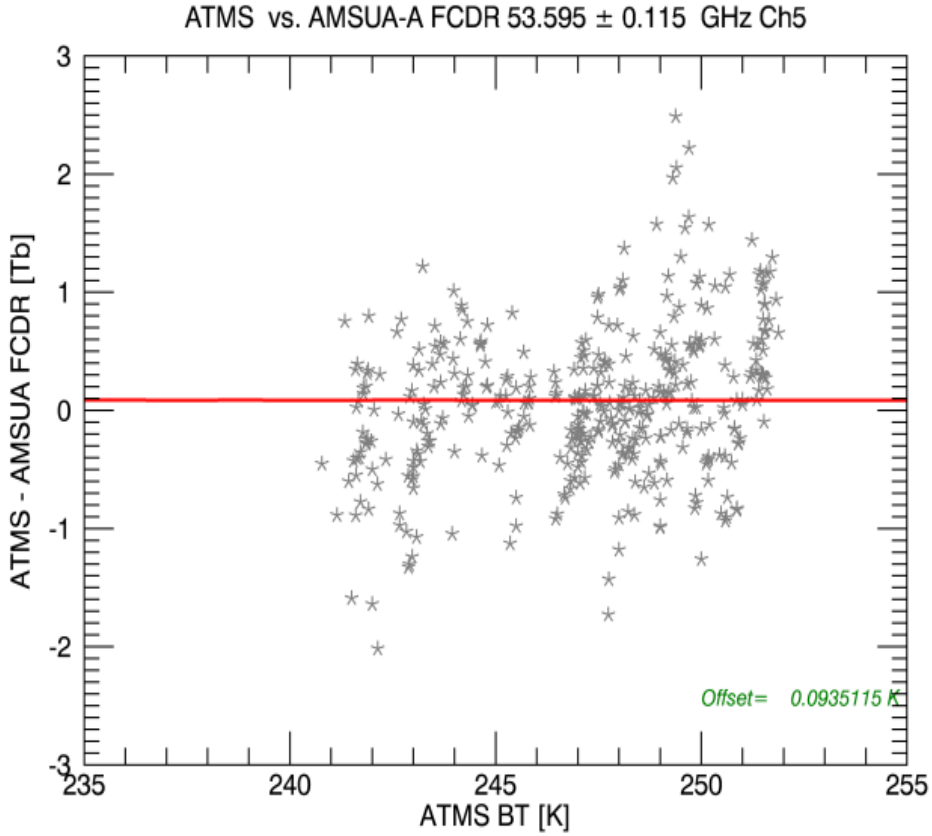
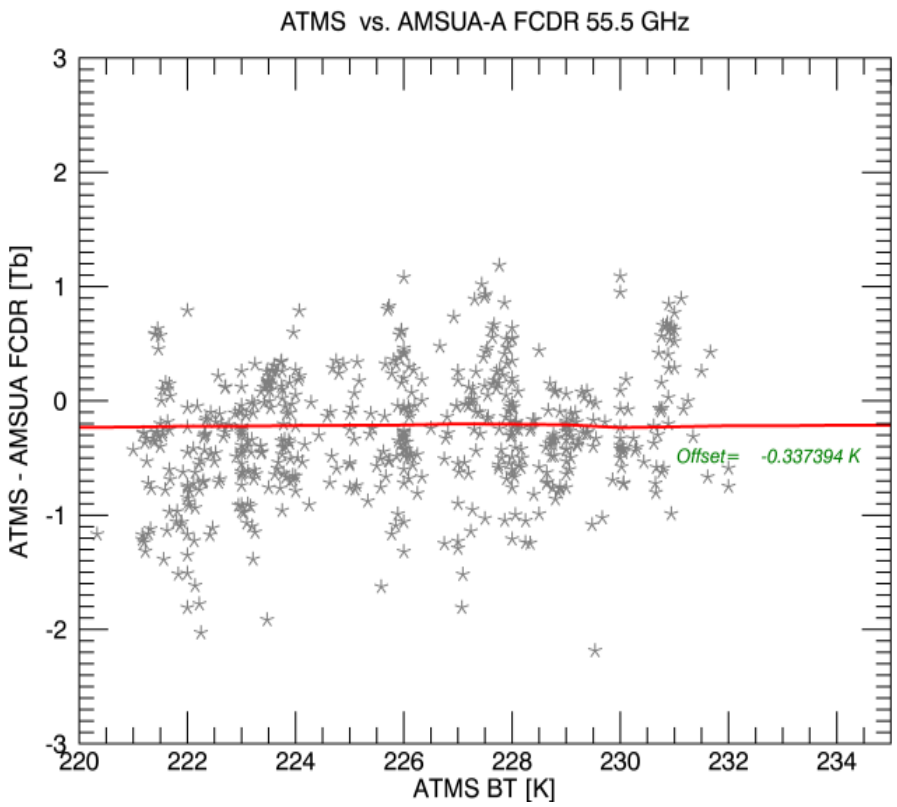
Inter- comparison of AMSU/MSU FCDR and ATMS-SDR-Temperature

Collocation data set for SATMS versus AMSU was identified for Oct 2015 – Dec 2016. SATMS was collocated with AMSU-A onboard Aqua and AMSU-A onboard N18
(Selection Criterion Distance < 30 Km, T <5 Mins SD < 1K)





Shows the temperature dependence of bias of ATMS. Close to pre-launch levels (Weng et al, 2016)

ATMS-SDR and FCDR both very close to maintain pre-launch behavior in space.

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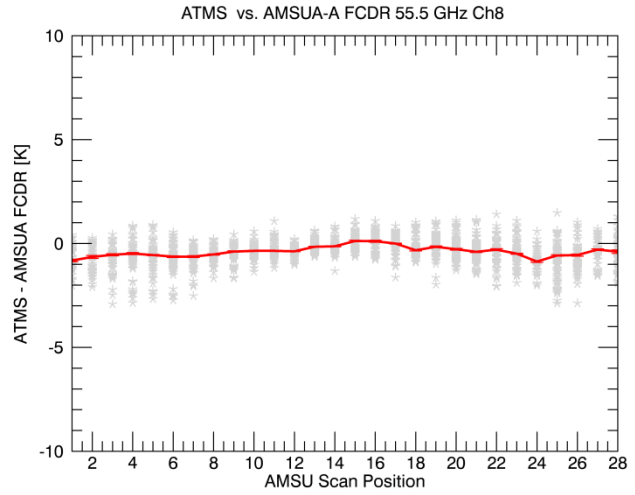
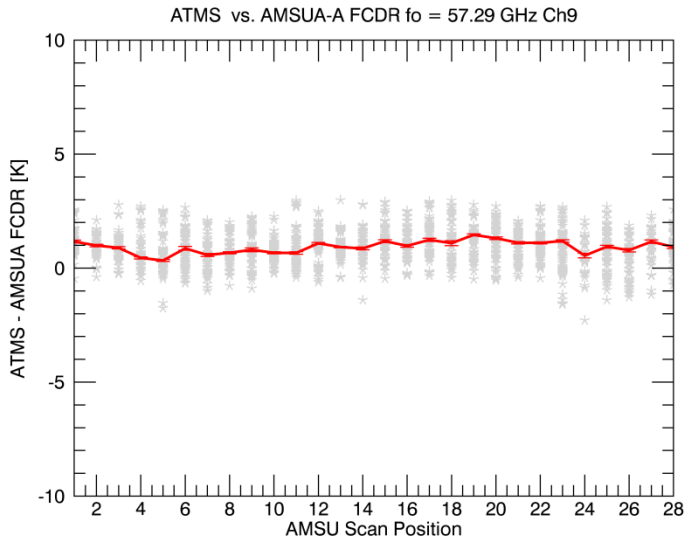
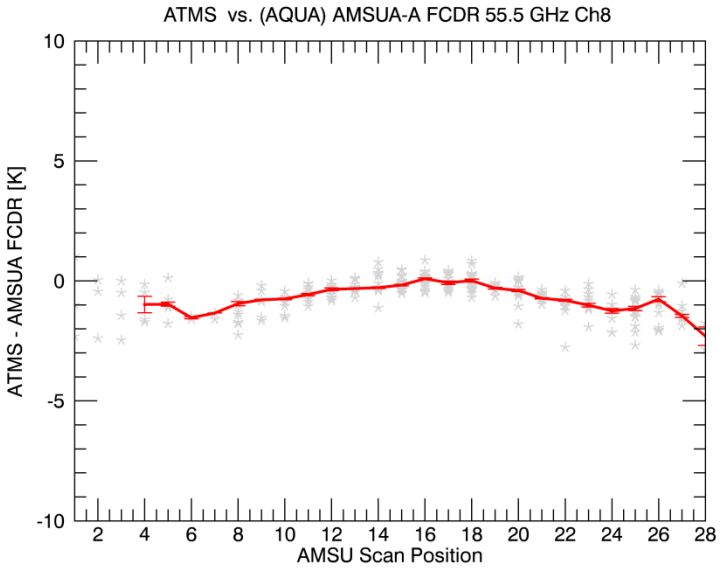
Comparison of AMSU/MSU FCDR and ATMS SDR versus Scan Angle

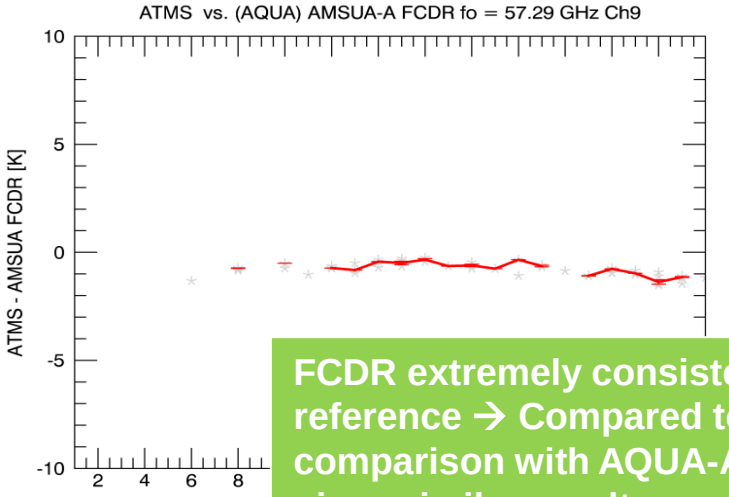
N18





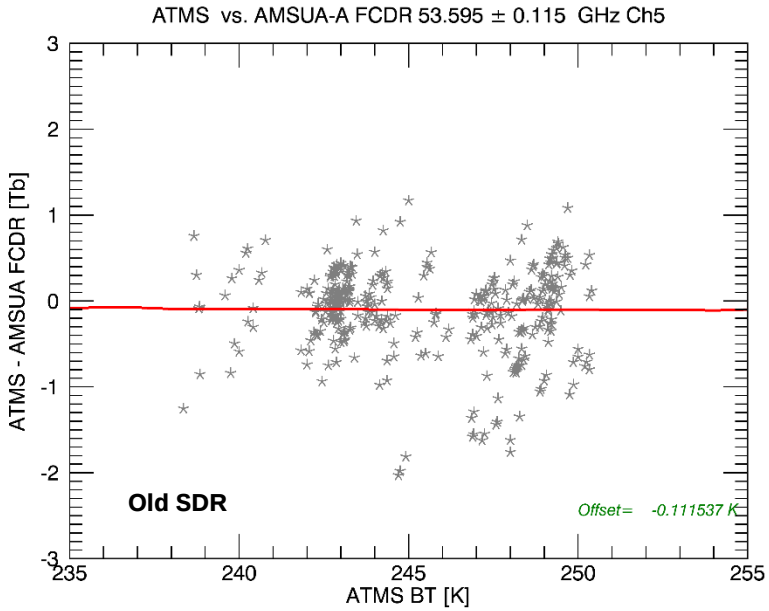
Aqua

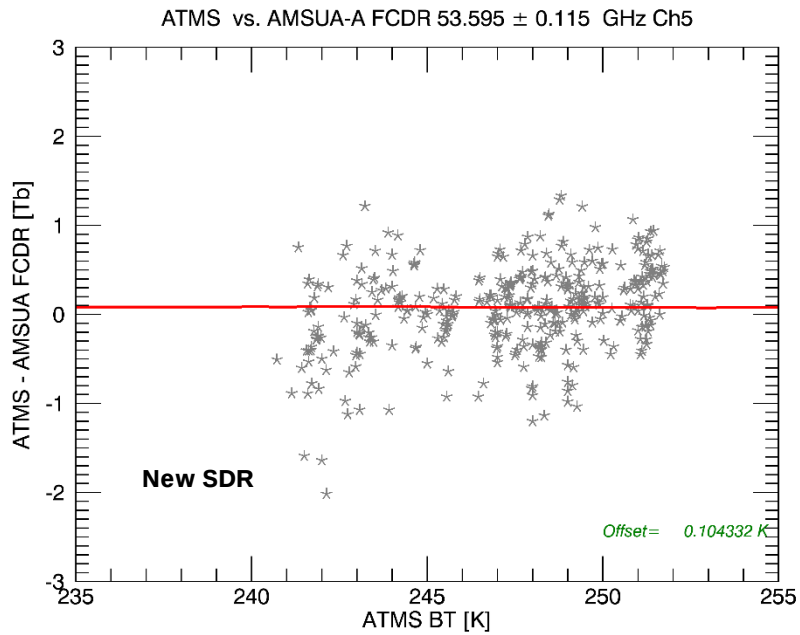




FCDR extremely consistent as a reference → Compared to N18, Inter-comparison with AQUA-AMSU FCDR gives similar results

Comparison of AMSU/MSU FCDR and ATMS SDR





Comparisons show inter-comparision with FCDR is capale of revealing changes in SDR processing. In this case shows change in bias from old version SDR to new version SDR

Summary

- It is proposed that AMSU-A/MSU FCDR can be used as a high quality in-orbit reference for monitoring MW Channels of In-orbit instruments.
- AMSU-A/MSU instruments provide three decade unbroken chain of observations. Channels overlap with several existing MW sensors (MWTS-2 ,MTVZA, SSMI, GMI, ATMS, AMSR(2/E), AMSU/MSU)
- The FCDR is built using the IMICA technique and provides nearly pre-launch level of stability. Comparisons can reveal wide range of scan angle biases, temporal and temperature dependent biases.
- It is proposed to build FCDR's for dual use (Climate + Calibration)

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Thank You

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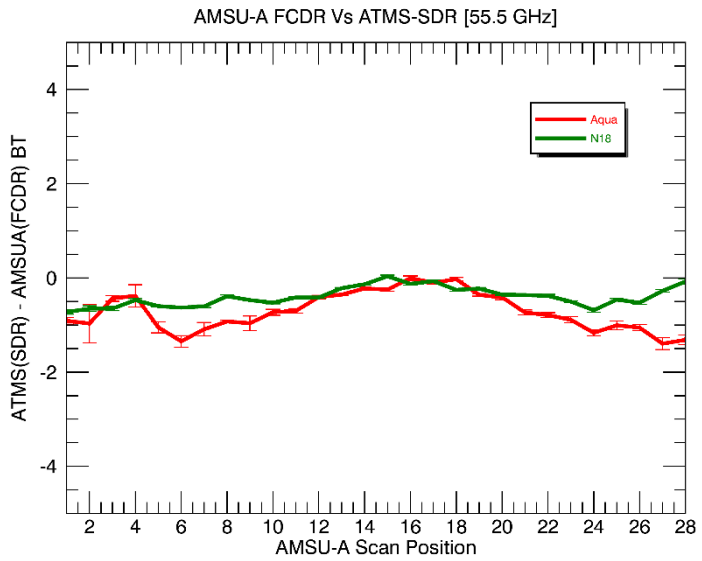
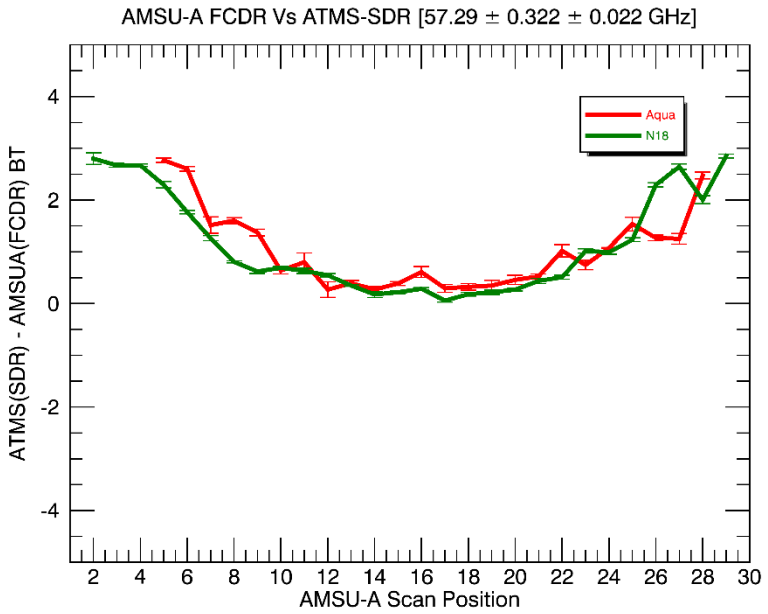
Inter- comparison of AMSU/MSU FCDR and ATMS-SDR-Scan Angle





M. Burgdorf's Answers

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