An initial assessment of microwave imager/sounder MTVZA-GY data from Meteor-M N2 satellite

S. Uspensky[1], E. Kramchaninova[1], A. Uspensky[1],
P. Poli[2], S. English[2] , C.Lupu[2]
1 – SRC Planeta, Roshydromet
2 - ECMWF

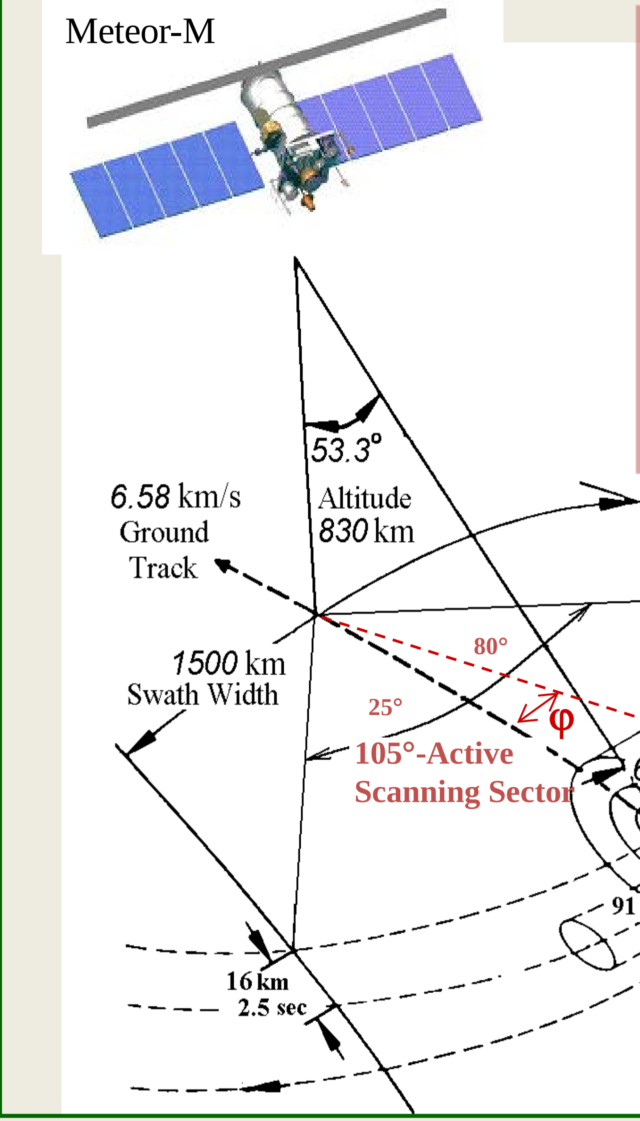
ITSC-XX: Lake Geneva, Wisconsin, USA, 28 October-3 November 2015

Outline

- Instrument design
- Post-launch absolute calibration and data assessment in SRC Planeta
- Data assessment in ECMWF
- Preliminary data assimilation trials in Hydrometcenter of Russian Federation
- Conclusion

2

Microwave Imager/Sounder MTVZA-GY



Parameter	Value
Frequencies, GHz	**10.6, 18.7, 23.8, 36.5, 52-57, 91, 183.31**
Channels	**29**
Antenna Aperture, cm	**65**
Spatial Resolution, km	**16-198**
Sensitivity, K/pixel	**0.3-1.7**
Calibration Accuracy, K	**< 1**
Swath Width, km	**1800**
Conical Scanning Period, s	**2.5**
Data Rate, Kbit/s	**35**
Mass, kg	**94**
Power , W	**80**

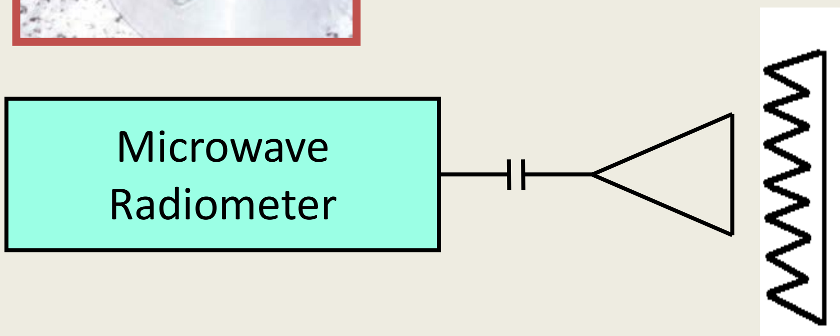
Courtesy I.Cherny, NTC Kosmonit, Moscow

Channel numbering in MTVZA-GY HDF data sets and RTTOV v11

Channel no in MTVZA-GY data file (HDF)	Channel no in RTTOV coefficient's file	Central frequency and polarisation, GHz	Channel name (atmospheric sounding channels)
1	1	10.6V	
2	2	10.6H	
3	3	18.7V	
4	4	18.7H	
5	5	23.8V	
6	6	23.8H	
7	9	36.7V	
8	10	36.7H	
9	25	91.65V	
10 (unavailable)	26	91.65H	
11	15	52.80V	O1
12	16	53.30V	O2
13	17	53.80V	O3
14	18	54.64V	O4
15	19	55.63V	O5
16	20	57+0.32± 0.1H	O6
17	21	57+0.32± 0.05H	O7
18	22	57+0.32± 0.025H	O8
19	23	57+0.32± 0.01H	O9
20	24	57+0.32± 0.005H	O10
21	29	183.31±1.4	HO3
22	27	183.31±7.0	HO1
23	28	183.31±3.0	HO2
24 (unavailable)	-	-	
25 (unavailable)	-	-	
26	7	31.5V	
27	8	31.5H	
28 (unavailable)	-	-	
29 (unavailable)	-	-	

Onboard calibration (signal to TDR)

Two-point calibration scheme: warm load and space



$r < 0.0001$

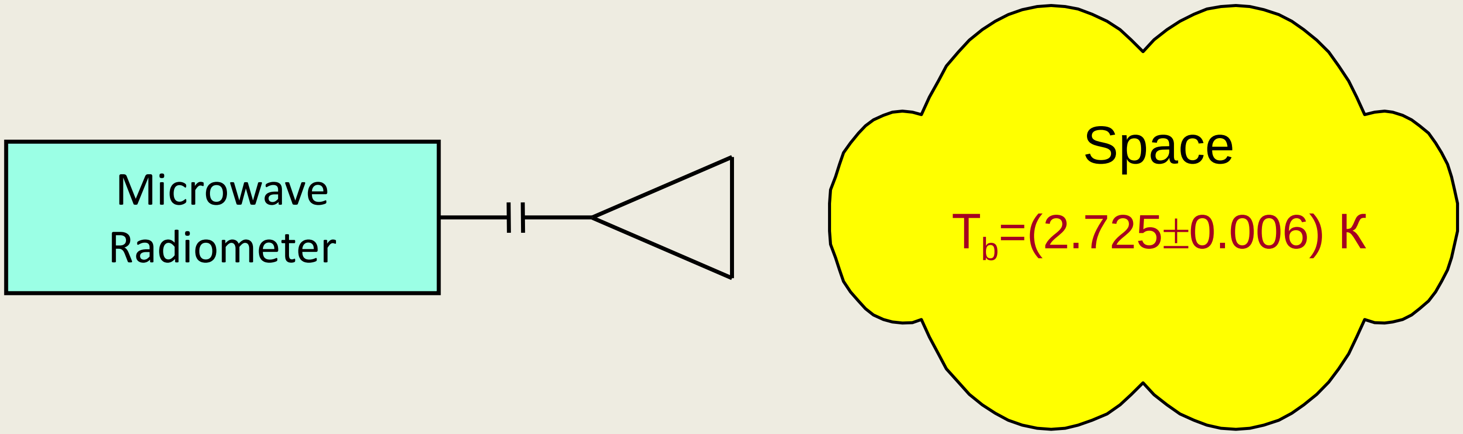
$\delta r = \pm 0.000001$

$\varepsilon = 1 - r = 0.9999\ldots$

$T_0 = 300$ K

$T_b = \varepsilon T_0$

$\Delta T_b \leq 0.05$ K



Courtesy I.Cherny, NTC Kosmonit, Moscow

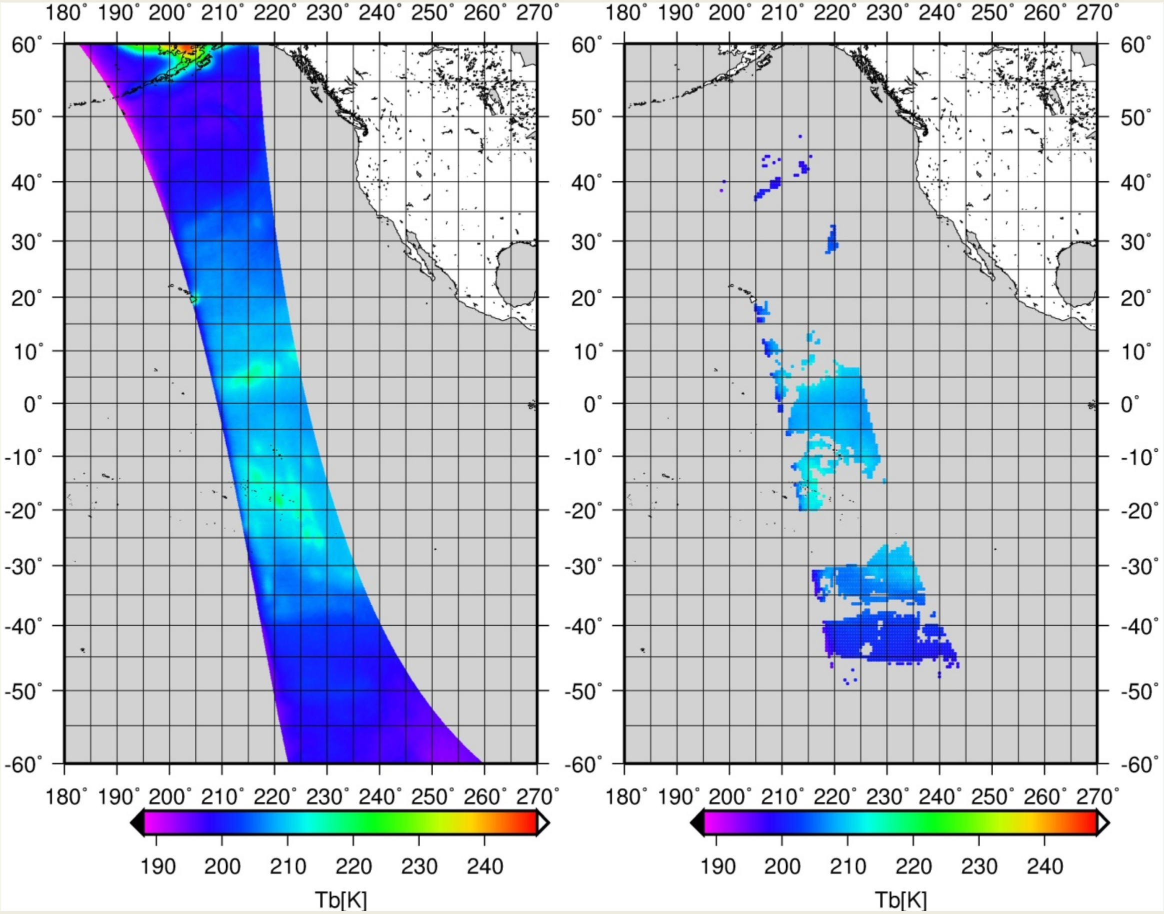
Absolute calibration

Post-launch absolute calibration algorithm is based on comparison between observed radiances (antenna brightness temperatures) and RTM-simulated radiances (sensor brightness temperature) and linear regression.

6

An example of dataset used for absolute calibration (06:22 UTC Jan 28 2015) over ocean between 60°S and 60°N in clear-sky, calm conditions

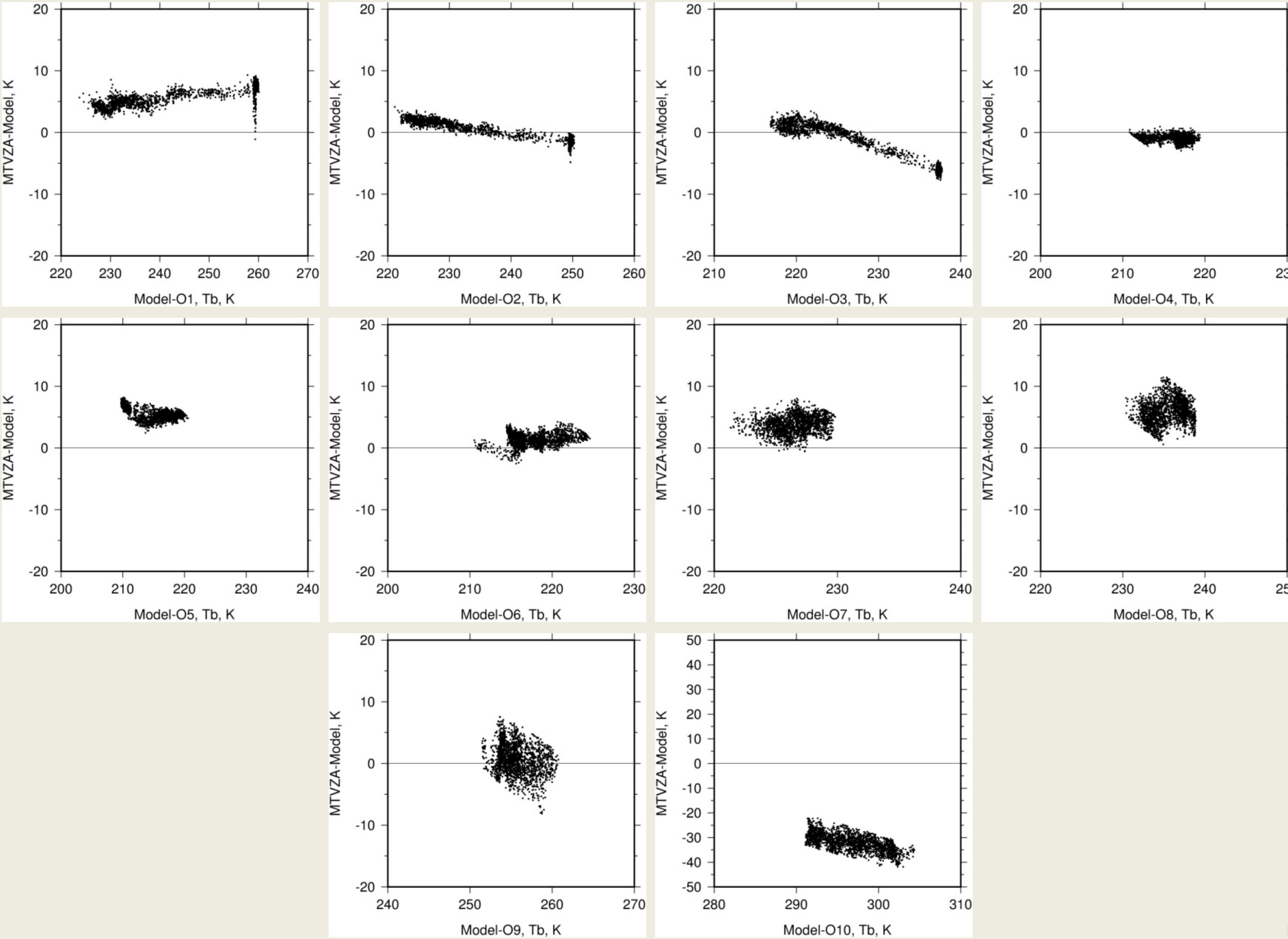
a) b)



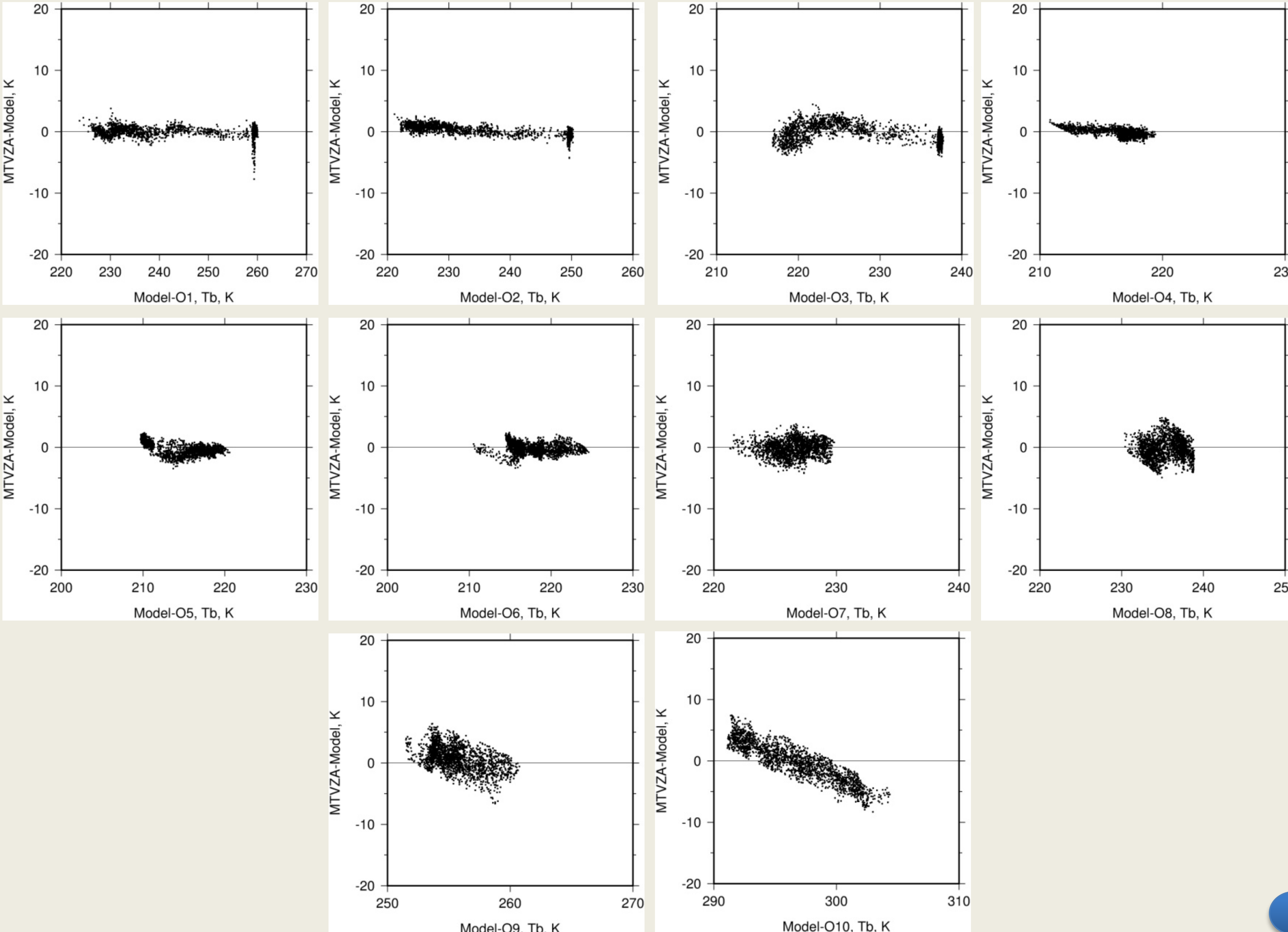
a) Channel 1 (10.6 GHz,V) – an overview;

b) Channel 15 (52.8 GHz,V) – filtered precipitating clouds, surface wind less than 7m/sec

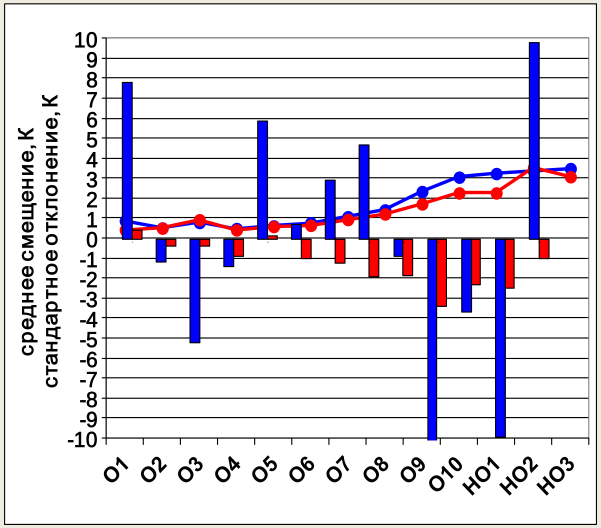
Scatterplots of brightness temperature differences Observation – Background (O-B) vs brightness temperatures, before post-launch calibration applied, data from Jan 26 2015.

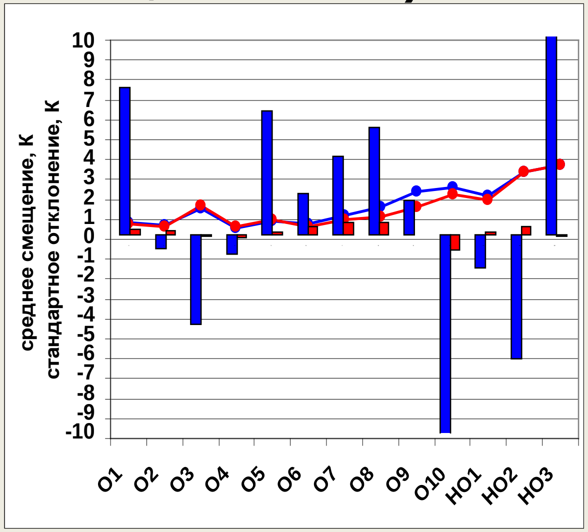


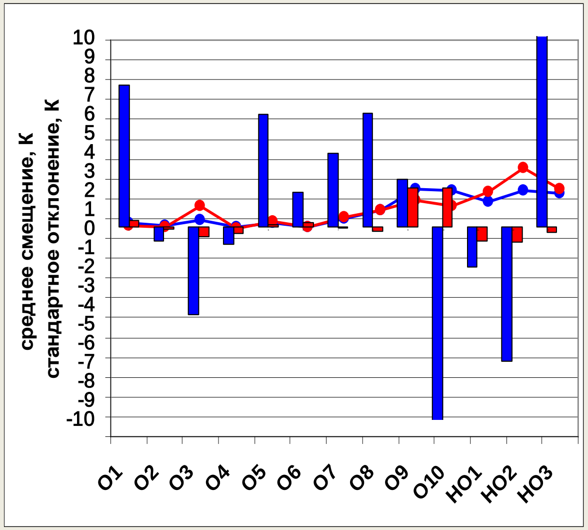
Scatterplots of O-B after post-launch calibration, data from Jan 26 2015.

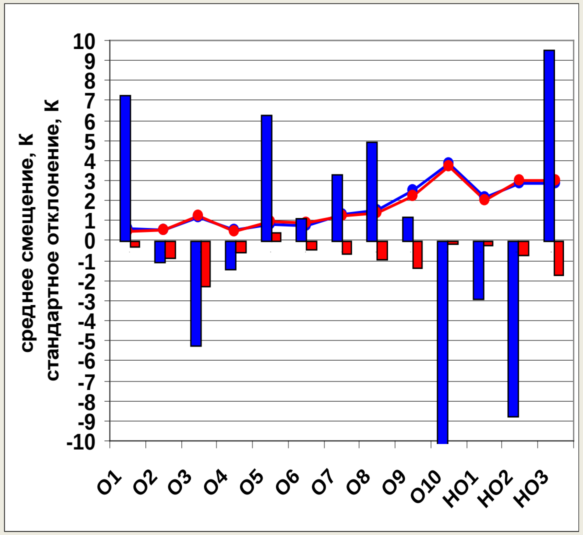


Global biases (bar) and STD (curve) for ascending (left) and descending (right) orbits. Data for selected dates of Jan-March 2015
(blue – before post-launch calibration, red – after).

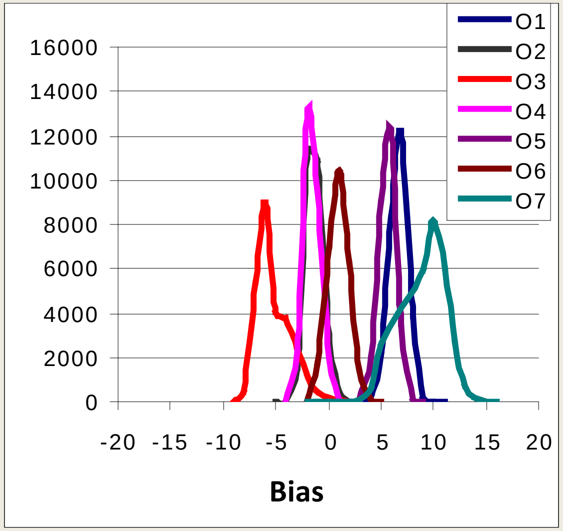


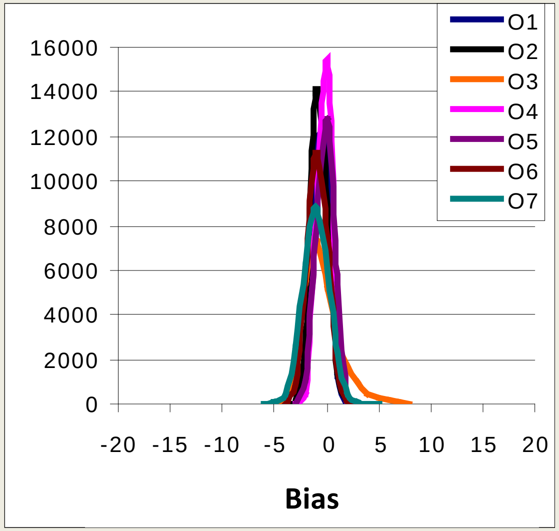


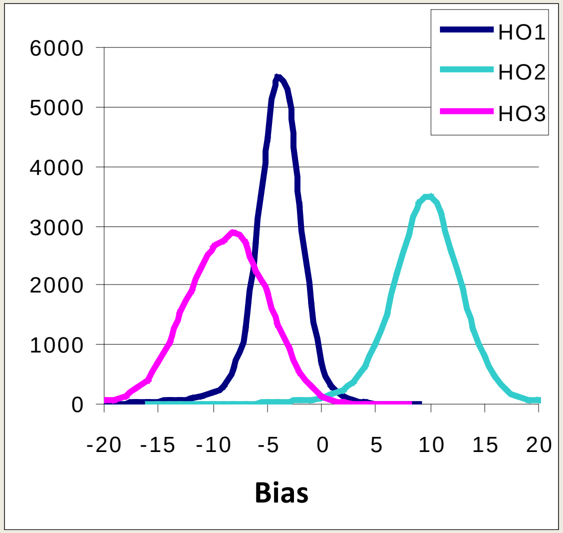


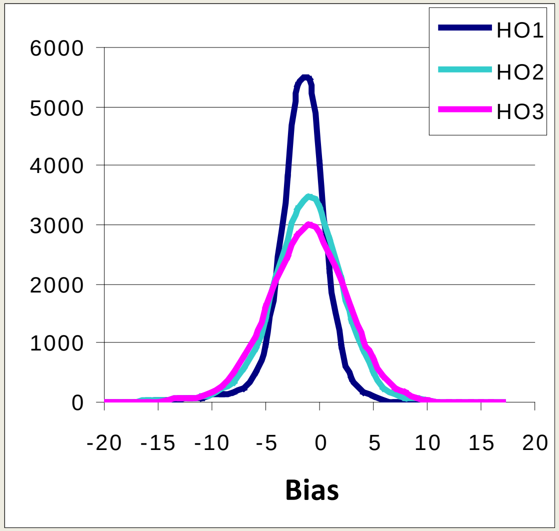


Distribution of O-B differences for MTVZA-GY channels 11-17 (O1-O7) and 21-23 (H01-H03), using all data from March 19 2015. Left – before, right – after post-launch absolute calibration. Upper – temperature sounding channels, lower – humidity sounding channels.

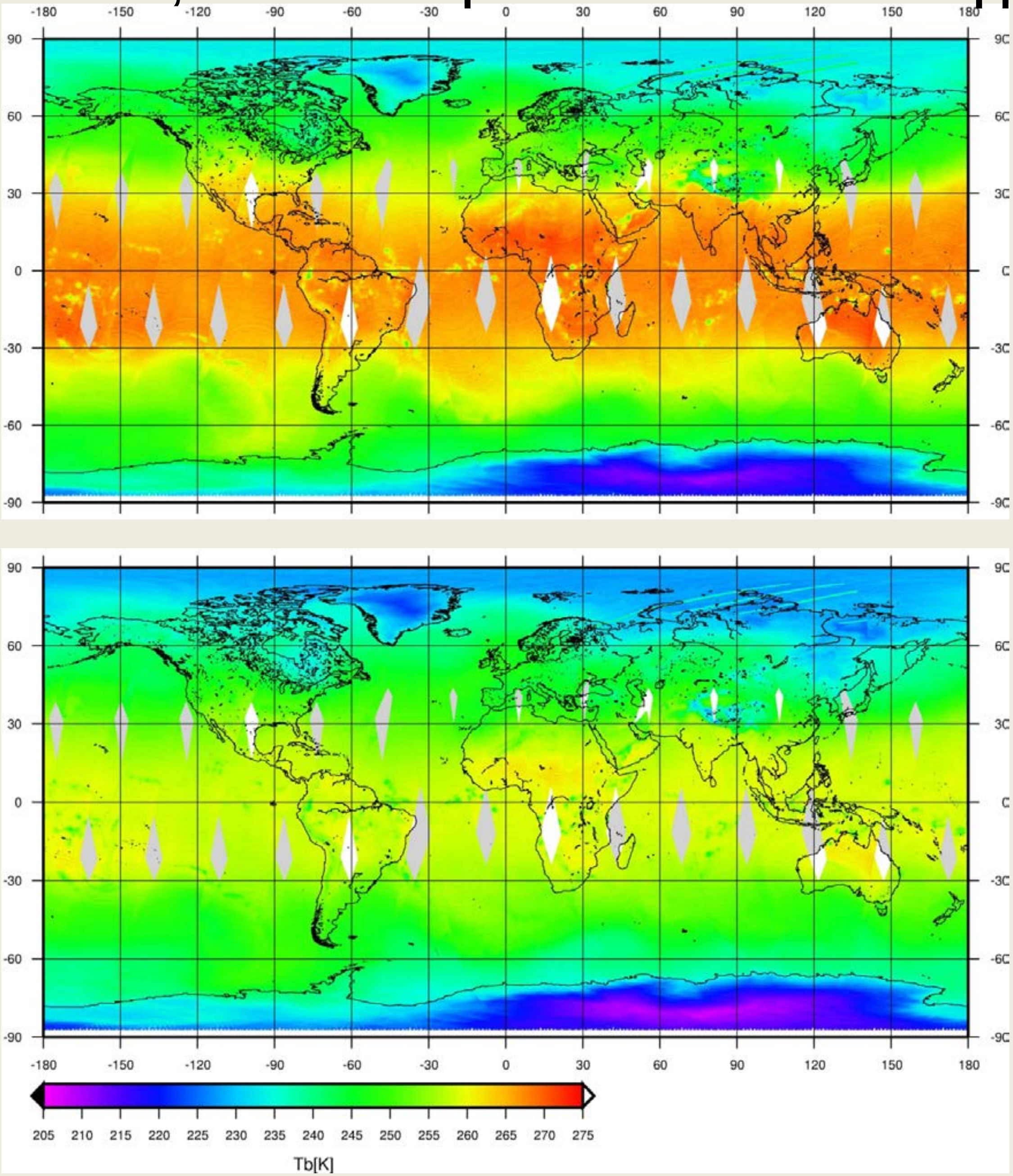








Global distribution of SDRs for channel 52.8 GHz, March 22 2015, upper – before, lower – after post-launch calibration applied.



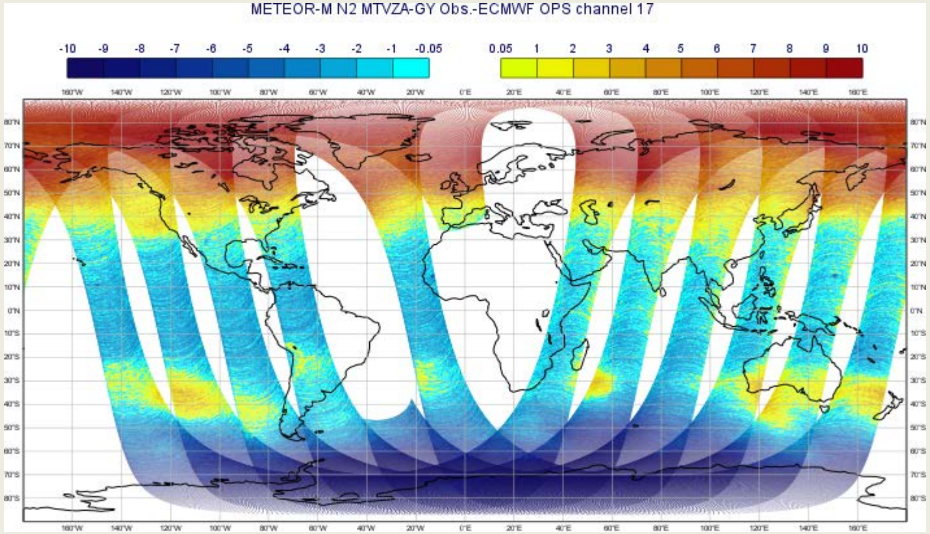
Summary

- For the most channels there were large air-mass dependent biases. After the post-launch calibration the biases are within limits except for the stratospheric channels (O7-O10). Bias distribution now became more like normal Gaussian type for most channels.
- The stripping noise in most channels was also detected, especially for the humidity sounding channels.

MTVZA-GY data assessment in ECMWF

Temperature sounding channels

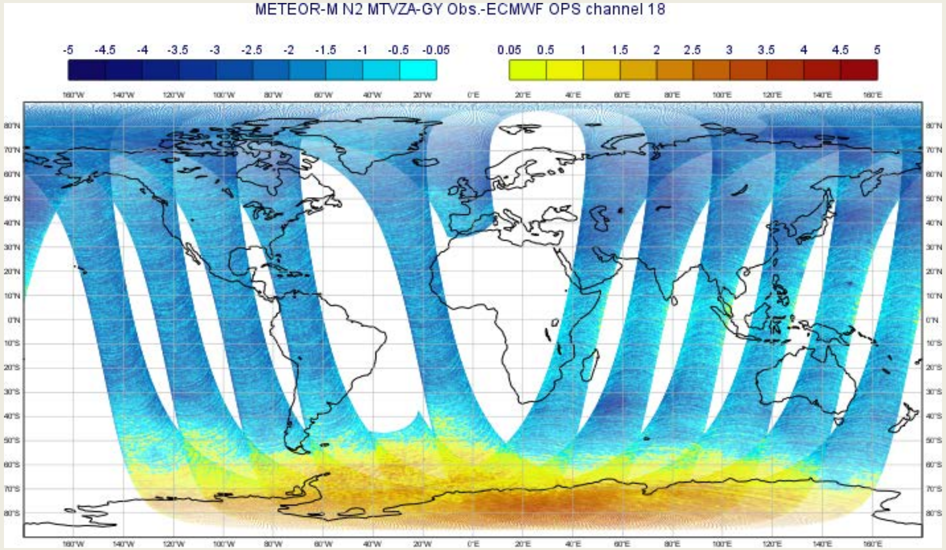
Observation minus Background difference from 8 July 2015



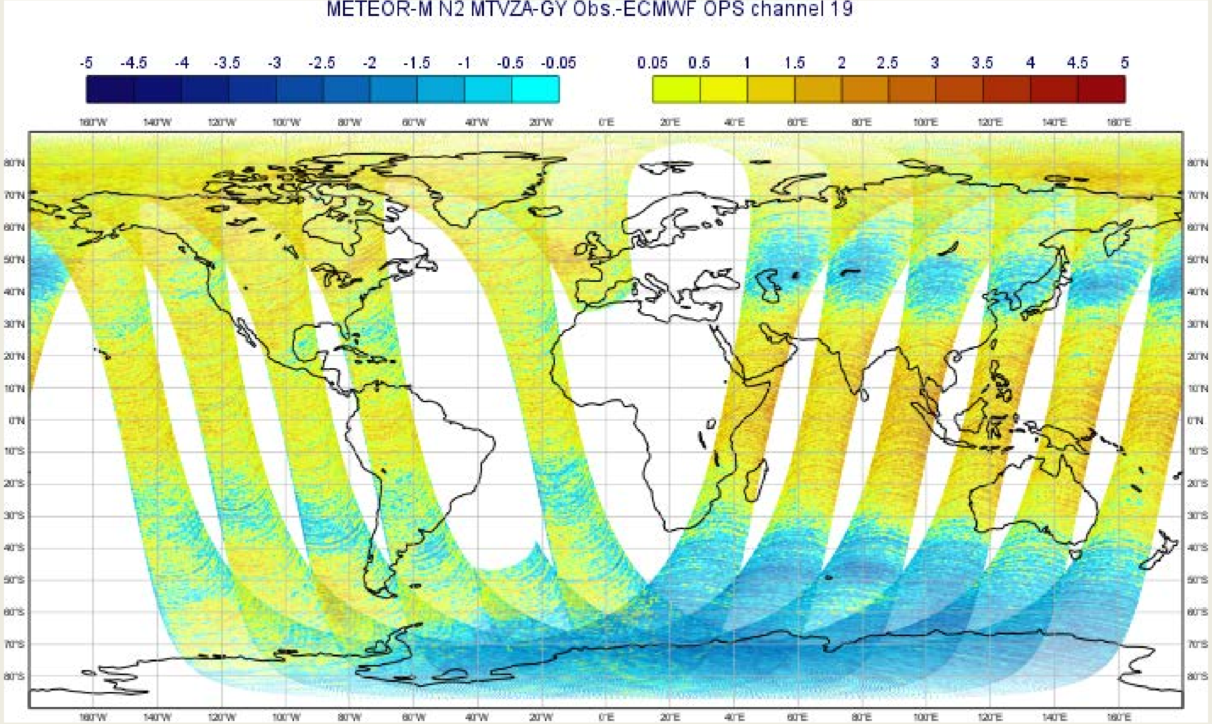
MTVZA channel 53.8GHz, V (similar to AMSU-A Ch.6)

This is the first sounding channel not to “see” the surface. We can see large airmass biases. This may be indicative that the assumed bandpass and true bandpass are not the same, however it could also be due to an error in the calibration along the orbit. There is little evidence for this channels of ascending-descending bias differences. Stripping noise is clearly visible. There is a large mean bias – the global mean being around 3.5 K.

Channel 18 shows similar behaviour to channel 17 with a strong north-south bias gradient. The stripping noise is clearly evident. Unlike channel 17 there is now clear evidence of a difference in bias between ascending and descending orbits. There is a strange cold anomaly in the Southern Indian Ocean, warmer O-Bs over Eastern Russia, which may point to calibration issues and there are some scan lines that appear very warm.



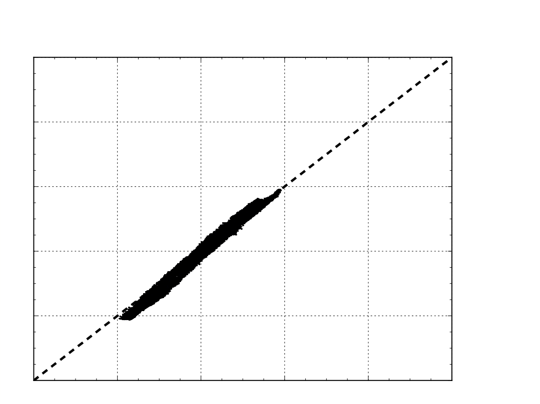
MTVZA channel 54.64GHz, V (similar to AMSU-A Ch.7/8)

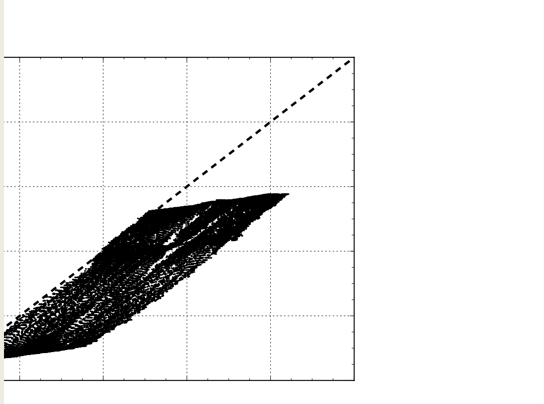


The bias is now warmest in the tropics and coldest at the poles. The ascending-descending bias differences and stripping are however similar to the two lower channels.

MTVZA channel 55.63GHz, V (similar to AMSU-A Ch.8/9)

There are some anomalous observations in channel 18 (54.64GHz), and the sizeable bias in channel 20 (55.63GHz)

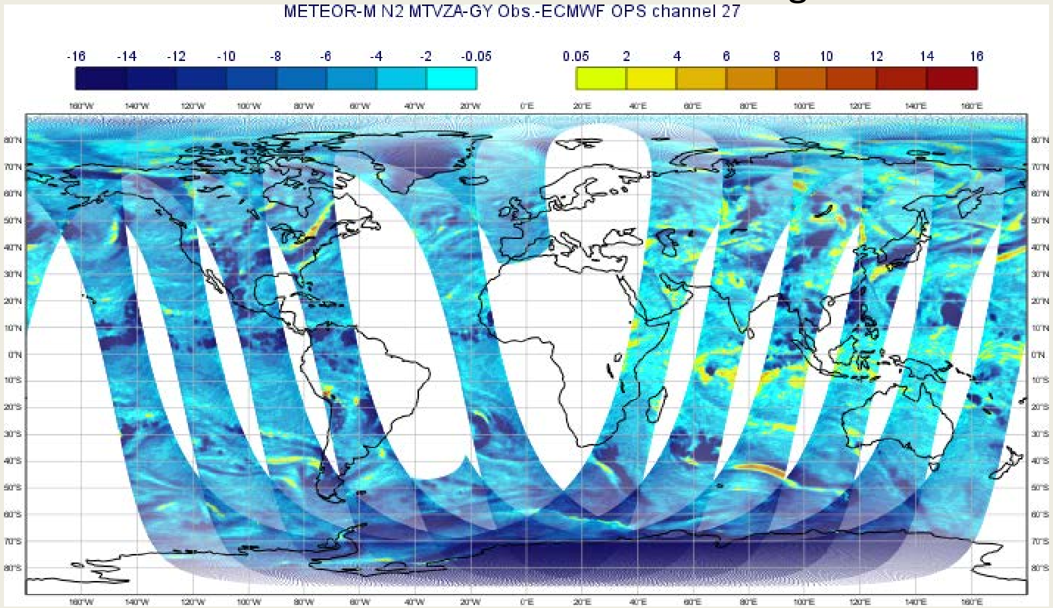




Background versus observed brightness temperature for channels 54.64GHz (left) and 55.63GHz(right).

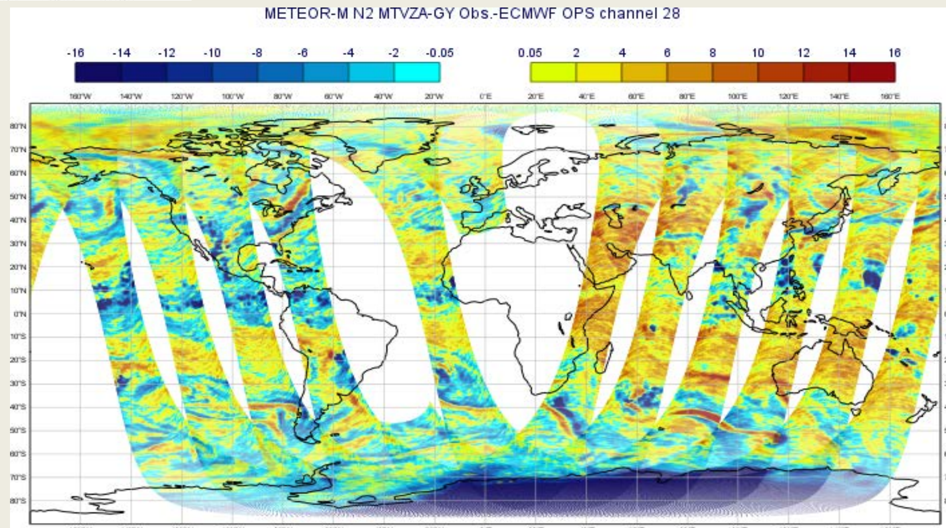
Humidity sounding channels

Observation minus Background difference from 8 July 2015

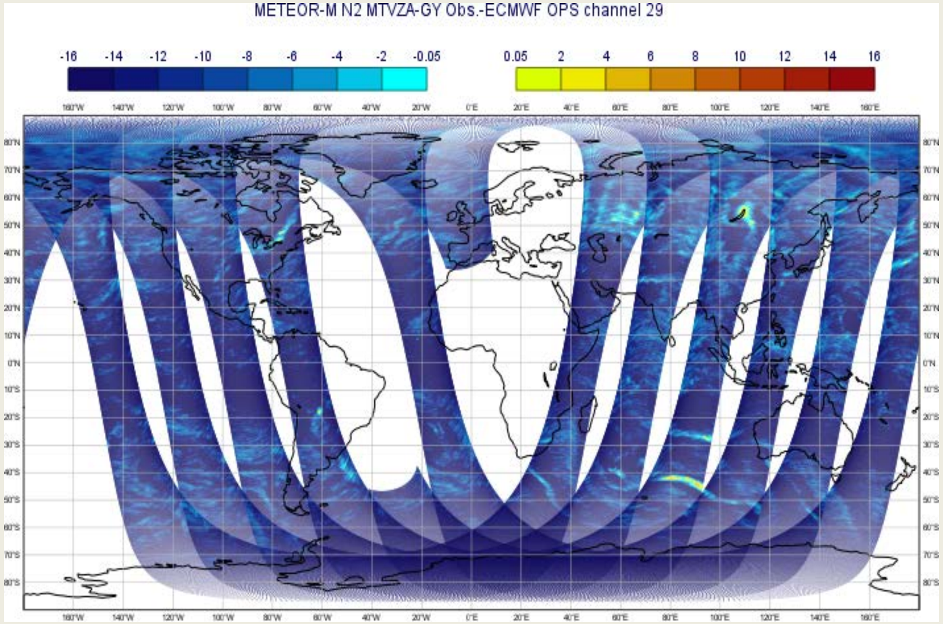


The ascending-descending bias difference seen in the temperature sounding channels is also clearly evident in the first humidity channel, with warmer biases in the eastern hemisphere. However other than this the data appears to be good.

MTVZA channel 183.31±7.0 GHz
(similar to MHS-5)



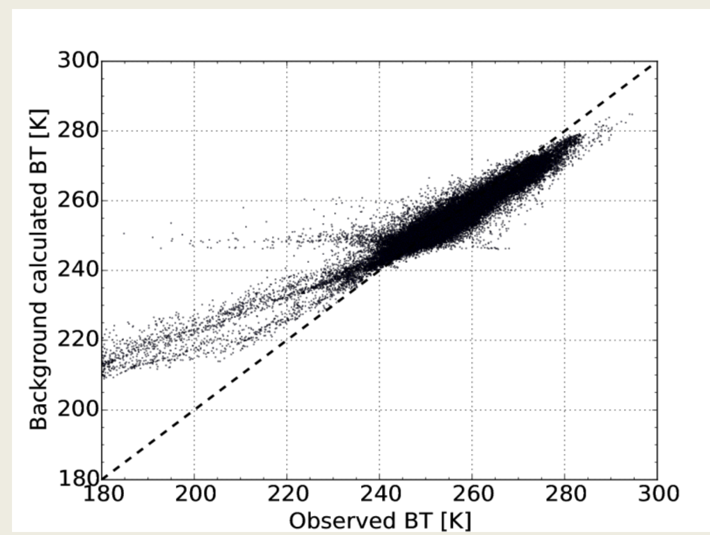
MTVZA channel 183.31±3.0 GHz
(similar to MHS-3)



MTVZA channel 183.31±1.4 GHz
(similar to MHS-4)

There is also a strong air-mass bias variation for the humidity.

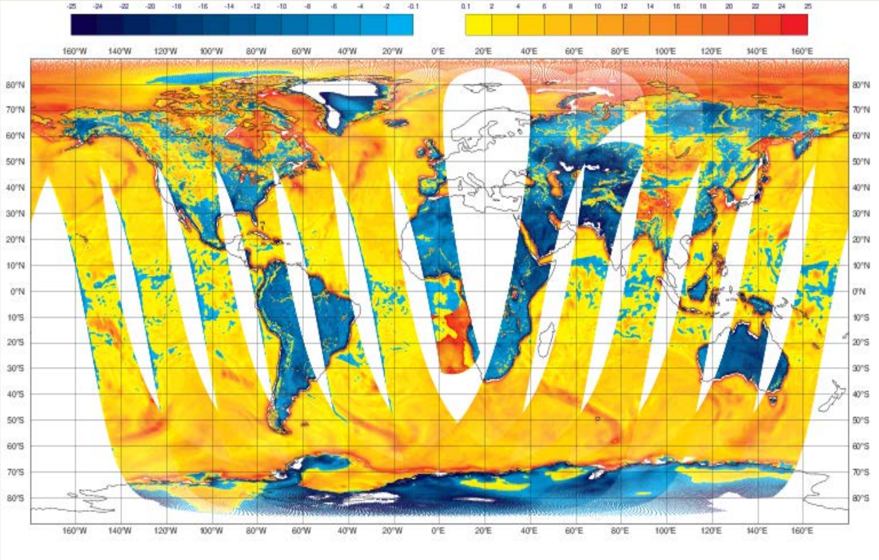
At warm observed brightness temperature there is generally good agreement, but at cold observed brightness temperature there is very poor agreement.



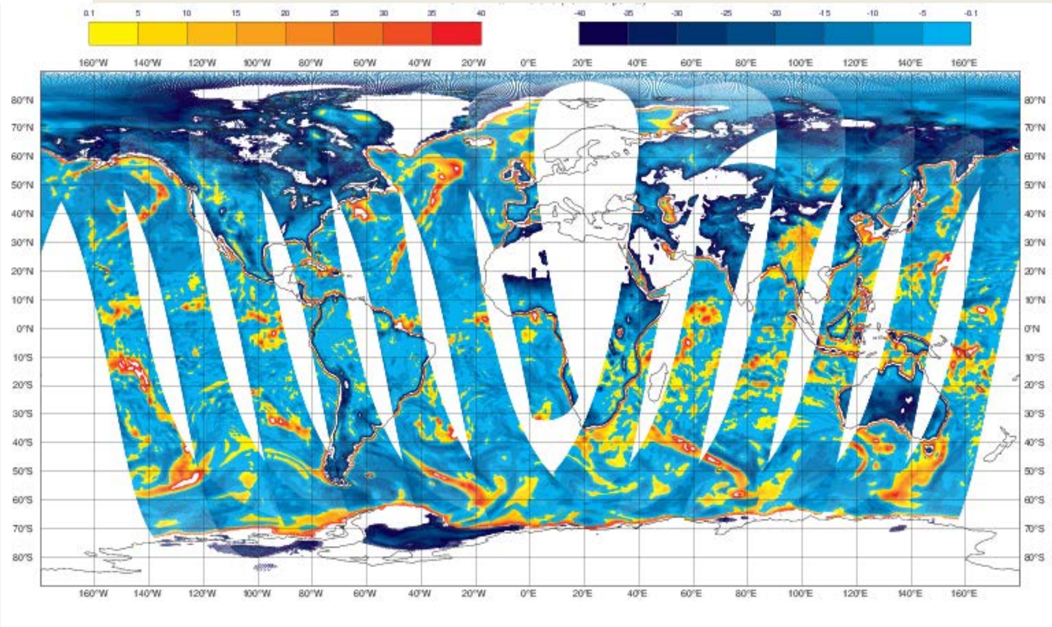
Background BT versus observed BT for channel 183.31±3.0 GHz.

Imagery channels

Observation minus Background difference from 8 July 2015



18 GHz vertical and horizontal background departures. Apart from a strange anomaly at the start of the first ascending orbit the data looks OK.



Summary (ECMWF)

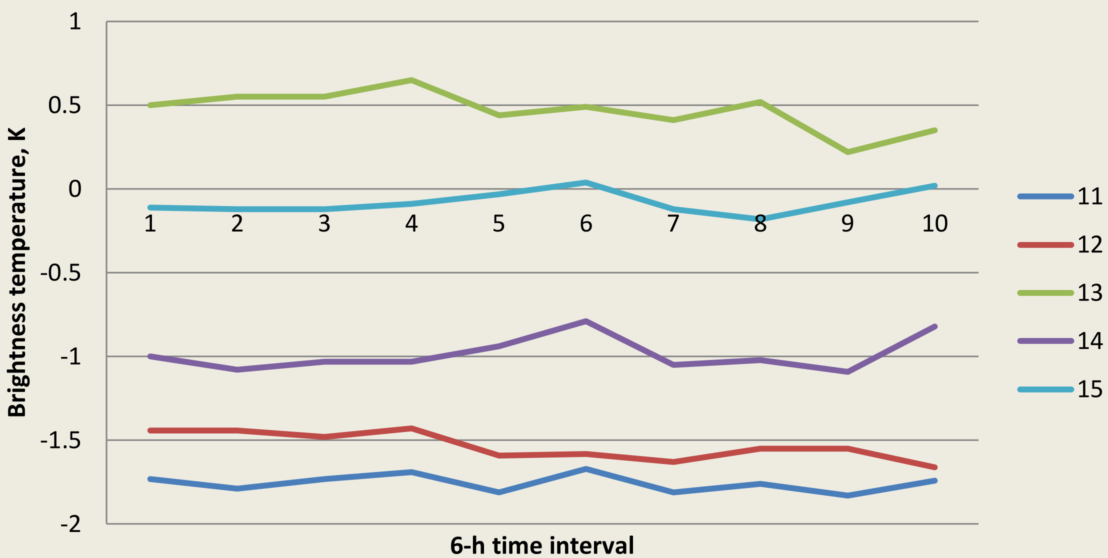
- The results for MTVZA-GY are similar to early results from the SSMIS instruments on DMSP, with a number of issues that are broadly reminiscent of SSMIS.
- Most MTVZA-GY channels have ascending-descending bias differences, stripping noise and air-mass dependent biases.
- When looking at the imagery channels there is the coastline bias caused by geolocation errors.
- These issues would need to be resolved before assimilation trials.

Preliminary data assimilation trials in Hydrometcenter of Russian Federation

For the period of 2015091318 to 2015091600 observed brightness temperatures for troposphere sounding temperature channels were compared with simulated temperatures based on NCEP GFS 6-hour forecast and RTTOV, 10 steps in total. Measurements over the sea surface within ±3 hours from NCEP data were used for analysis (observation window). If the discrepancies between measured and calculated values were over 3K those measurements were discarded.

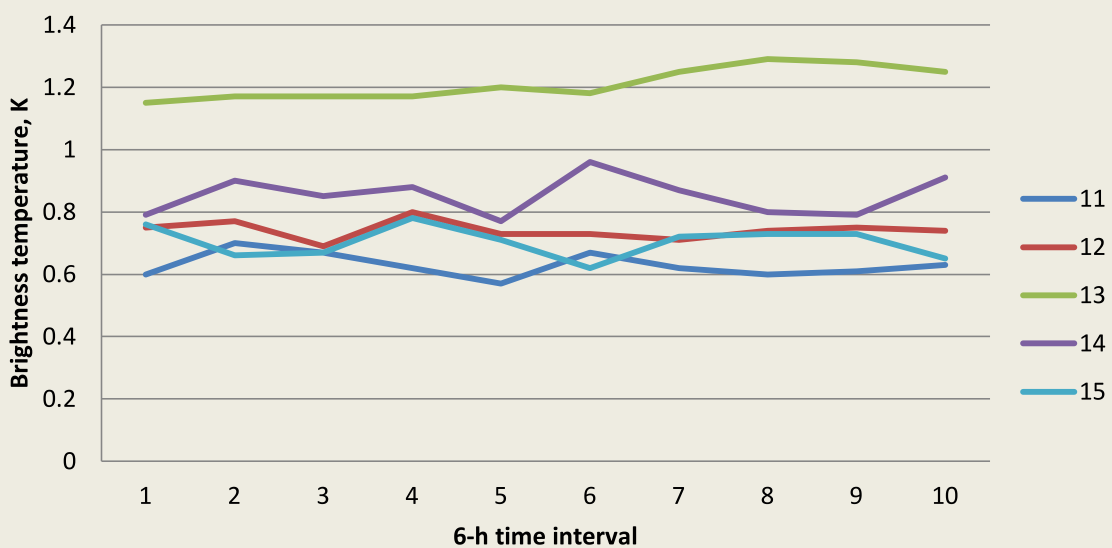
MTVZA-GY data assessment in Hydrometcenter of Russian Federation

Bias: MTVZA-GY minus 6-h forecast NCEP



Channel no, GHz	11 52.8	12 53.3	13 53.8	14 54.64	15 55.63
STD for mean biases	0,053	0,083	0,12	0,104	0,069

STD: MTVZA-GY minus 6-h forecast NCEP



Channel no, GHz	11 52.8	12 53.3	13 53.8	14 54.64	15 55.63
% of discarded measure ments (discrepa ncy>3K)	6,8	3,4	29,7	0,0	0,0

Summary (Hydrometcenter of Russian Federation)

- According to preliminary results, channels 52.8 53.3 and 55.63 GHZ could be used in the NWP assimilation scheme after bias correction. Channel 54.64 GHz could possibly be utilized, while the STD in this case is rather big (average 0.85). Channel 53.8GHz is currently of no use since biggest STD and almost 30% of discarded data.
- Bias correction studies are now underway. Procedure for bias correction (air-mass dependent) will be similar to the one used for AMSU-A data.

Conclusion

- On-orbit calibration was explored using RTM calculations and GFS NCEP data.
- The results for MTVZA-GY are similar to early results from the SSMIS instruments on DMSP.
- MTVZA-GY instrument performance proved to be stable and is according to specs.
- There is a need to refine TDR to SDR conversion (calibration coefficients), especially for upper temperature channels. It would be useful to use the COSMIC RO data and we plan to do it in the future.
- We plan to work with NTC Kosmonit to implement more accurate geolocation and to develop channel-dependent stripping noise mitigation algorithm.