Comparison of AMSU-B brigtness temperatures

simulated by RTTOV-7 and by ARTS

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Outline

- Motivation.
- Set up.
- Results.
- Conclusions/future work.

Motivation

- UTH climatology using:
  - ECMWF fields,
  - RT model,
  - scale the obtained BT to UTH.

- Cannot use ARTS $\Longrightarrow$ too time consuming.

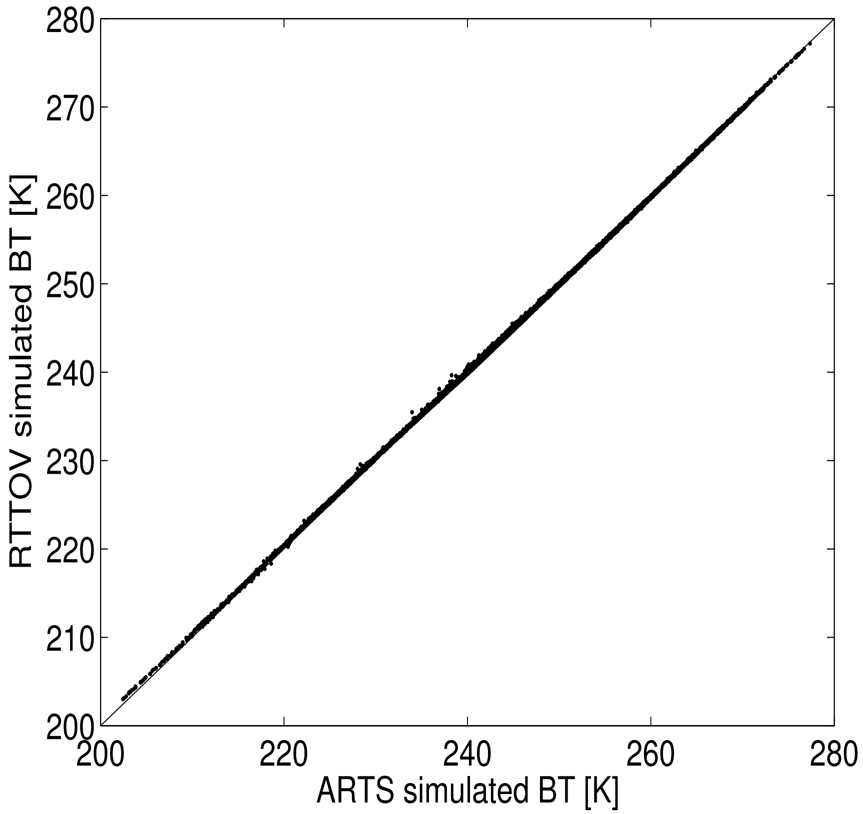
- Use a fast RT model $\Longrightarrow$ RTTOV-7.

- Comparison between RTTOV-7 and ARTS.

Set up

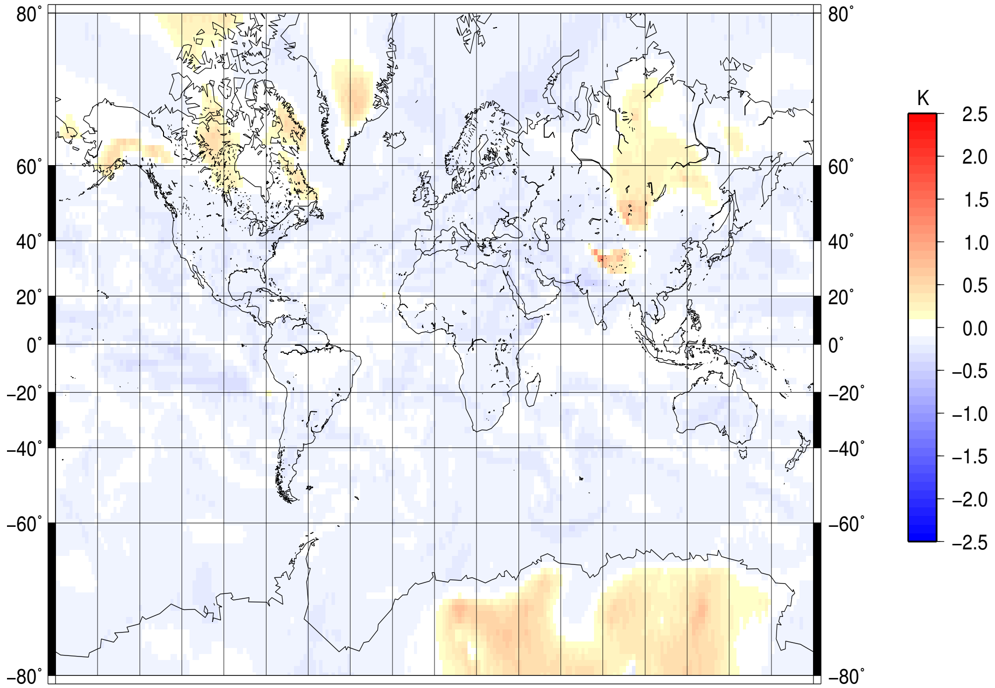
- Global comparison (total number of profiles:29040).
- 1 day, 1 time: January 1, 2000 00:00 UT.
- Temperature, specific humidity, pressure ECMWF ERA-40 fields taken as input (geopotential height additionally for ARTS).
- For both models the ECMWF profiles were interpolated and smoothed to the RTTOV 7 pressure levels.
- Emissivity was set to 0.6, further calculations have been done with emissivity 0.95.
- First, AMSU-B channel 18 was simulated, then the comparison was extended to the 4 other channels.

Channel 18 (183.31±1.00 GHz), emissivity 0.6



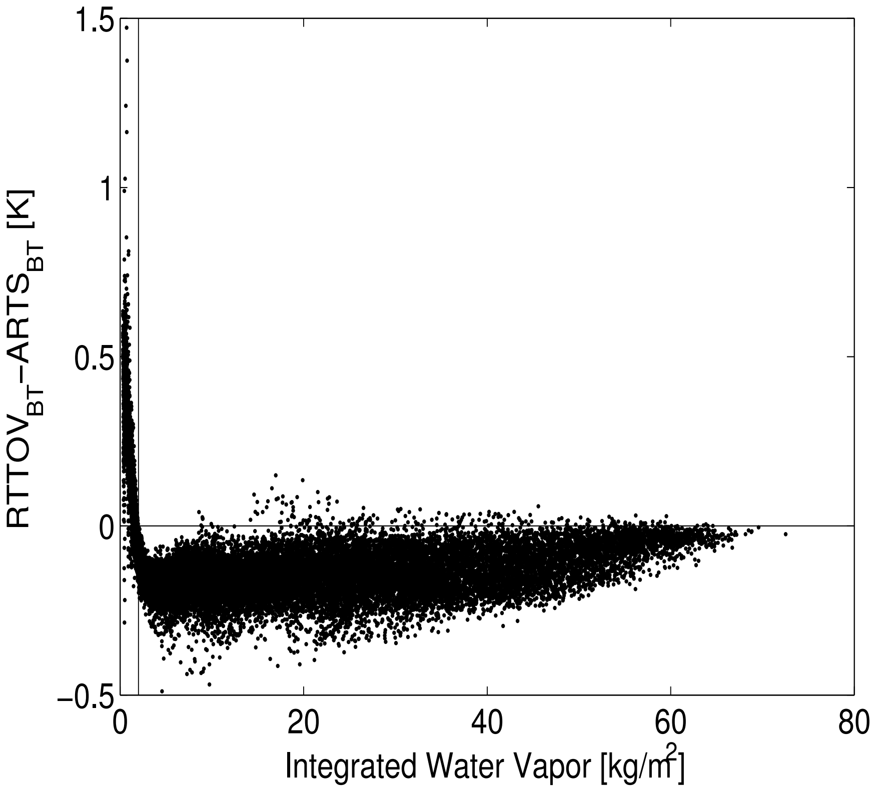
- RTTOV-7 BTs against ARTS BTs.
- Very good agreement.

Channel 18 (183.31±1.00 GHz), emissivity 0.6



- Overall agreement still good.
- Well spread negative bias (-0.14 K).
- Clear and visible positive bias in specific regions, representing 12.1% of the total number of profiles.

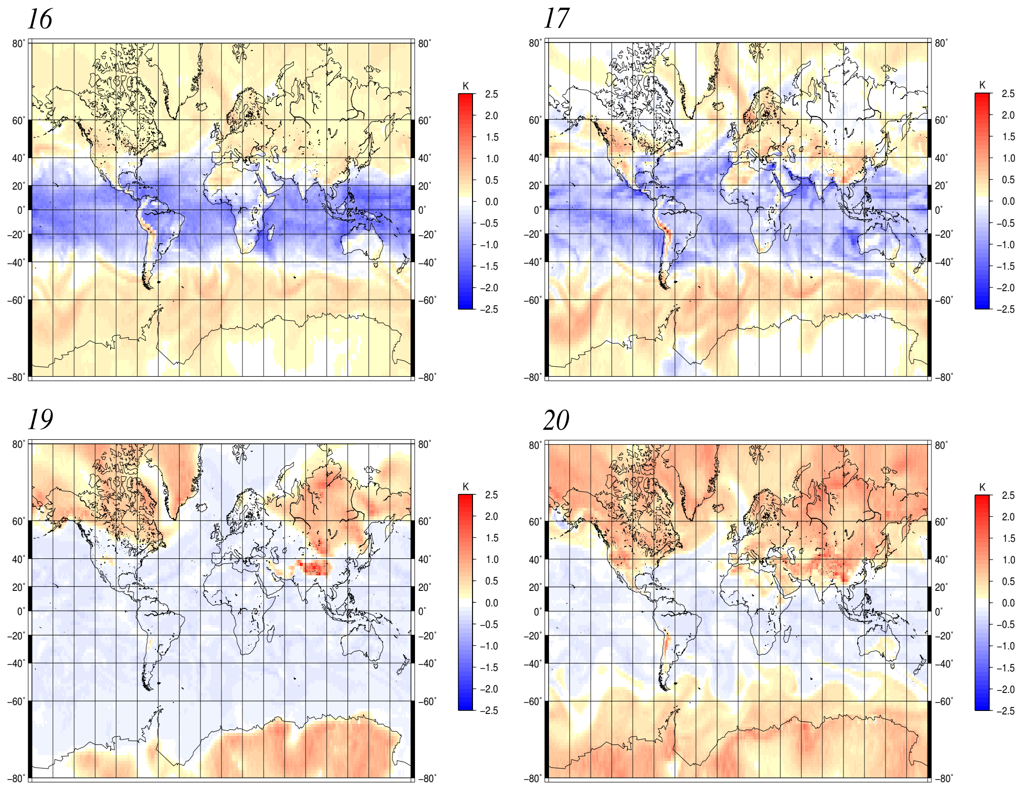
Channel 18, dependence to IWV



- Clear dependence of the positive bias on low humidity content.
- Dependence documented by Garand *et al* [1] for RTTOV 5 and 6.

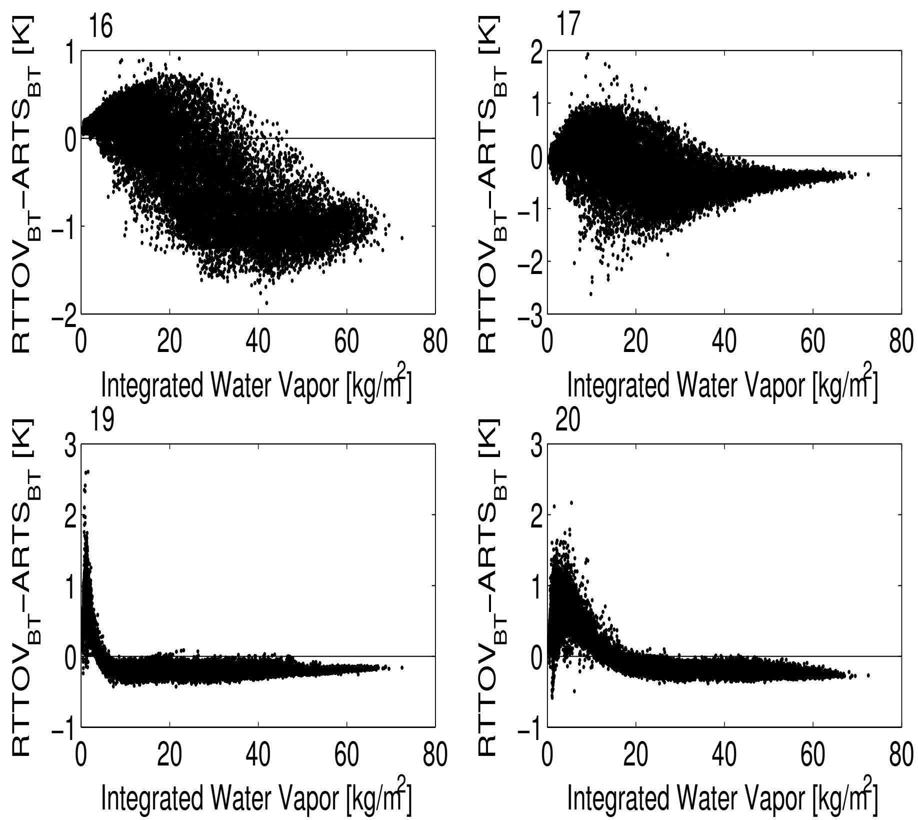
[1] L.Garand *et al*. Radiance and jacobian intercomparison of radiative transfer models applied to HIRS and AMSU channels. *J. Geophys. Res., 106(D20):24,017-24,031, 2001.*

Channels 16 (89 GHz), 17 (150 GHz), 19 (183.31±3.00 GHz), and 20 (183.31±7.00 GHz), emissivity 0.6



- Negative bias in the tropics.
- Positive bias in the polar regions and at mid latitudes.
- Similar patterns as for channel 18.
- More profiles exhibiting positive bias (25.3% and 55.2% of the profiles).

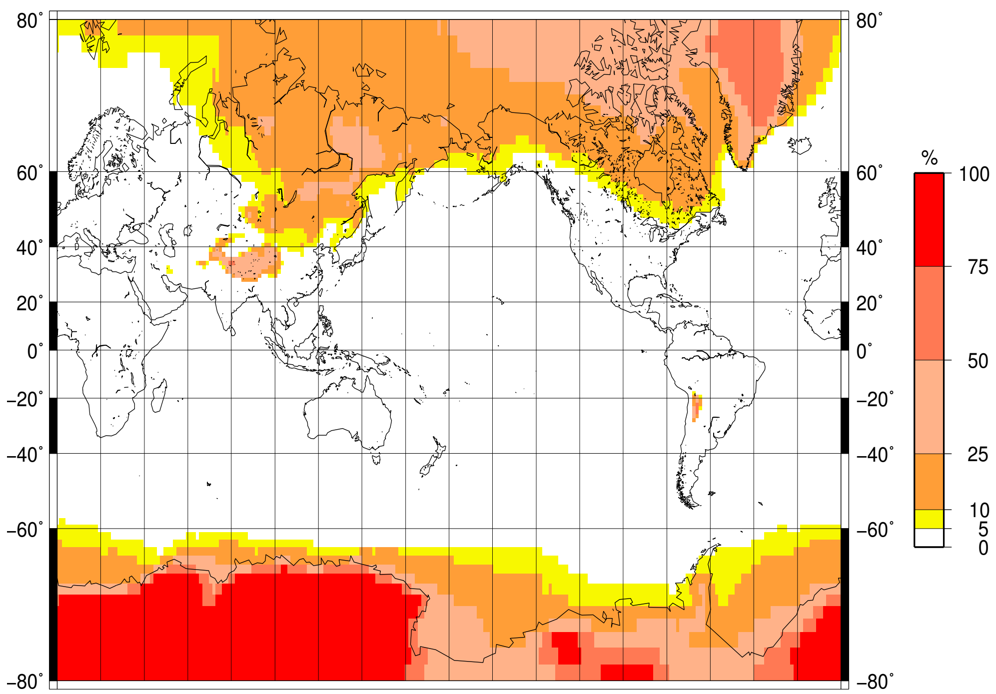
Channels 16, 17, 19, and 20, dependence to IWV



- For sounding channels, strong dependence of positive bias on low IWV.
- The threshold at which the bias changes sign is moving to higher IWV for channels with lower sounding altitude.
- For surface channels, positive biases occur for IWV lower than the mean IWV.

Global distribution of IWV from ERA-40 profiles

IWV$<2\,kg/m^2$



- December 1999 to November 2000.
- 1460 profiles for each grid point.
- Highest occurrences of dry profiles in the polar regions.
- Only a yearly picture, there are strong seasonal variations.

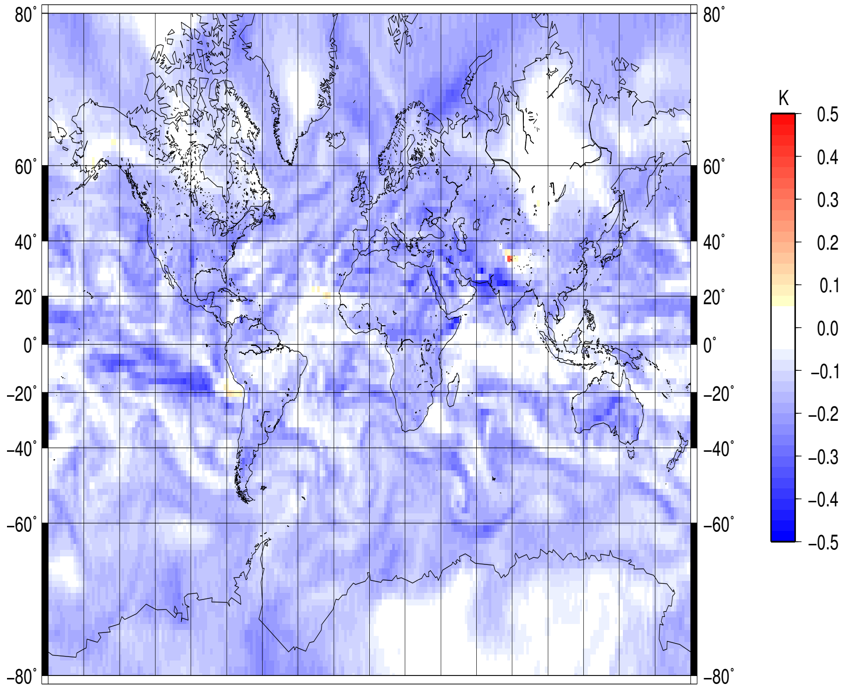
Emissivity

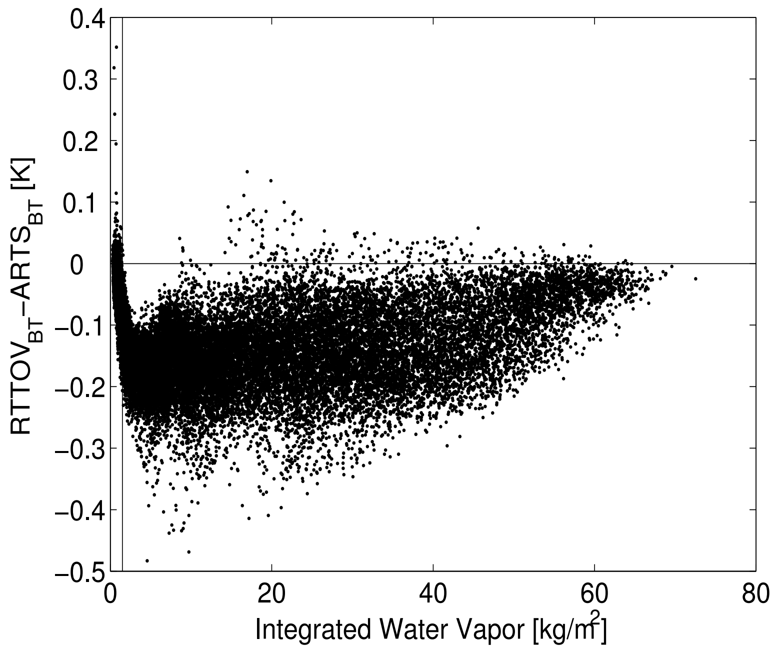
- Snow emissivity is important because most of profiles leading to a positive bias are located in snow covered area.
- Snow emissivity highly variable, from 0.45 to 0.9 at 150 GHz[2].
- Low emissivity (0.6): representative for ocean surface[3] and lower end of the snow emissivity range.
- High emissivity (0.95): representative for land and higher end of the snow emissivity range.

[2] F. Weng and B.Yan. A microwave snow emissivity model. In *The Thirteenth International TOVS Study Conference, 2004.*

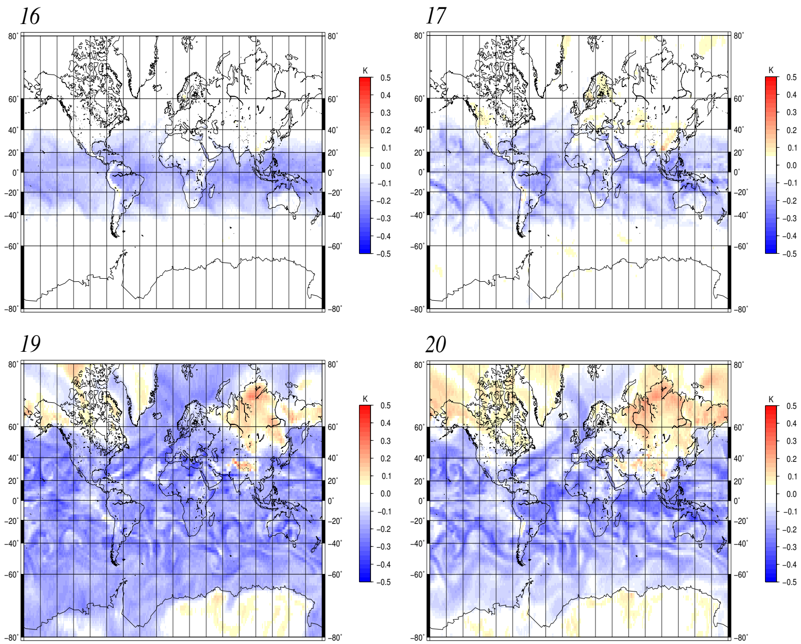
[3] S. J. English. Estimation of temperature and humidity profile information from microwave radiances over different surface types. *J. Appl. Meteorol., 38:1526-1541, 1999*

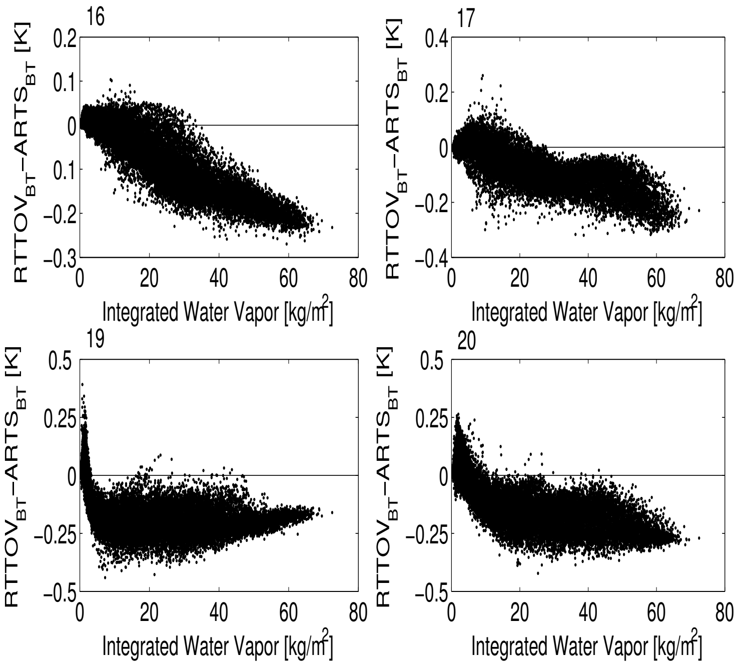
Channel 18, emissivity 0.95





Channel 16, 17, 19, and 20, emissivity 0.95



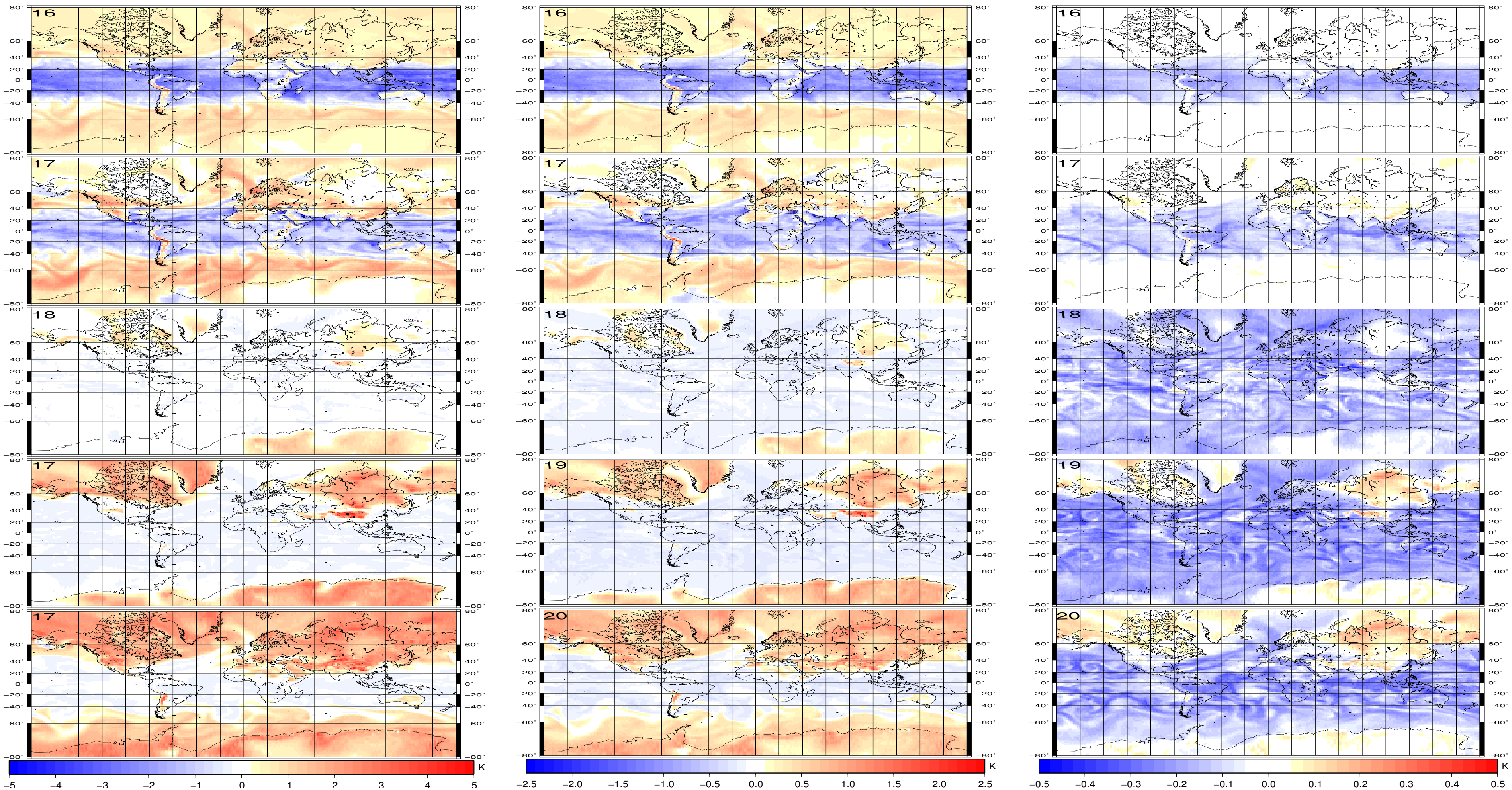


Comparison of low and high emissivity simulations

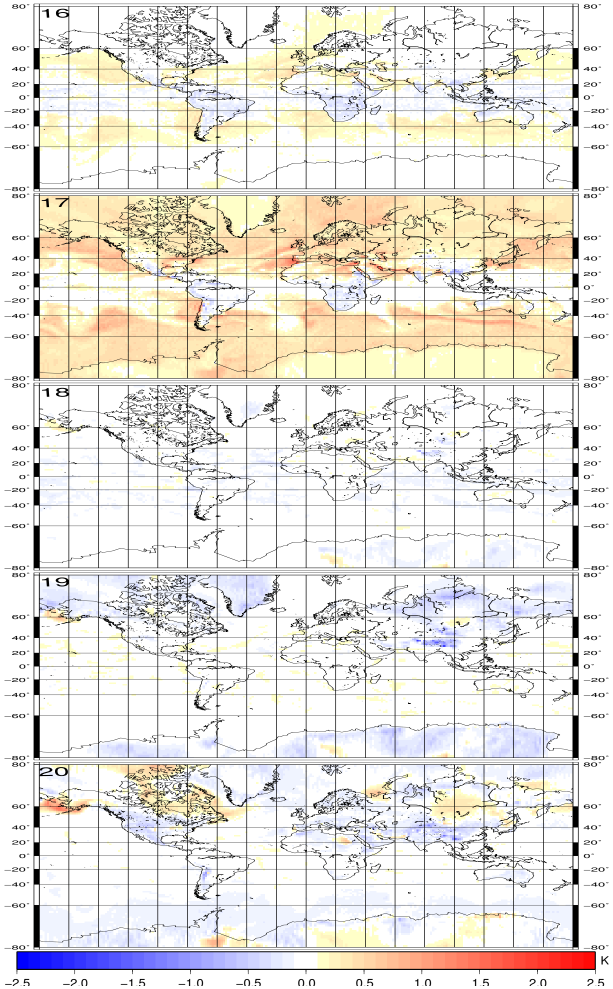
Channel	Mean Diff.	Standard Dev.	Min. Diff.	Max. Diff.
Low Em. (0.6)				
16	-0.142	0.530	-1.876	0.906
17	-0.123	0.454	-2.624	1.926
18	-0.094	0.154	-0.489	1.472
19	-0.002	0.350	-0.427	2.605
20	0.208	0.398	-0.585	2.169
High Em. (0.95)				
16	-0.049	0.073	-0.270	0.103
17	-0.046	0.074	-0.320	0.260
18	-0.134	0.066	-0.483	0.352
19	-0.146	0.102	-0.440	0.391
20	-0.095	0.113	-0.422	0.264

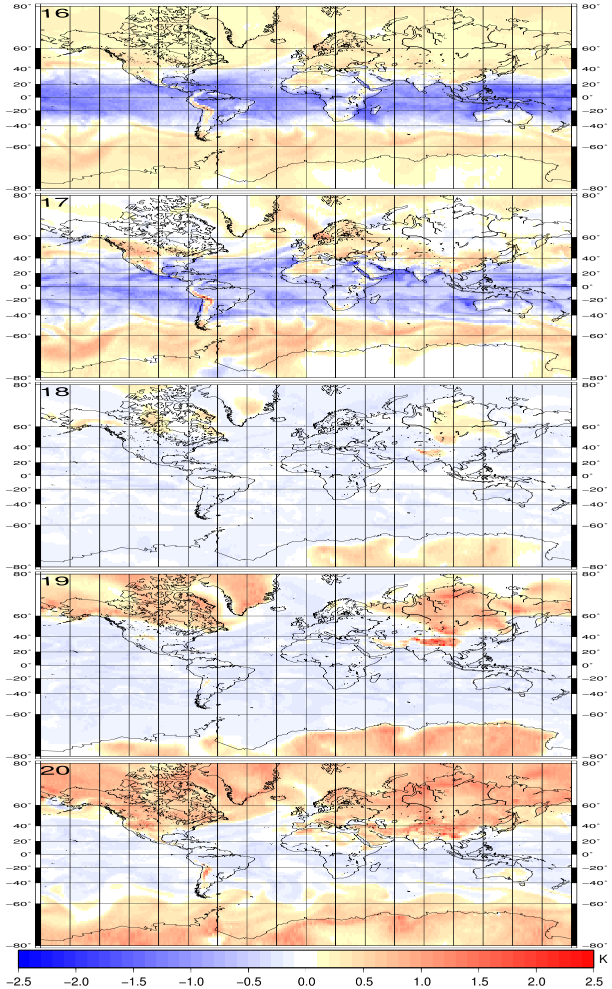
- The low surface emissivity shows the largest discrepancies.
- Even in this case, biases and standard deviations are consistent with Garand *et al*.
- Do the biases maximise with decreasing emissivity?

Comparison with emissivity 0.1



Comparison of the continua





Summary

- The low emissivity case shows the larger discrepancies.
- The biases and their standard deviations between the models are modest.
- However, a projection onto a map reveals that certain biases always occur over specific regions.
- Further simulations showed that the positive bias maximises with decreasing emissivity.
- The comparison of different continuum showed that the flat biases are due to the use of different continuum associated with the models.

Conclusion

- Since the biases are emissivity dependant and maximise with low emissivity, the discrepancies are most probably due to different way of handling of the surface.

- For channel 18,the upper tropospheric humidity channel, the positive bias in dry regions is up to 1.5 K.

- For channel 18, a 1 K, in the RT model, corresponds to a 7% relative dry bias in the UTH.

- The documented biases will introduce regional and seasonal biases in numerical weather prediction models analyses and satellite climatologies, if they are not taken into account.

Future work