Characterize the FY-3 MWTS using NWP fields

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Thanks to all who contributed to this work

Outline

- **Initial FY-3A data quality assessment at ECMWF**
  - **(OBS – Modelled T_B) for FY-3A & comparison with MetOp & Aqua**
  - **Initial Assimilation Experiments**
- **Characterising the FY-3A MWTS**
  - **Passband Uncertainties & Non-linearity Effects**
  - **Assessment in the ECMWF Model & CMA Grapes Model**
  - **Improved Assimilation of MWTS**
- **Initial Assessment of FY-3B**

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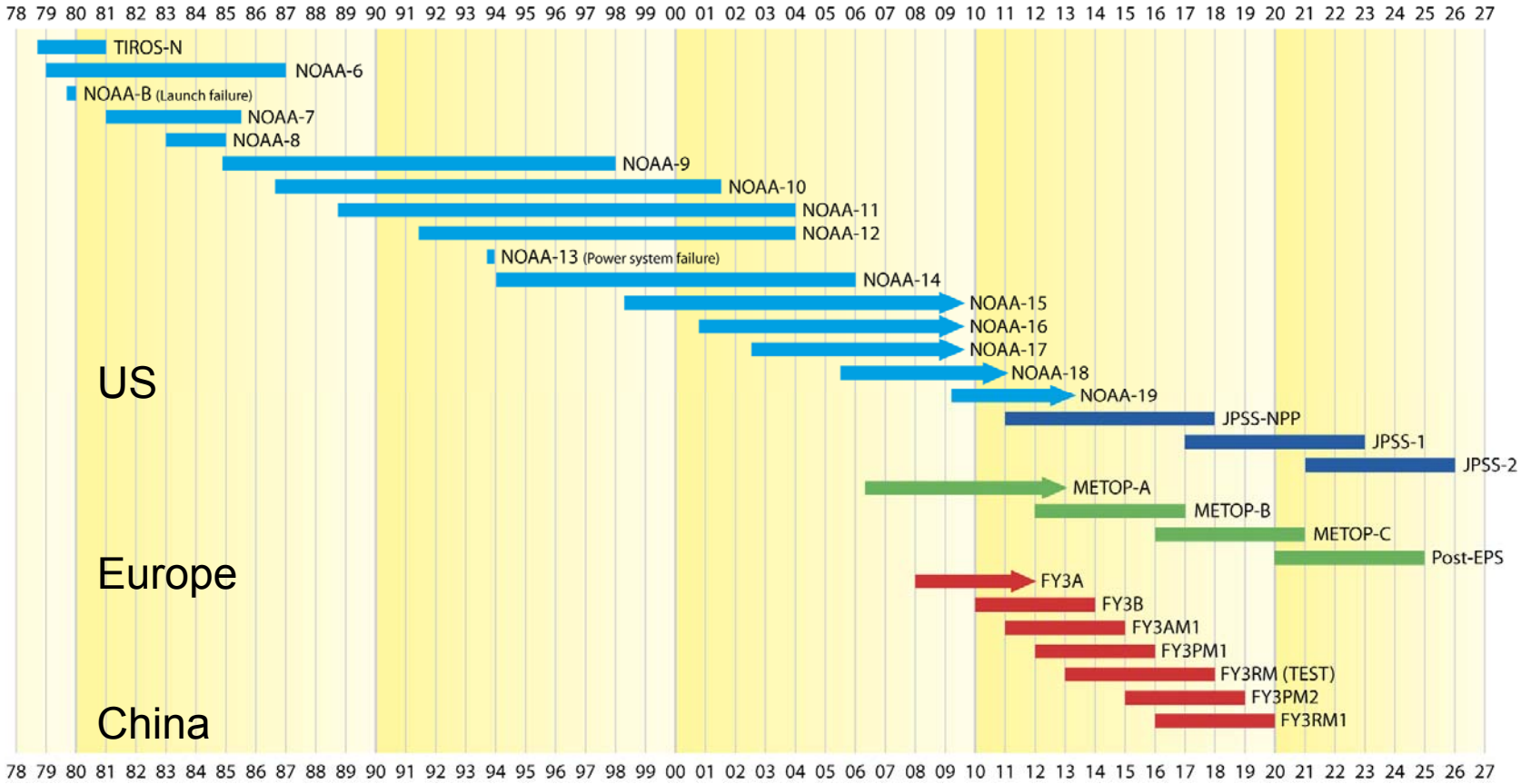
Operational Sounding Satellites



- Microwave sounding data provides information on temperature and humidity which has been widely used in :
  - Operational NWP data assimilation systems and;
  - Climate research – to determine long term trends in atmospheric state
- The US has launched a series of polar satellites, dating back to 1978;
- Europe began to contribute in 2006 (MetOp-A)
- China began to contribute in 2008 (FY-3A)

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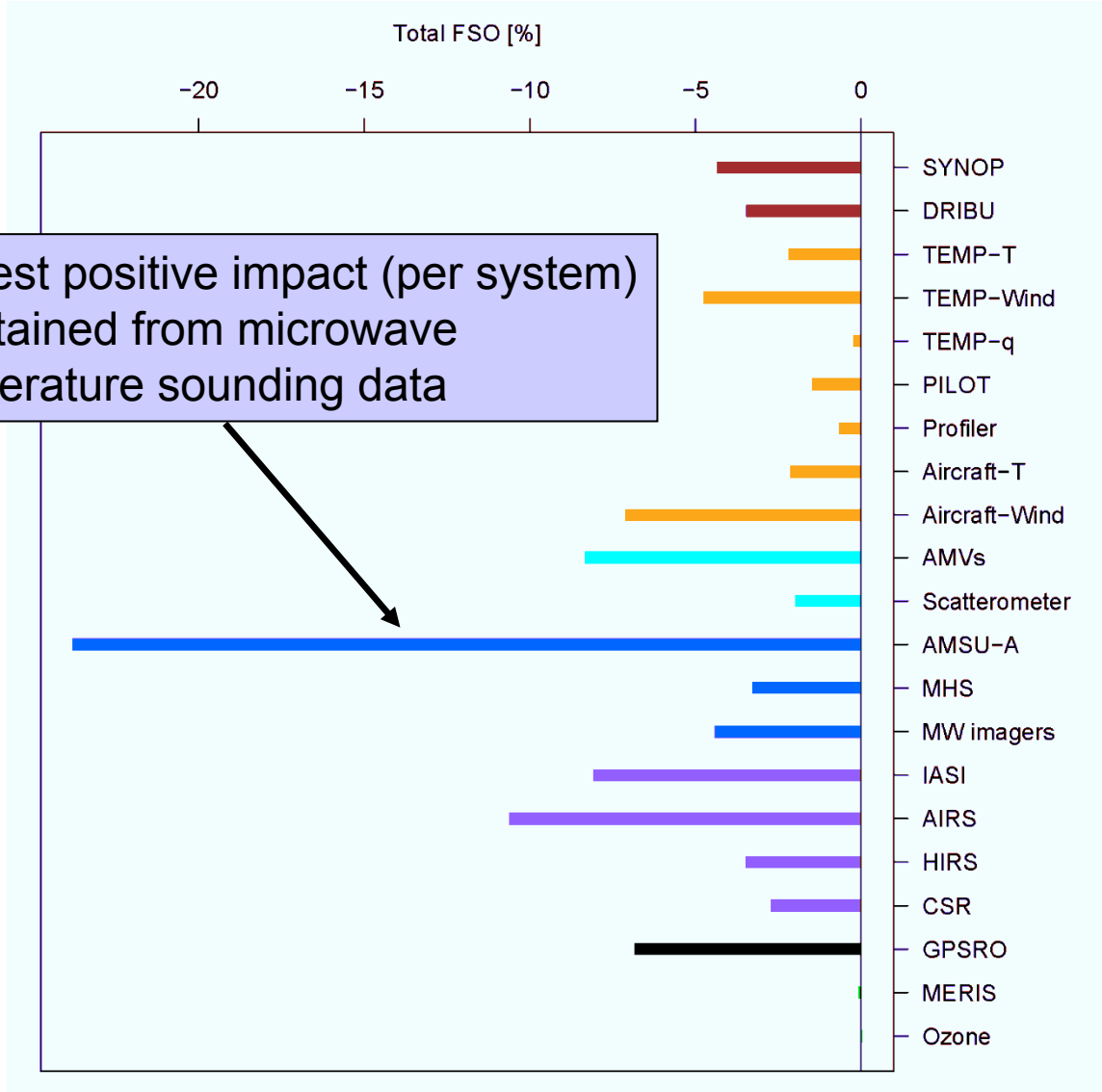
The importance of MW sounding data in NWP



Largest positive impact (per system) is obtained from microwave temperature sounding data

Forecast sensitivity to observations (FSO) Is an adjoint based technique for assessing the influence of observing systems on forecast accuracy

(from C. Cardinali, ECMWF)

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The FY-3A/B Instrument Suite

Infrared Atmospheric Sounder (IRAS) 20 channels (~HIRS/3)

Microwave Temperature Sounder (MWTS) 4 channel (~MSU)

Microwave Humidity Sounder (MWHS) 5 channel (~MHS)

Microwave Radiation Imager 10 channels (~AMSR-E)

Initial Data Quality Assessment : General Approach

- **Approach involves a comparison of observations (OBS) with simulated observations based on short range (up to T+9 hour) forecast fields ('First Guess', FG) and radiative transfer modelling → 'FG departures'**
- **FG is 'proxy' for truth → 'FG departures' (OBS – FG) indicate error in the measurements or RT modelling**
- **High accuracy of the NWP fields results from the large & diverse range of observations assimilated (MW sounders, Advanced IR sounders, GPSRO, radiosondes … etc)**
- **Able to detect biases at ~0.1K level for temperature sounders (MWTS and IRAS), sensitivity slightly lower for MW humidity sounders & imagers (~0.5K)**
- **Similar work ongoing at NOAA/NCEP, UK Met Office, DWD and JMA**

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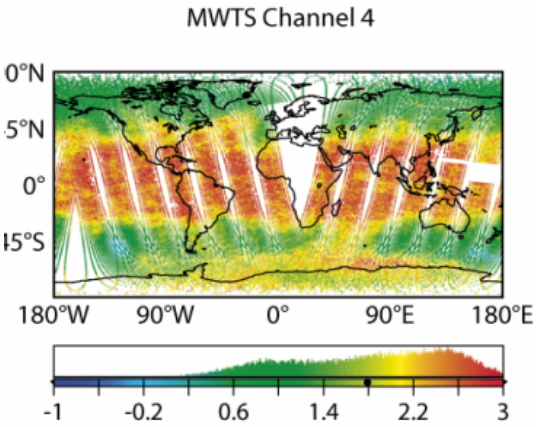
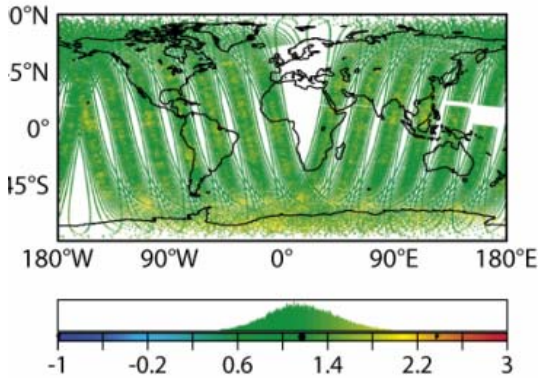
Characterize the MWTS

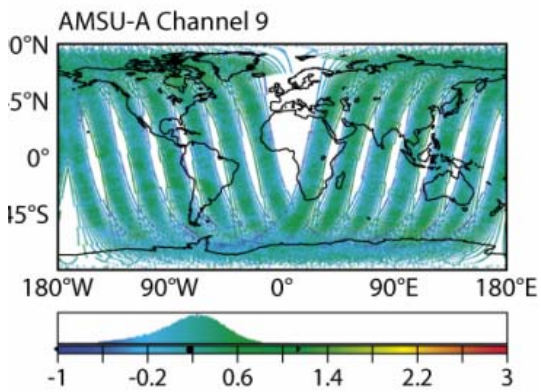
The OMB comparison between FY-3A/MWT and MetOp/AMSU-A



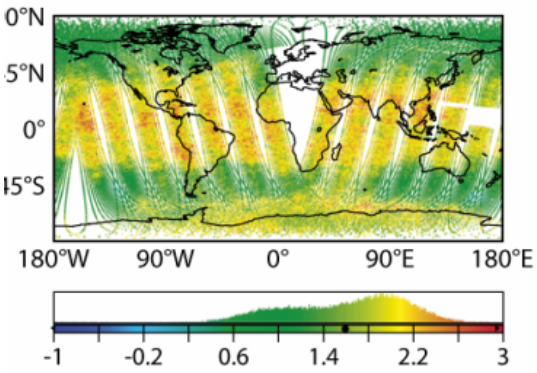
Specification



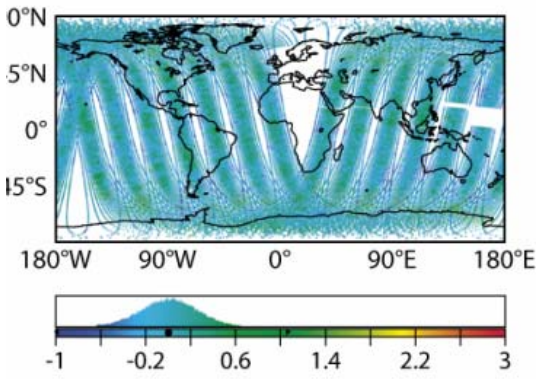
Optimized Passband



MetOp AMSU-A



PreLaunch Measurement



Optimization+NonLinearity Correction

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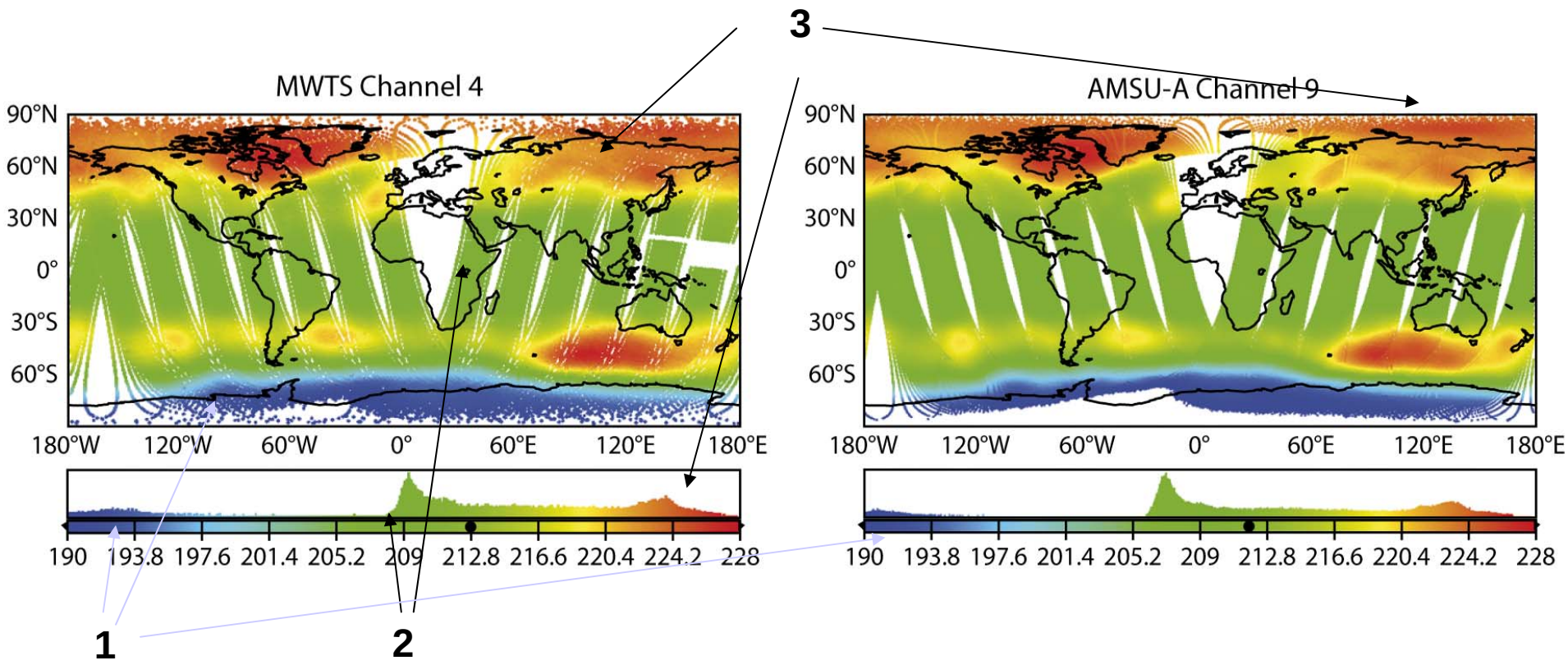
Characterize the MWTS

Comparison of MWTS and AMSU-A Brightness Temperatures



Brightness temperature map from the cycle 2008091700

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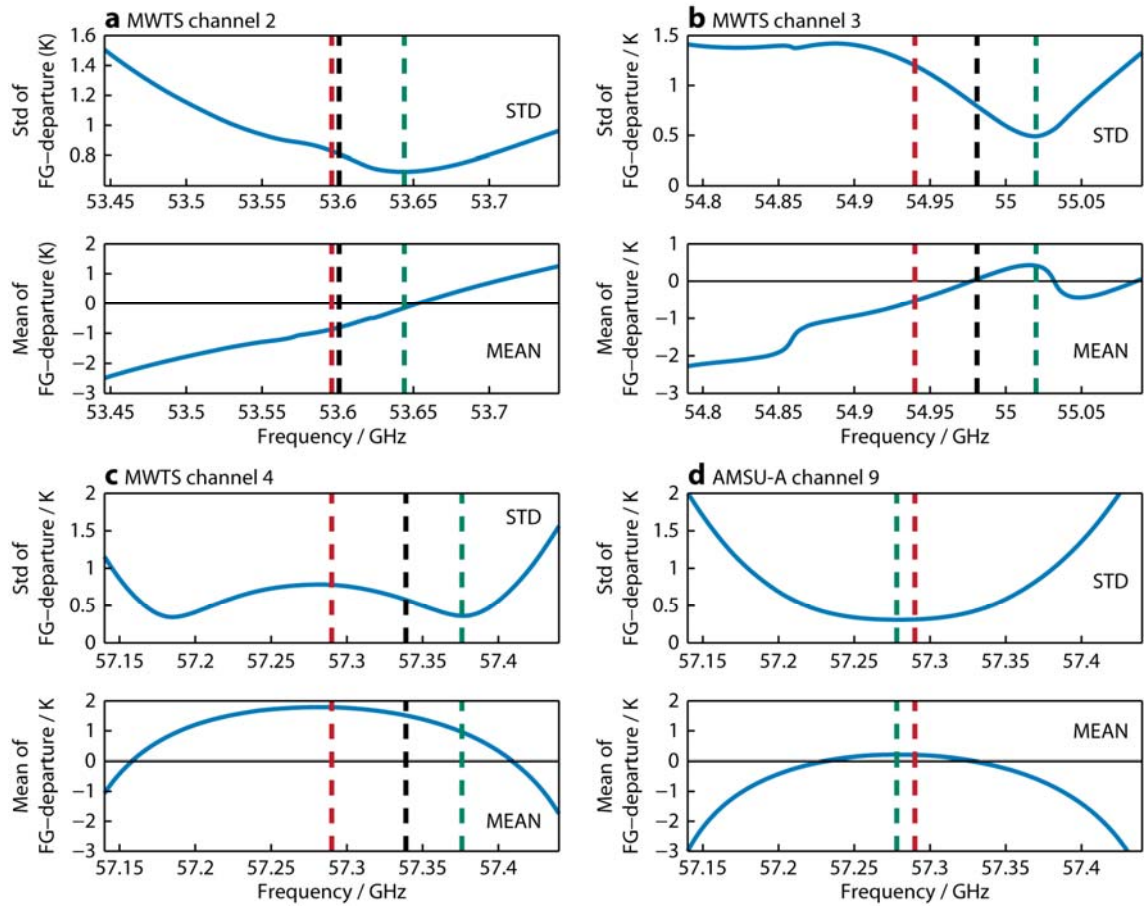
Optimisation of pass band centre frequency estimates



Pass band centres:

design spec.
measured
optimised

- Shifts exist relative to pre-launch measurements
- Residual biases for ch 3 and 4

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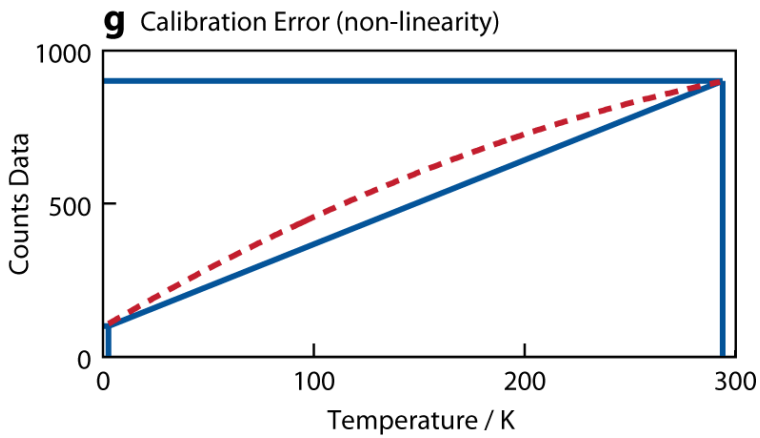
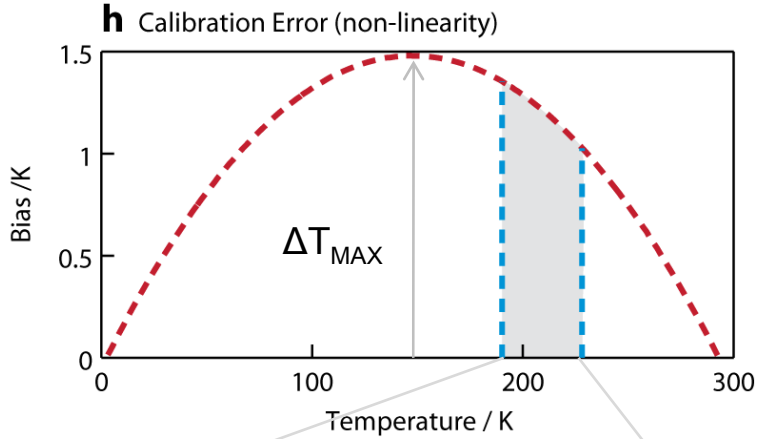
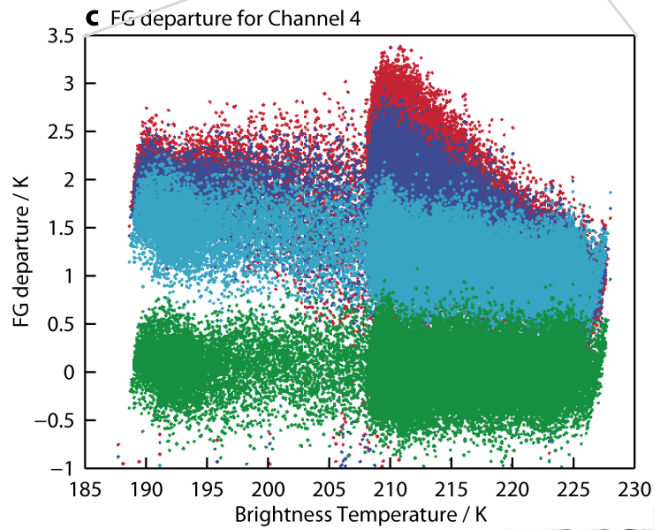
MWTS Radiometer Non-linearity







FIRST GUESS DEPARTURES
- design specified pass band
- pre-launch measured
- optimised
- non-linearity corrected

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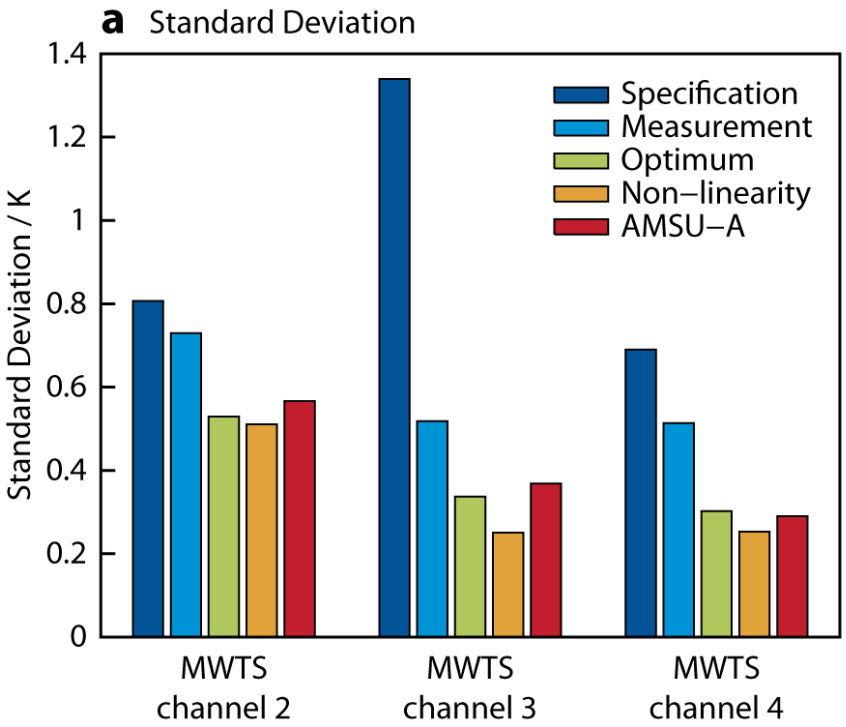
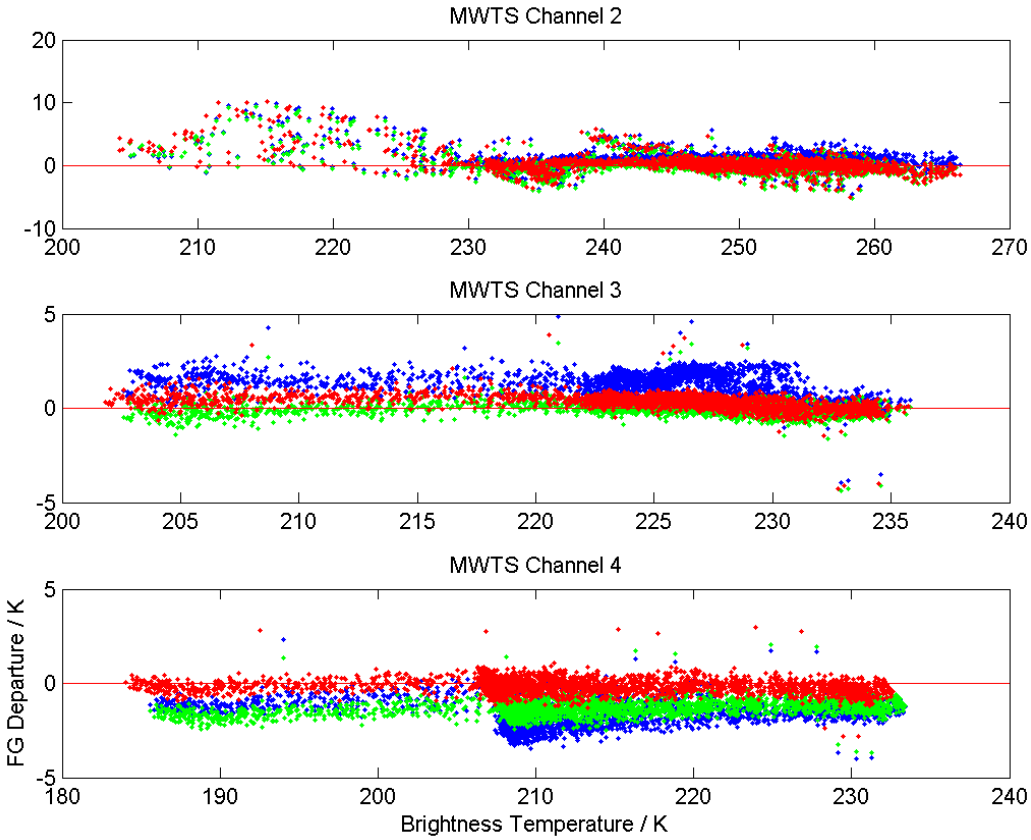
Characterising the FY-3A MWTS: Comparison with AMSU-A

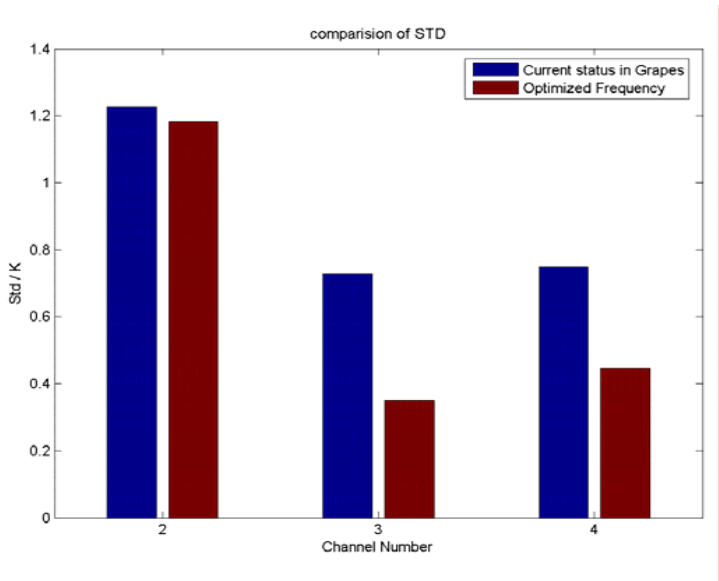


The passband and non-linearity corrections bring the data close to AMSU-A quality

Characterising the FY-3A MWTS:
Assessing corrections in the CMA-GRAPES model



Pre-launch measured passband
Optimised passband
Optimised + non-linearity corrected



→ the corrections, developed at ECMWF, improve the (OBS-GRAPES_MODEL) fits.

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MWTS OSEs Forecast Verification: Z at 200, 500 and 700 hPa

Normalised differences in RMS Errors in Z, verified against own analysis
90% confidence intervals shown

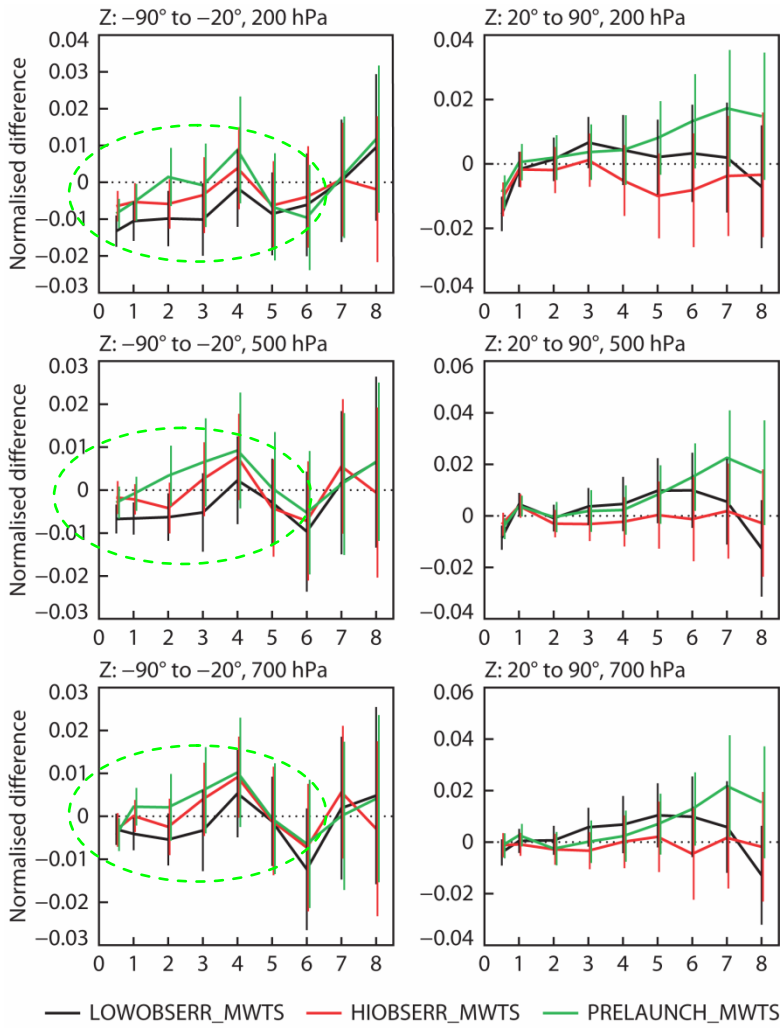
Small improvements in SH in going from:

original data

→ recalibrated (low weight)

→ recalibrated (high weight)

NH close to neutral with some benefit in recalibrated data



Improvement due to MWTS data

PRELAUNCH_MWTS
(full system + original MWTS data)

HIOBSERR_MWTS
(Full system + optimised MWTS with low weight)

LOWOBSERR_MWTS
(Full system + optimised MWTS with high weight)

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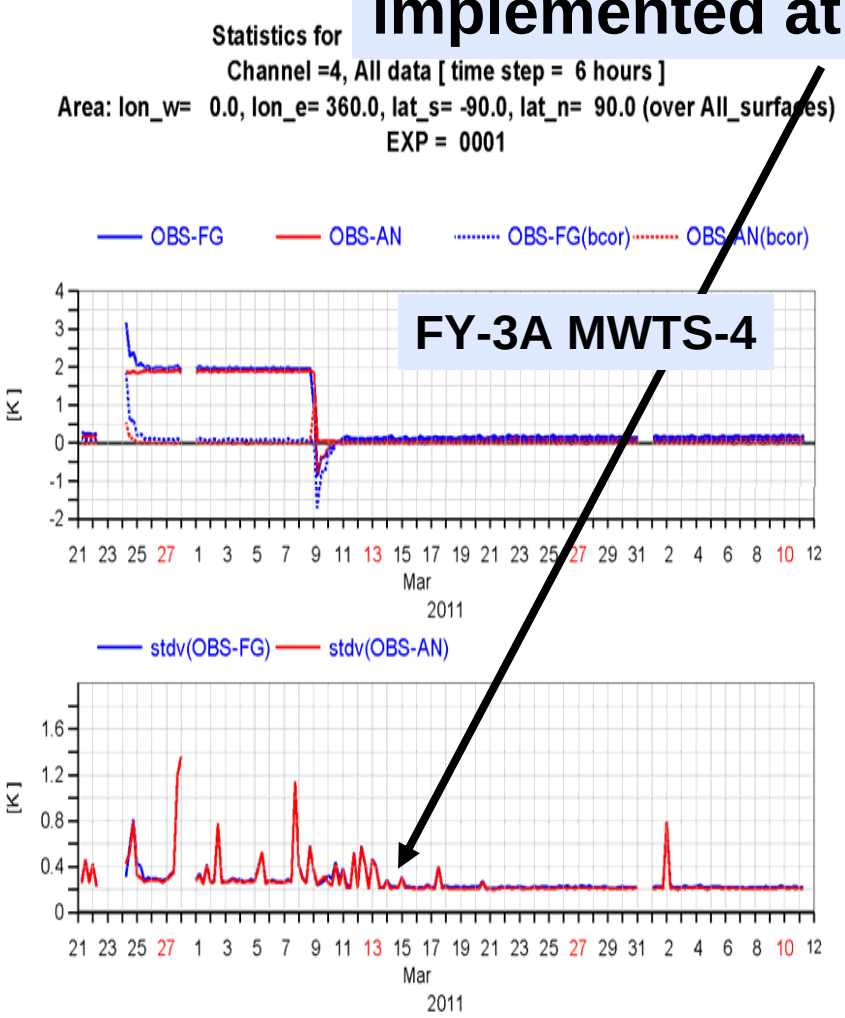
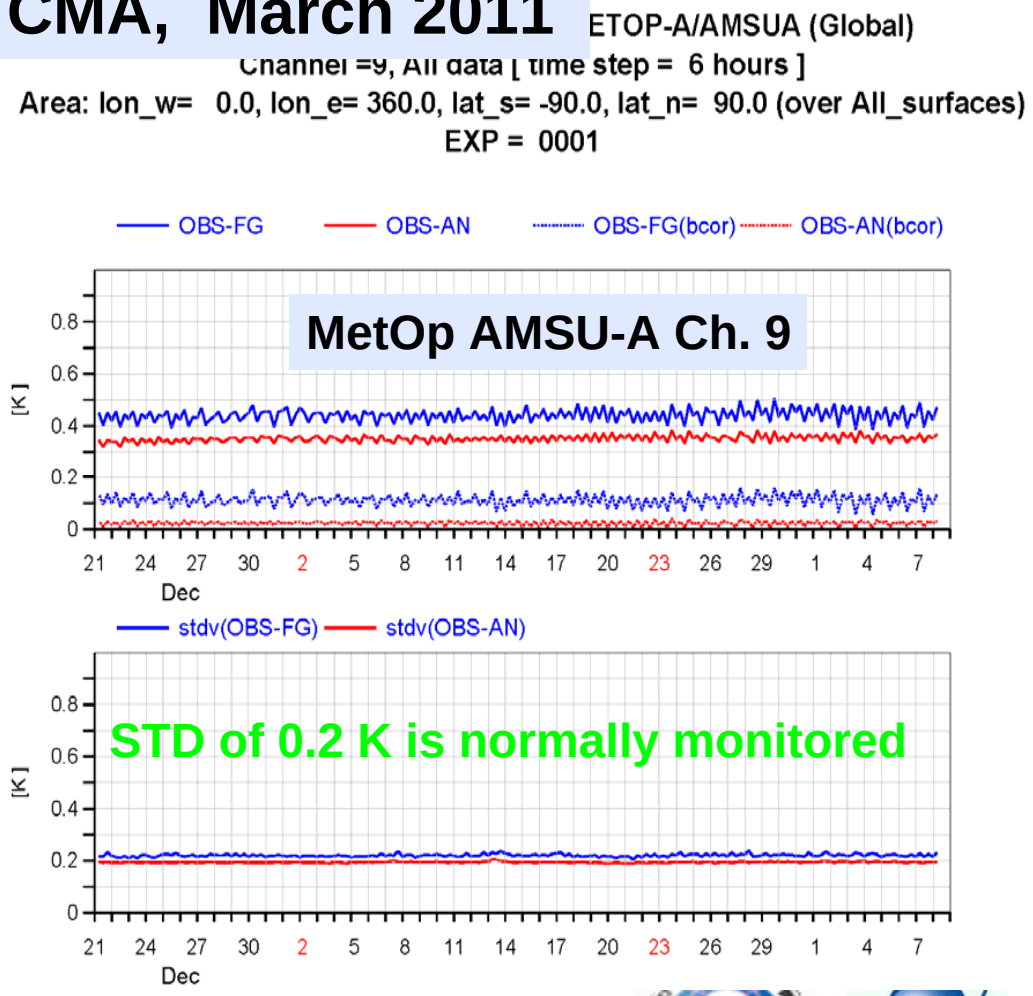
MWTS: current status

Ground system changes implemented at CMA, March 2011



FY-3A MWTS-4



MetOp AMSU-A Ch. 9

STD of 0.2 K is normally monitored

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Initial FY-3B Evaluation

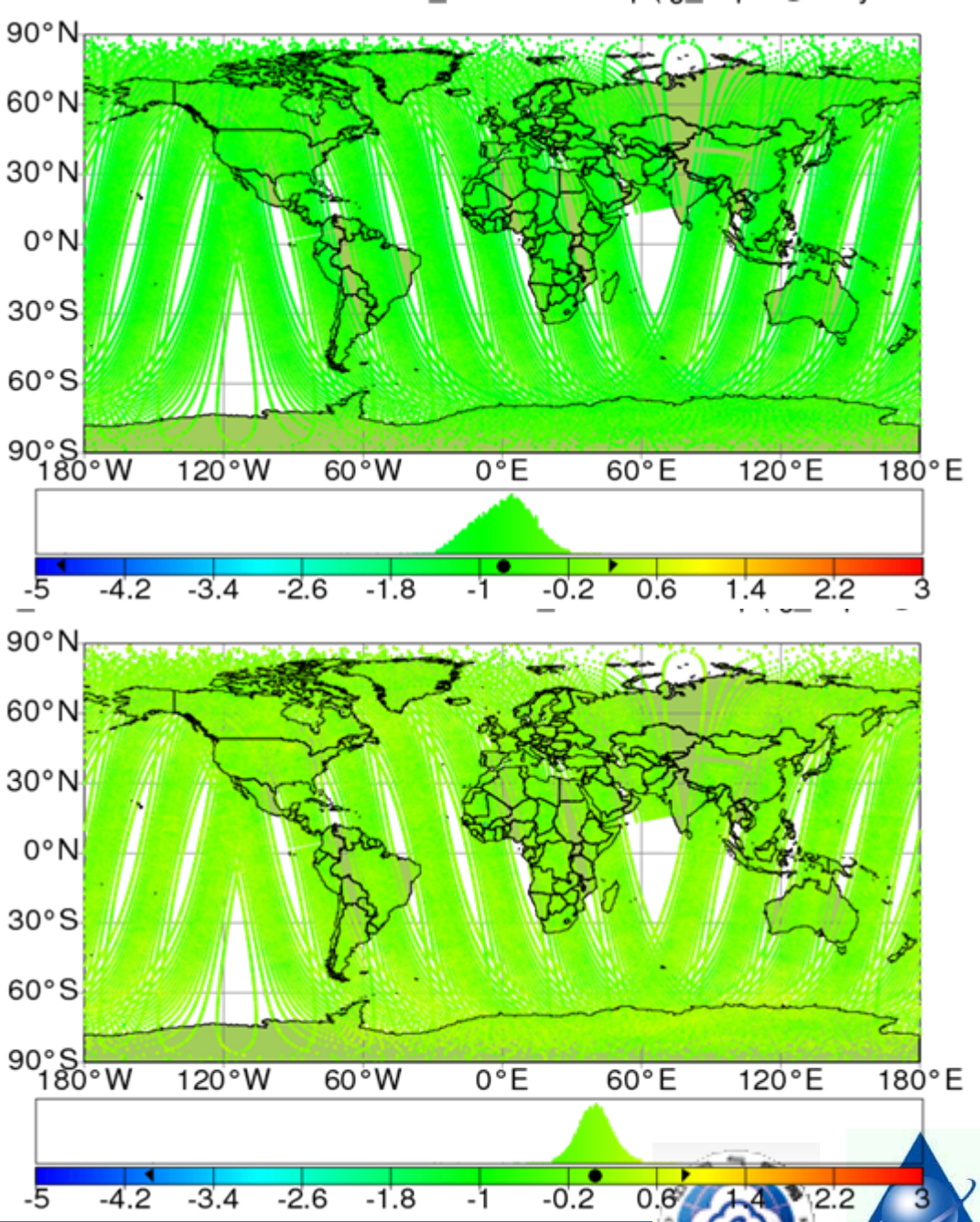
FY-3B MWTS FG Departure Channel 3: 54.072 GHz

- **Correction of passband measurement bias and radiometer non-linearity has been implemented in pre-processing at NSMC/CMA**

- **No significant problems with the MWTS-2 and -3 observations**

- **Cross scan bias is dominant & accounts for non-gaussian FG departures (corrected by variational bias correction scheme):**

  After VarBC
  STDEV(O-FG) = 0.17 K



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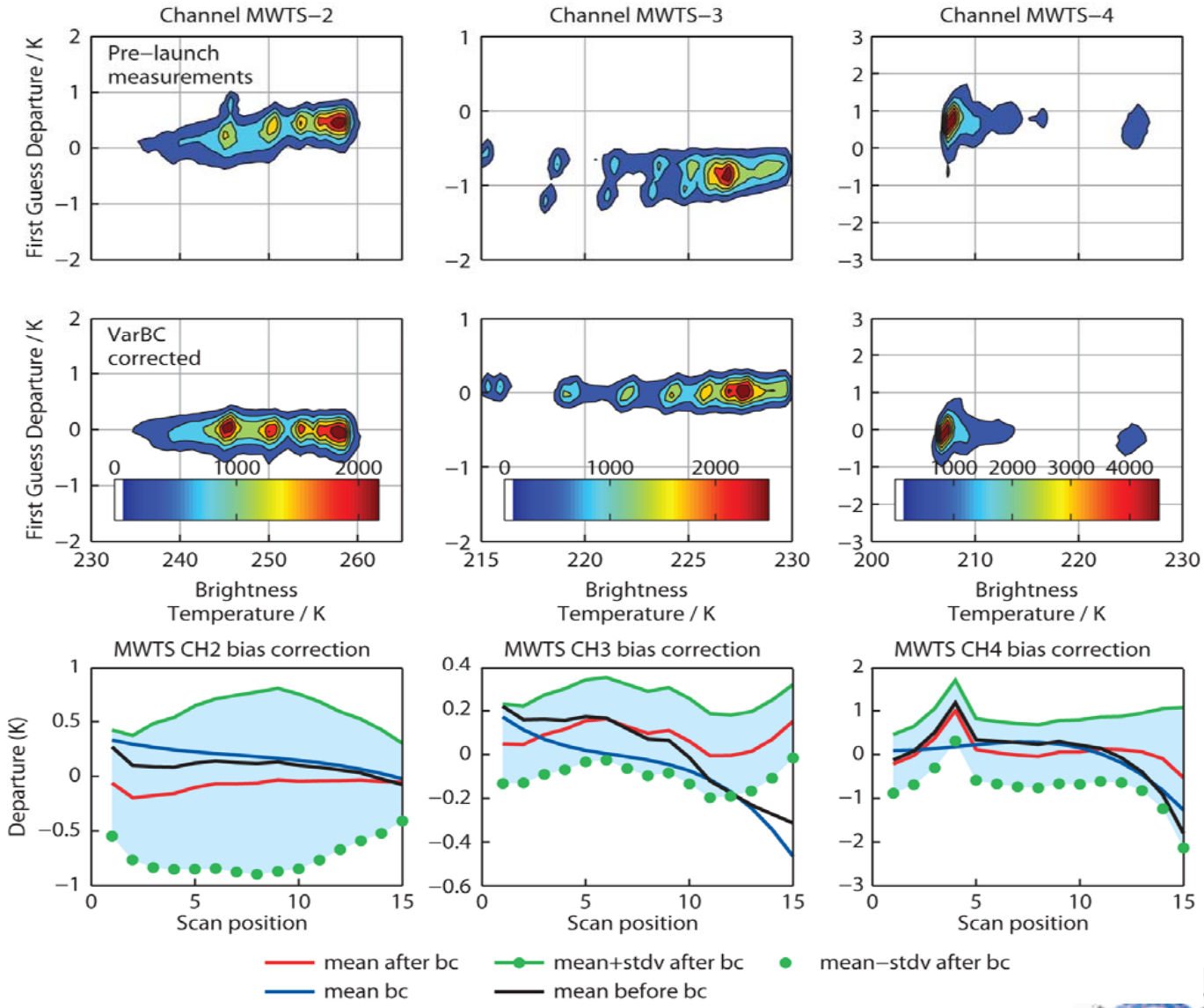
MWTS FG Departure



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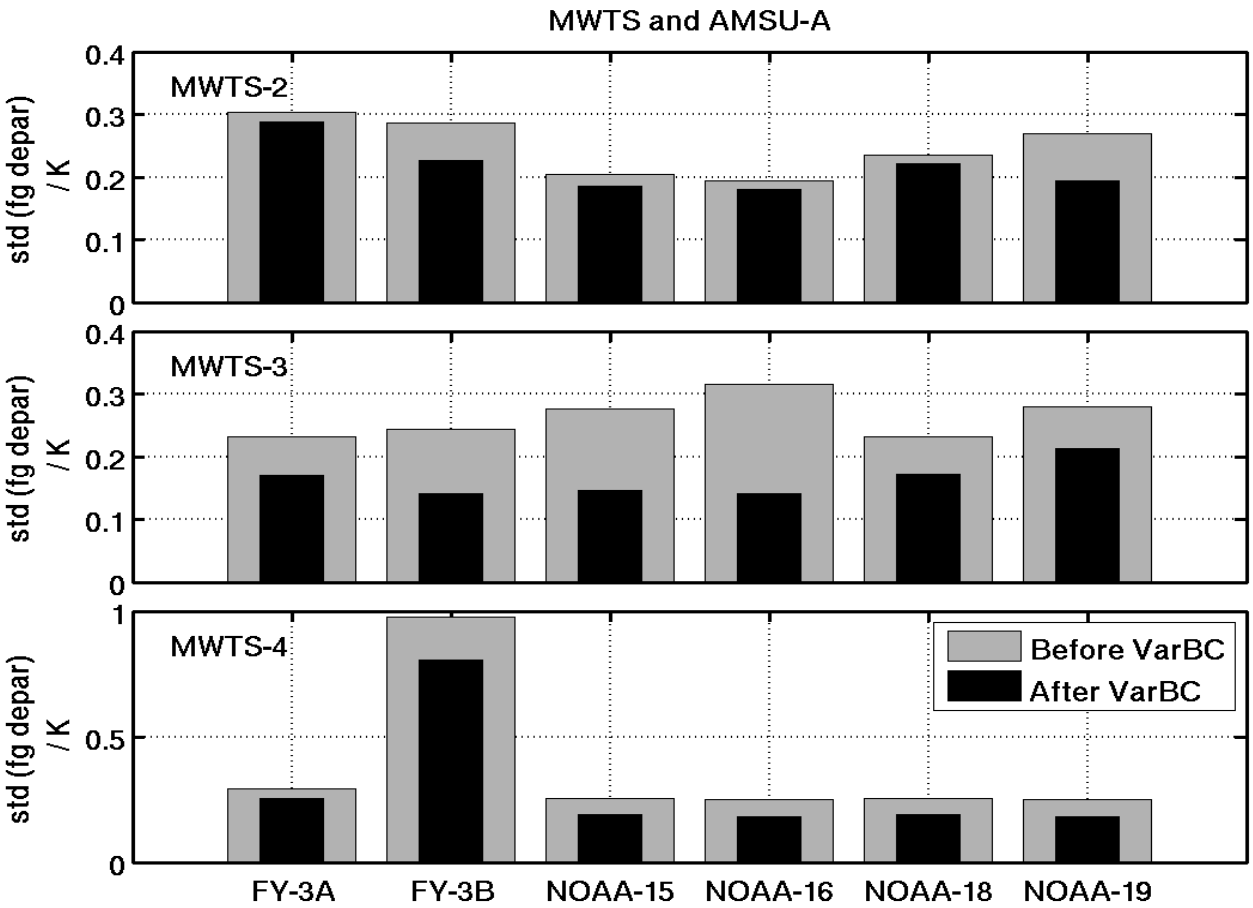
Comparison between MWTS and AMSU-A



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Summary

- A detailed study of the FY-3A revealed, and corrected, biases in MWTS related to :
  - Uncertainties in the passband centre frequencies
  - Radiometer non-linearities
- These corrections bring the MWTS data close to the quality of equivalent AMSU-A data & in assimilation experiments this MWTS data delivers improvements in forecast accuracy.
- Initial assessment of FY-3B suggests the data is comparable with its counterpart.
- The high values of NWP in Cal/Val of new satellite sensors has been clearly demonstrated – further improvements in FY-3A and FY-3B data are expected, and it is hoped NWP will again play a crucial role for FY-3C, …. FY-3G !

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