Toward assimilation of CrIS and ATMS in the NCEP Global Model

Andrew Collard[1], John Derber[2], Russ Treadon[2], Nigel Atkinson[3], Jim Jung[4] and Kevin Garrett[5]

[1] IMSG at NOAA/NCEP/EMC [2] NOAA/NCEP/EMC [3]Met Office, UK
[4]U. Wisconsin/CIMSS [5] Riverside Technology, Inc./NOAA/NESDIS

Content

- ATMS
  - Introduction
  - Spatial Averaging
  - Comparison with Forecast Model
  - Assimilation Configuration
- CrIS
  - Current Status
- Final Remarks

- ATMS
  - Introduction
  - Spatial Averaging
  - Comparison with Forecast Model
  - Assimilation Configuration
- CrIS
  - Current Status
- Final Remarks

Introduction

- ATMS is a microwave sounder on NPP launched on October 28 2011.
- ATMS has similar channels to AMSU-A/MHS and most of the AMSU-A/MHS processing can by directly applied to ATMS.
- However, ATMS has different field of view sizes and separations:
  - AMSU-A-like channels on ATMS have 2.2° fields of view (5.2° for channels 1&2) separated by 1.1° (Nyqvist-sampled)
  - Equivalent channels on AMSU-A are 3.3° across and separated by 3.3°.
  - MHS-like channels on ATMS are 1.1° across and also separated by 1.1° (so all ATMS channels are bore-sighted).
  - MHS channels have a width and separation of 1.1111°
- The smaller FOV size for most of ATMS's temperature sounding channels results in higher noise than the equivalent channels for AMSU-A. Also it would be helpful to have ATMS channels 1&2 have a similar FOV to the other AMSUA-like channels. Resampling is required.

Introduction (contd)

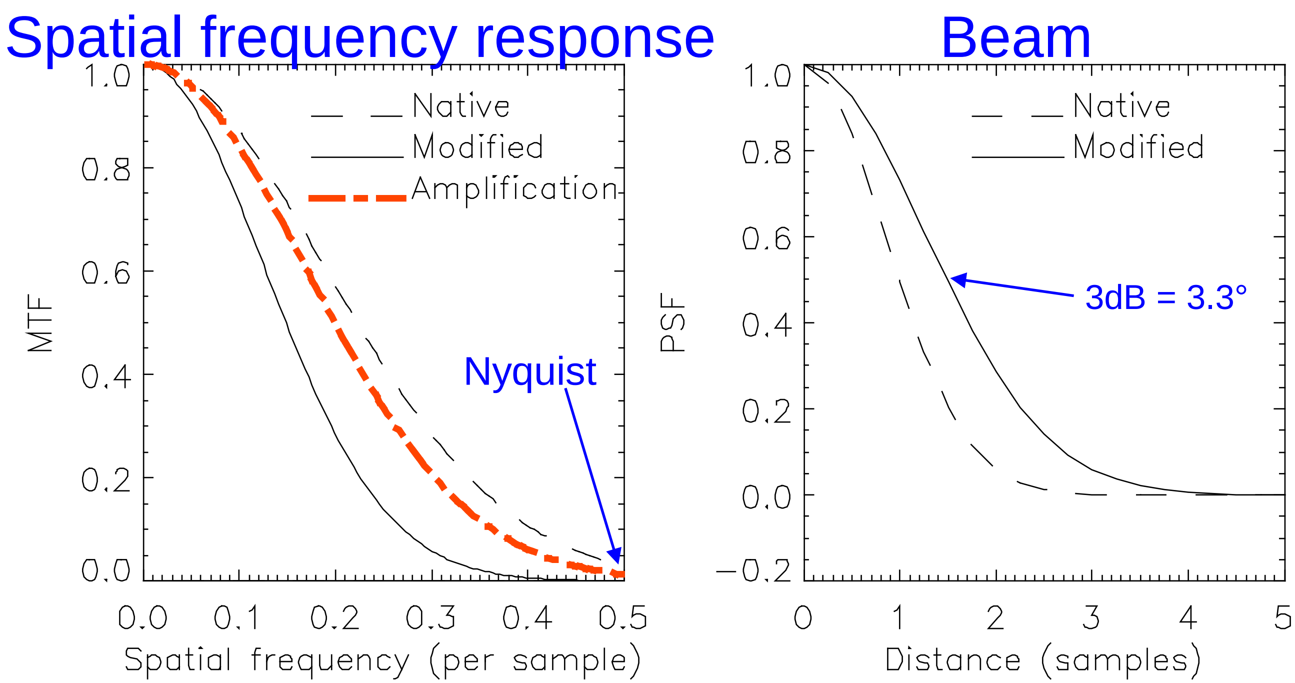
- We are routinely receiving ATMS data as BUFR
- We are using the antenna temperatures contain in these files (following our use of AMSU-A/MHS radiances)
- The comparisons shown are based on first-guess departure statistics (observed radiances minus those calculated from a 6-hour forecast) for the NCEP GSI assimilation system.
- As much as possible the performance is assessed relative to that of AMSU-A/MHS on NOAA-19.

- ATMS
  - Introduction
  - Spatial Averaging
  - Comparison with Forecast Model
  - Assimilation Configuration
- CrIS
  - Current Status
- Final Remarks

Spatial Averaging / Re-Mapping

- We use the AAPP FFT-based remapping code (described by Nigel Atkinson) to re-map (and in the process spatially average) the AMSU-A like ATMS channels to a common field of view (3.3°).
- This is to reduce the noise on the temperature sounding channels and also to allow the 5.2° FOV channels 1 and 2 to be consistent with the other AMSU-A like channels (as these are used for cloud-detection).
- Special attention has to be paid to missing and bad data as this will affect surrounding points in the re-mapped product.
- Similarly, we did not want to assimilate observations within 5 scan-positions/scan-lines of each other and they will be correlated.
- In this presentation we are showing both raw and re-mapped data.

Broadening the beam width: - temp sounding channels



2.2° to 3.3°

- Relatively easily done using FT technique
- Sample averaging (3 x 3) is an alternative
- Recover AMSU-A-like noise levels: noise reduction factor is ~0.3
- The output can then be spatially thinned or re-mapped if required

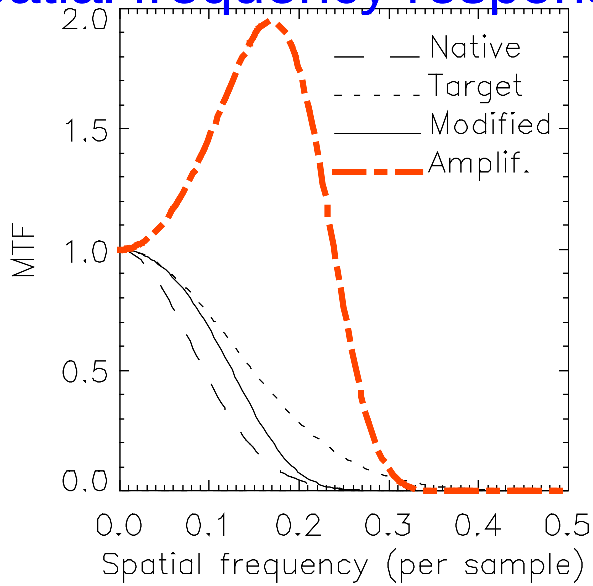
From Nigel Atkinson

Narrowing the beam width: 23.8 and 31.4 GHz

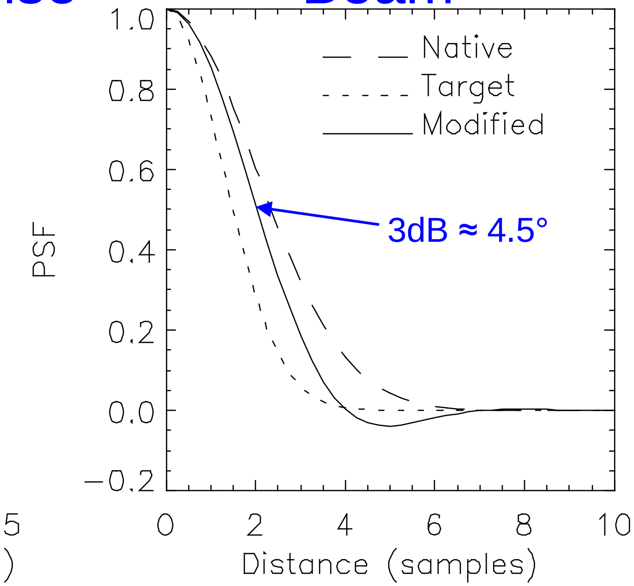
These channels are assimilated operationally at some centres – used for cloud liquid water at MetO

-not the case when ATMS spec was formulated!

Spatial frequency response



Beam



5.2° to 3.3° ?

- Cannot be done perfectly, but can do a reasonable job at the lowest spatial frequencies
- Noise factor is ~0.7 in the example above
- Fixed modification – not scene dependent

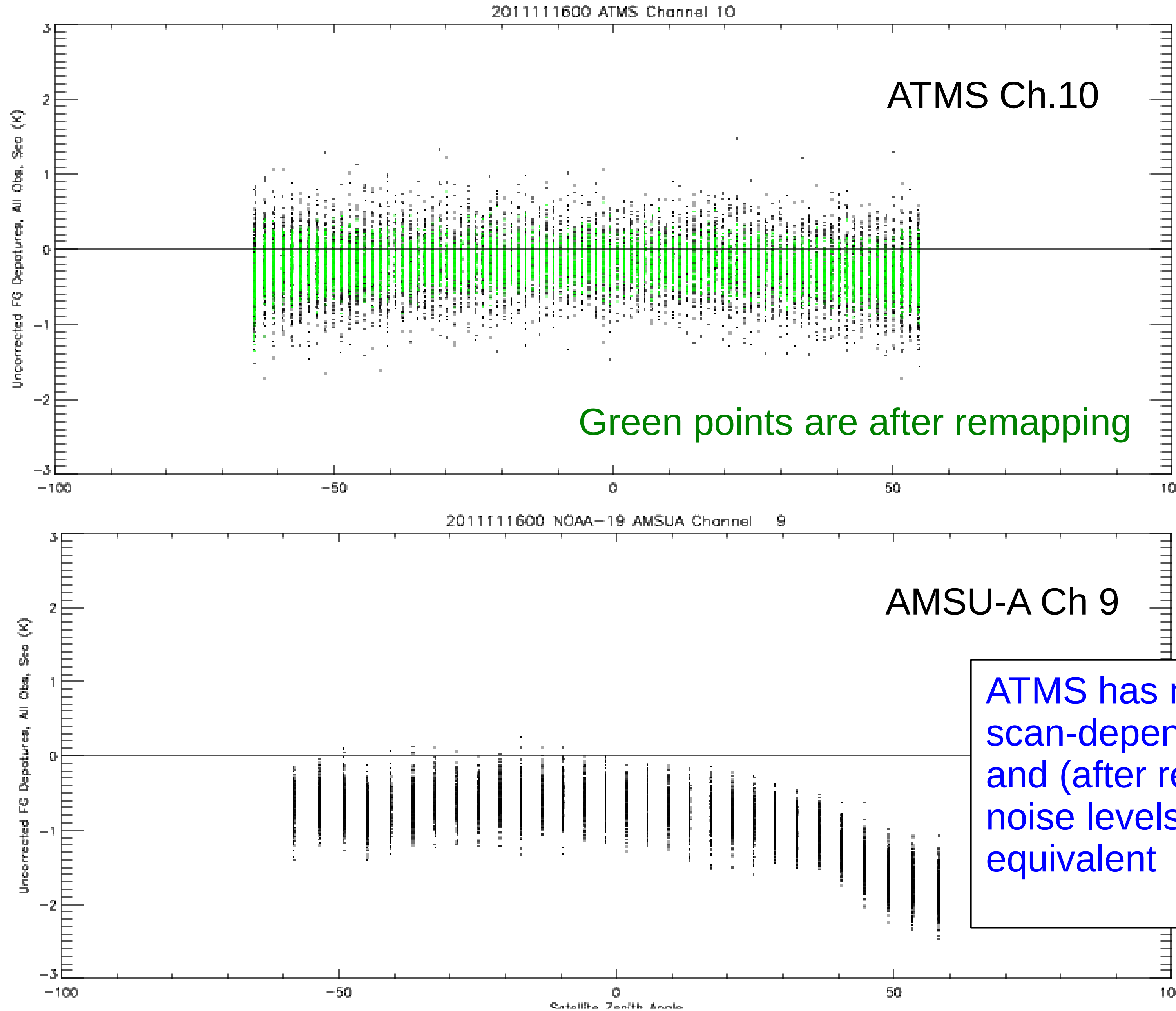
From Nigel Atkinson

- ATMS
    - Introduction
    - Spatial Averaging
    - Comparison with Forecast Model
    - Assimilation Configuration
- CrIS
    - Current Status
- Final Remarks

AMSU-A vs ATMS Stats

Antenna Temperatures

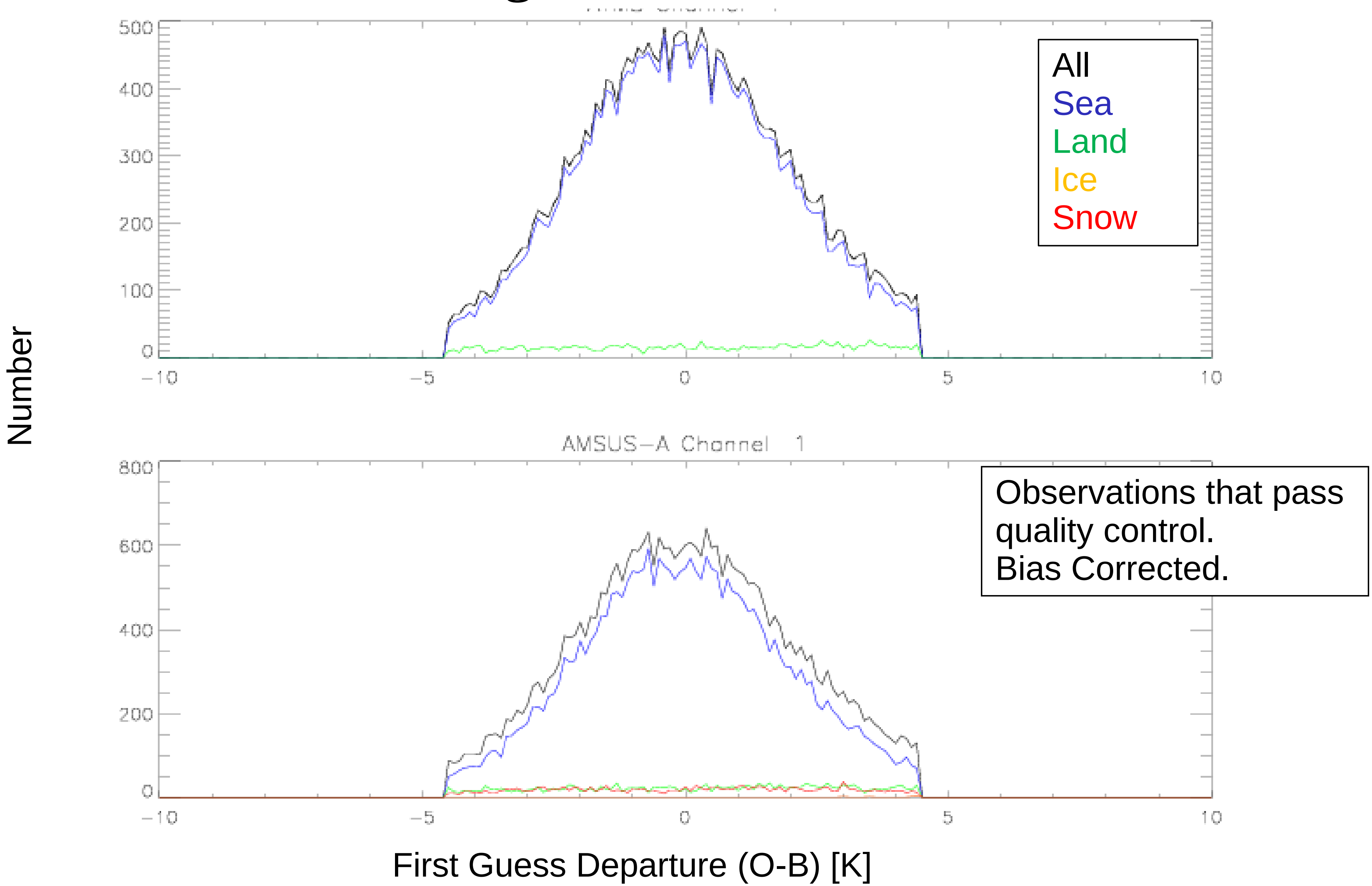
Uncorrected First Guess Departure; All Obs over Sea (K)



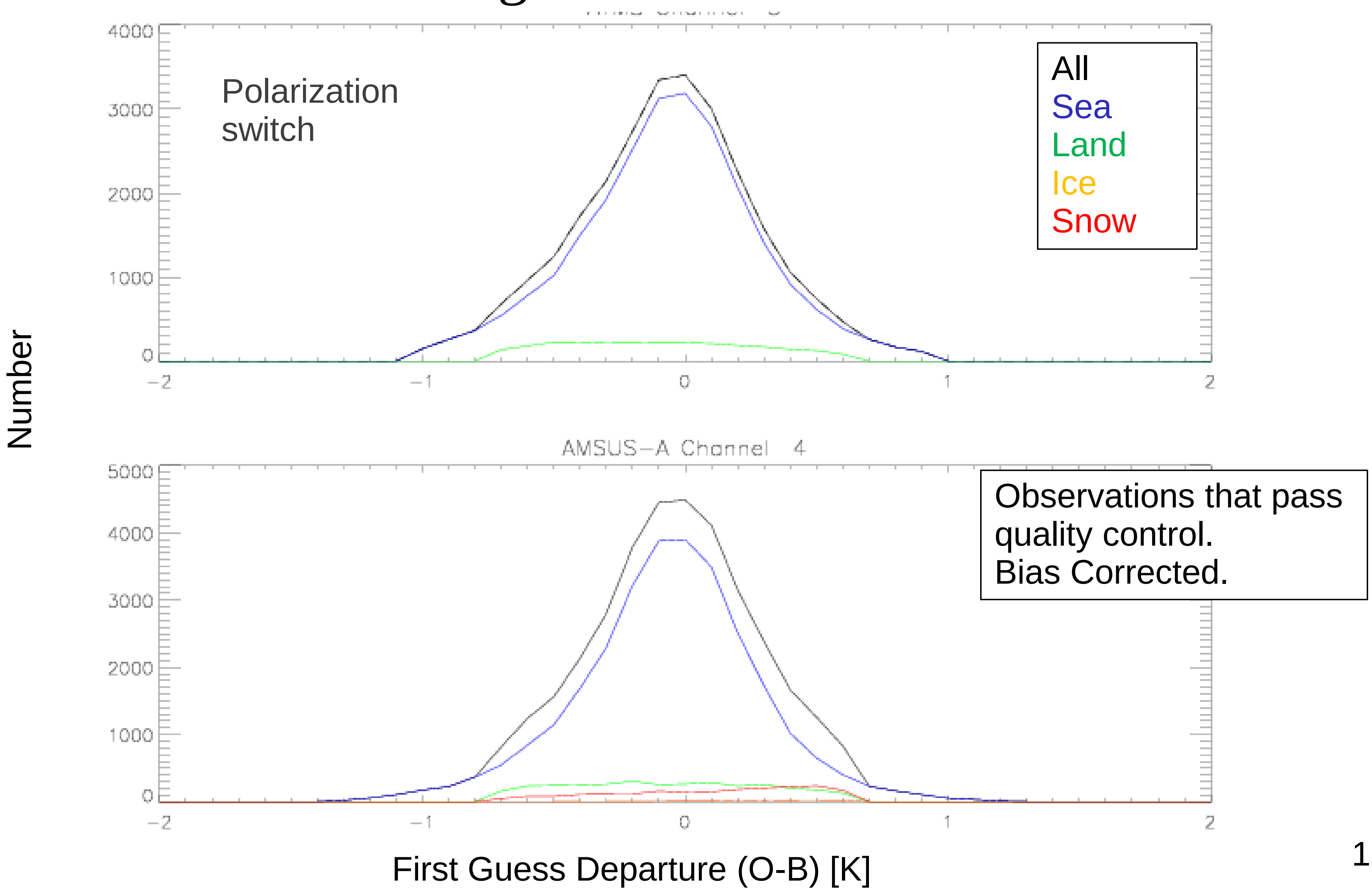
Satellite Zenith Angle (degrees)

ATMS has much better scan-dependent bias and (after re-mapping) noise levels are equivalent

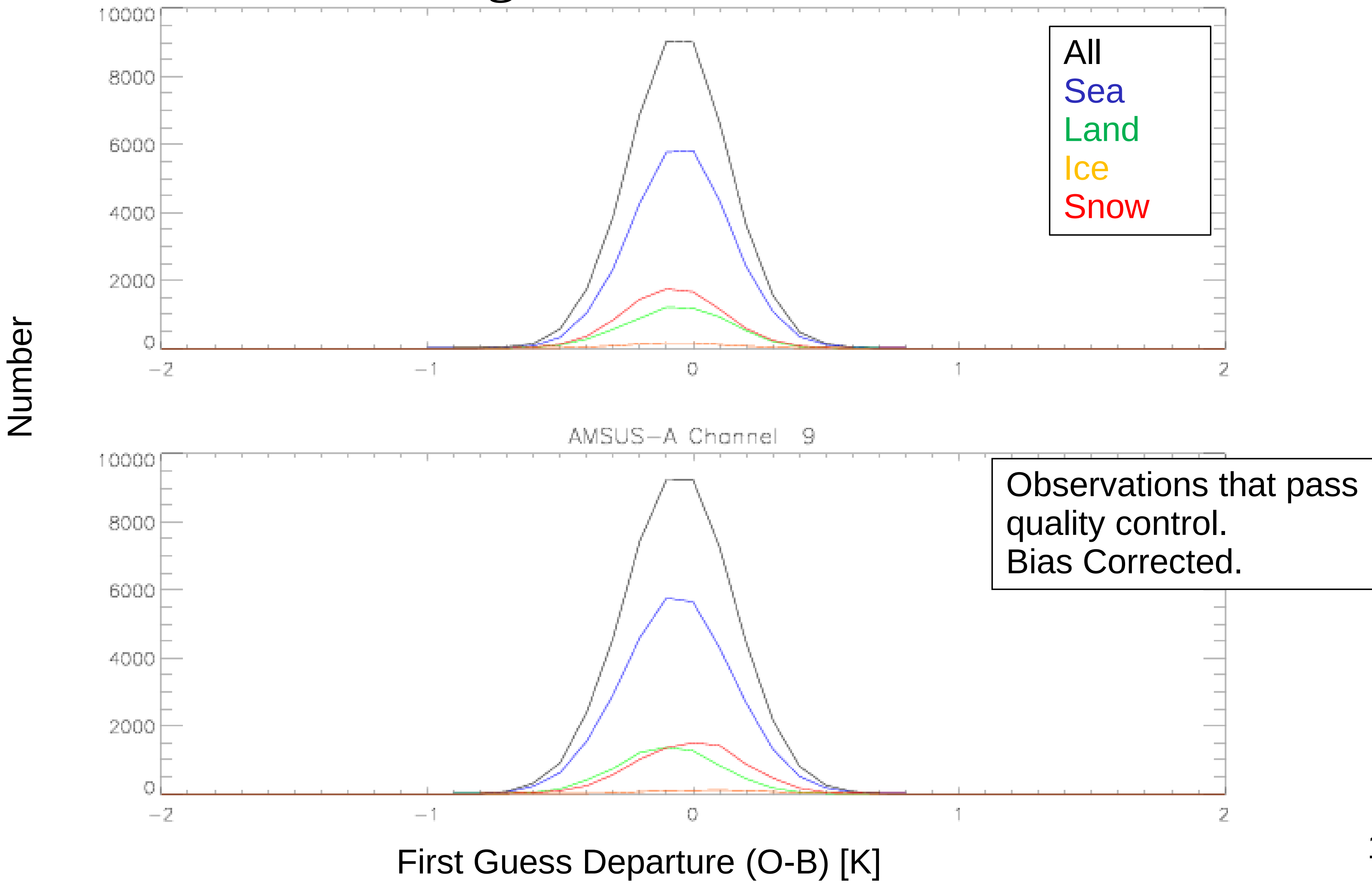
Histogram ATMS Ch. 1



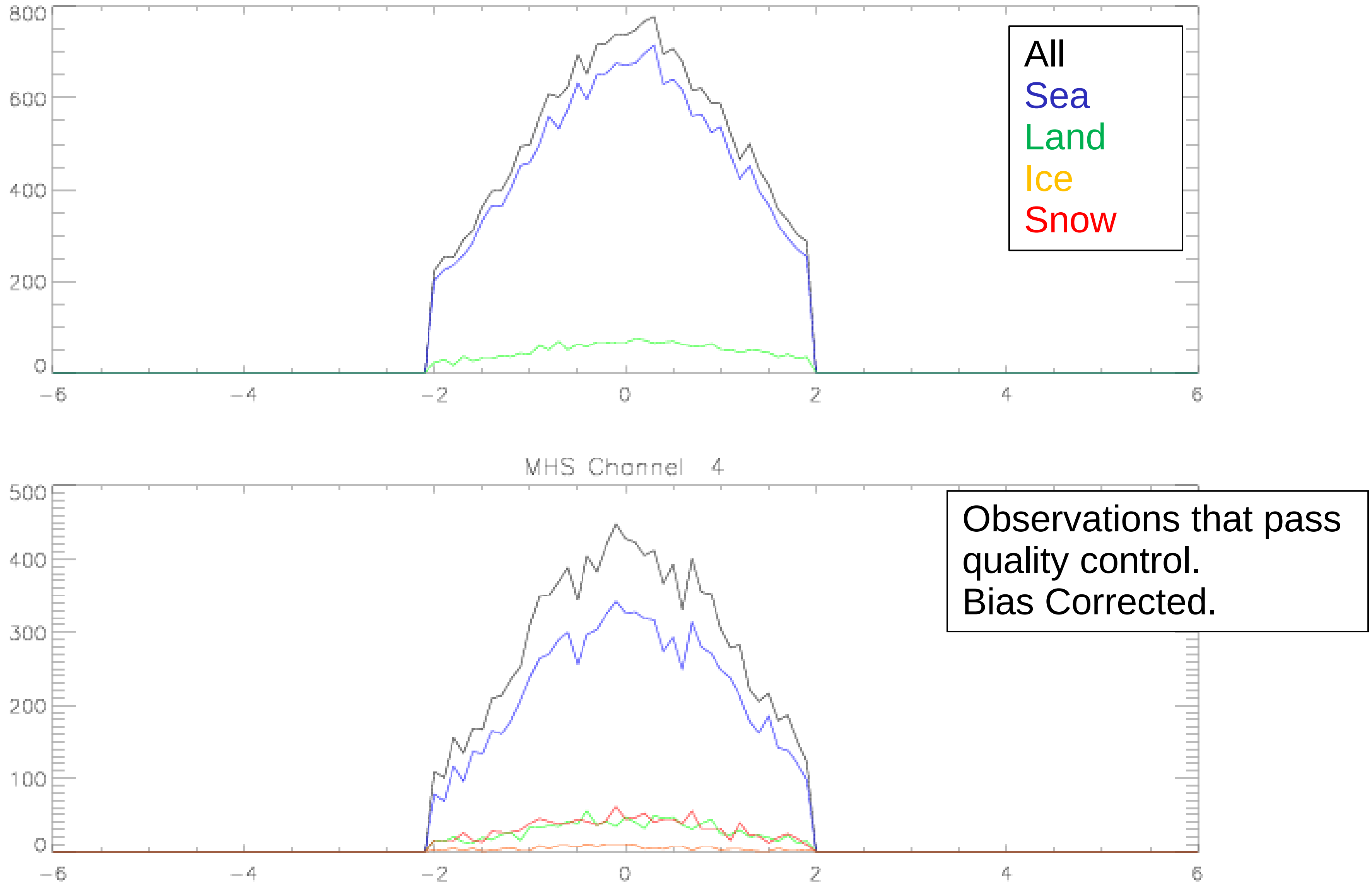
Histogram ATMS Ch. 5



Histogram ATMS Ch. 10



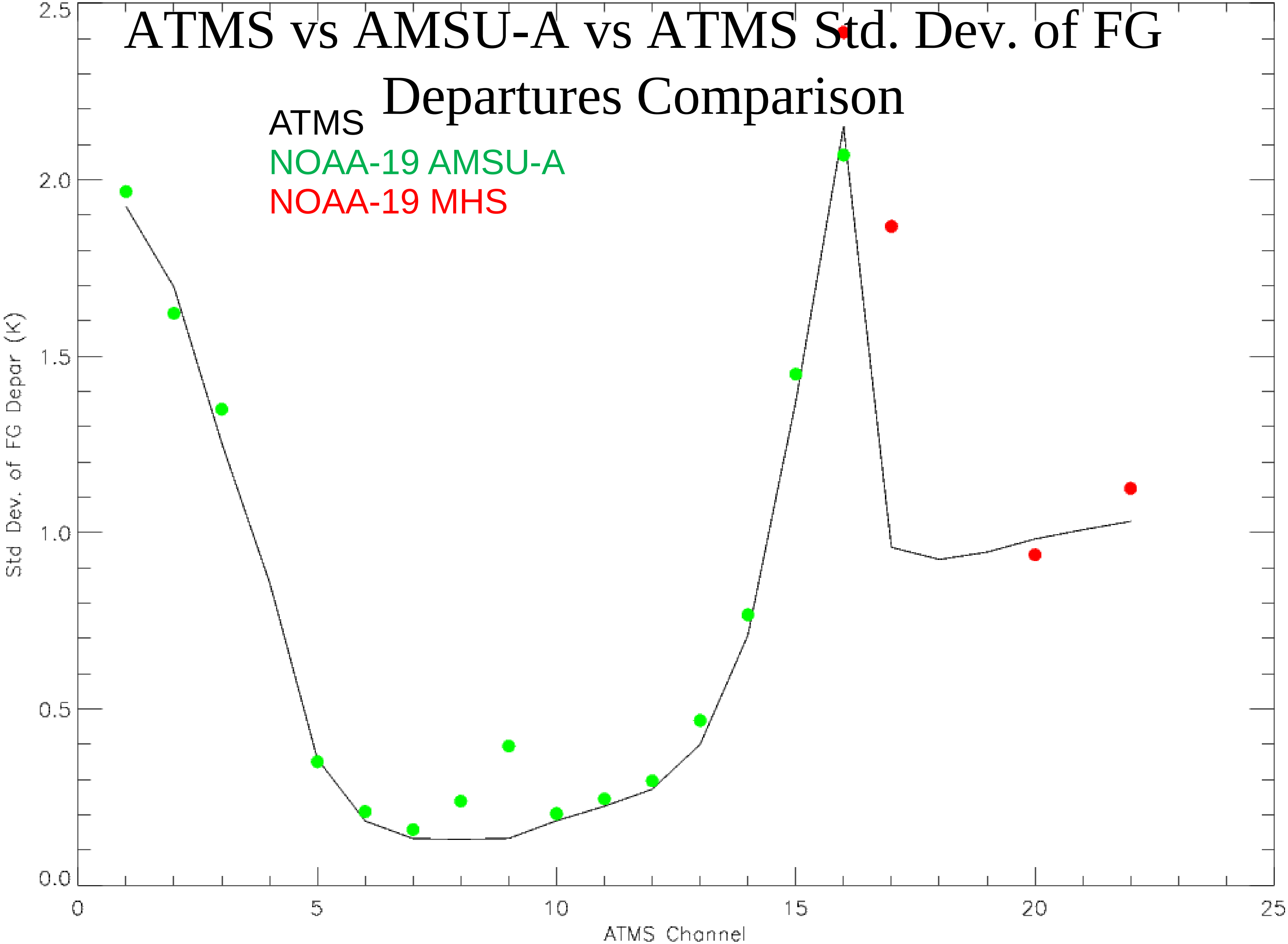
Histogram ATMS Ch. 20



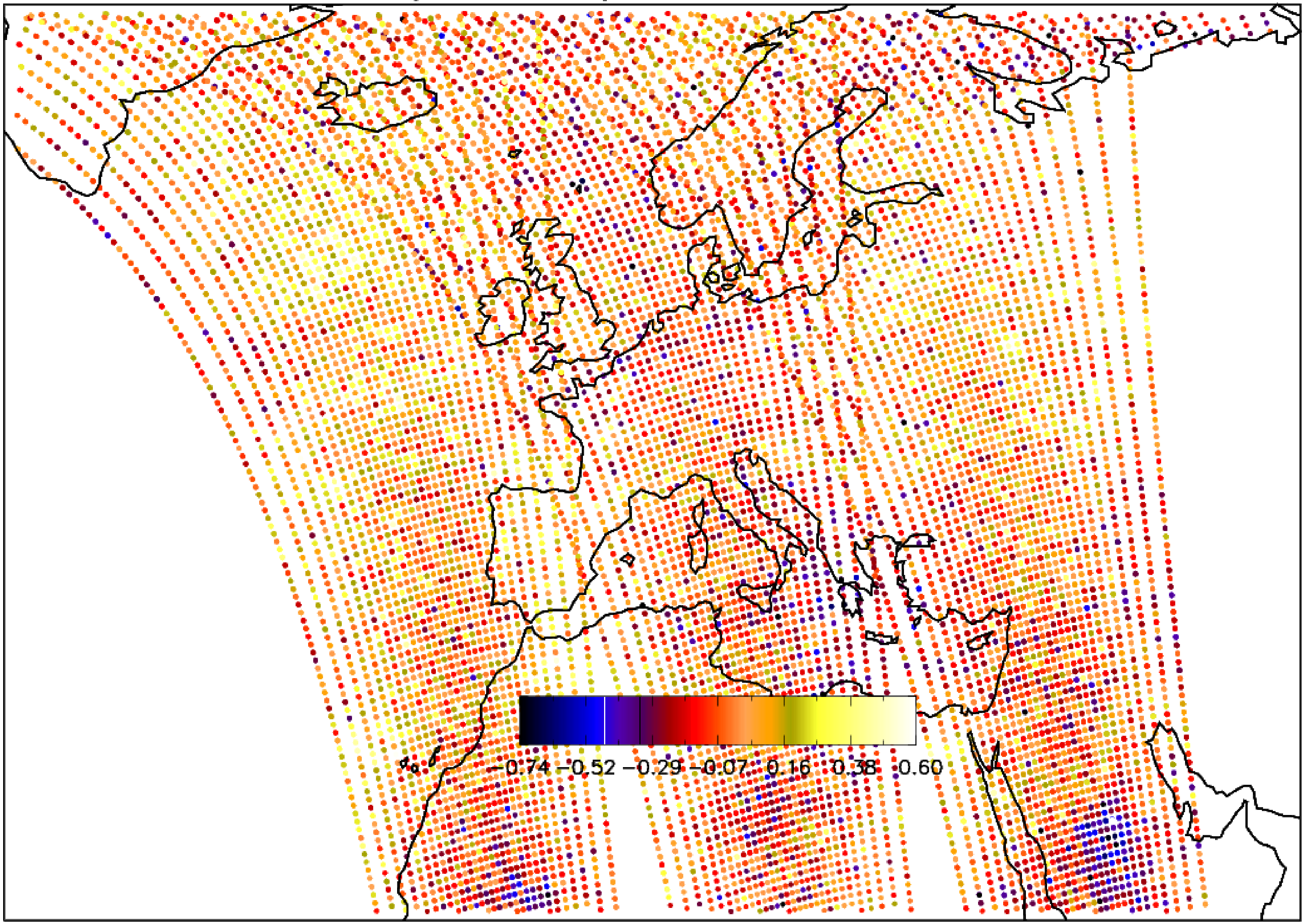
Number

First Guess Departure (O-B) [K]

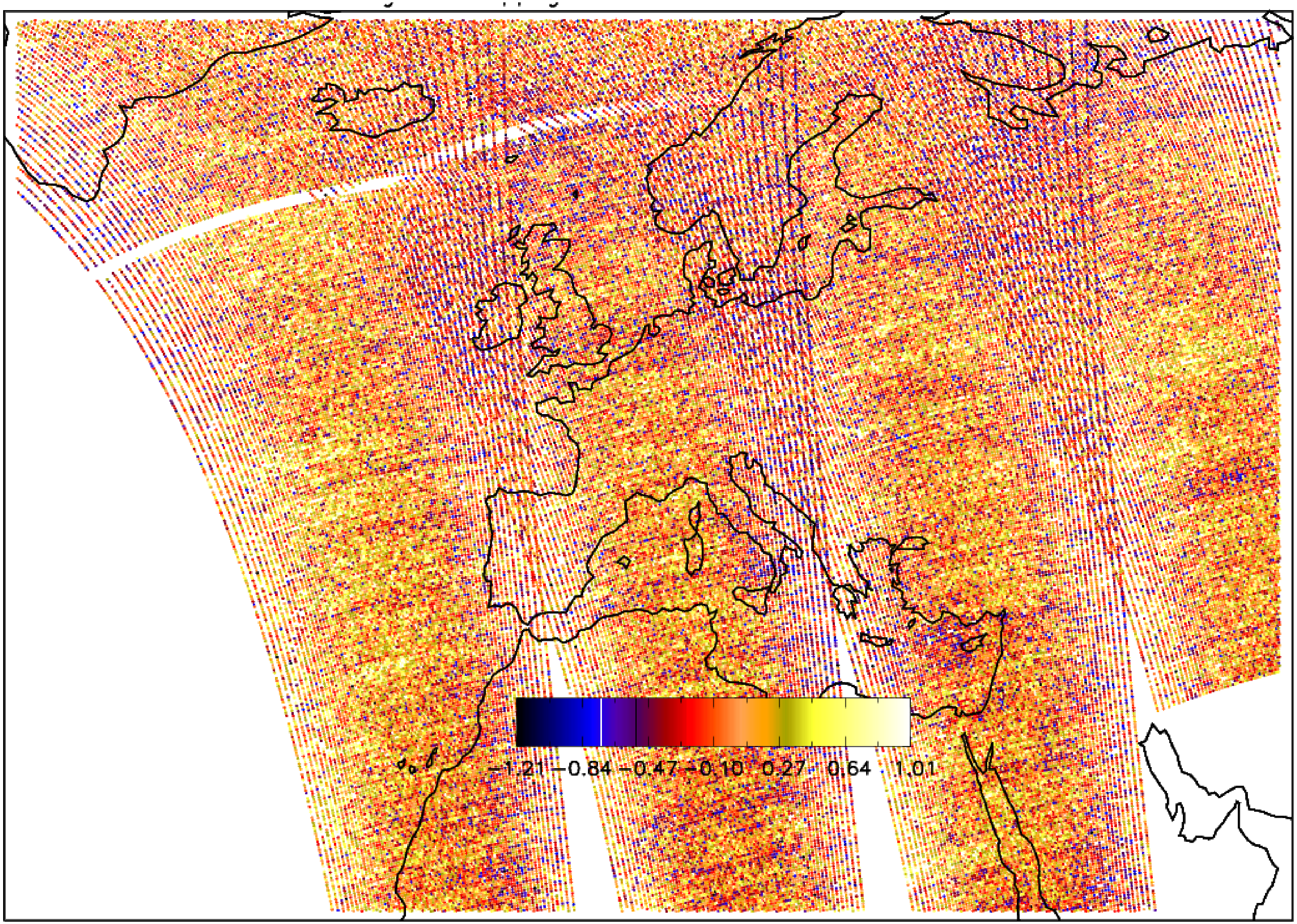
ATMS vs AMSU-A vs ATMS Std. Dev. of FG Departures Comparison



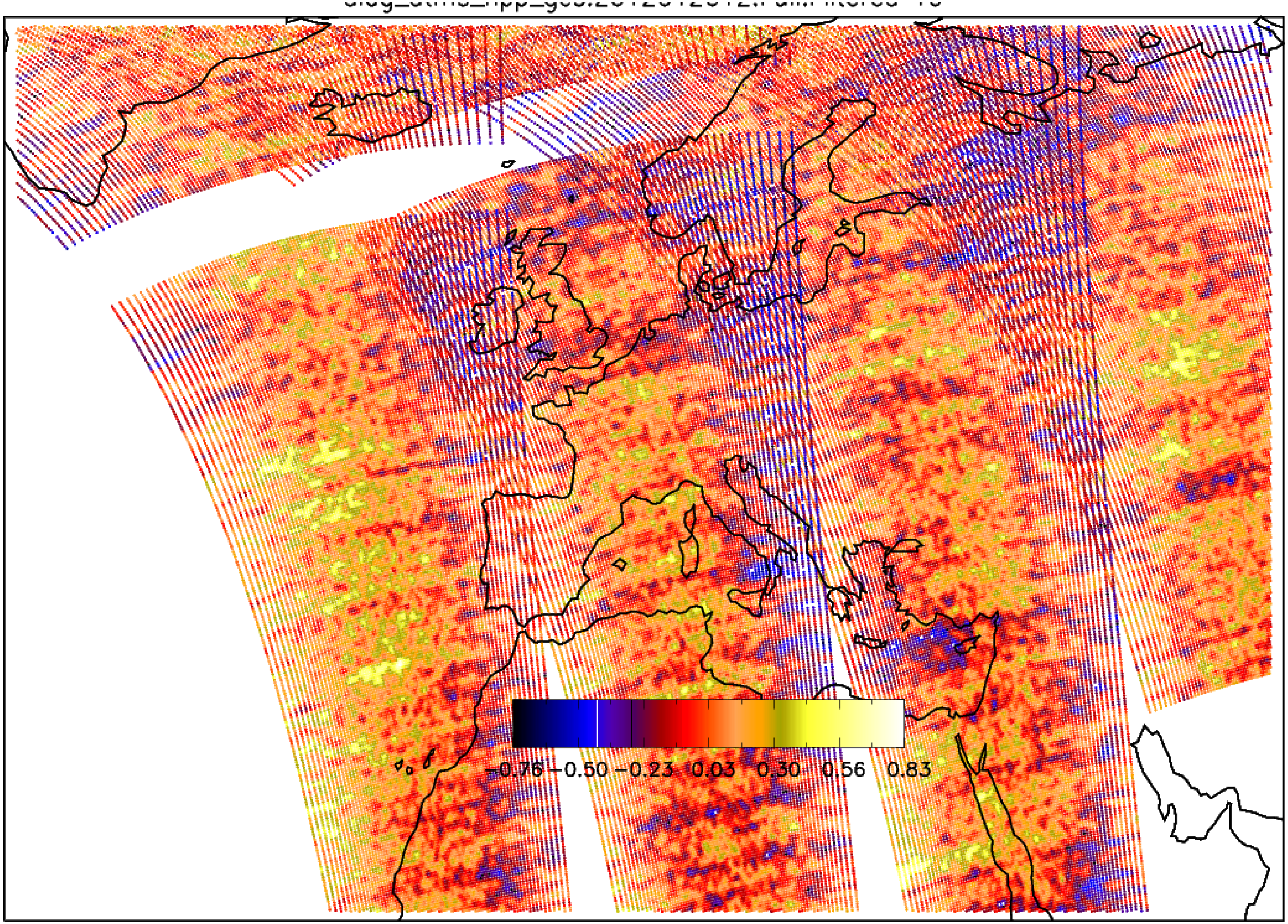
AMSU-A Ch 9 First-Guess Departures



Unfiltered ATMS Ch 10 First-Guess Departures



Filtered ATMS Ch 10 First-Guess Departures



Caveat!

- ATMS is still in a pre-operational phase and appears to be performing well.
- It is not clear whether the striping note above is significant.

- ATMS
  - Introduction
  - Spatial Averaging
  - Comparison with Forecast Model
  - Assimilation Configuration
- CrIS
  - Current Status
- Final Remarks

Assimilation Configuration

- The assimilation configuration follows AMSU-A/MHS as closely as possible but with some differences:
  - Assumed observation errors differ slightly. See next slide
  - Data are not assimilated over snow and ice
    - … as the empirical model used in CRTM has not been developed for ATMS.
  - Only data every 5th scan position and 5th scan line may be assimilated
    - … as spatial averaging introduces spatially correlated observation errors

Observation Errors

ATMS Channel	AMSU-A N-19 Obs Error (K)	ATMS Obs Error (K)	
1	2.50	5.00	Surface
2	2.00	5.00	Surface
3†	2.00	5.00	Surface
4		3.00	
5†	0.55	0.55	
6	0.30	0.30	
7	0.23	0.30	Minimization
8†	0.23	0.30	Minimization
9	*0.25	0.30	Minimization
10	0.25	0.30	
11	0.35	0.35	
12	0.40	0.40	
13	0.55	0.55	
14	0.80	0.80	
15	*3.00	*3.00	

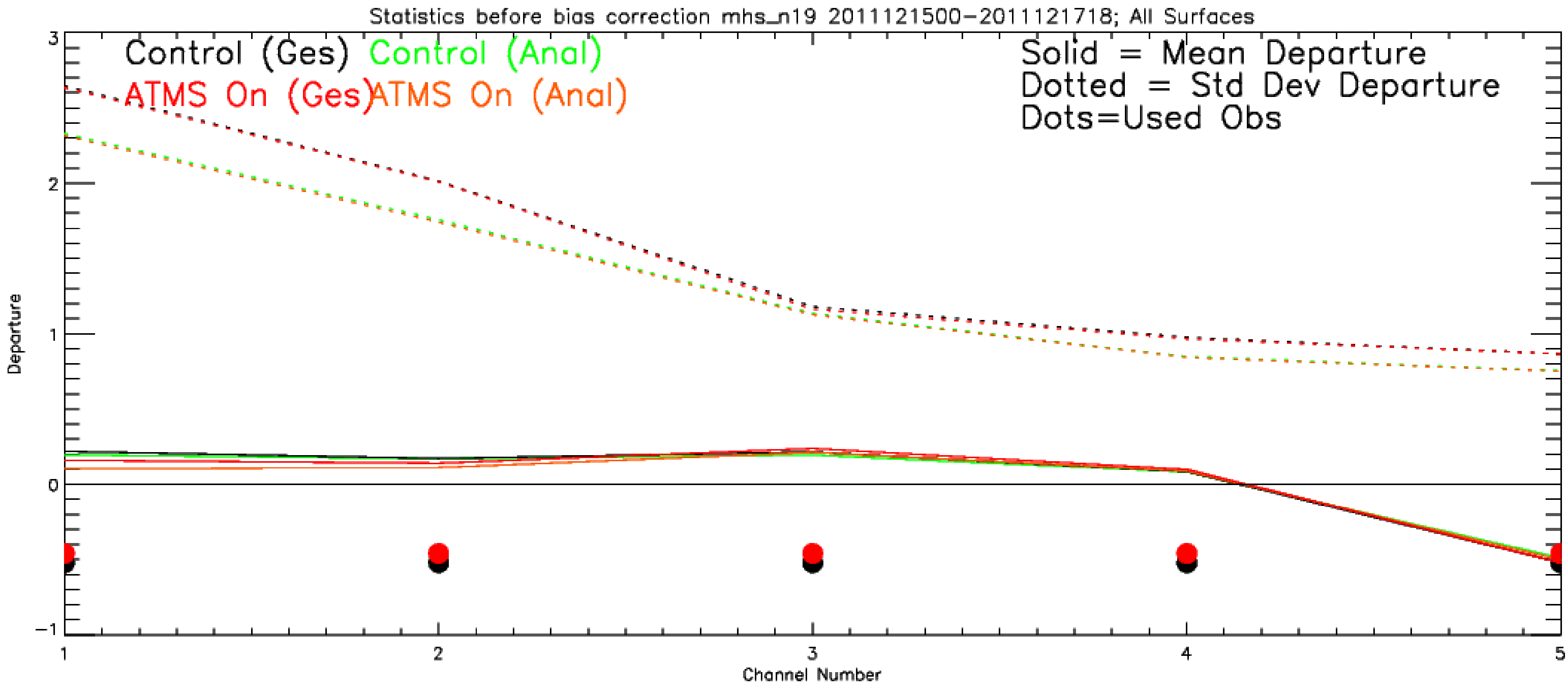
†ATMS and AMSU-A have different polarizations.

*Channel not used

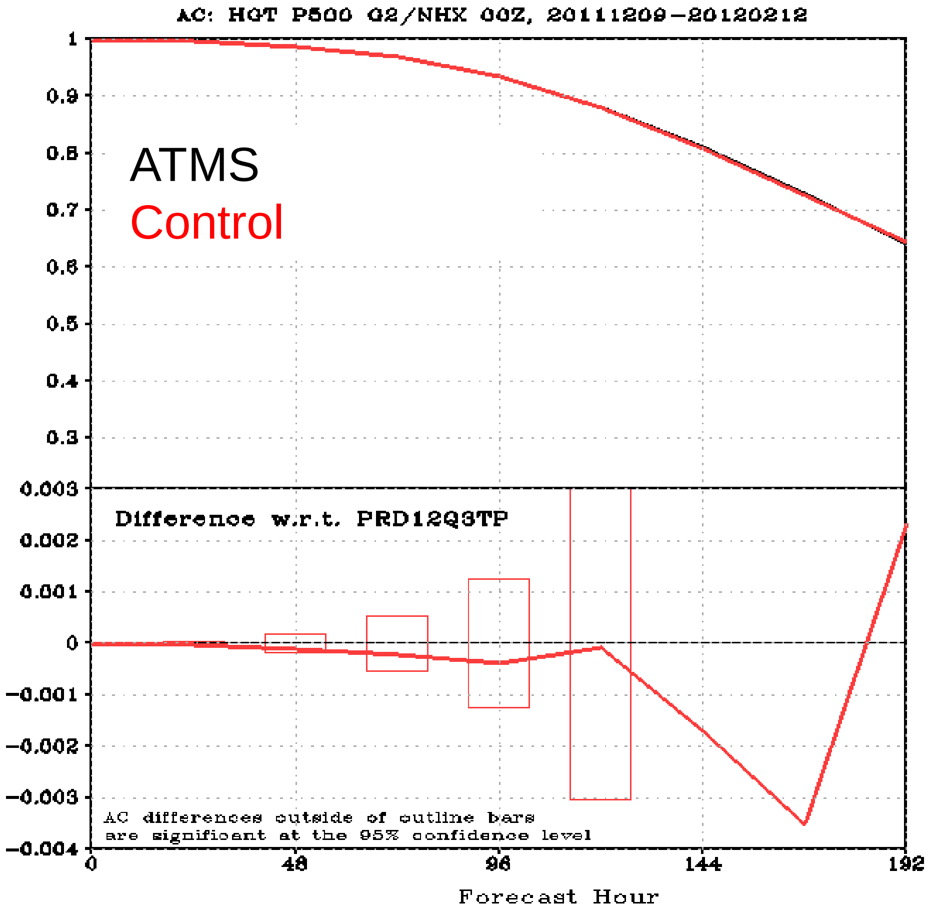
ATMS forecast impact

- Low resolution experiments (T254) have been run from December 9th 2011 – February 12th 2012 and show statistically neutral impact
  - This is not unexpected as ATMS observations are very close to those from NOAA-18, NOAA-19 and Aqua.
- Due to computational constraints at NCEP, the full resolution (T574) trials are being run by NESDIS on a JCSDA machine
  - These experiments are on-going

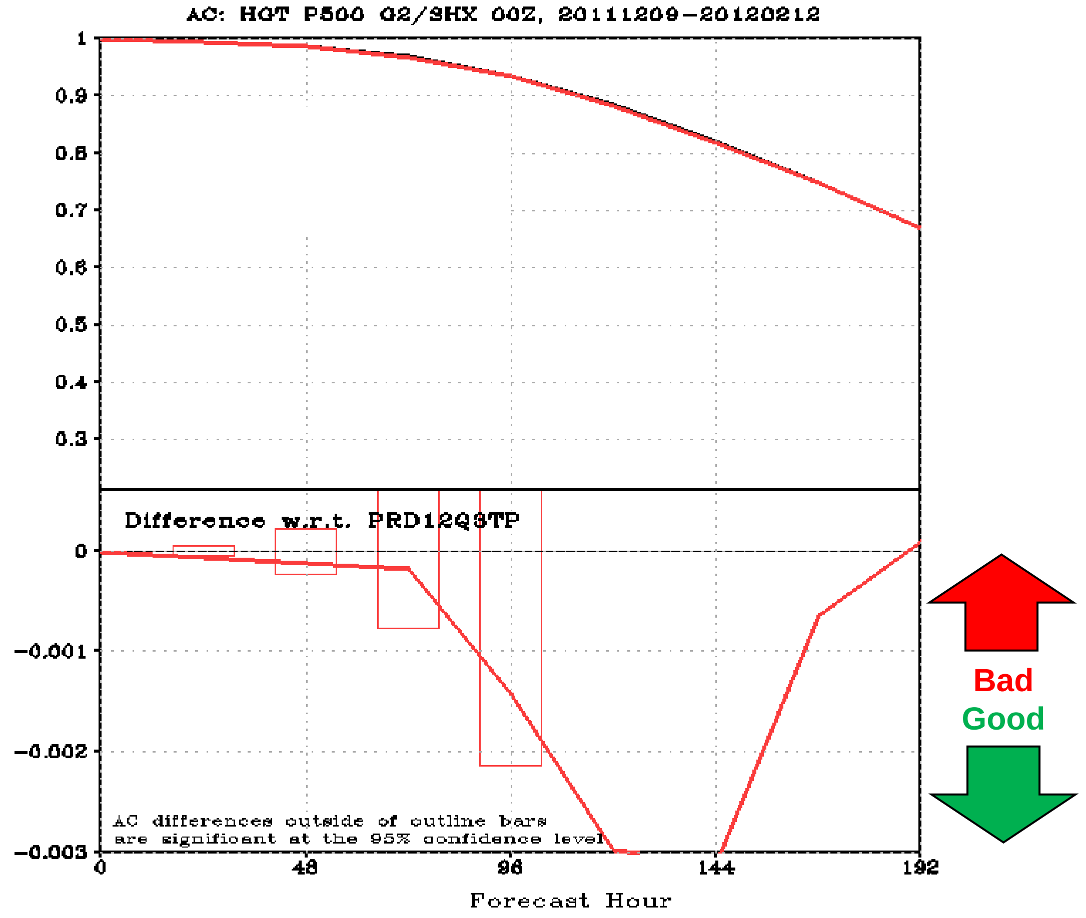
Improvement to Water Vapour?
Fit to NOAA-18 MHS



Neutral forecast impact at T254



N. Hemis 500hPa Geopotential Height Anomaly Correlation

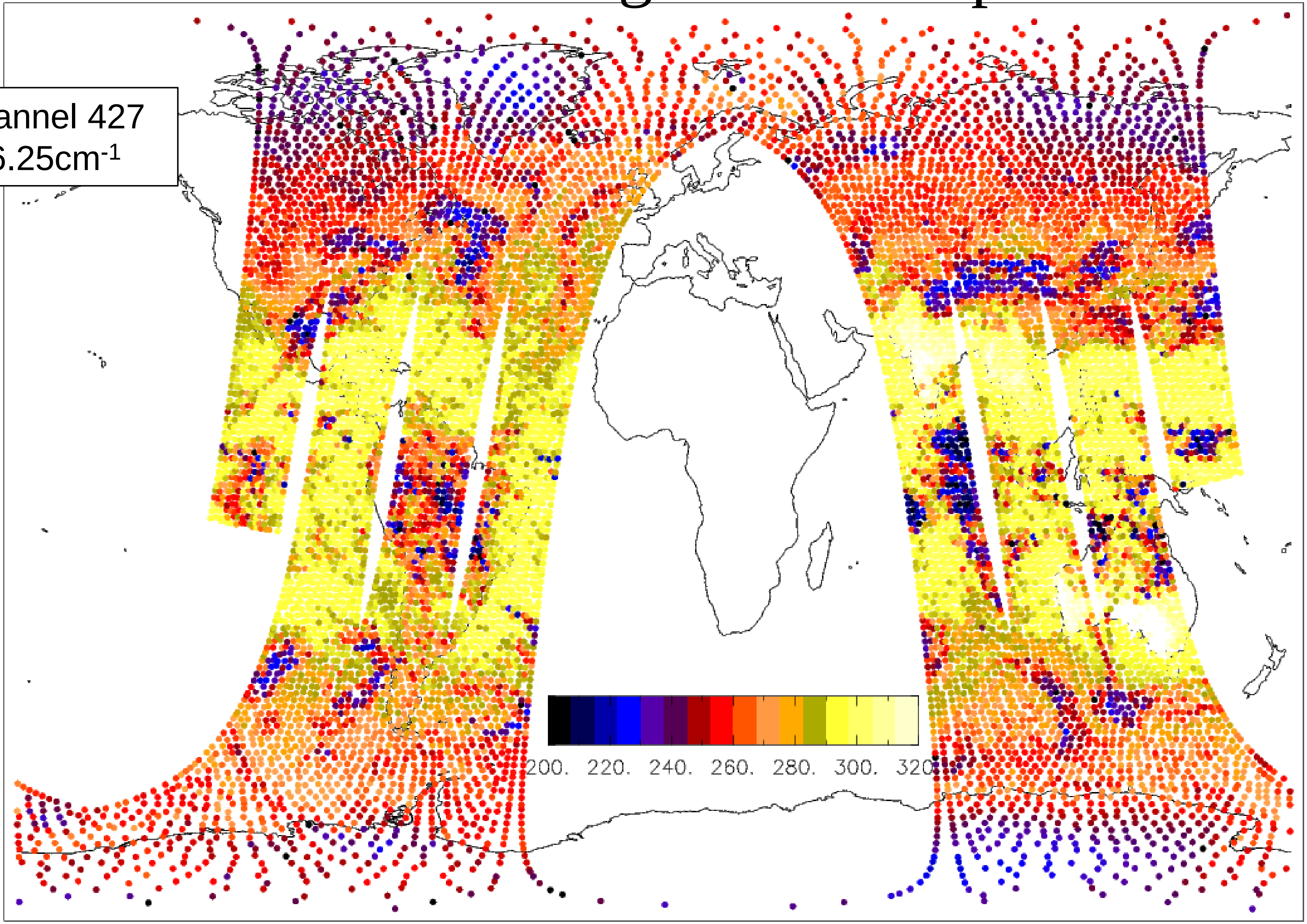


S. Hemis 500hPa Geopotential Height Anomaly Correlation

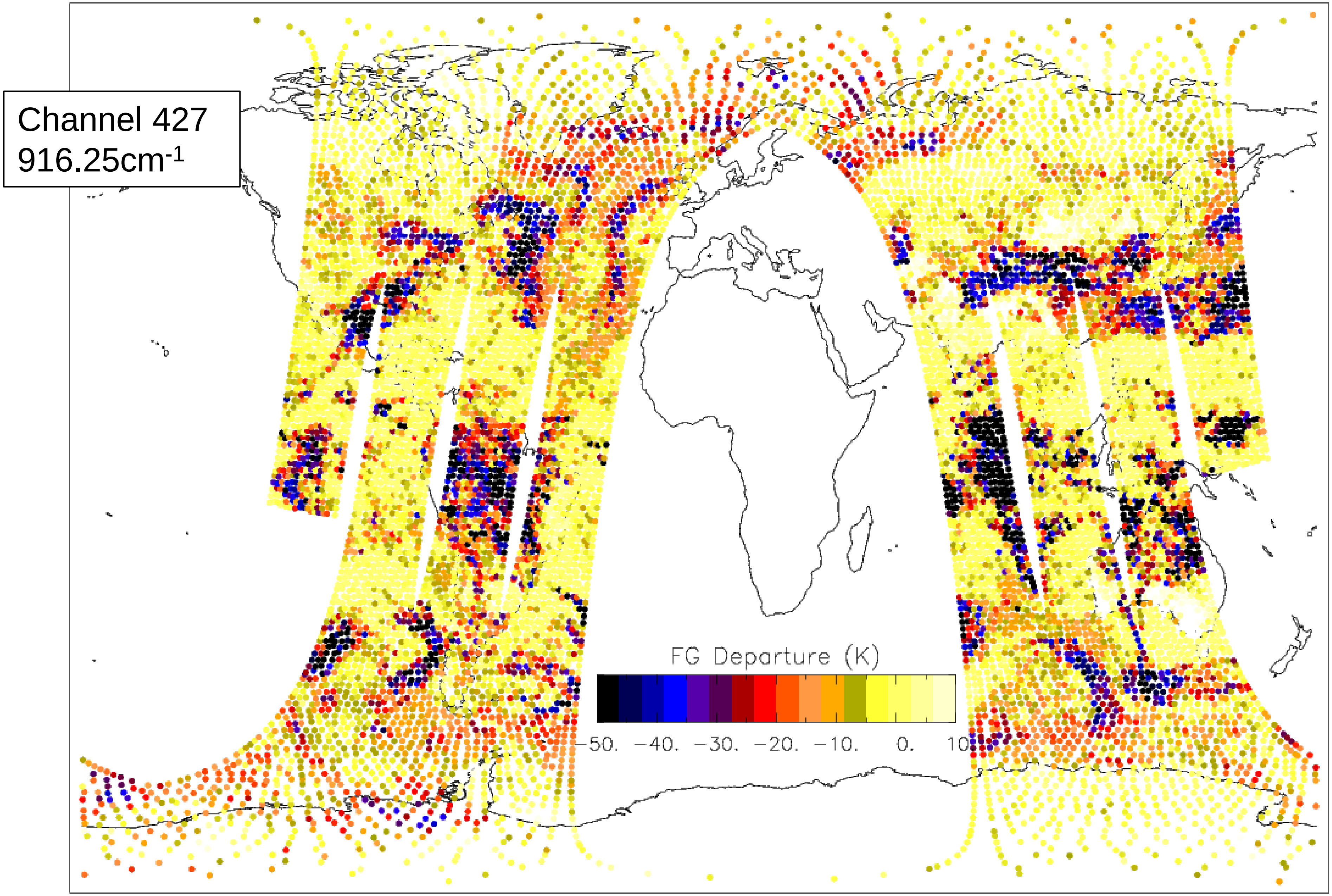
- ATMS
    - Introduction
    - Spatial Averaging
    - Comparison with Forecast Model
    - Assimilation Configuration
- CrIS
    - Current Status
- Final Remarks

CrIS Observed Brightness Temperatures

Channel 427
916.25cm^{-1}



CrIS First-Guess Departures



- ATMS
  - Introduction
  - Spatial Averaging
  - Comparison with Forecast Model
  - Assimilation Configuration
- CrIS
  - Current Status
- Final Remarks

Conclusions

- ATMS observations appear to be of good quality.
- In particular the bias characteristics seem much better than for AMSU-A
- Using the AAPP re-mapping tool, AMSU-A like noise performance can be obtained.