



# A first look at data from MTVZA-GY on Meteor-M N2

Satellite Applications Technical Memo 34

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**History:**

Version	Date	Comment
1.0	11 August 2015	Initial
1.1	13 August 2015	New plots generated with zenith angle set to 65°

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## Abstract

This report describes the initial evaluation of data from MTVZA-GY on Meteor-M N2. The NWP SAF Radiance Simulator is used to derive simulated brightness temperatures that are compared with the instrument observations. Comparisons are also done with SSMIS on F19, to demonstrate that the simulated brightness temperatures are realistic.

### 1. Introduction

The MTVZA-GY is a 24-channel microwave imager/sounder with conical scan geometry. 12 hours of sample level 1B data have been generated by ROSHYDROMET SRC Planeta and provided to EUMETSAT for evaluation through the STG Operations Working Group.

For this study, the NWPSAF radiance simulator has been used, together with RTTOV v11, to generate model background brightness temperatures (BTs) for each channel. The observed BTs are then compared with the simulated BTs. For more information on the radiance simulator, see [http://www.nwpsaf.eu/deliverables/rad\\_sim/index.html](http://www.nwpsaf.eu/deliverables/rad_sim/index.html). RTTOV coefficients were generated from a channel list provided by Alexander Uspensky of SRC planeta. A single 6-hour global model analysis was used, centred on 00Z on 8<sup>th</sup> July 2015.

The instrument is described on the following WMO Oscar web page: <http://www.wmosat.info/oscar/instruments/view/333>. It should be noted that the zenith angle is 65°, not 53.3° as reported on Oscar. (This information was provided by SRC Planeta via ECMWF).

The data are supplied in HDF4 format and includes attributes that describe the channel frequencies, channel numbers, etc. It should be noted that there are some differences compared with the expected channel list:

- There are no channels at 42.0 or 48.0 GHz
- At 91.655 GHz there is only V polarisation, not H
- Some of the bandwidths are different
- The channel numbering system is different from that used in the RTTOV coefficient file.

It is assumed that the frequencies, bandwidths and polarisations given in the HDF files (and shown in the titles of each plot below) are correct, with the exception of 183 GHz channels, for which there is evidence of a channel swap (see next section). It is possible that there are other errors that have not so far been detected.

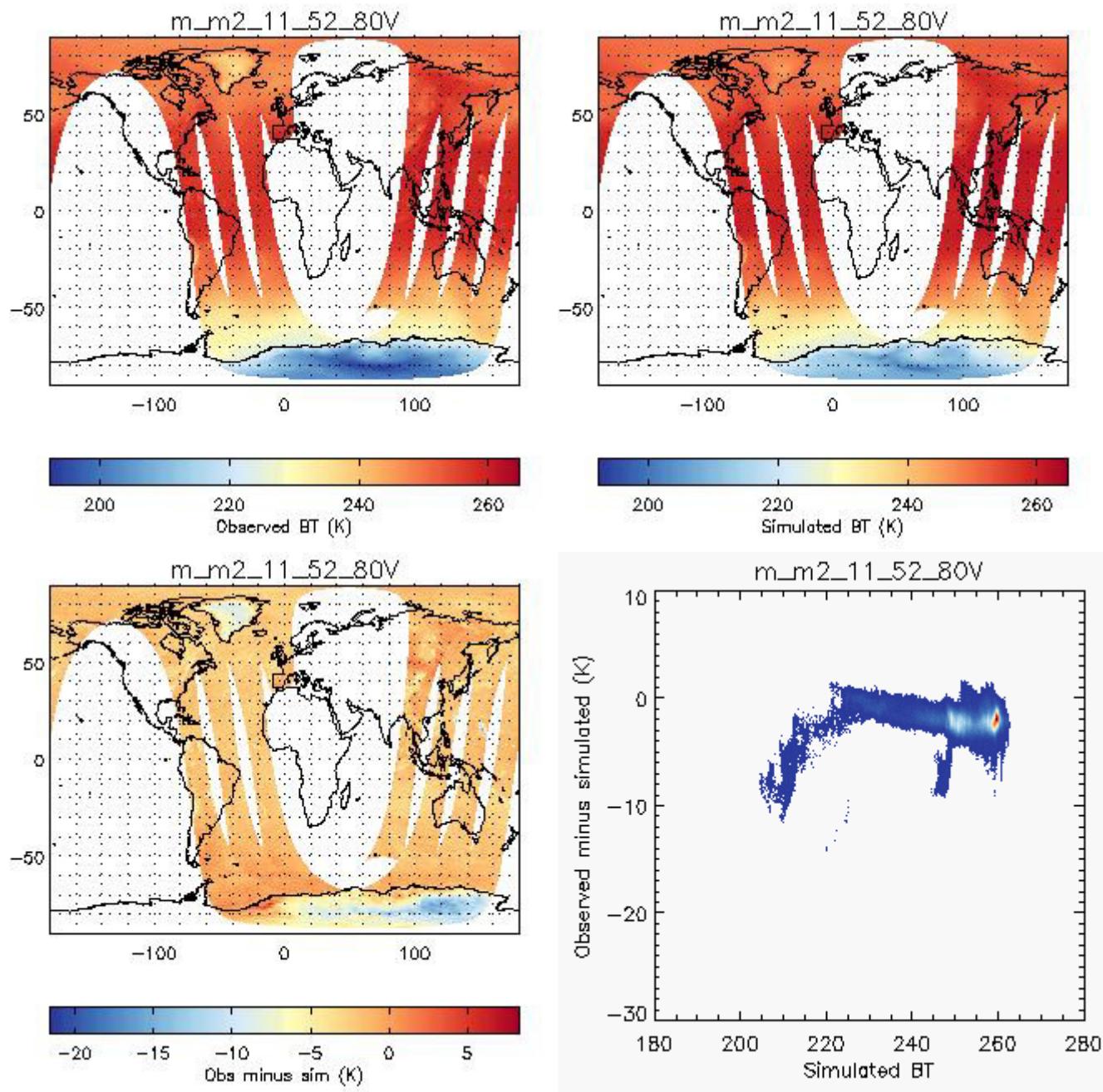
To assess the accuracy of the simulation, the exercise was repeated, for the same cycle, using SSMIS F19 data. The SSMIS is an instrument of similar size to MTVZA-GY, and also has a suite of 50-60 GHz and 183 GHz channels.

### 2. Results for MTVZA-GY

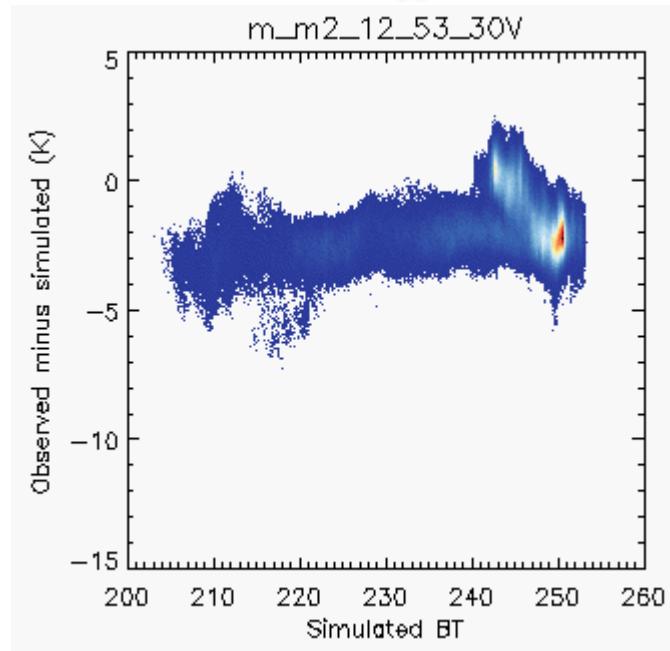
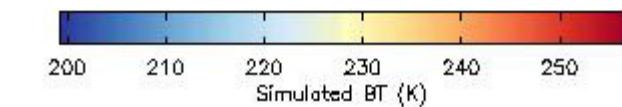
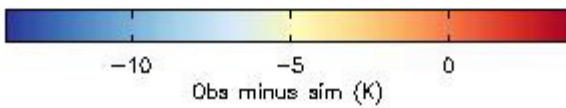
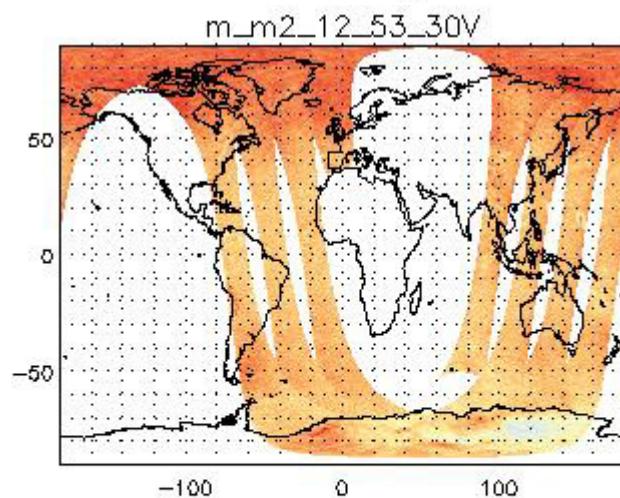
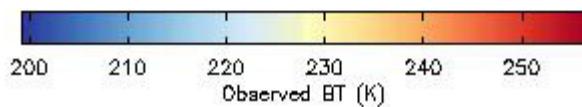
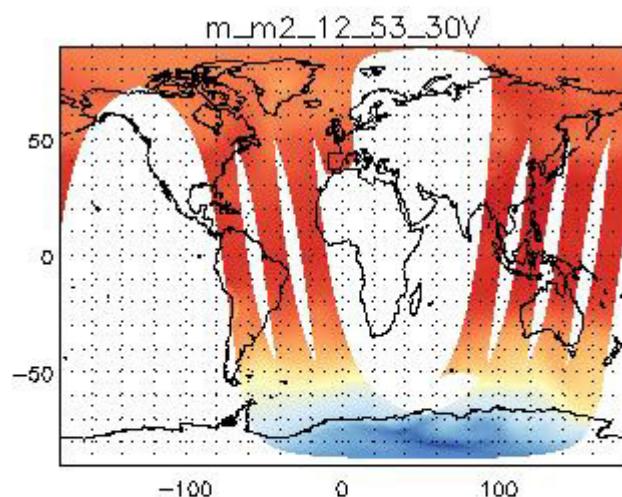
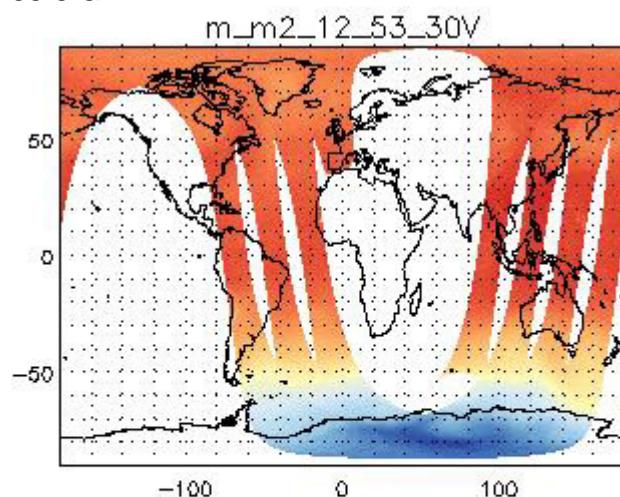
On the following pages (one page per channel), maps are provided showing the observed and simulated BTs and their difference, together with a scatter plot of BT difference as a function of simulated BT.

## 2.1. 52-57 GHz sounding channels

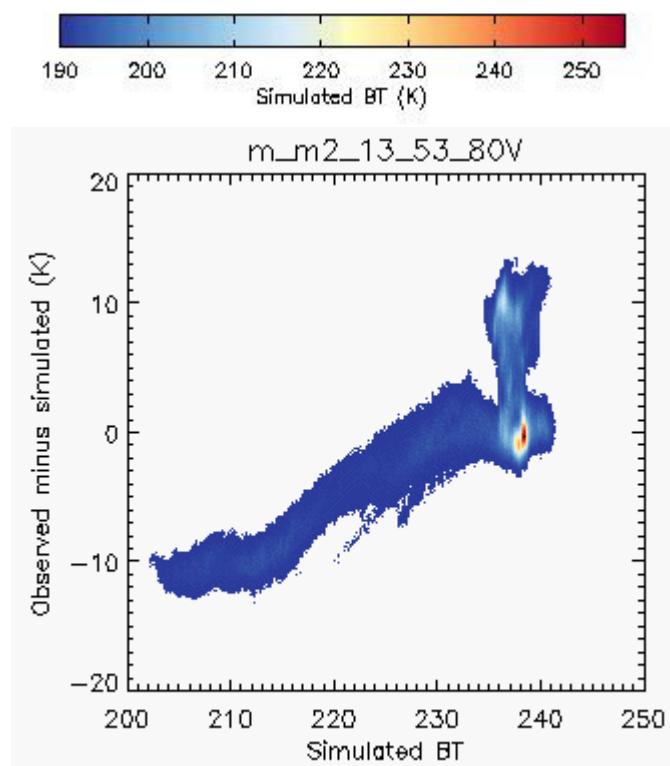
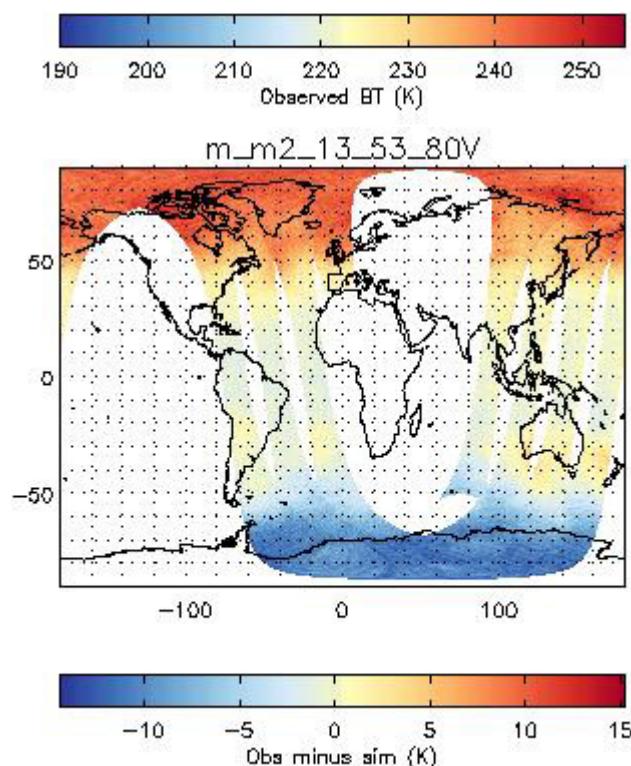
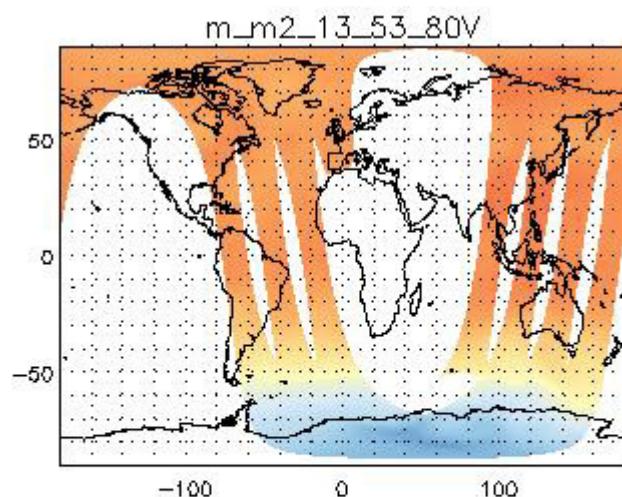
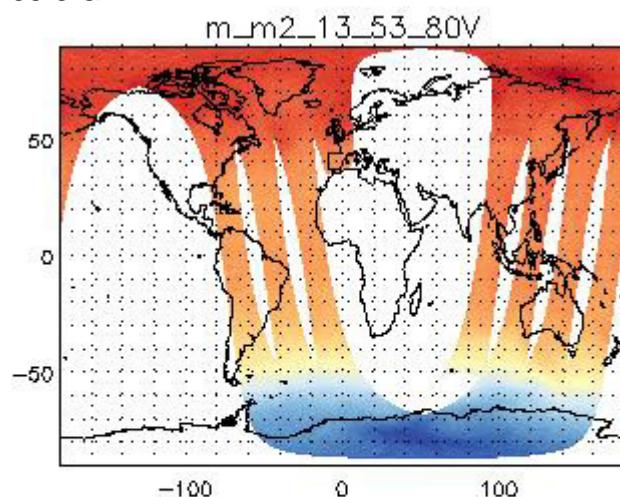
### 52.8 GHz



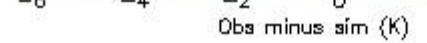
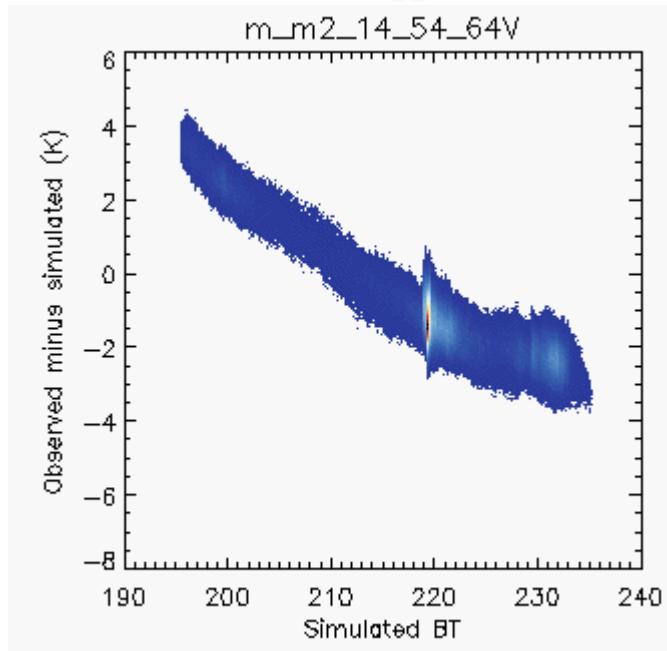
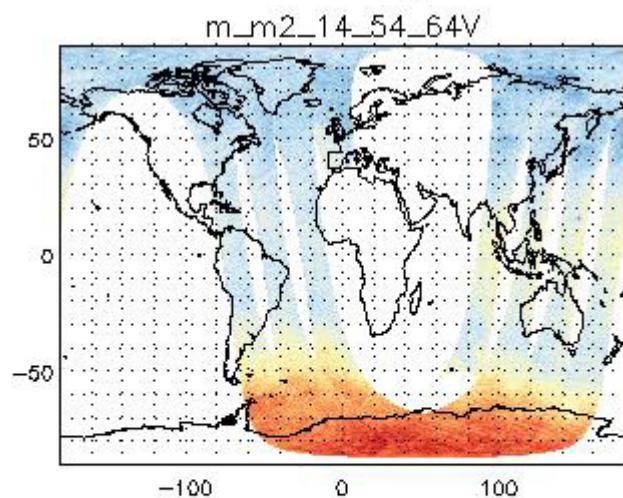
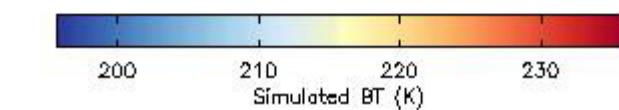
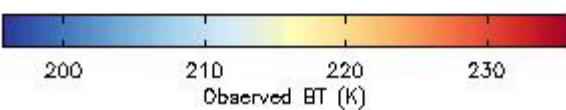
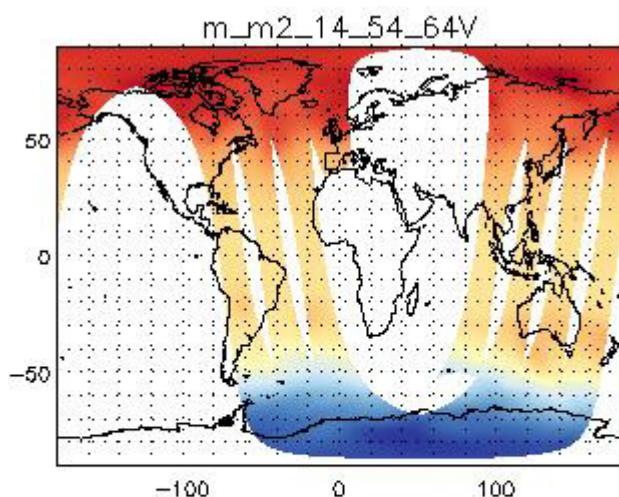
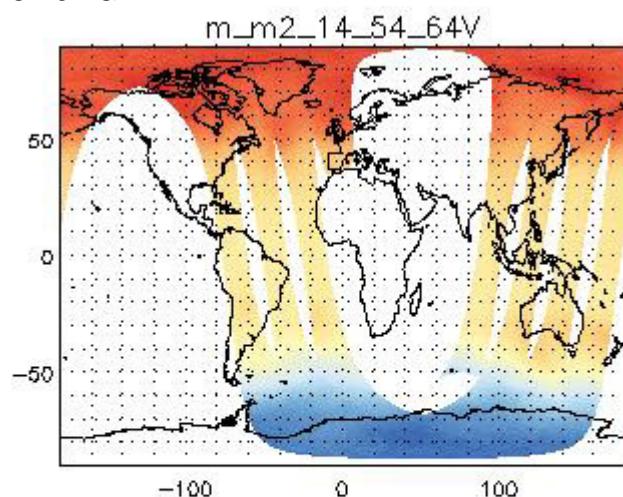
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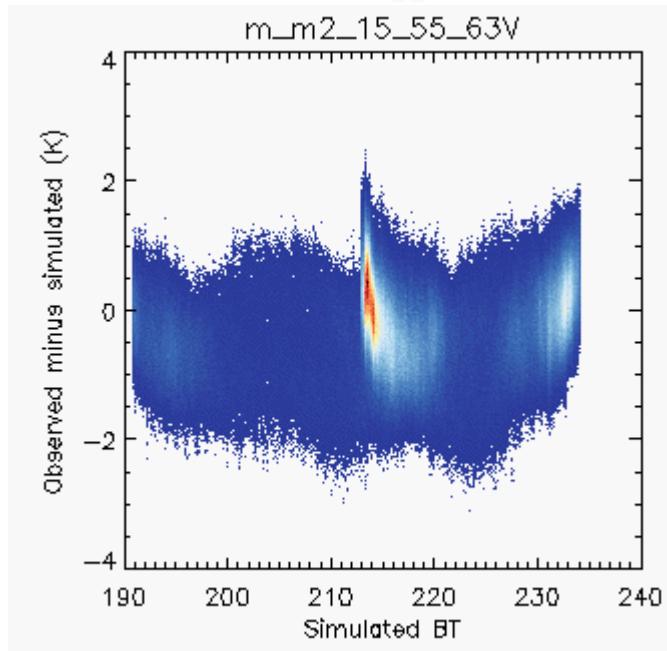
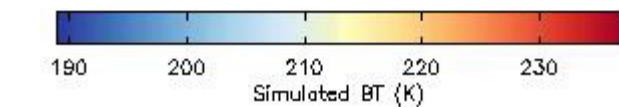
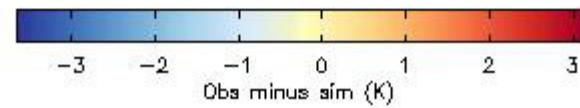
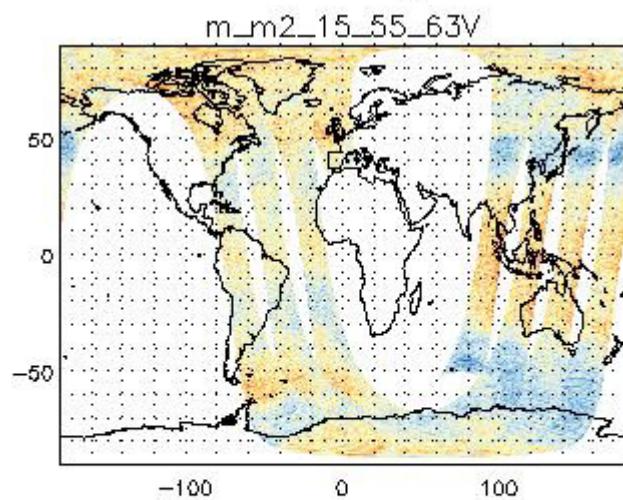
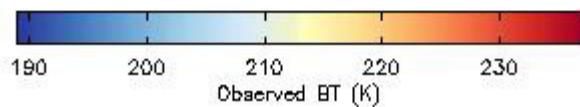
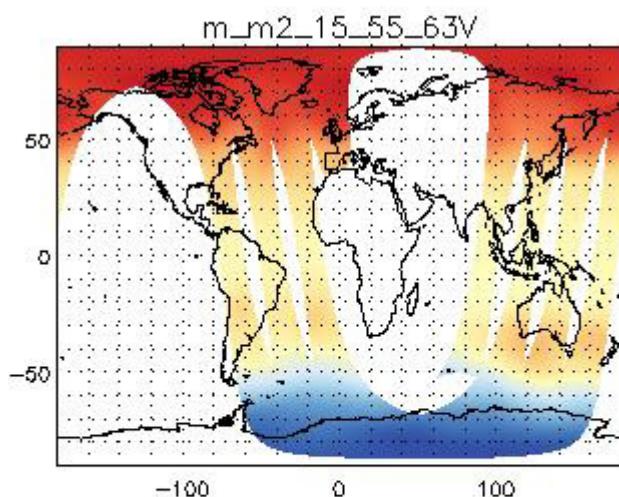
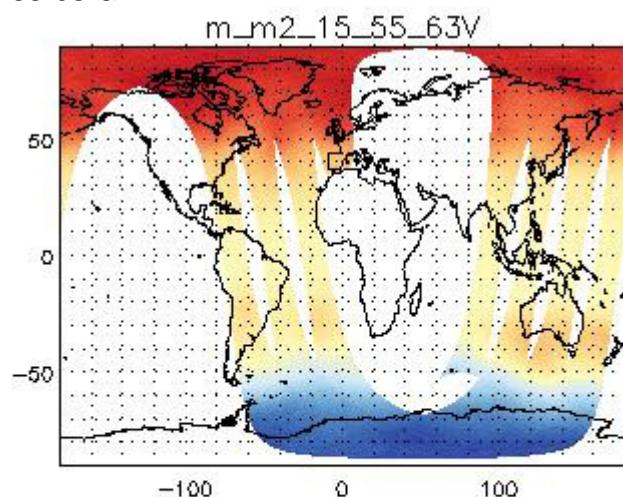
## 53.8 GHz



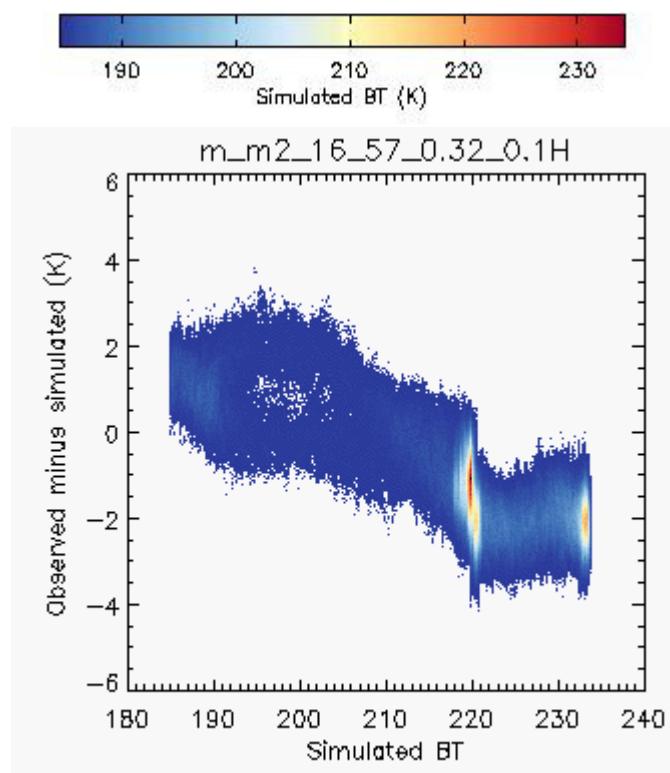
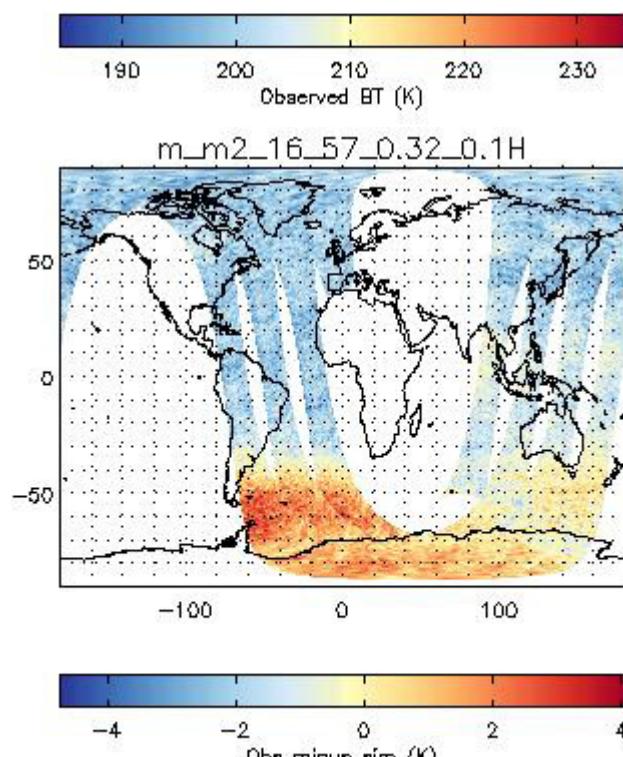
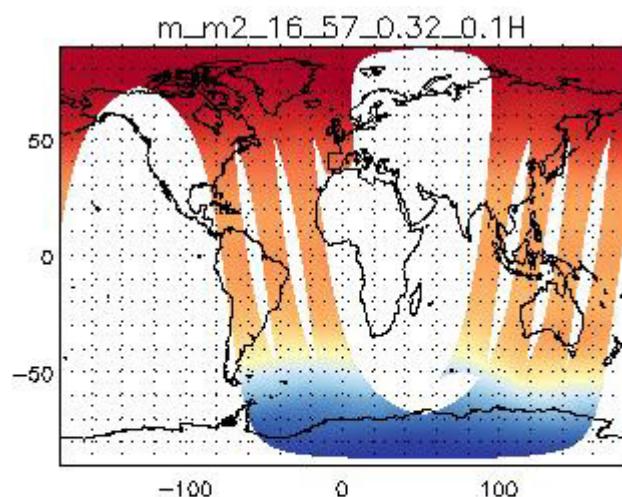
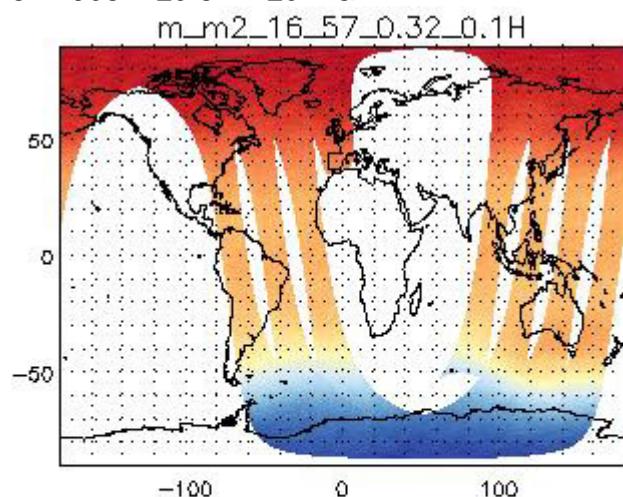
54.64 GHz



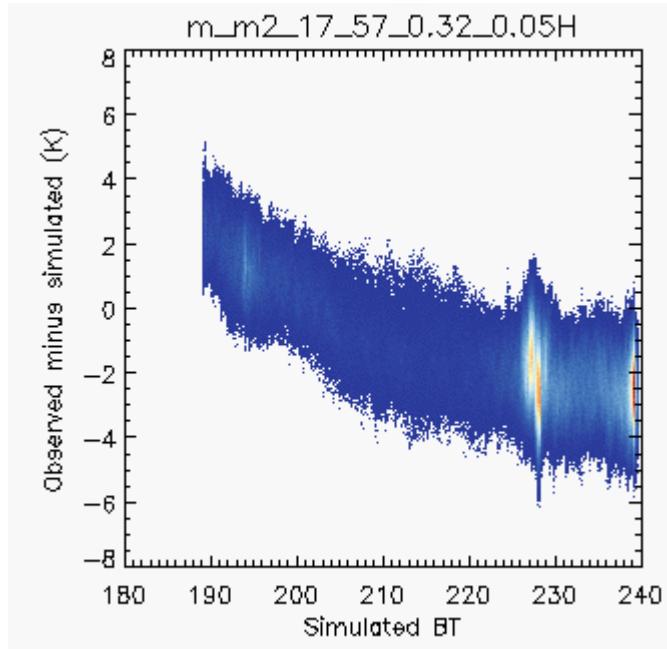
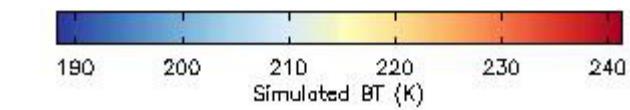
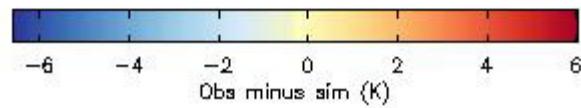
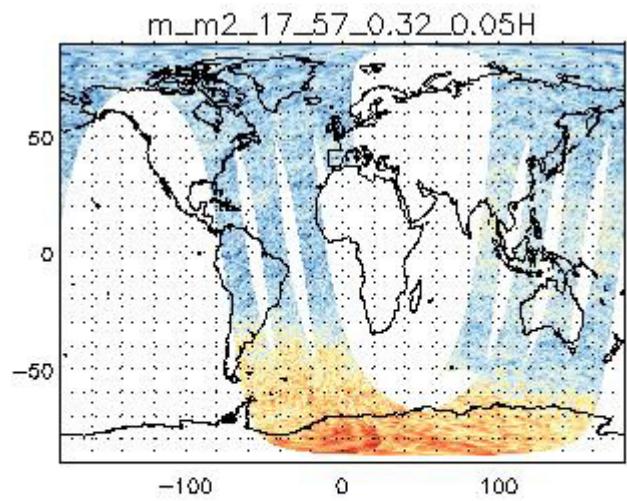
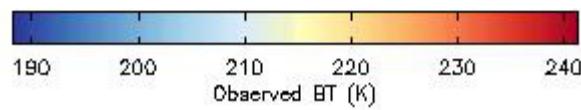
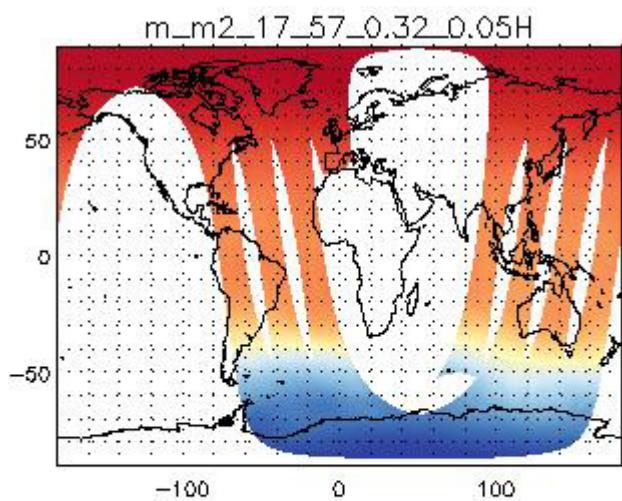
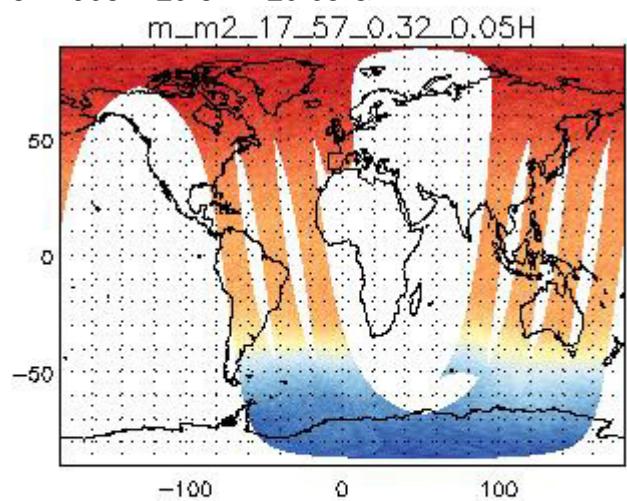
55.63 GHz



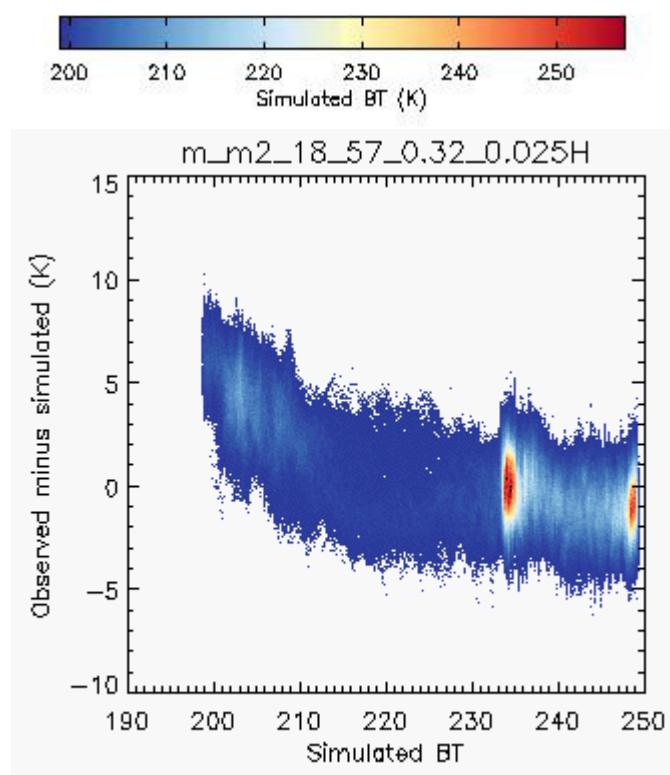
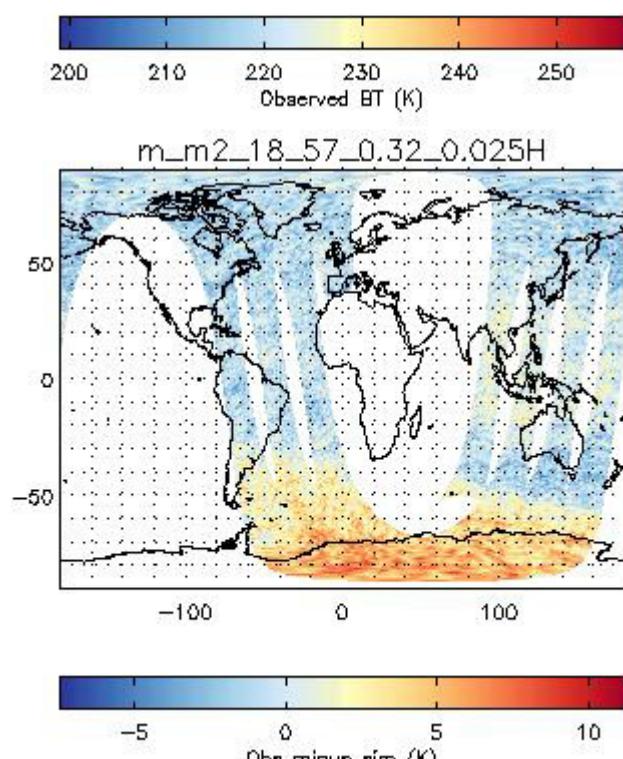
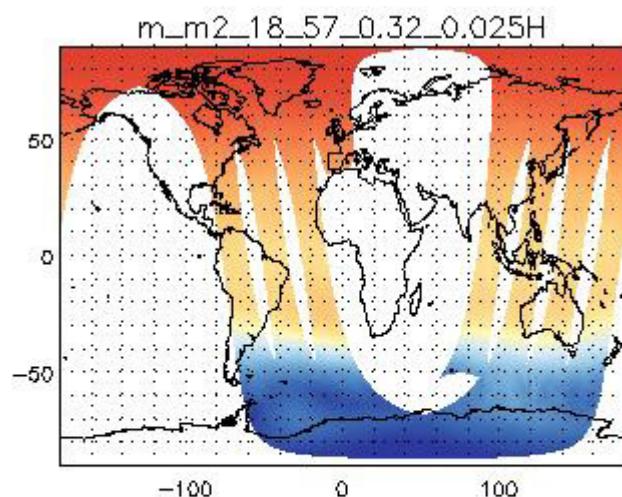
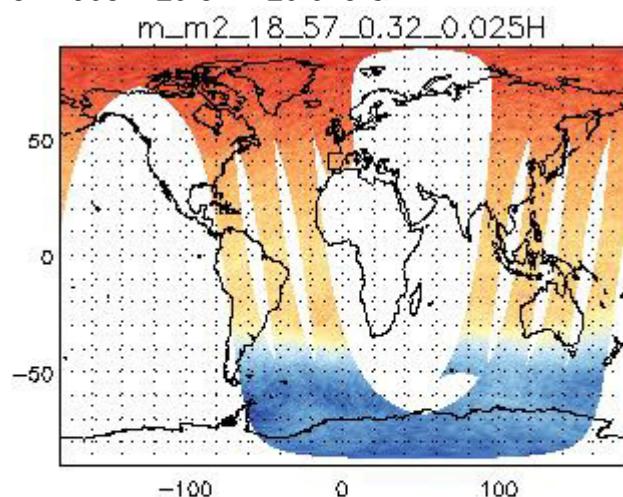
**57.290344±0.3222±0.1 GHz**



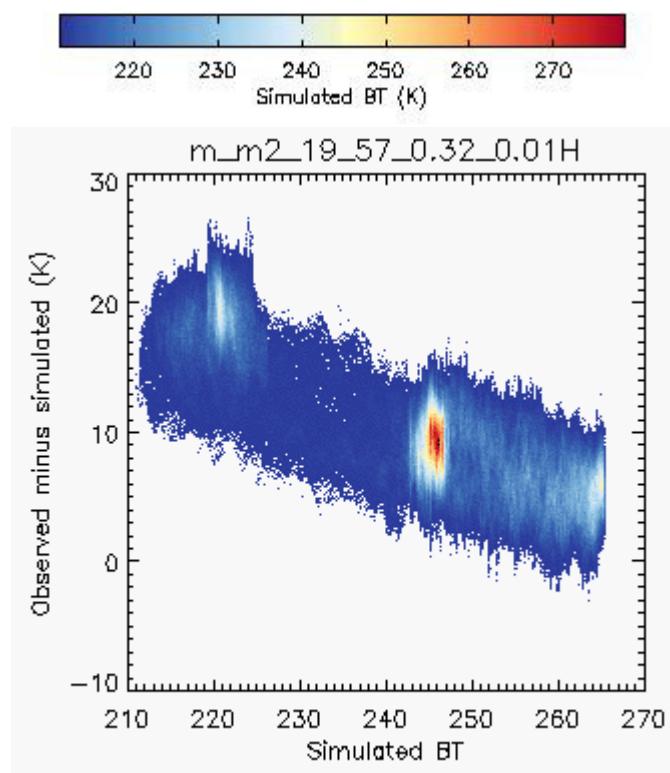
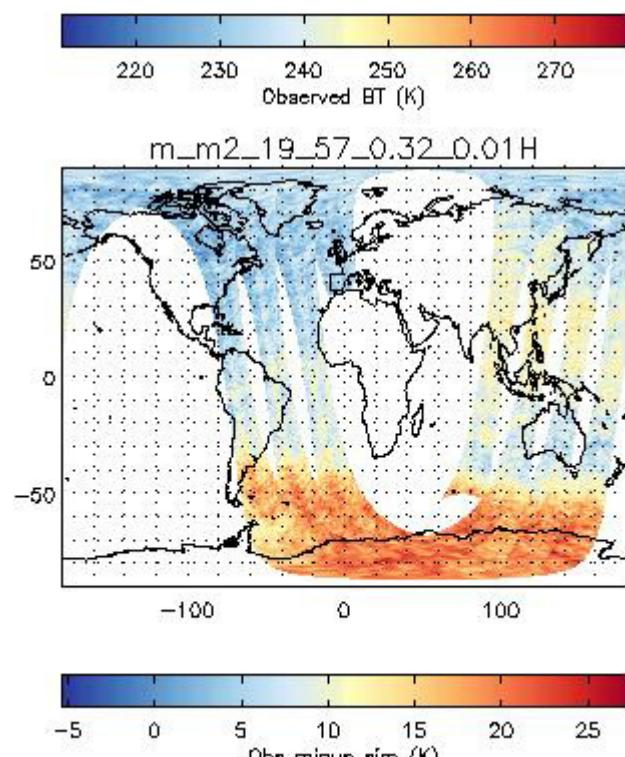
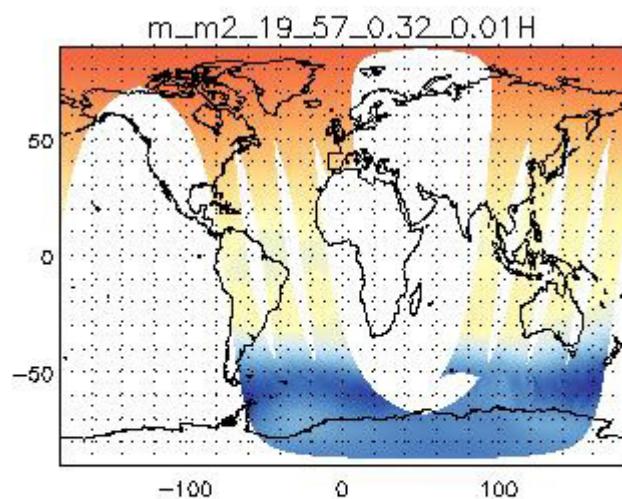
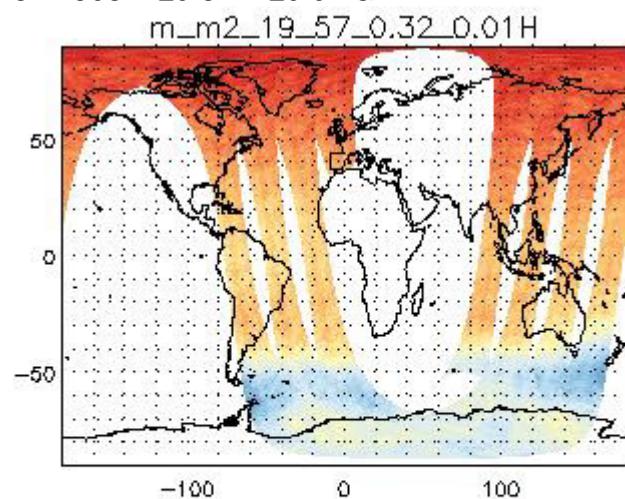
**57.290344±0.3222±0.05 GHz**



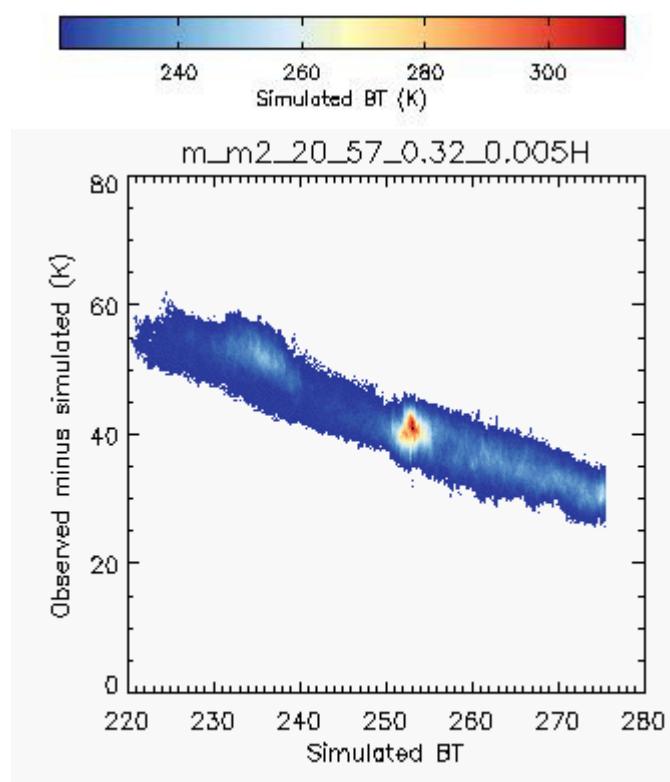
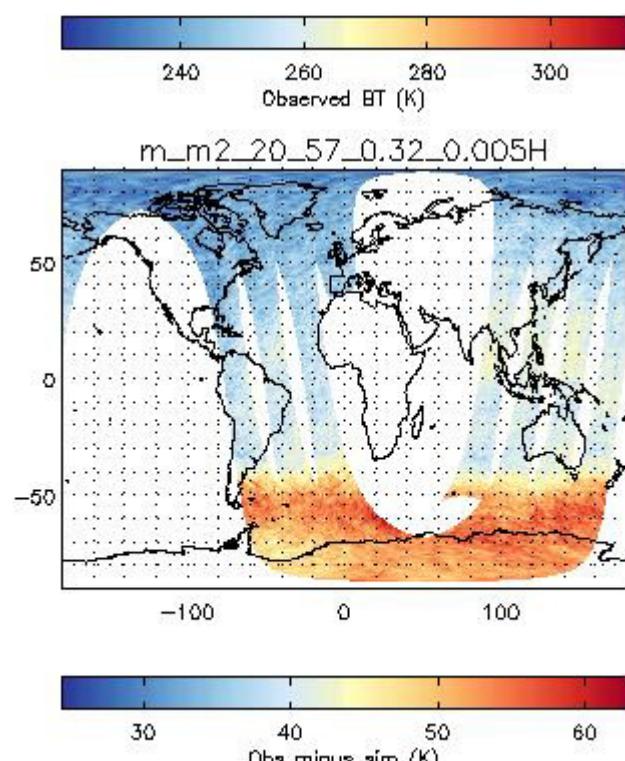
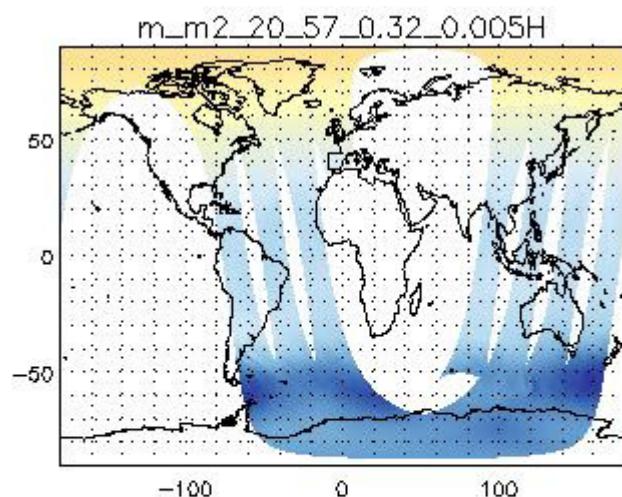
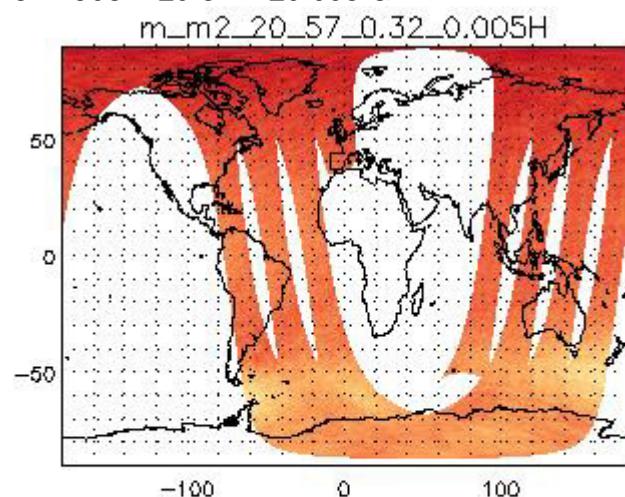
**57.290344±0.3222±0.025 GHz**



**57.290344±0.3222±0.01 GHz**

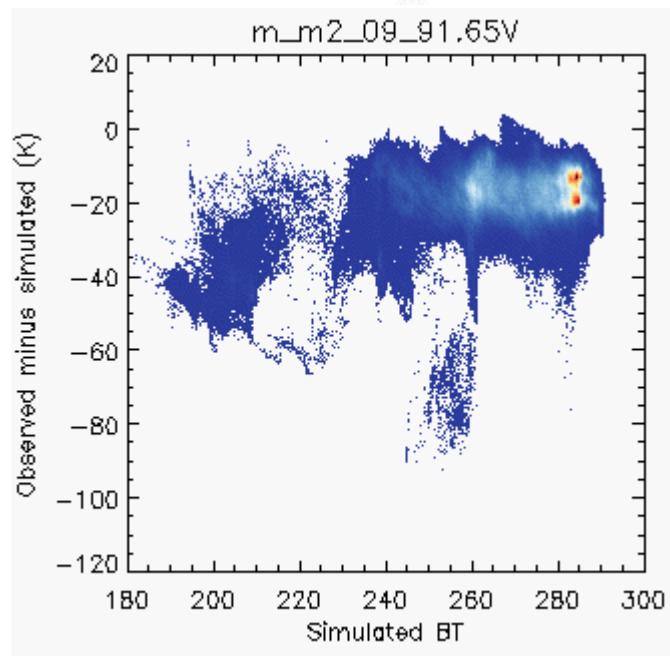
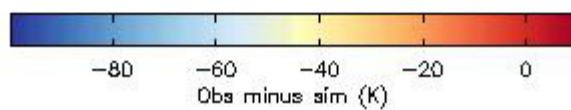
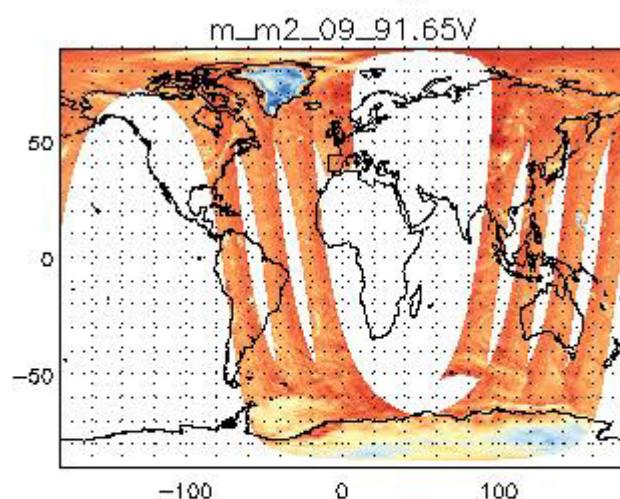
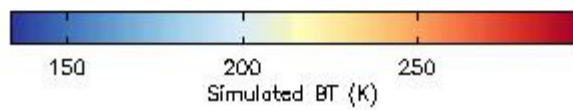
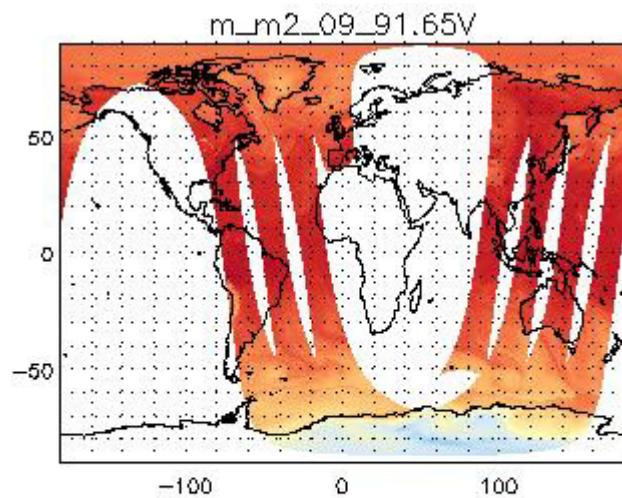
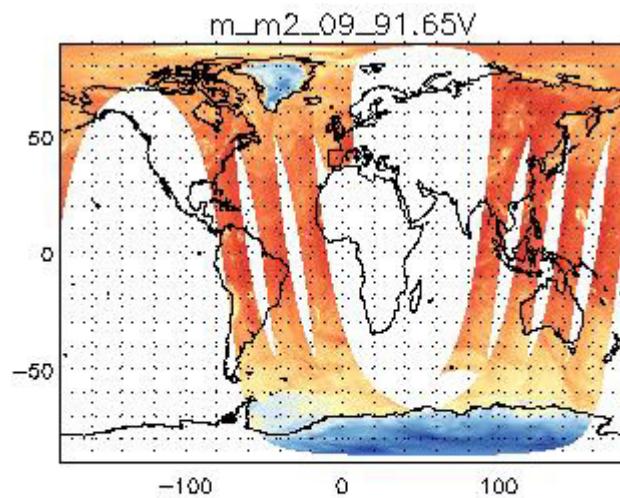


**57.290344±0.3222±0.005 GHz**

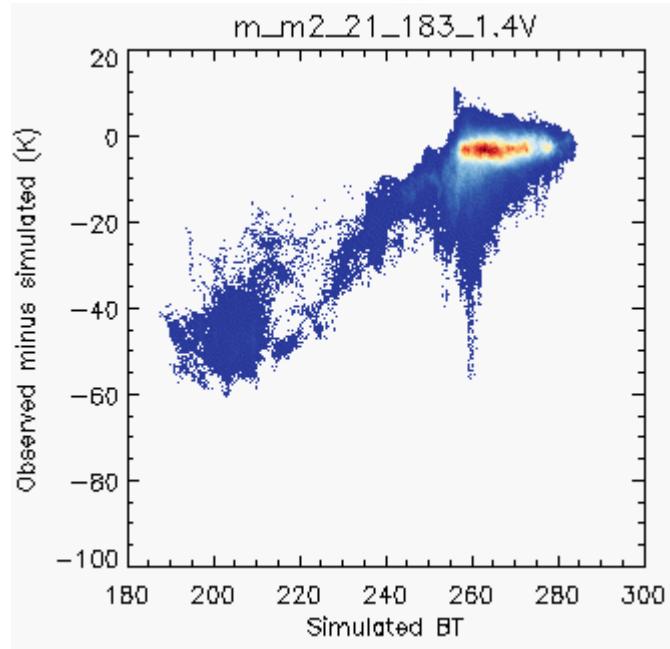
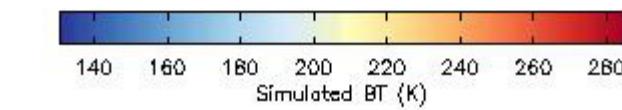
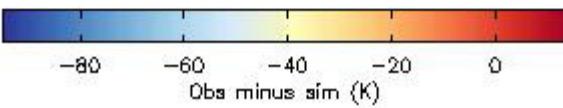
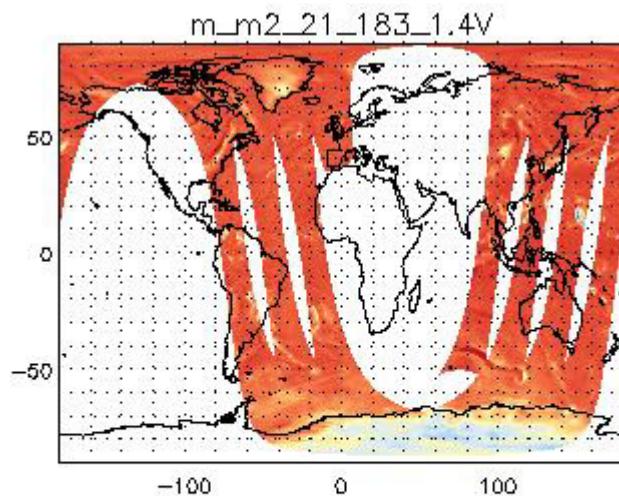
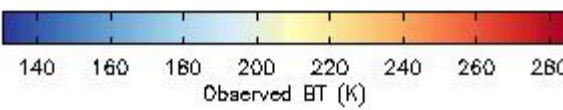
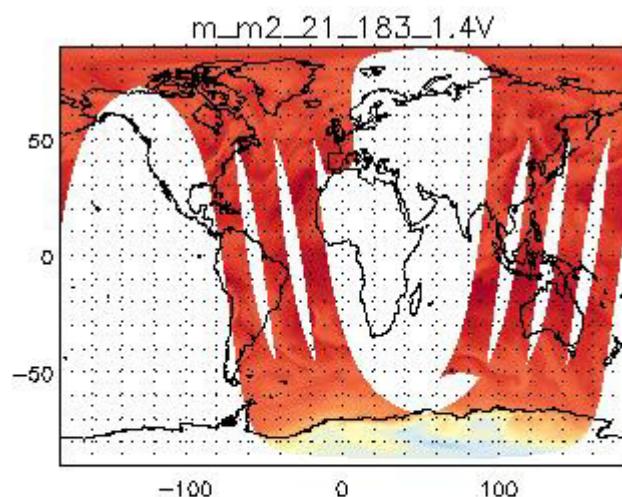
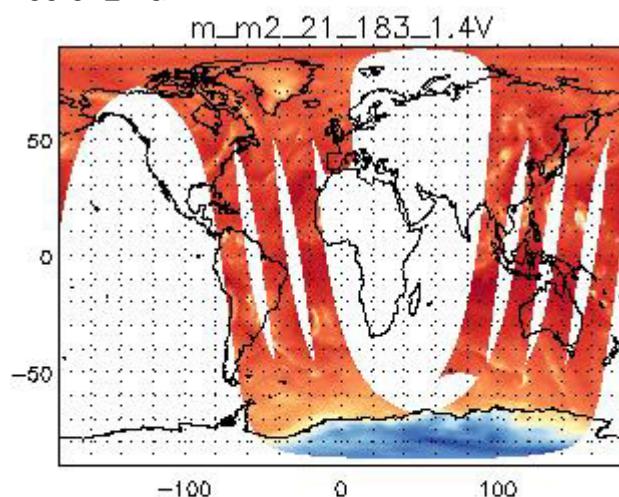


## 2.2. 91 GHz and above

### 91.65 GHz



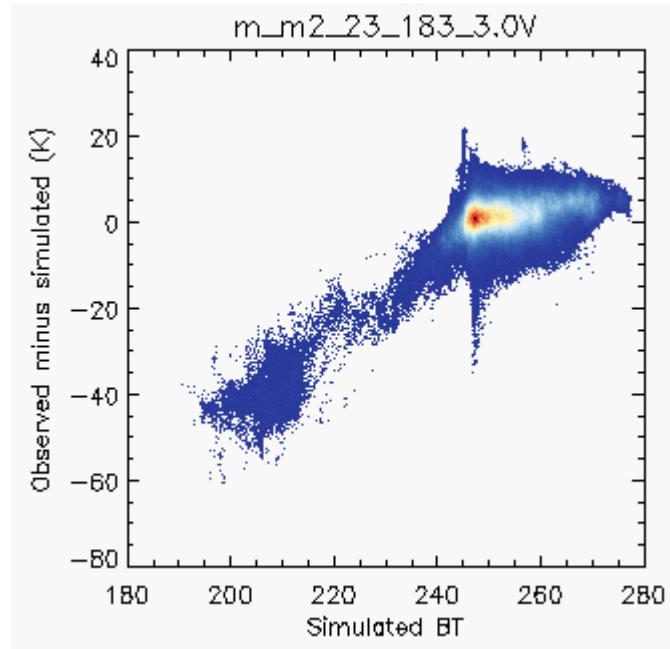
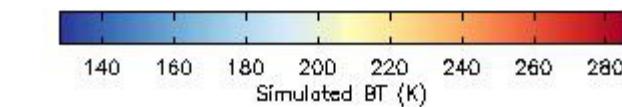
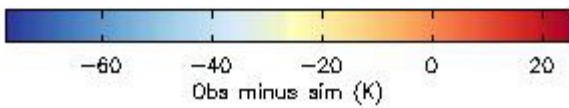
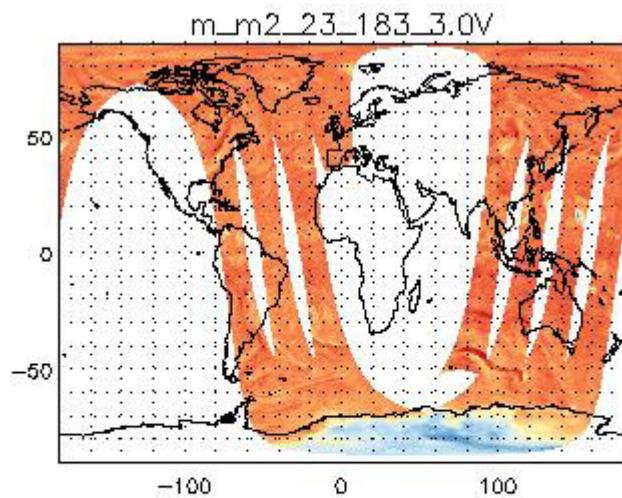
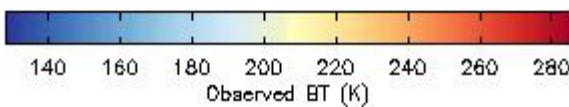
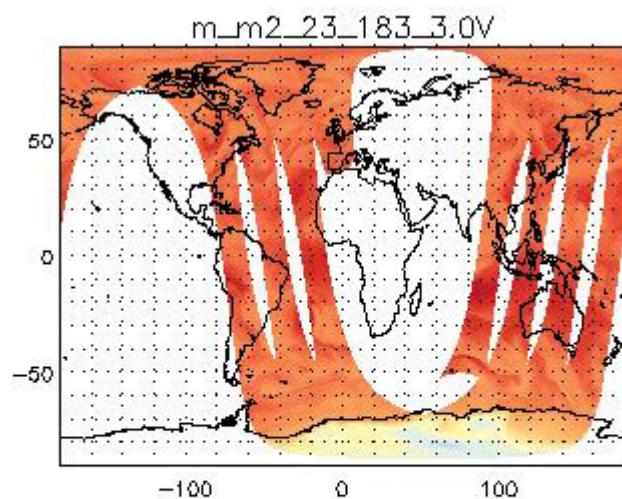
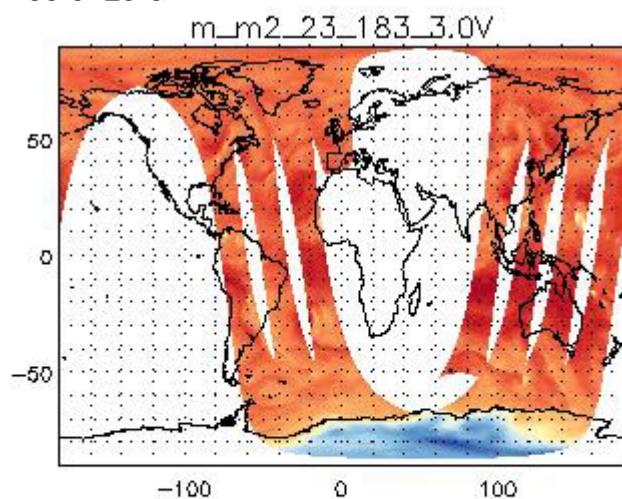
**183.31±7 GHz**



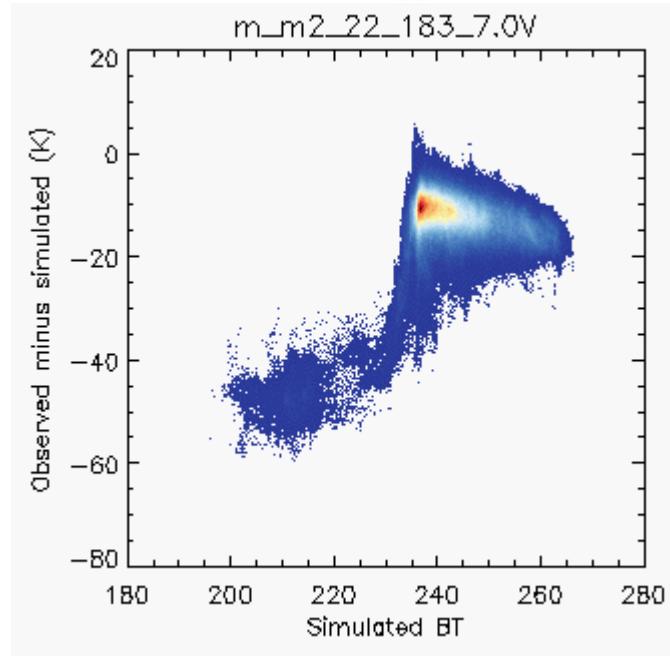
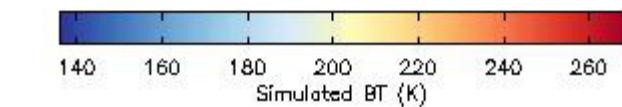
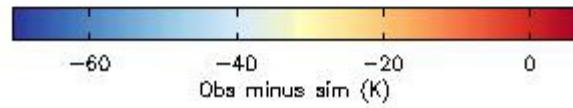
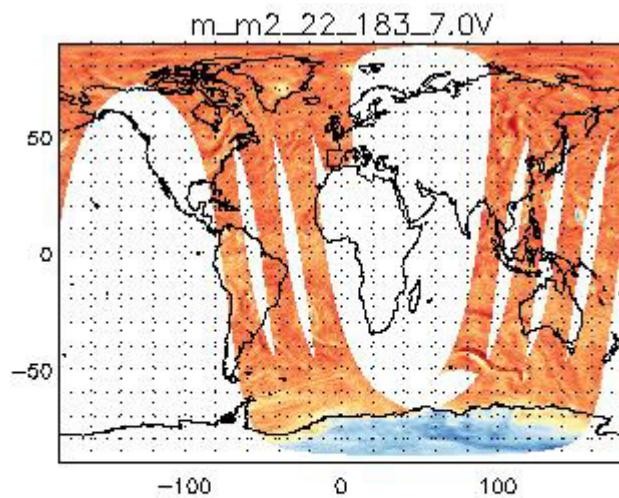
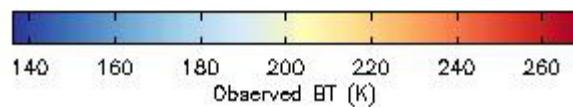
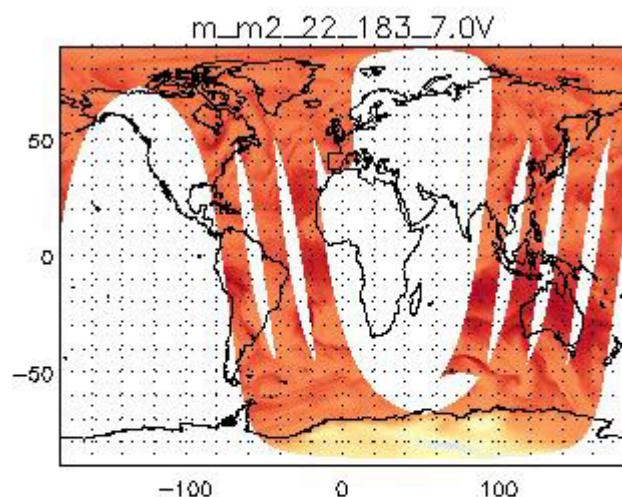
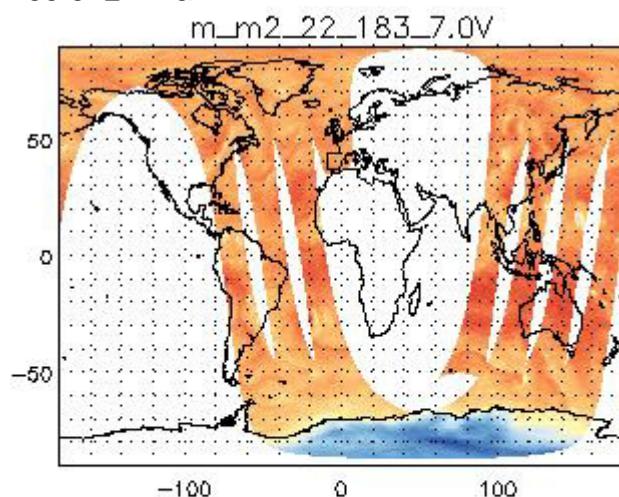
Note: The plots on this page assume that the  $183.31\pm7$  channel is mis-labelled as  $183.31\pm1.4$  in the HDF data. With the original labels, the observed BTs are 30K colder than simulated.

This should be verified.

**183.31±3 GHz**



**183.31±1.4 GHz**

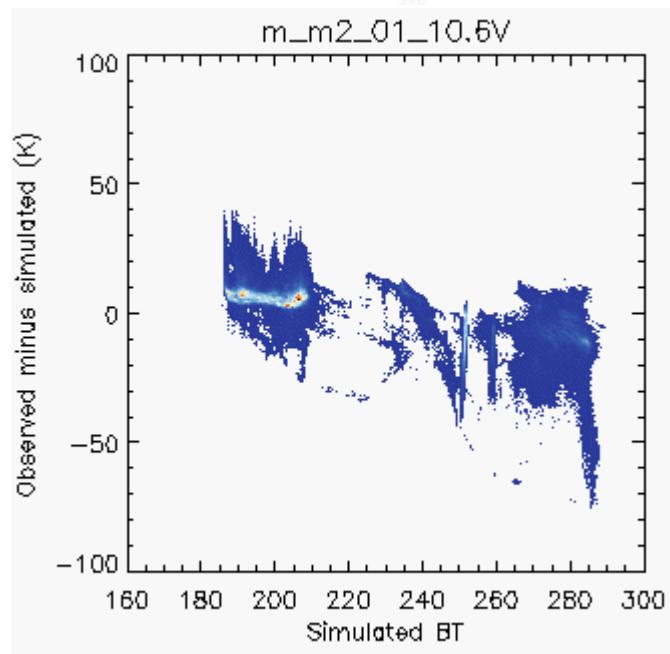
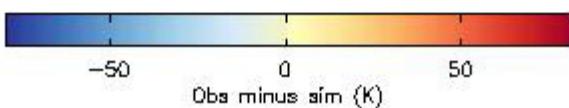
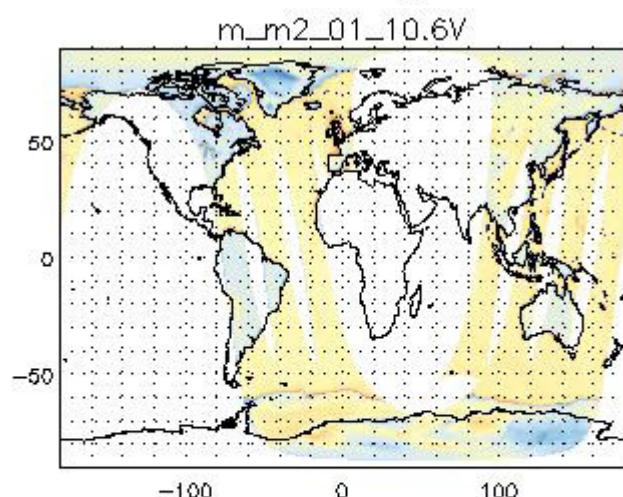
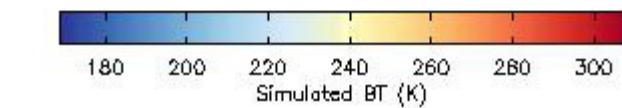
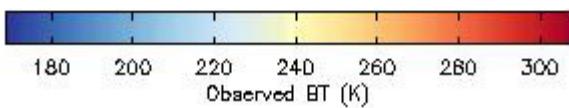
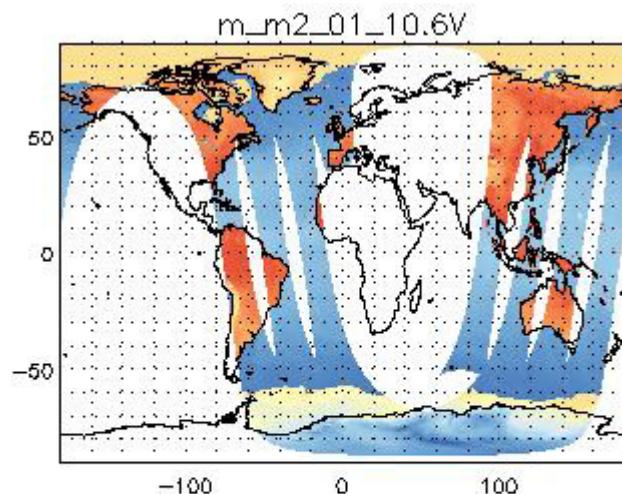
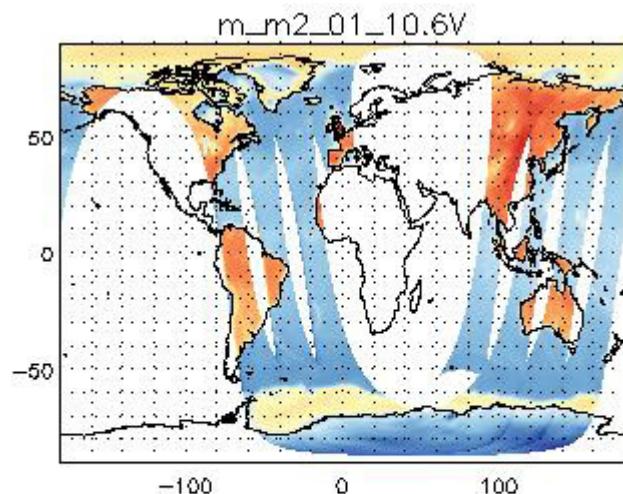


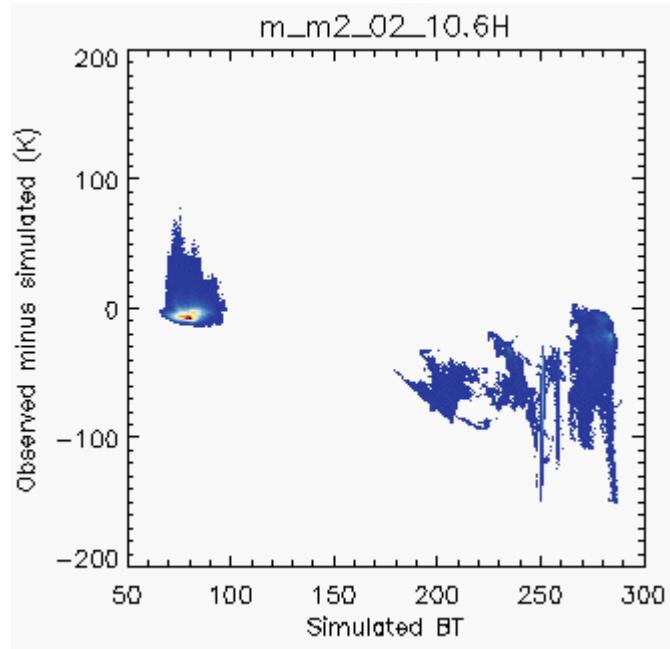
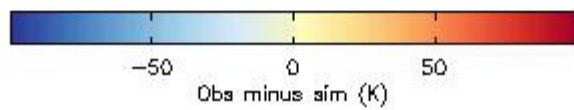
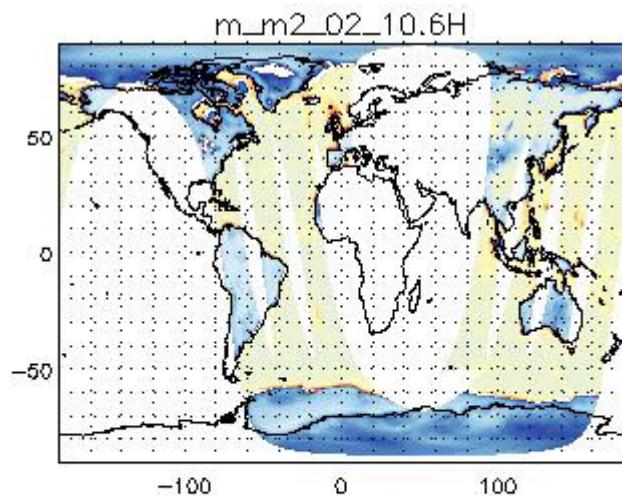
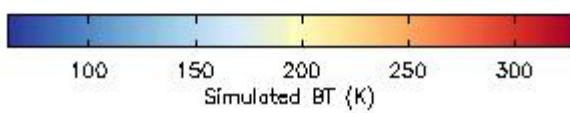
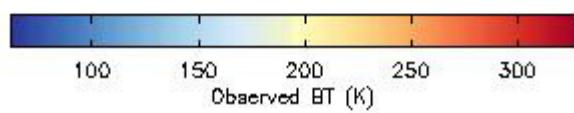
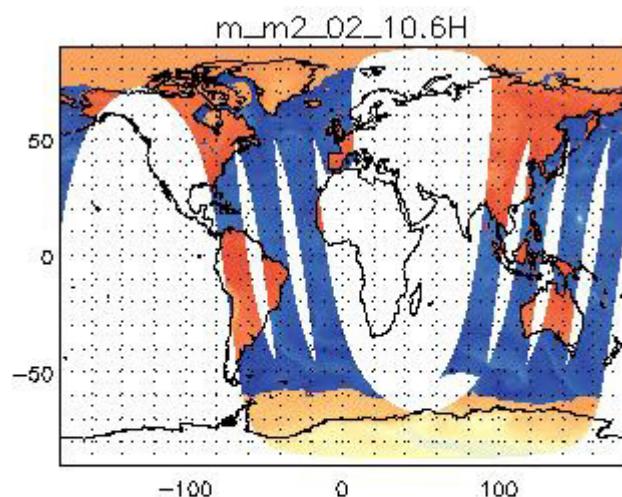
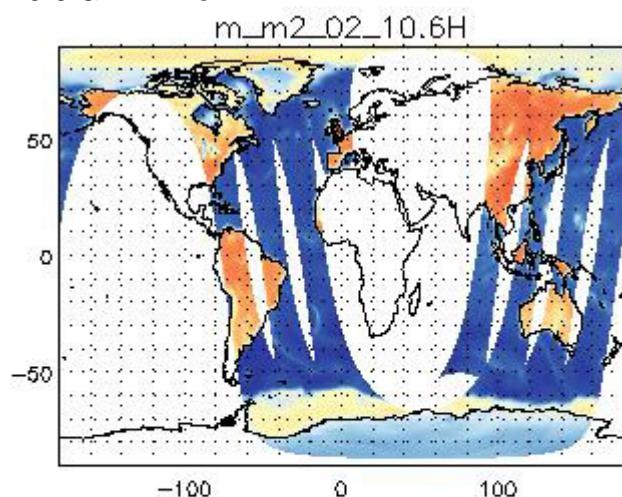
Note: The plots on this page assume that the  $183.31\pm1.4$  channel is mis-labelled as  $183.31\pm7$  in the HDF data. With the original labels, the observed BTs are 20K warmer than simulated.

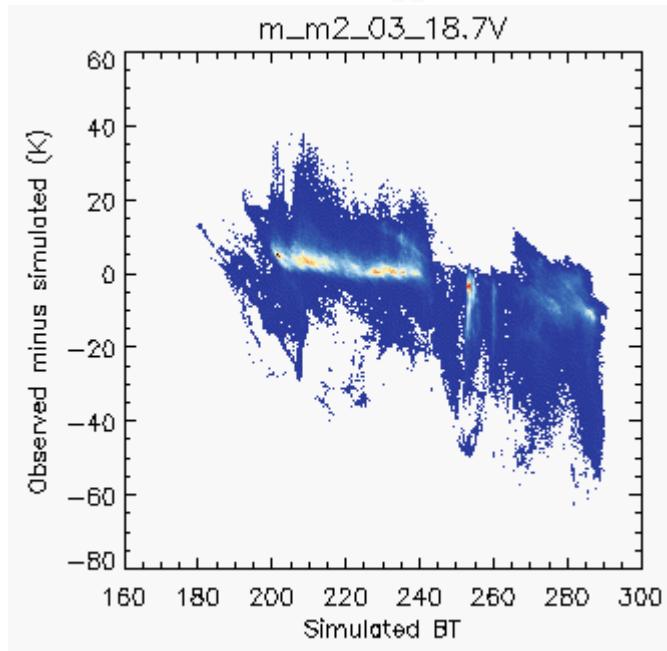
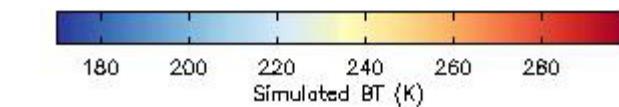
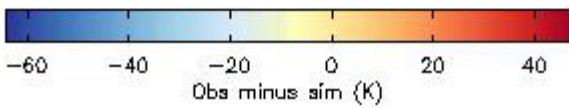
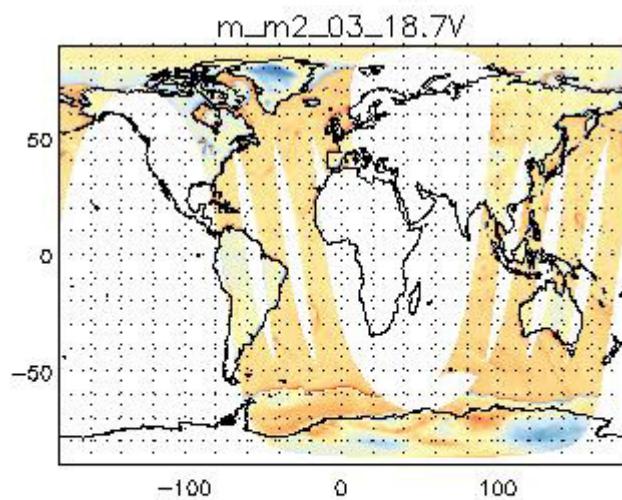
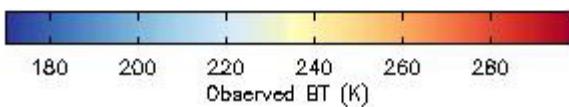
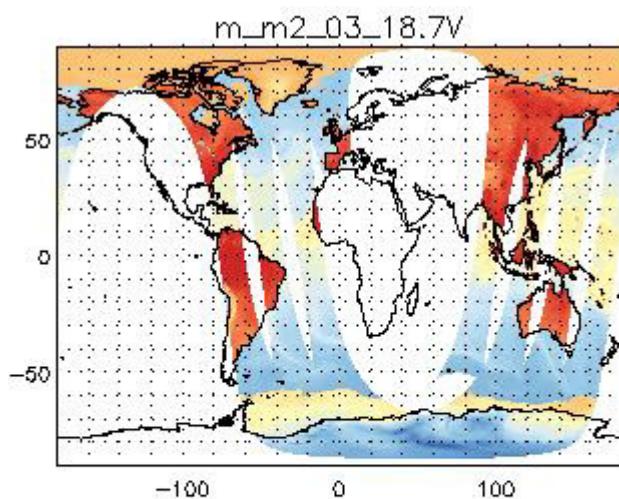
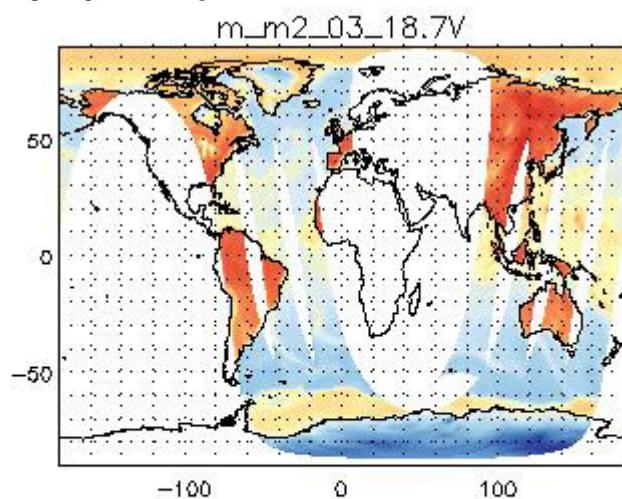
This should be verified.

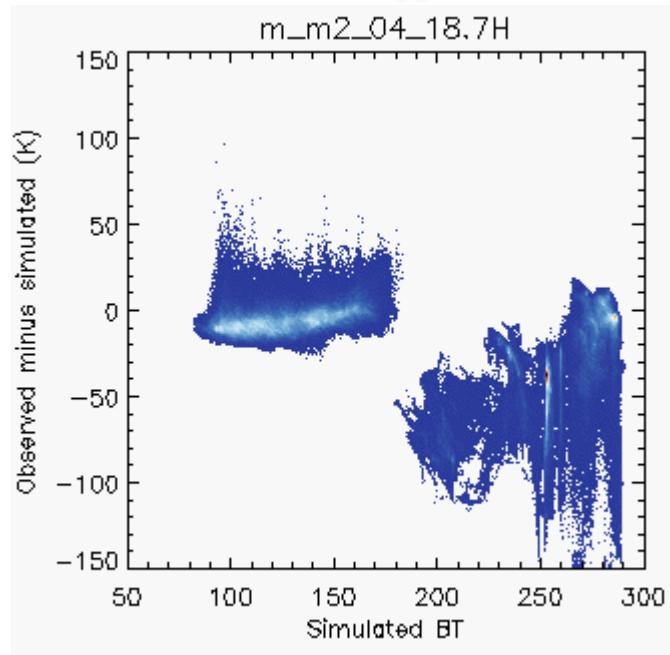
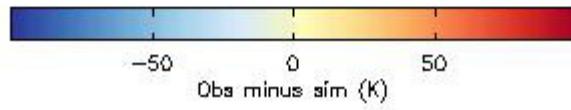
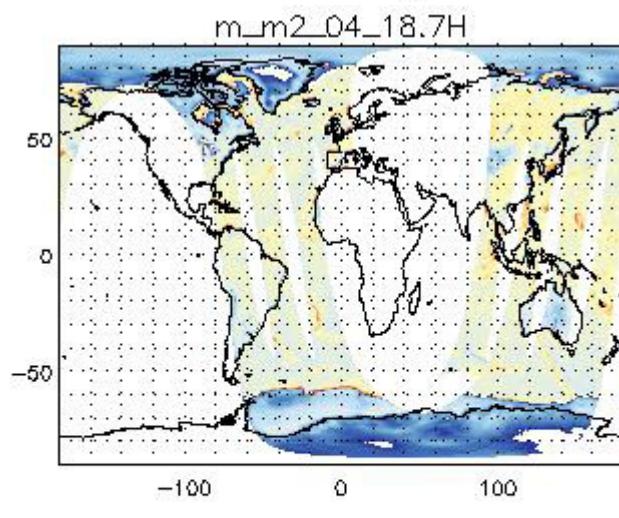
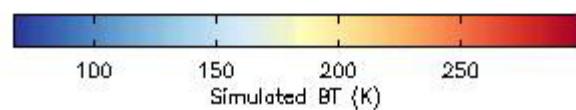
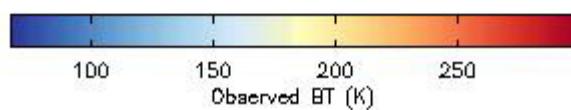
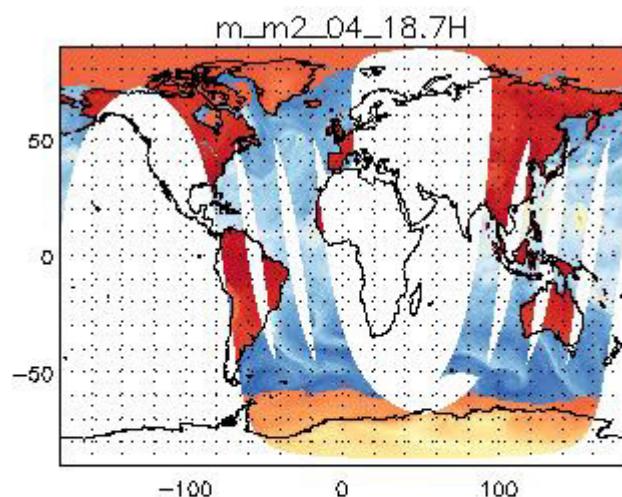
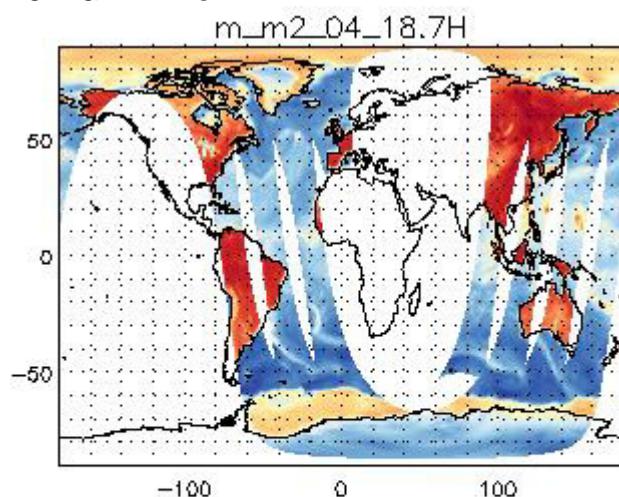
### 2.3. Low frequency window channels

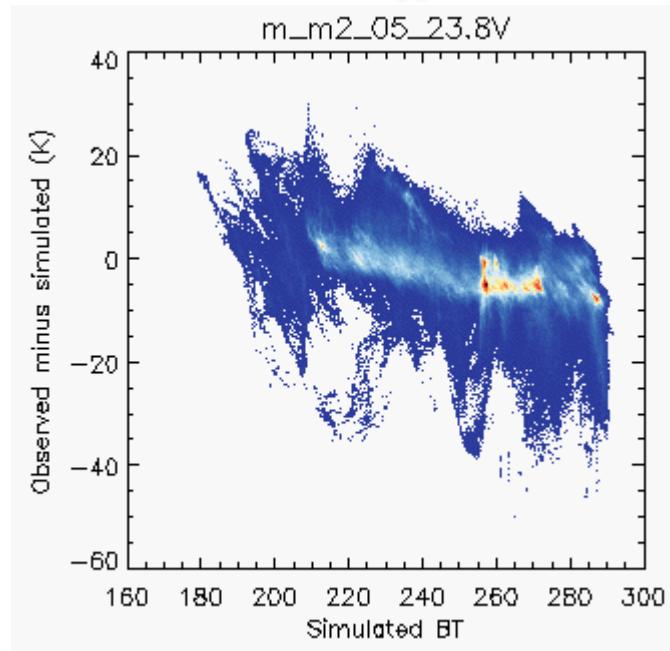
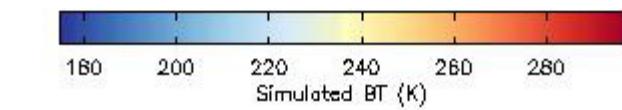
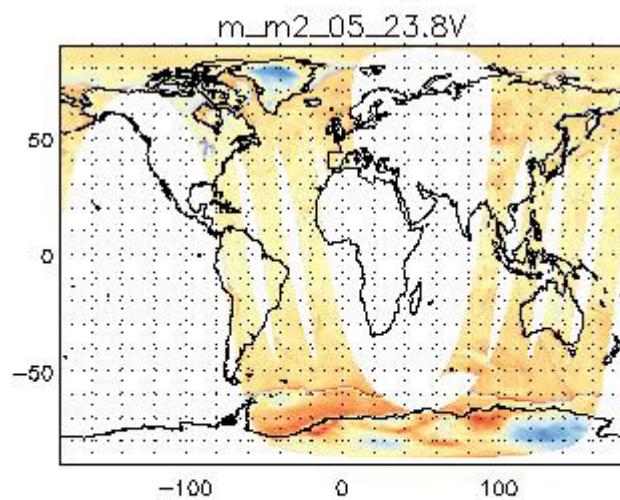
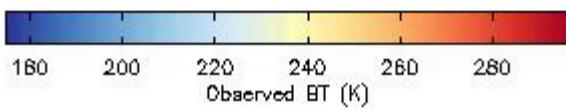
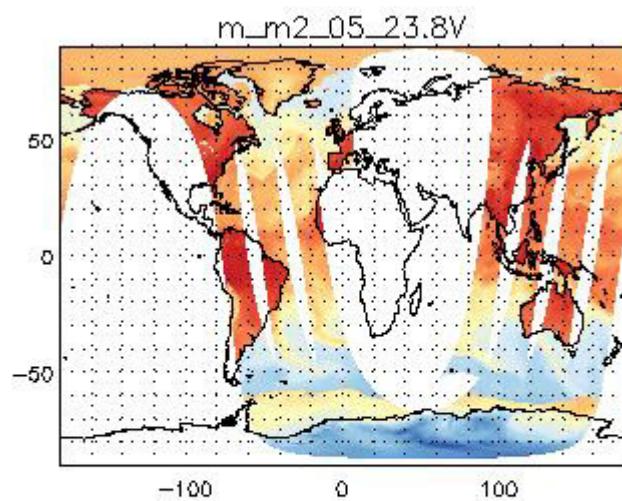
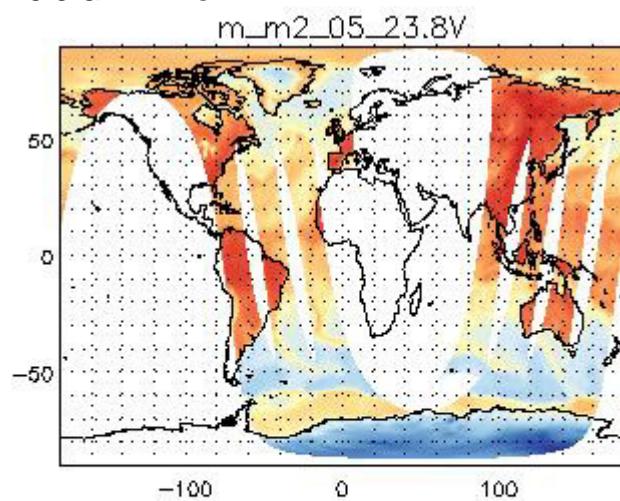
#### 10.6 GHz V-POL

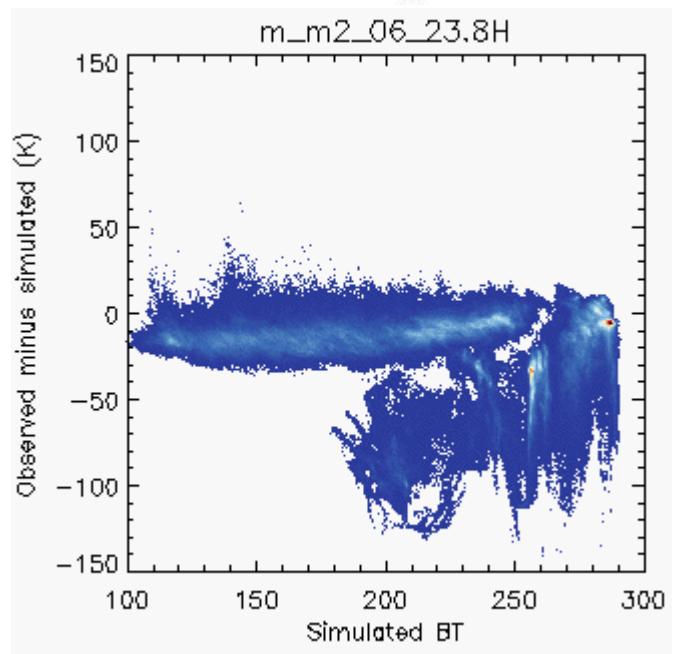
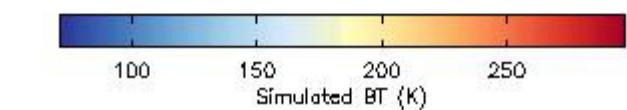
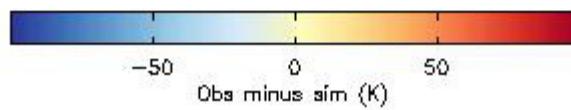
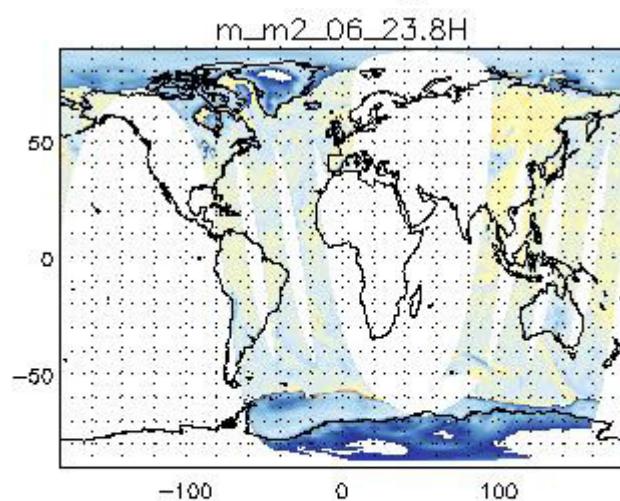
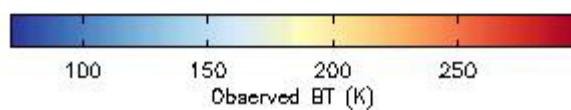
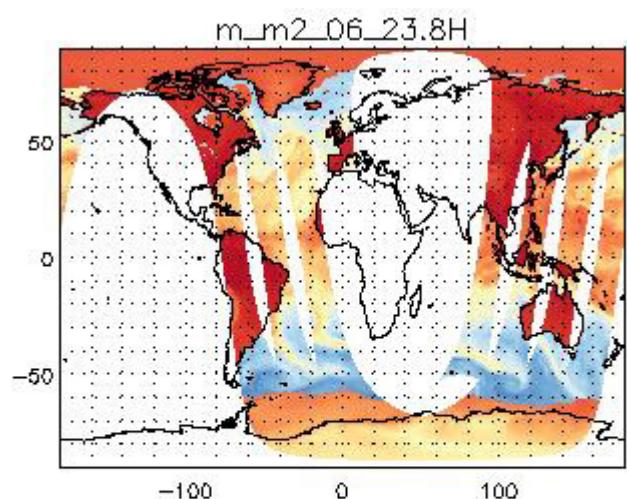
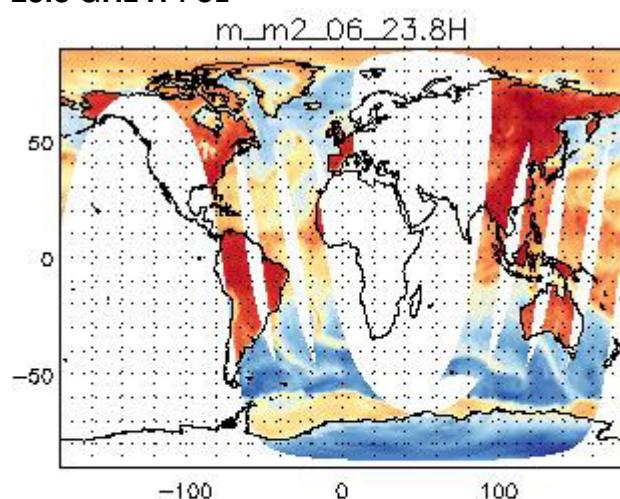


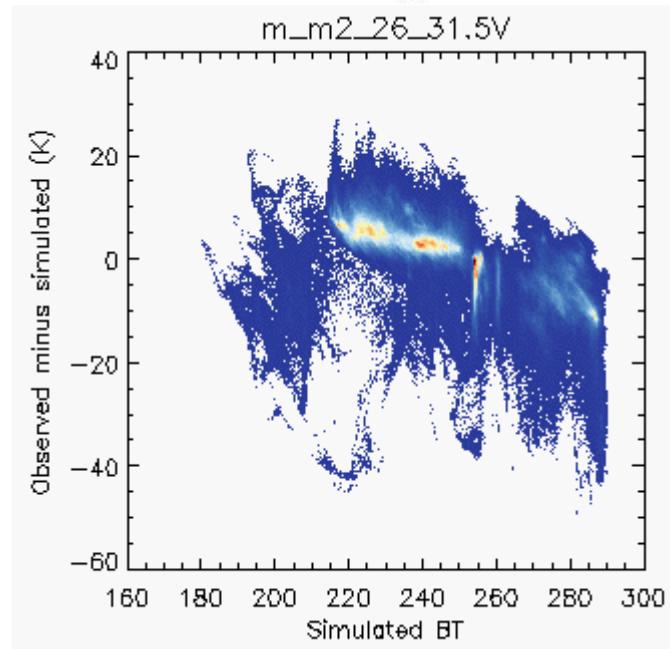
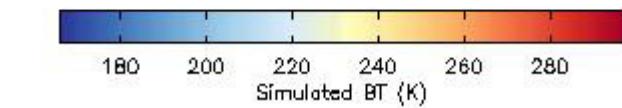
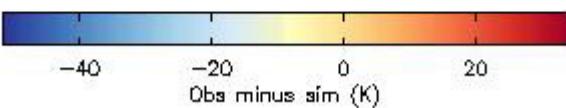
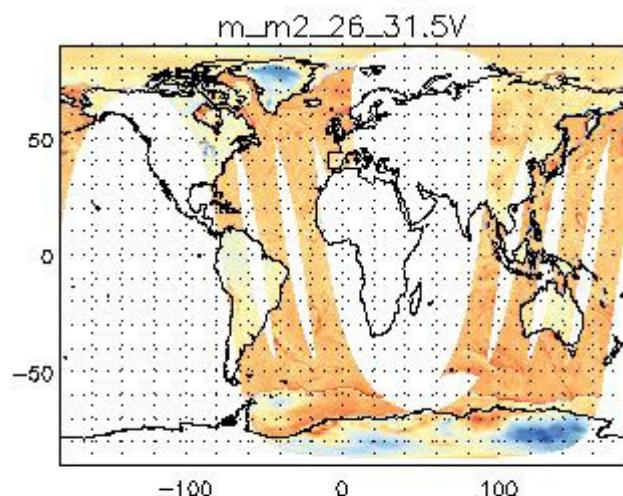
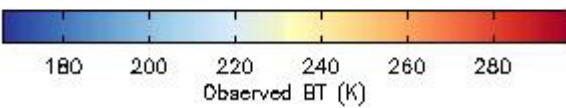
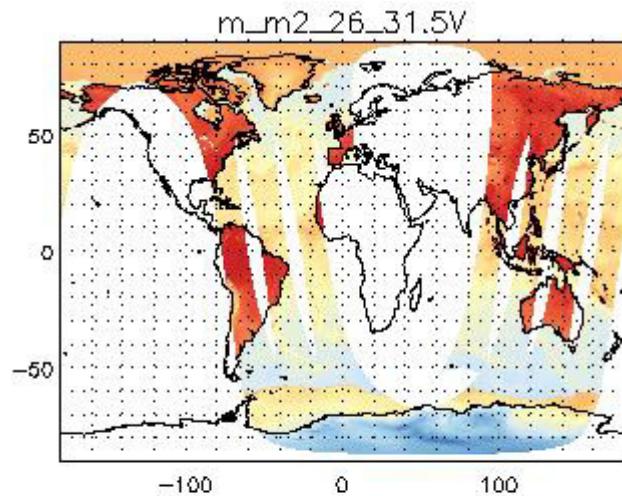
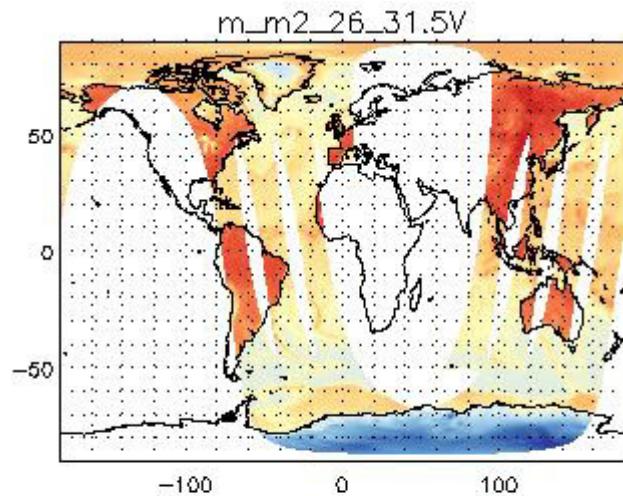
**10.6 GHz H-POL**


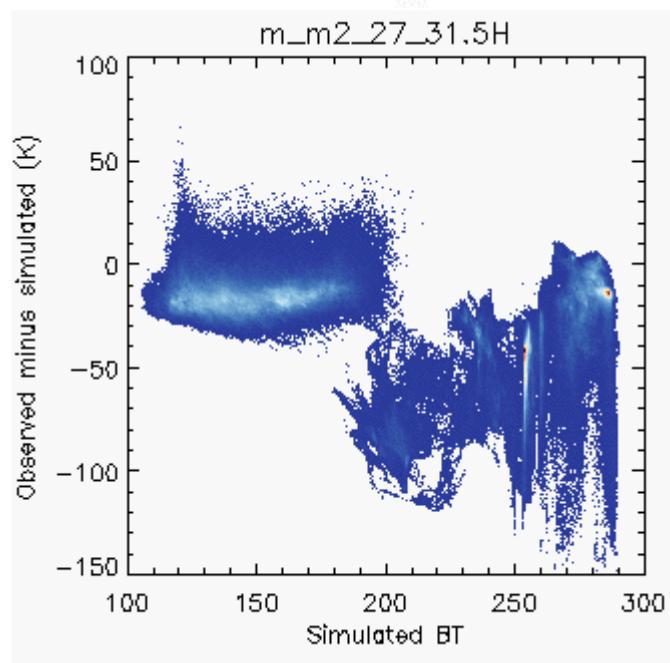
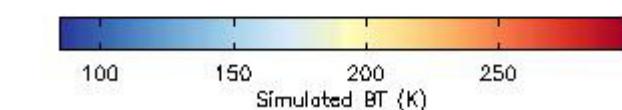
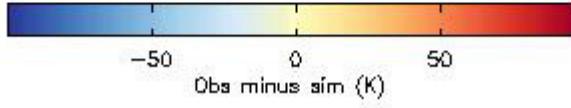
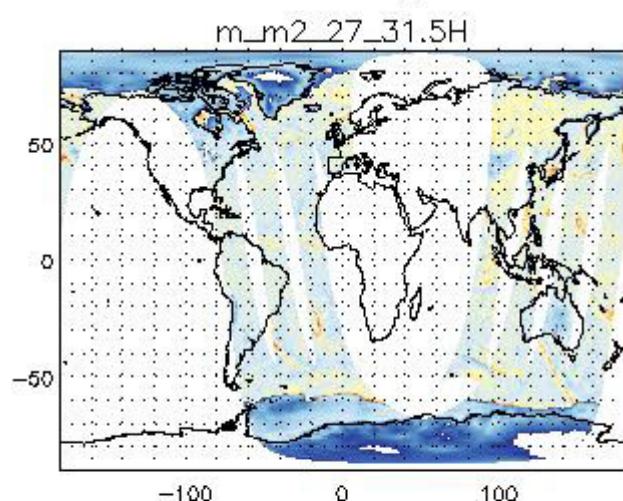
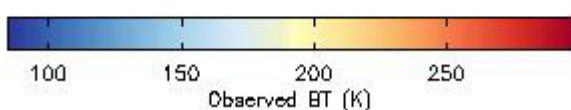
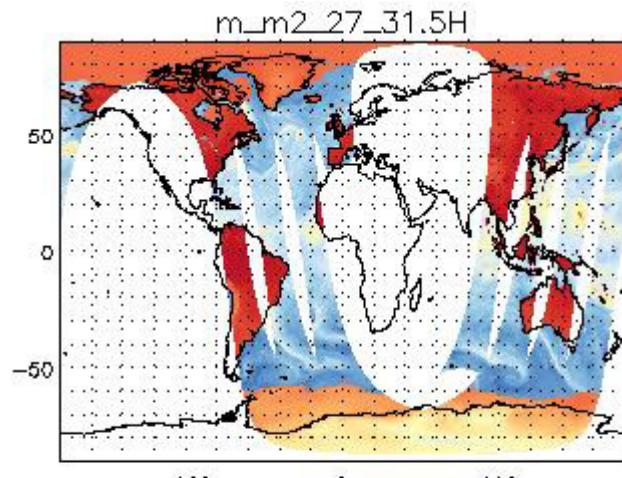
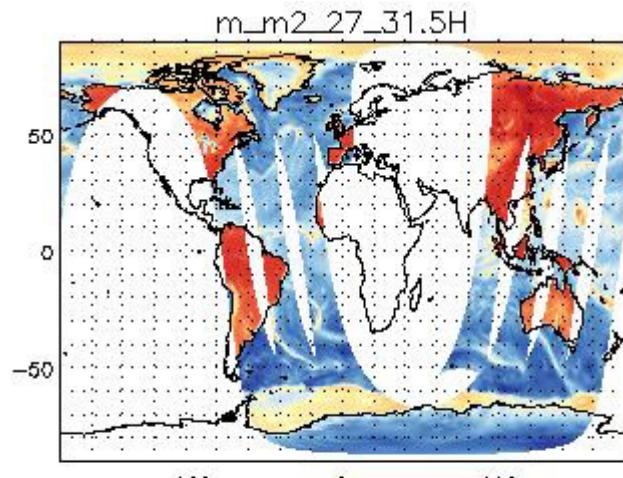
**18.7 GHz V-POL**


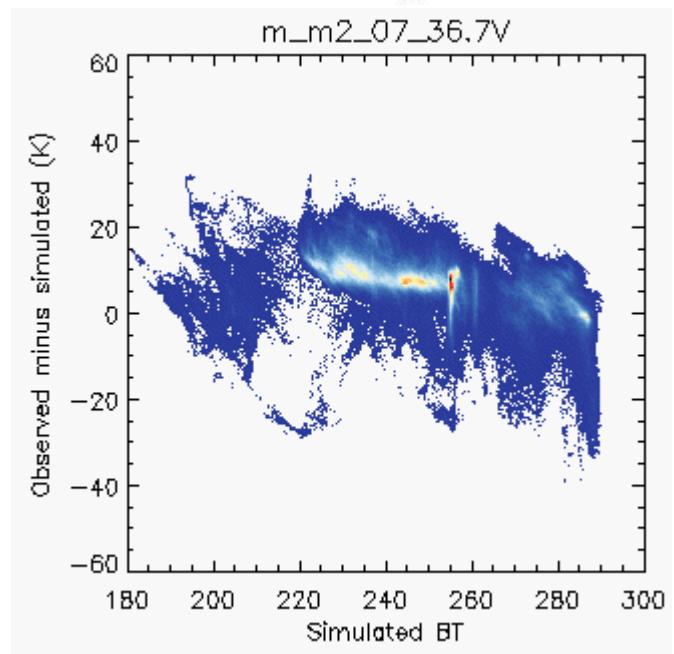
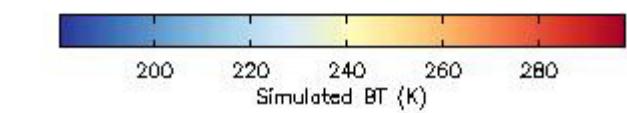
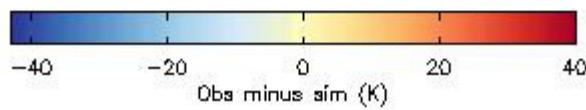
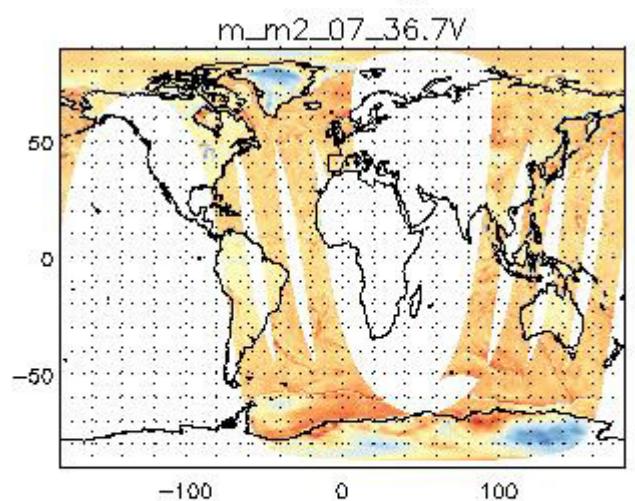
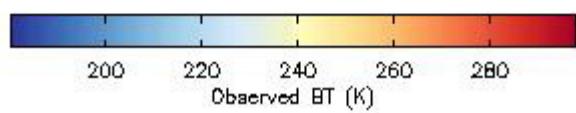
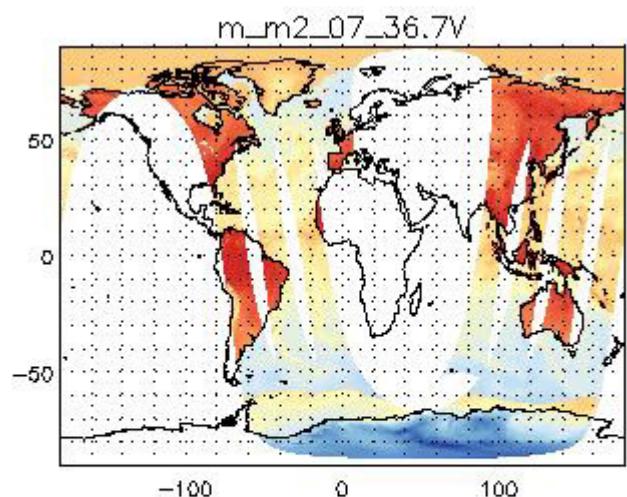
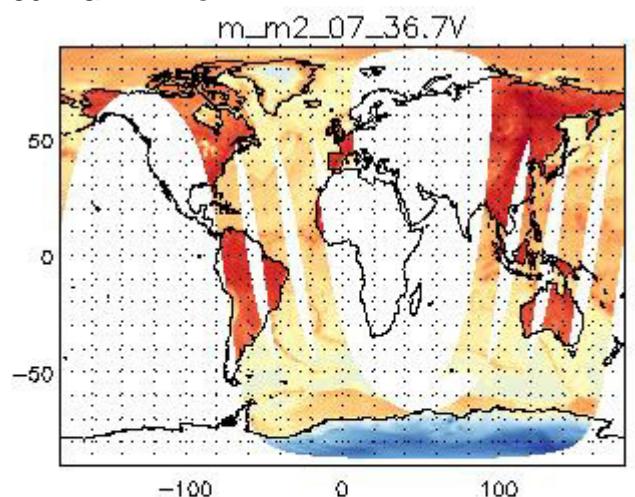
**18.7 GHz H-POL**


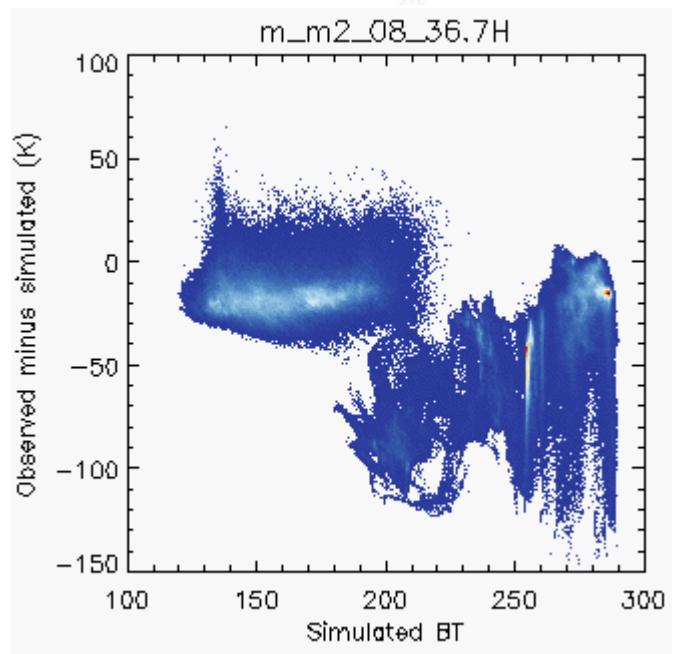
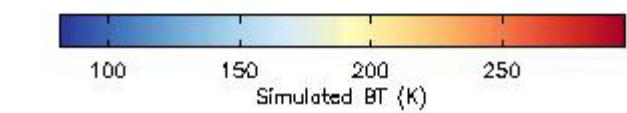
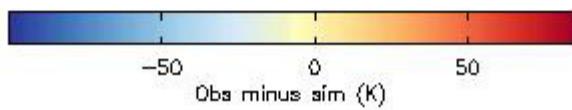
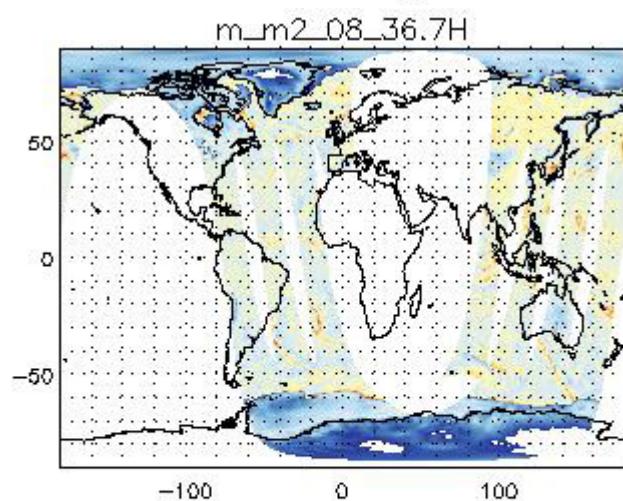
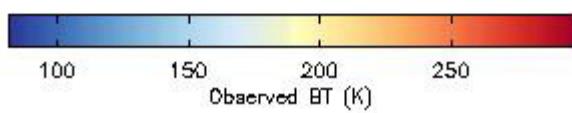
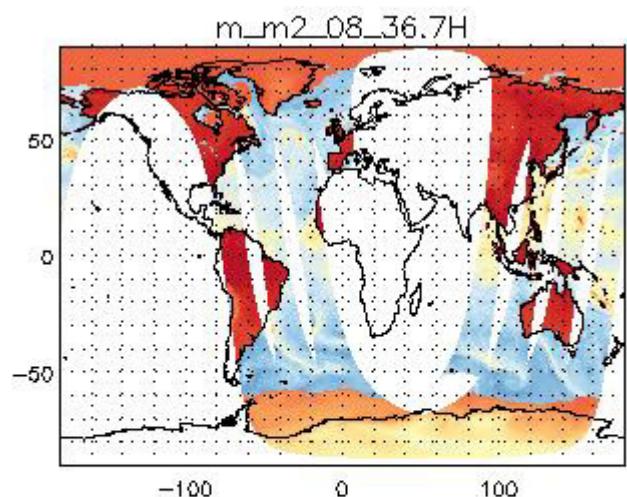
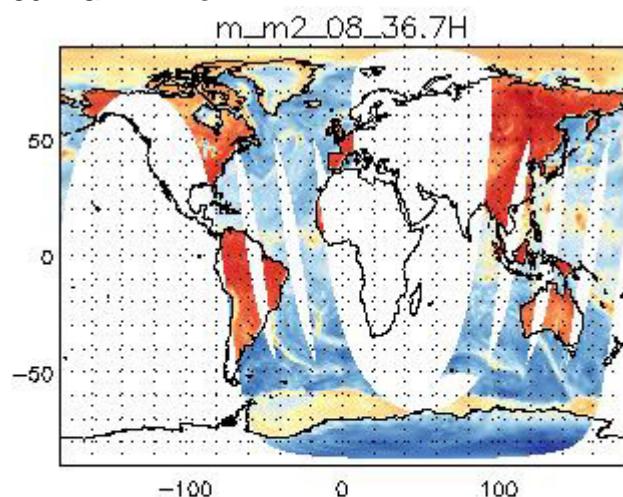
**23.8 GHz V-POL**


**23.8 GHz H-POL**


**31.5 GHz V-POL**


**31.5 GHz H-POL**


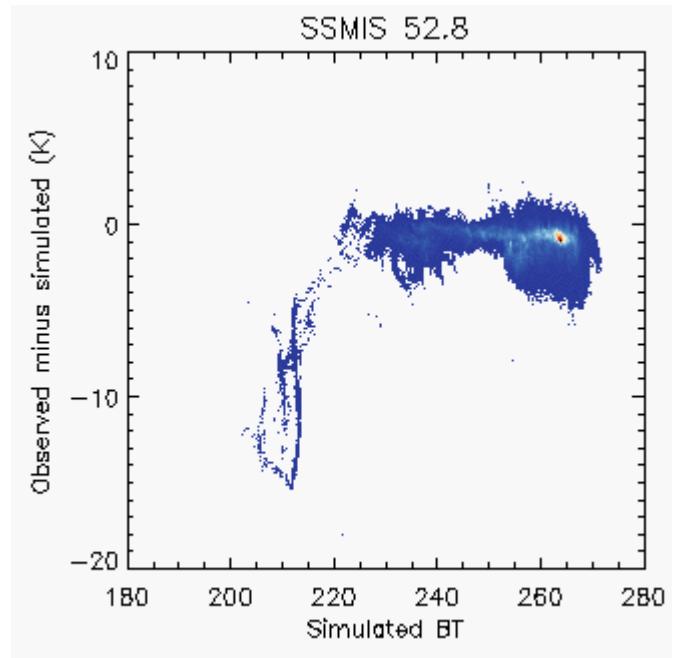
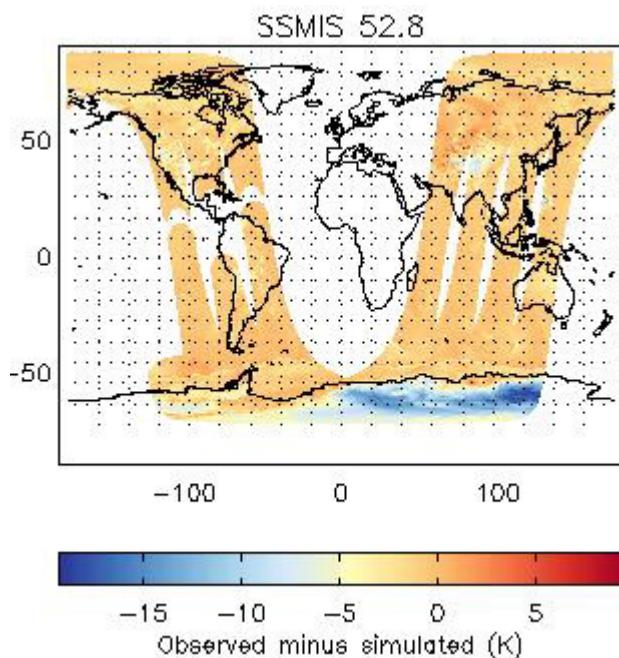
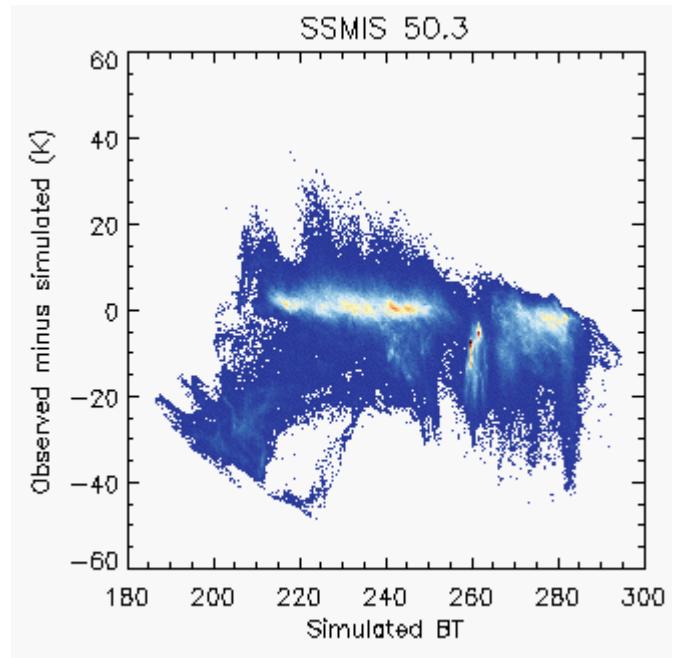
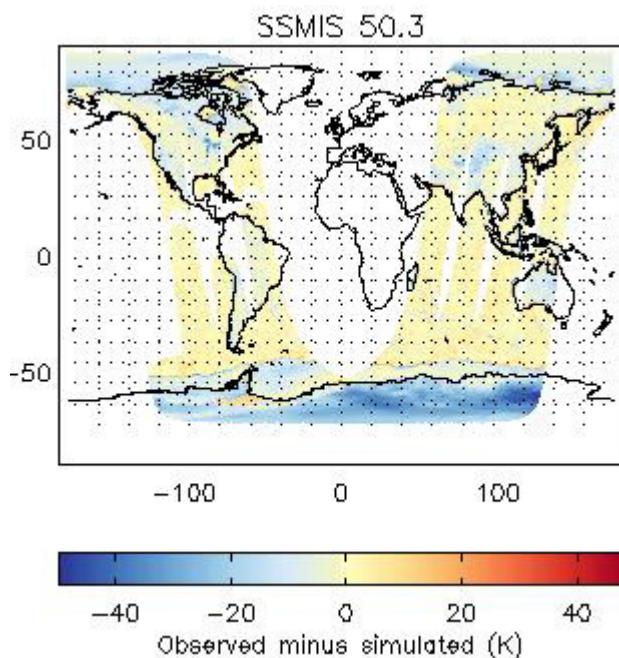
**36.7 GHz V-POL**


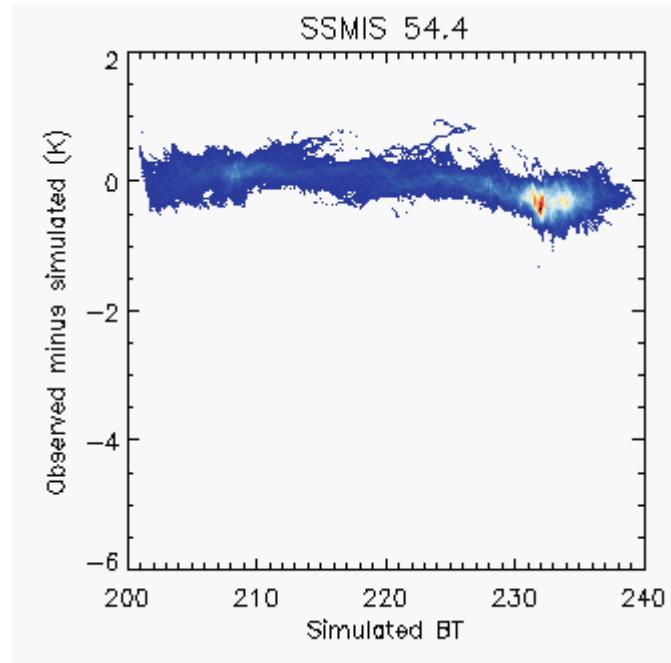
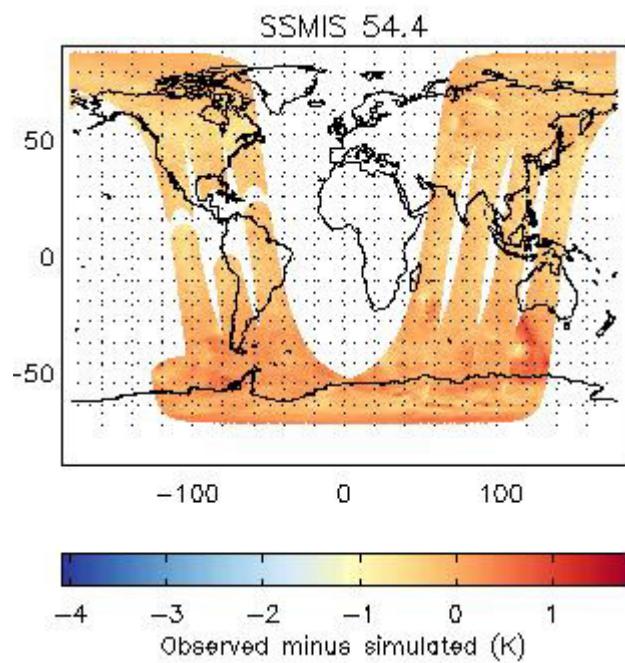
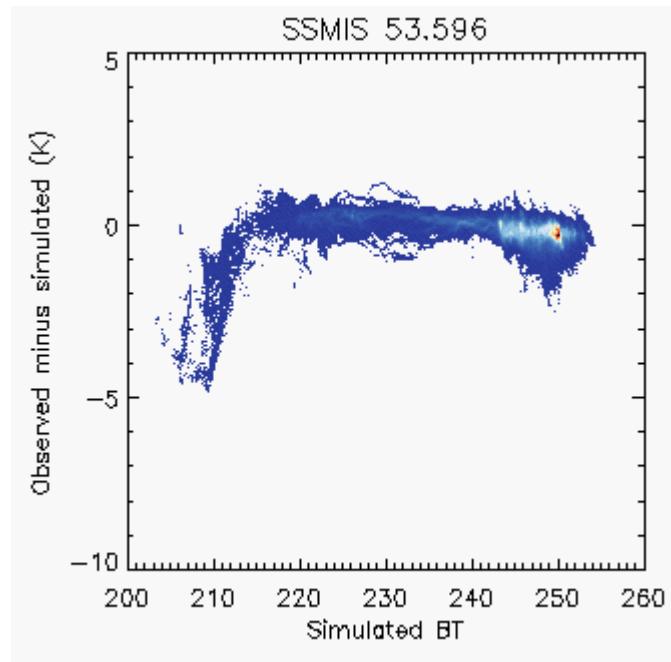
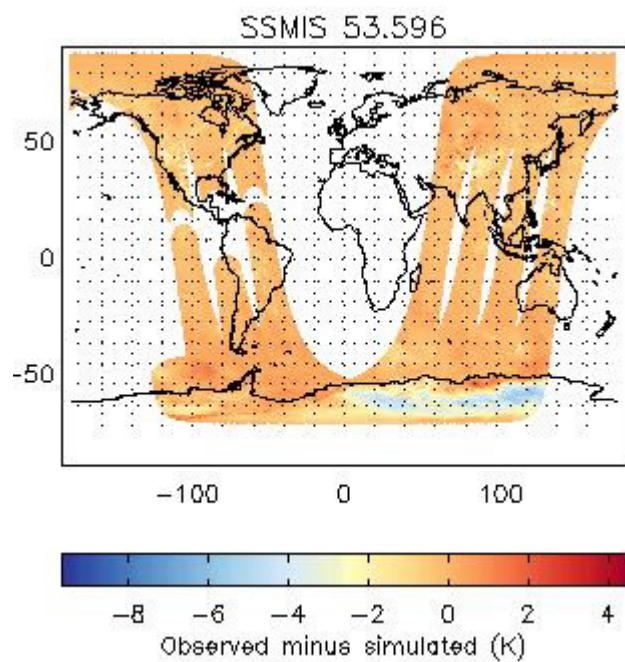
**36.7 GHz H-POL**


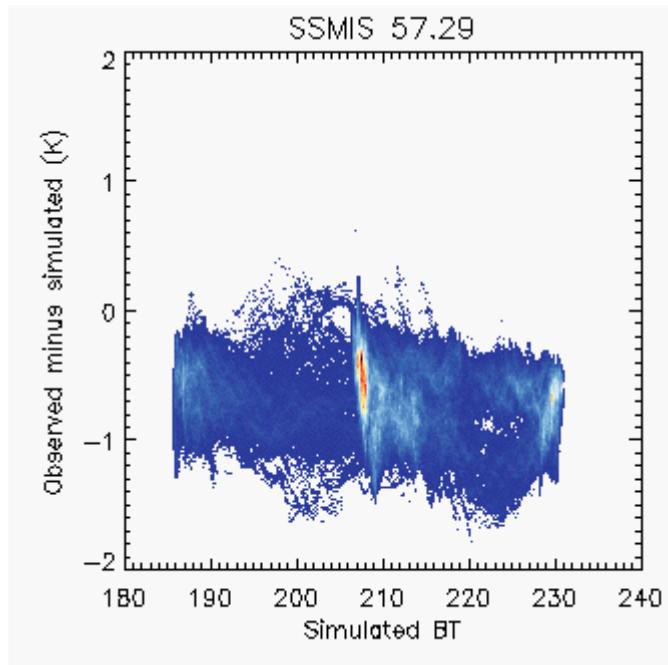
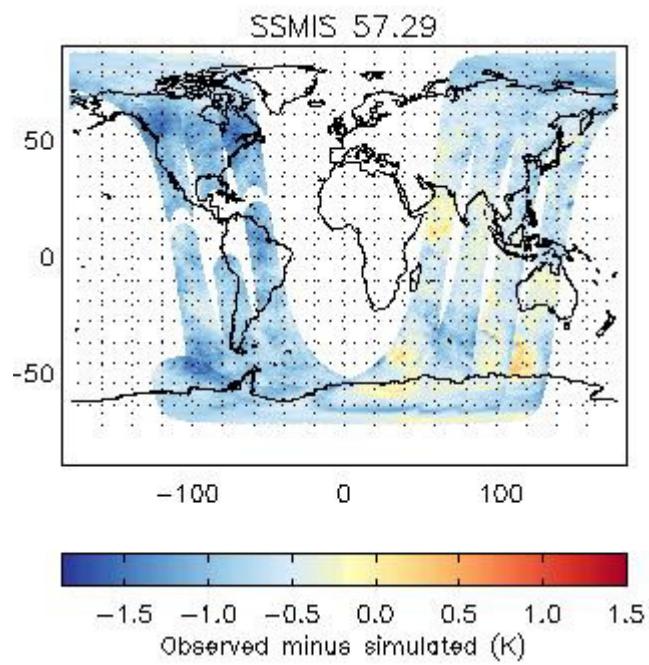
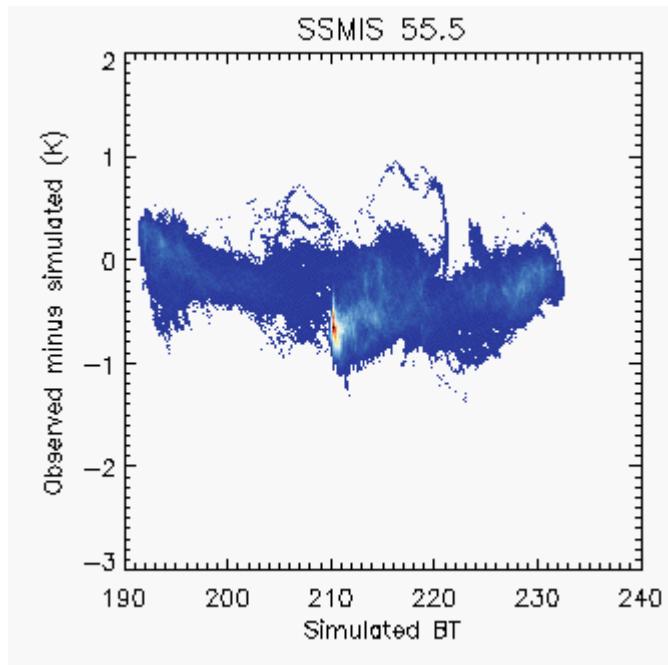
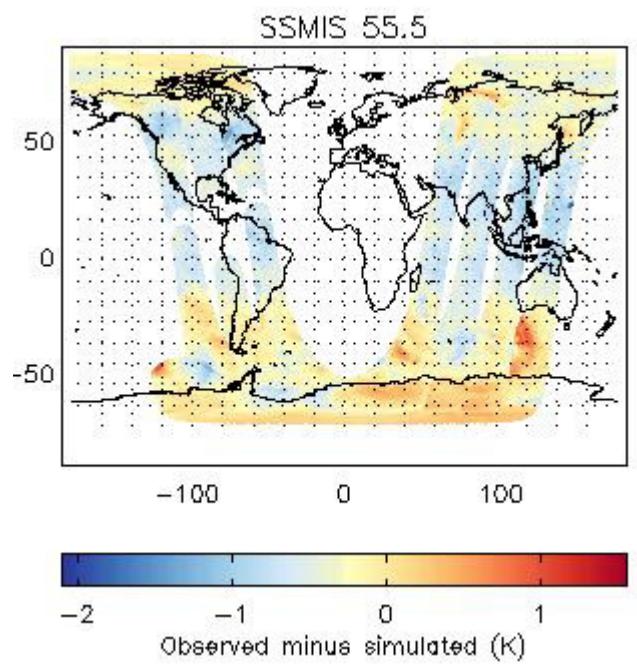
### 3. Results for SSMIS

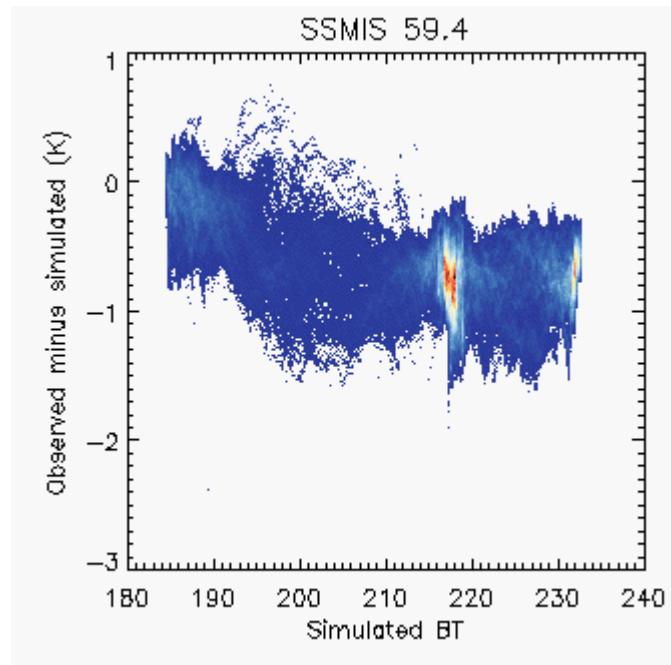
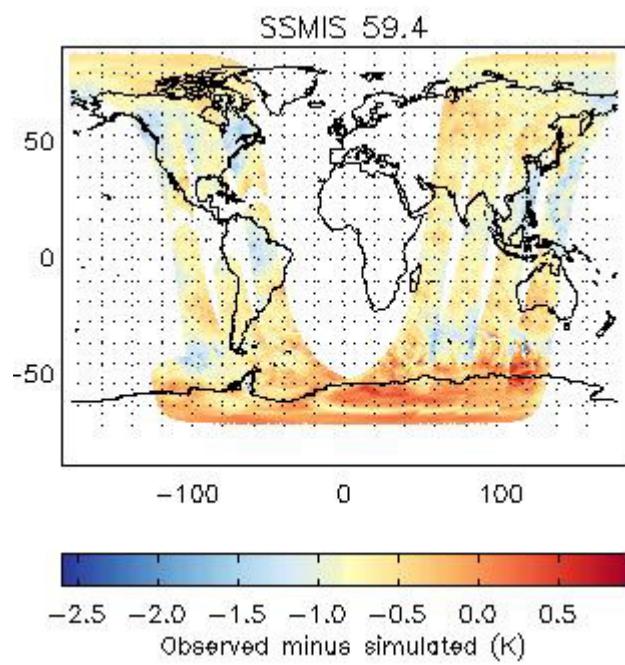
This section shows data from the Unified Pre-Processor (UPP), which includes corrections for spillover, solar contamination of the calibration target and main reflector emissivity. In the following pages, plots are only shown for channels that are similar to MTVZA-GY channels. Also, to save space only the difference plots are shown.

#### 3.1. 50-59 GHz sounding channels

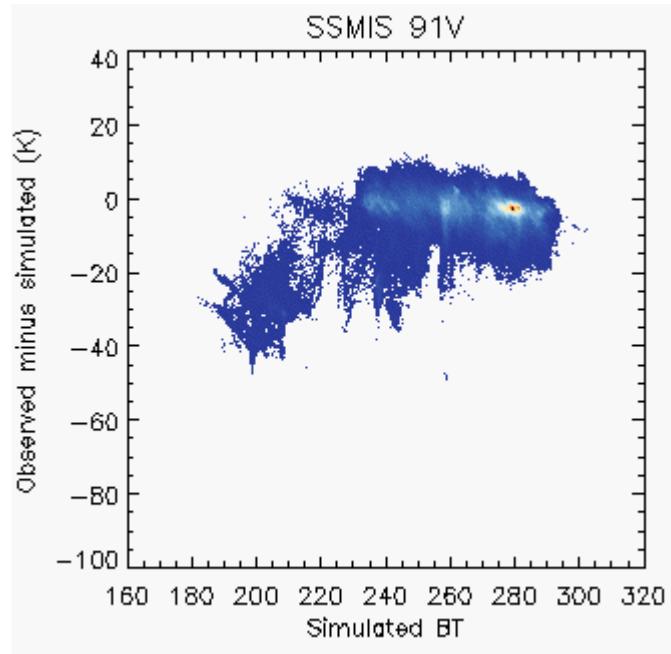
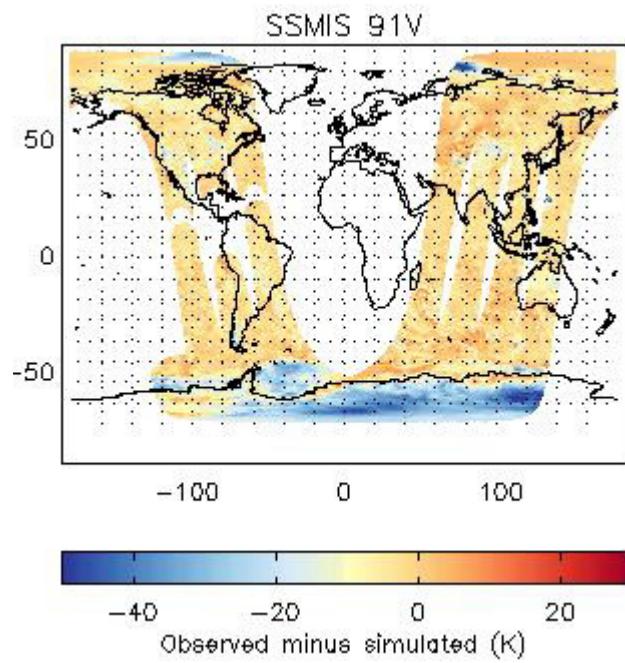


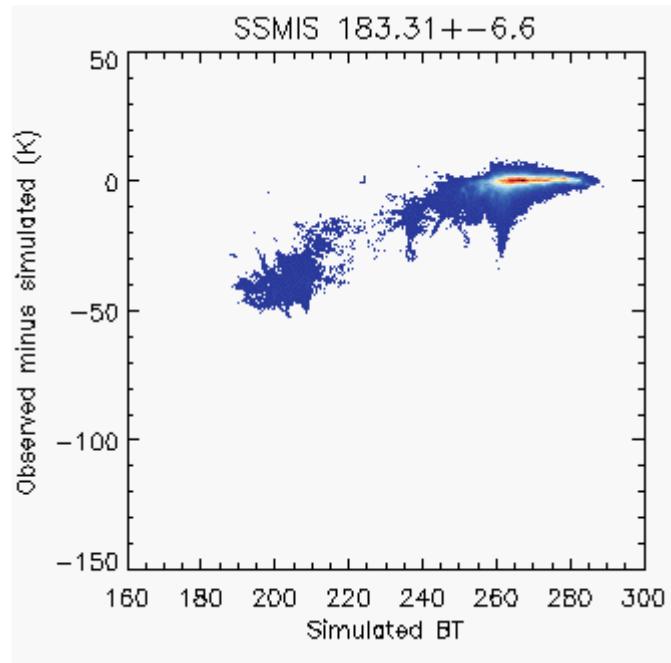
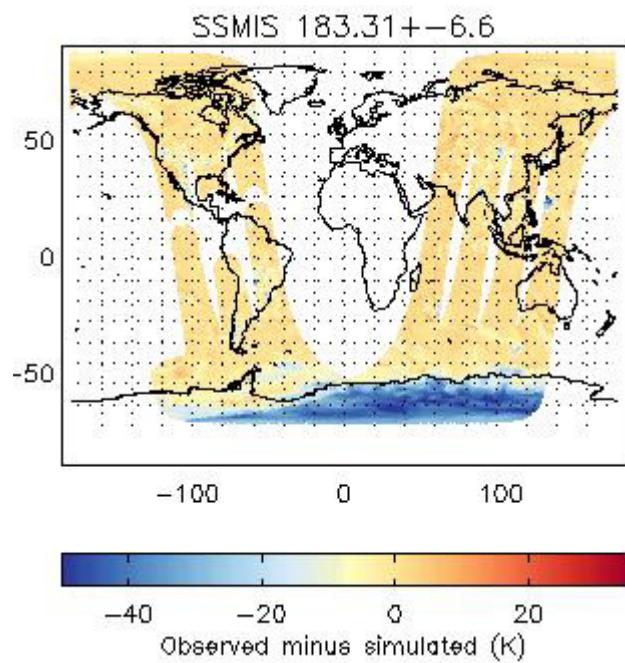
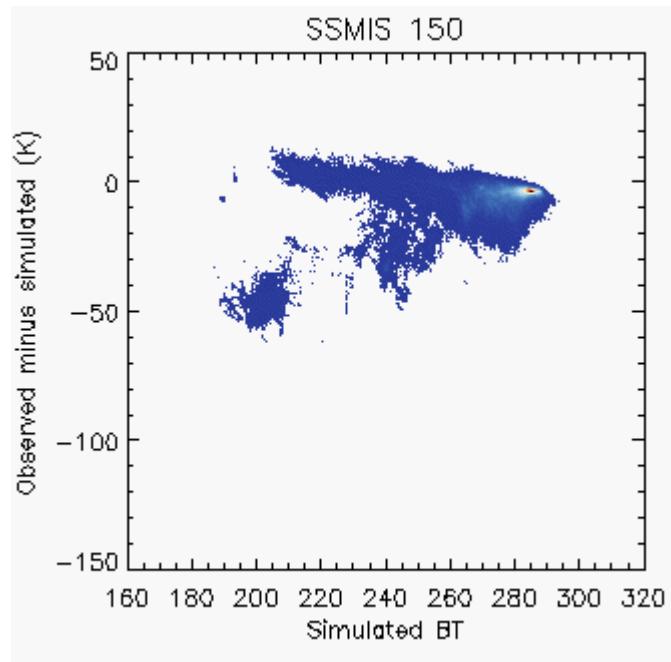
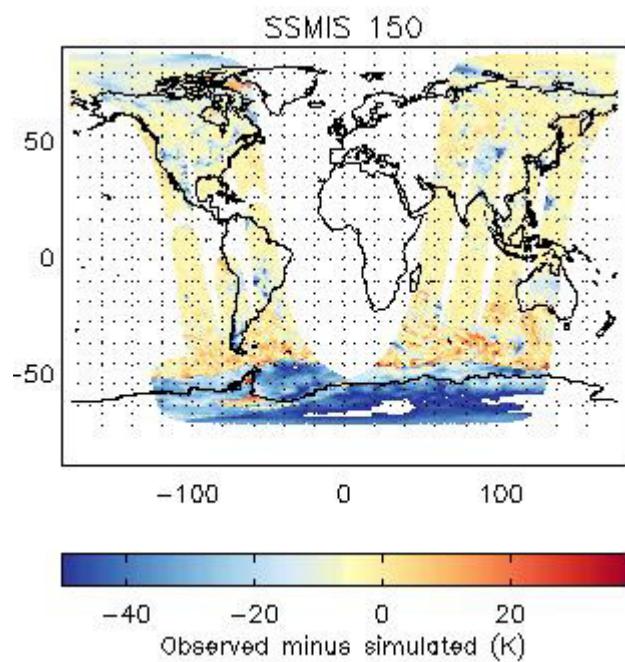


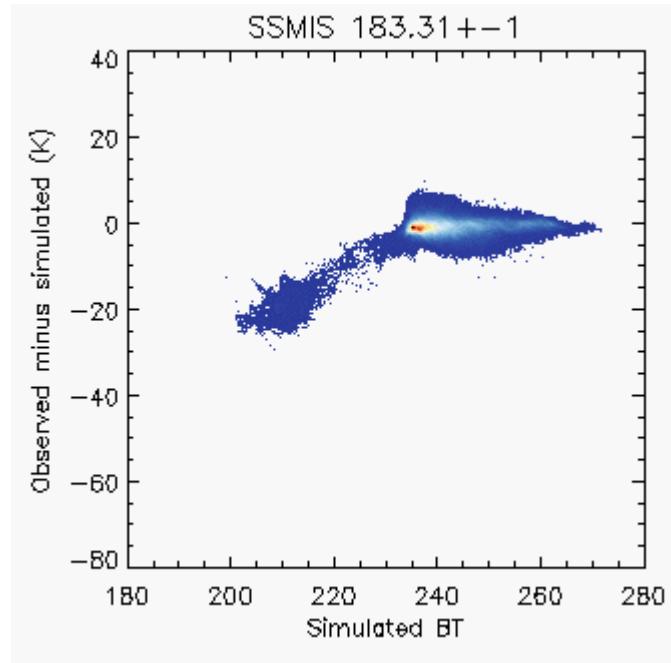
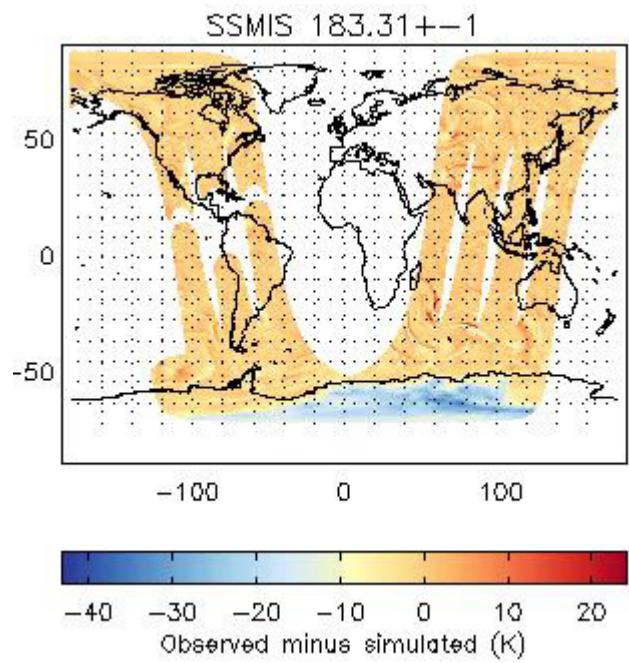
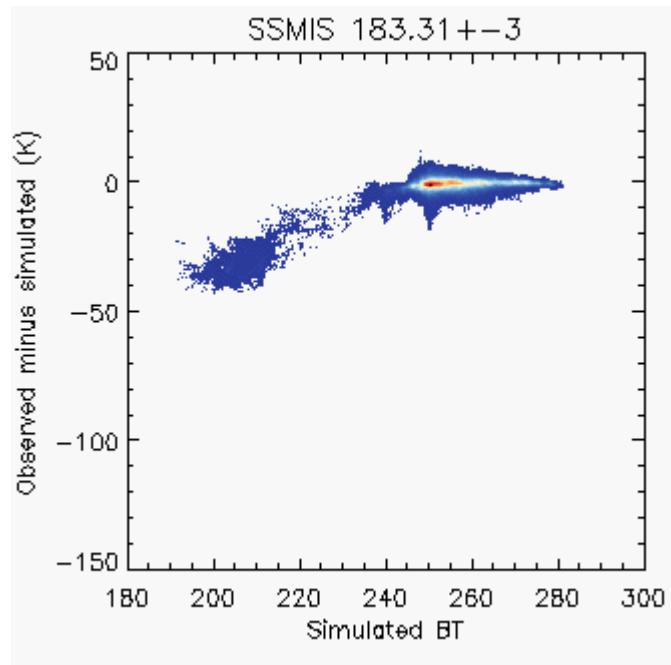
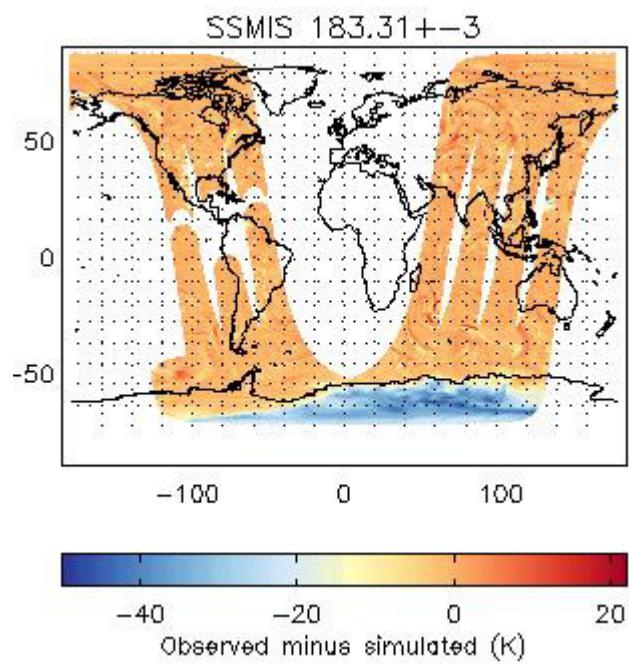




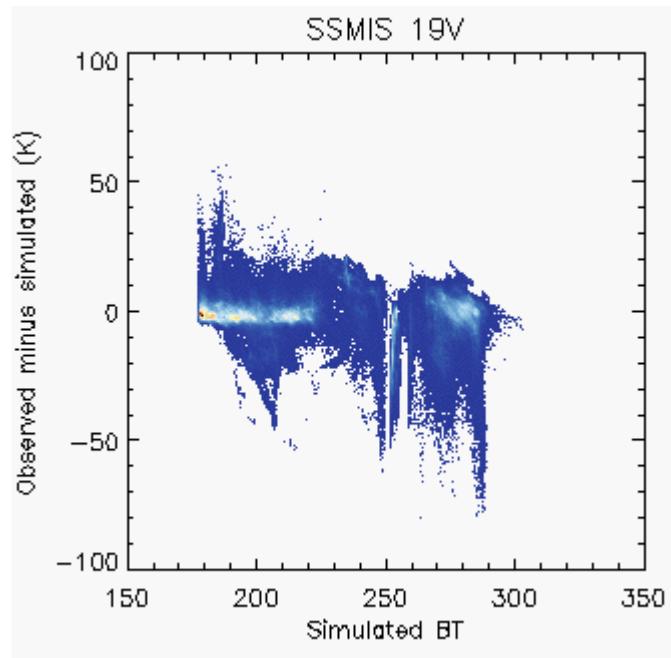
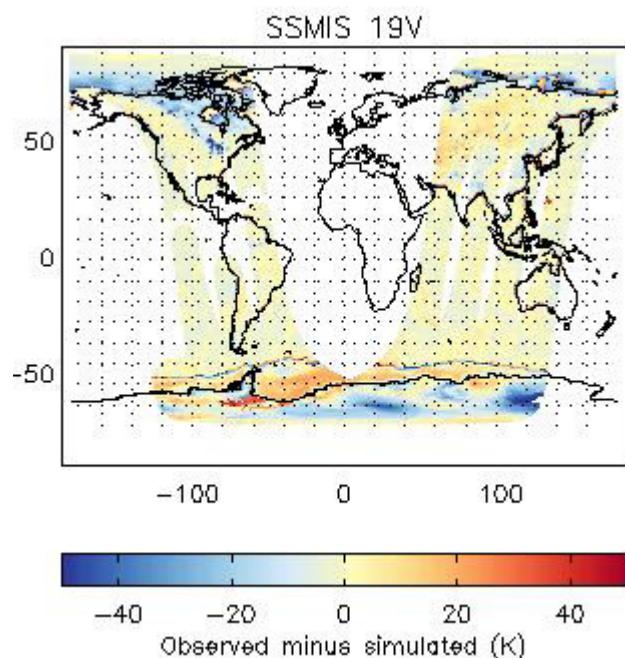
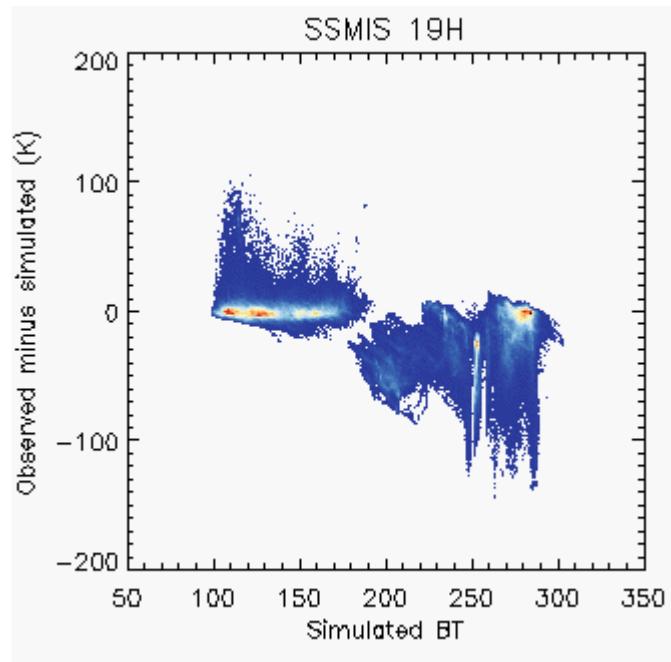
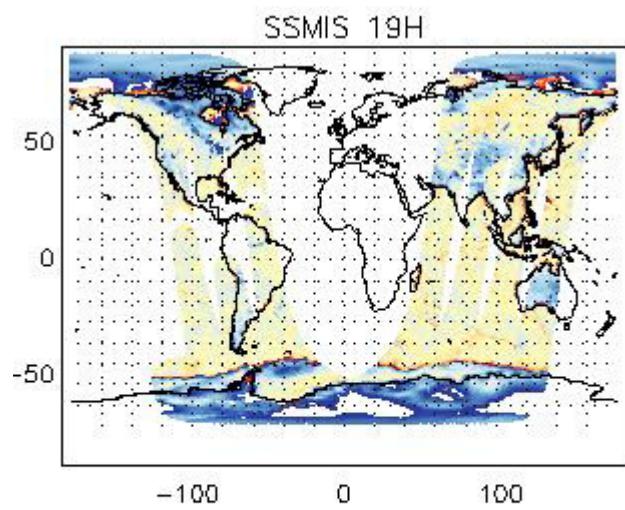
### 3.2. 91 GHz and above

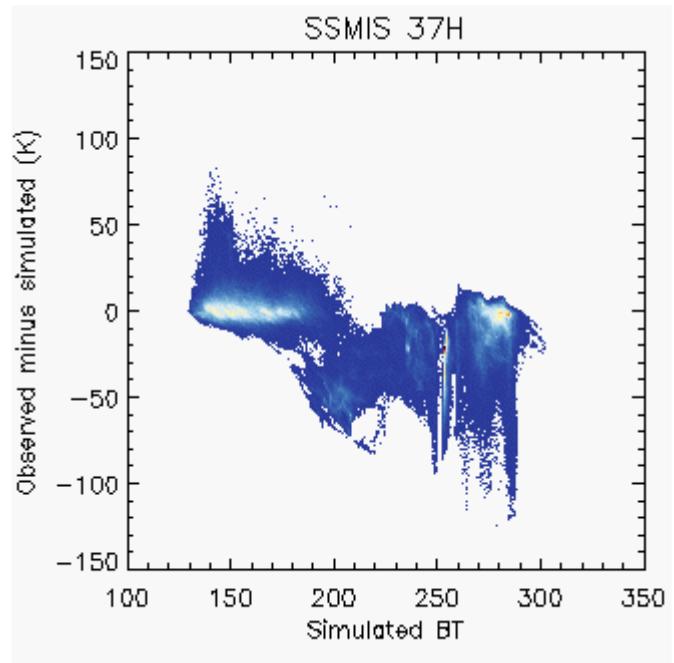
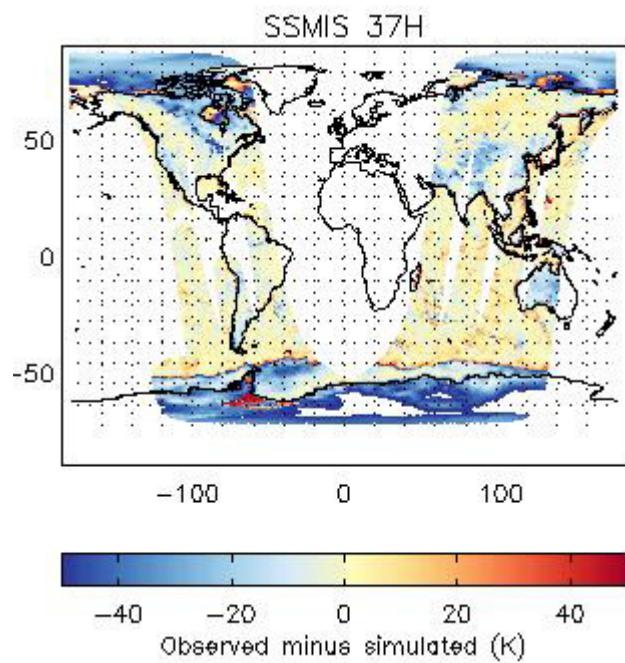
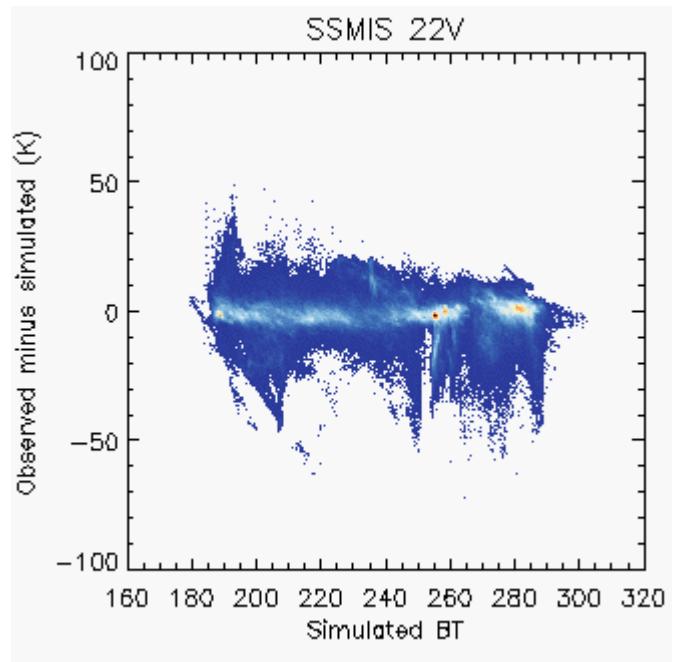
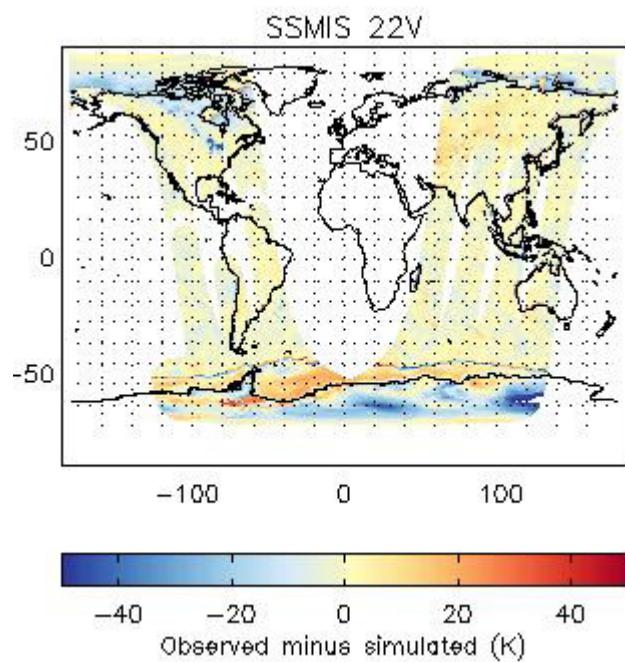


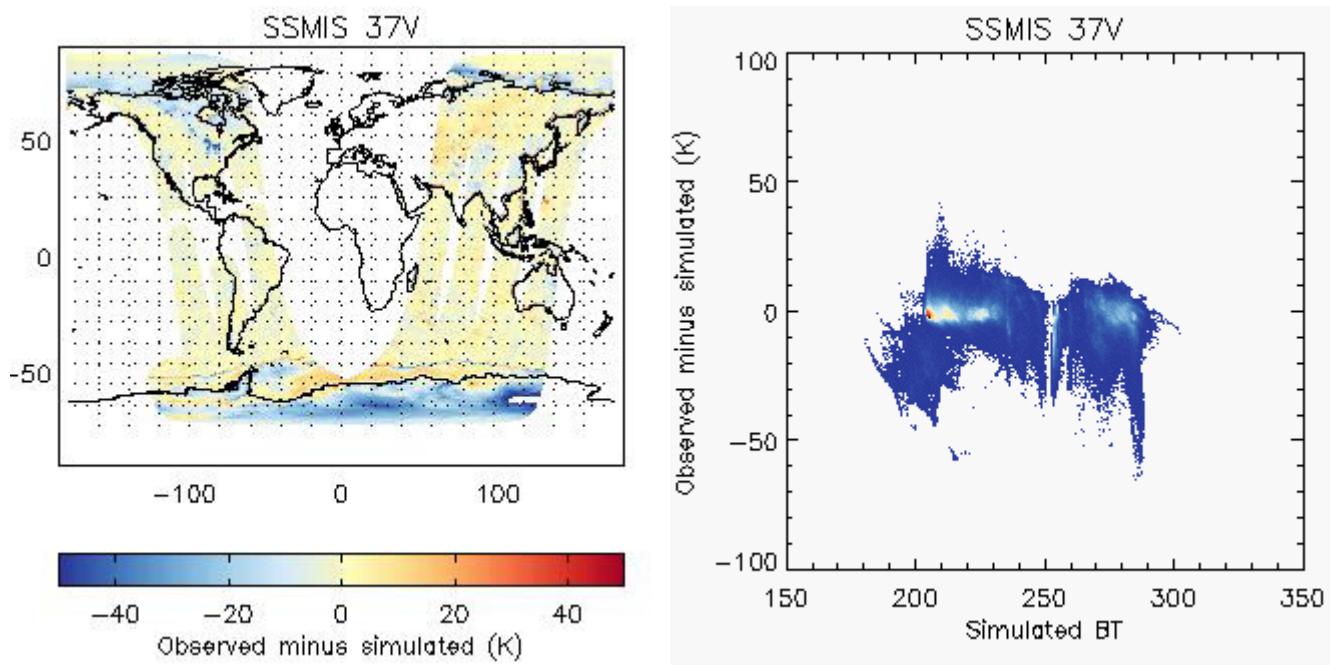




### 3.3. Low frequency window channels







## 4. Discussion

In general, one would expect significant model errors for the window channels, where errors are dominated by uncertainties in surface temperature and emissivity. But for sounding channels (especially 52-57 GHz) the model BTs should have much higher accuracy.

### 4.1. 52-57 GHz sounding channels

In the lower troposphere, the observed and simulated BTs are consistent to about 2K. However, there appears to be a problem for the two highest peaking channels,  $57.290344 \pm 0.3222 \pm 0.01$  and  $57.290344 \pm 0.3222 \pm 0.005$  GHz, with biases around 10K and 40K respectively and strong linear dependence of bias with scene temperature – the bias increasing for cold scenes. It is not clear what could cause such high measured brightness temperatures.

There is a noticeable air mass dependence at 53.8 GHz: 10K warmer in the Arctic and 10K colder in the Antarctic.

The SSMIS biases for these channels are all of the order 1K, or lower in some cases.

There is some noise apparent in the plots of MTVZA-GY BTs, difficult to quantify from this data (we would need warm and space counts to quantify the noise accurately).

### 4.2. 91 GHz and above

In these experiments there is no masking for cloud or ice. Looking at the SSMIS results, cloud/ice effects can be seen clearly as a depression of the observed minus simulated BTs. But the scatter plots show that a significant fraction of observations are consistent to within a few K.

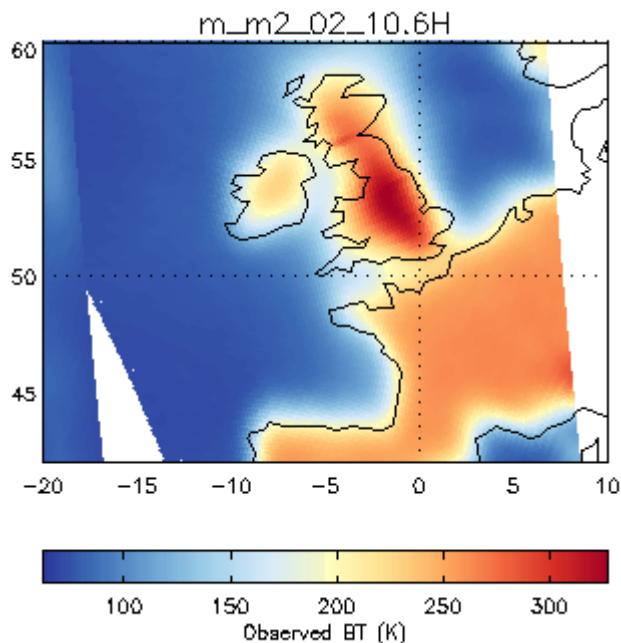
For MTVZA-GY we get the best agreement at 183 GHz by assuming that the highest peaking and lowest peaking channels are transposed. If this is not done, the biases approach 30-40K. Even with the channels transposed,  $183 \pm 7$  shows a warm bias of 10K which needs further investigation.

#### 4.3. Low frequency window channels

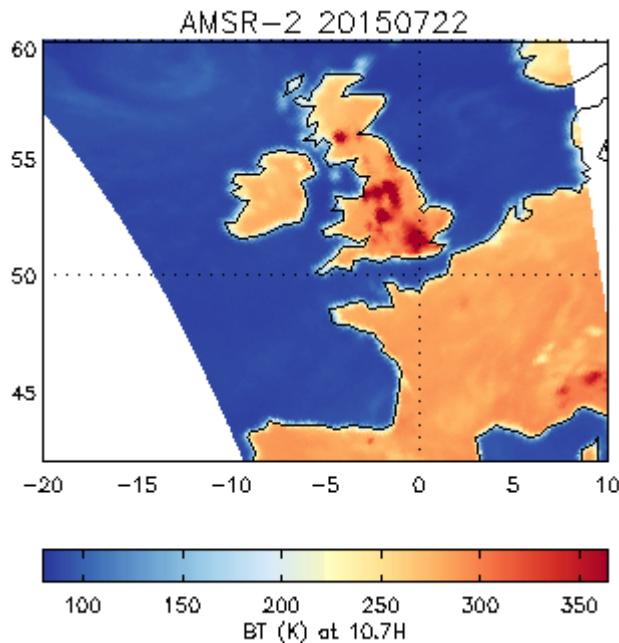
The SSMIS scatter plots show that the Radiance Simulator is doing quite a good job at modelling the majority of the BTs, over both ocean and land. There are discrepancies, as might be expected over polar regions.

For MTVZA-GY, the agreement is less good, with biases of 10K being not untypical.

It was noted that there is significant radio frequency interference (RFI) at 10.6 GHz over land in some locations. An example is shown below of anomalously high BT over the UK, observed with MTVZA-GY.



A similar plot for AMSR-2 (on a different day), which also shows RFI, is shown below. AMSR-2 has a 2m antenna and therefore the spatial resolution is significantly higher.



## 5. Conclusions

We welcome this opportunity to examine data from the MTVZA-GY instrument and are grateful to EUMETSAT and ROSHYDROMET SRC Planeta for making available the samples and the spectral response information. Although the MTVZA-GY has a relatively modest antenna size (65cm), it is of potential interest for NWP because of its suite of sounding channels (52-57 GHz and 183 GHz). Currently the only microwave imagers equipped with these channels are SSMIS and MTVZA-GY.

In this study the NWP SAF Radiance Simulator has been used to compare observed brightness temperatures with predictions based on NWP. Comparisons with SSMIS observations have shown that the Radiance Simulator is capable of producing realistic brightness temperatures, except for areas where modelling is difficult due to cloud or ice. The Radiance Simulator is therefore a useful tool for rapid evaluation of new sensors.

The study has showed that agreement between MTVZA-GY and the simulations is generally less good than is the case for SSMIS. This is perhaps not surprising: the SSMIS Unified Preprocessor has been developed over many years to account for several instrument artefacts. It is likely that similar effort would be needed for MTVZA-GY. There are a few specific issues, e.g. the two highest peaking channels at 57 GHz have large errors, and two channels at 183 GHz appear to have been assigned the wrong names in the HDF files.

Follow-on studies, aimed at improving the usefulness of these data in NWP, could include: (i) assessment of the effectiveness of bias correction methods, and (ii) assessment of the effectiveness of spatial averaging in reducing noise in the sounder channels (as is currently done for SSMIS).

We would encourage further collaboration on these issues.

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