

Comparison of radiative transfer models for AIRS

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- In data assimilation and retrieval applications it is important to understand the error characteristics of the forward model and its gradient (i.e. Jacobian).
- By comparing an ensemble of RT models with different methodology and based on different spectroscopy the spread of the differences can be an indication of the RT model error.
- Obvious 'bugs' in any of the models can also be identified during the comparison

Compare RT models by:

- Compute Br. Temps for all 2378 channels for 52 diverse profiles
- For some models compute jacobians for a selection of 20 channels and 52 profiles
- For some models compute layer to space transmittances of 20 channels and 52 profiles
- Use RFM as reference RT model

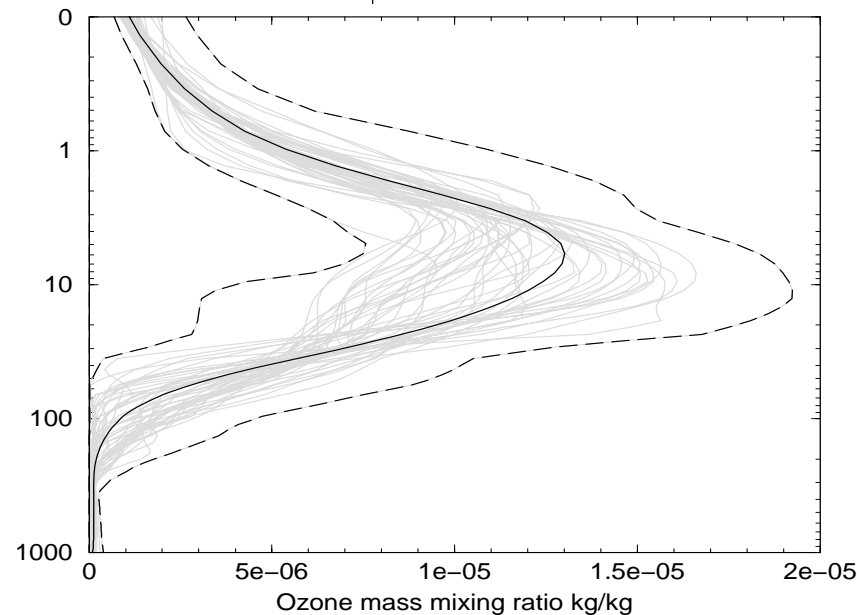
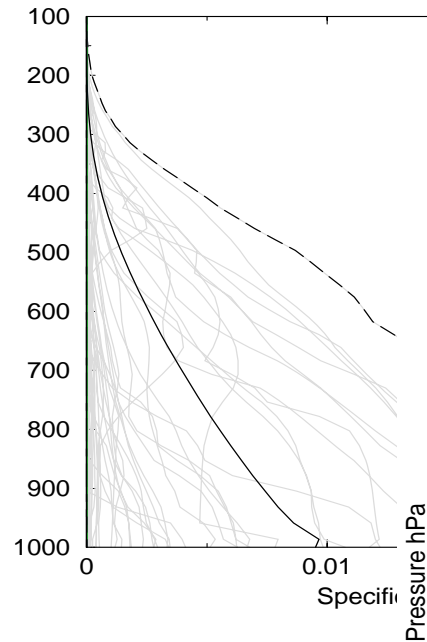
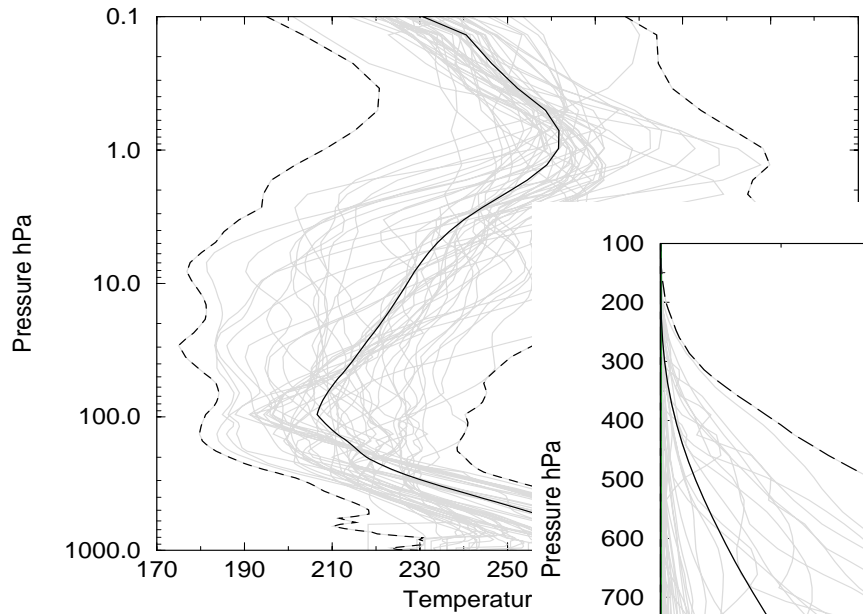
AIRS RT model Comparison



Model	Participant	Direct	Jacobian
RTTOV-7	R. Saunders, METO	Yes	Yes
RTTOV-8	R. Saunders, METO	Yes	Yes
Optran	Y. Han, NESDIS	Yes	Yes
OSS	J-L. Moncet, AER	Yes	Yes
LBLRTM	J-L. Moncet, AER	Yes	Yes
RFM	N. Bormann, ECMWF	Yes	Yes
Gastropod	V. Sherlock, NIWA	Yes	Yes
ARTS	A. Von Engel, Bremen	Yes	No
SARTA	S. Hannon, UMBC	Yes	No
PCRTM	Xu Liu, NASA	Yes	Yes
4A	S. Heilliette, LMD	Yes	Yes
FLBL	D.S. Turner, MSC	Yes	Yes
σ -IASI	G. Masiello, IMAA-CNR	Yes	Yes
Hartcode	F. Miskolczi, NASA	Yes	No

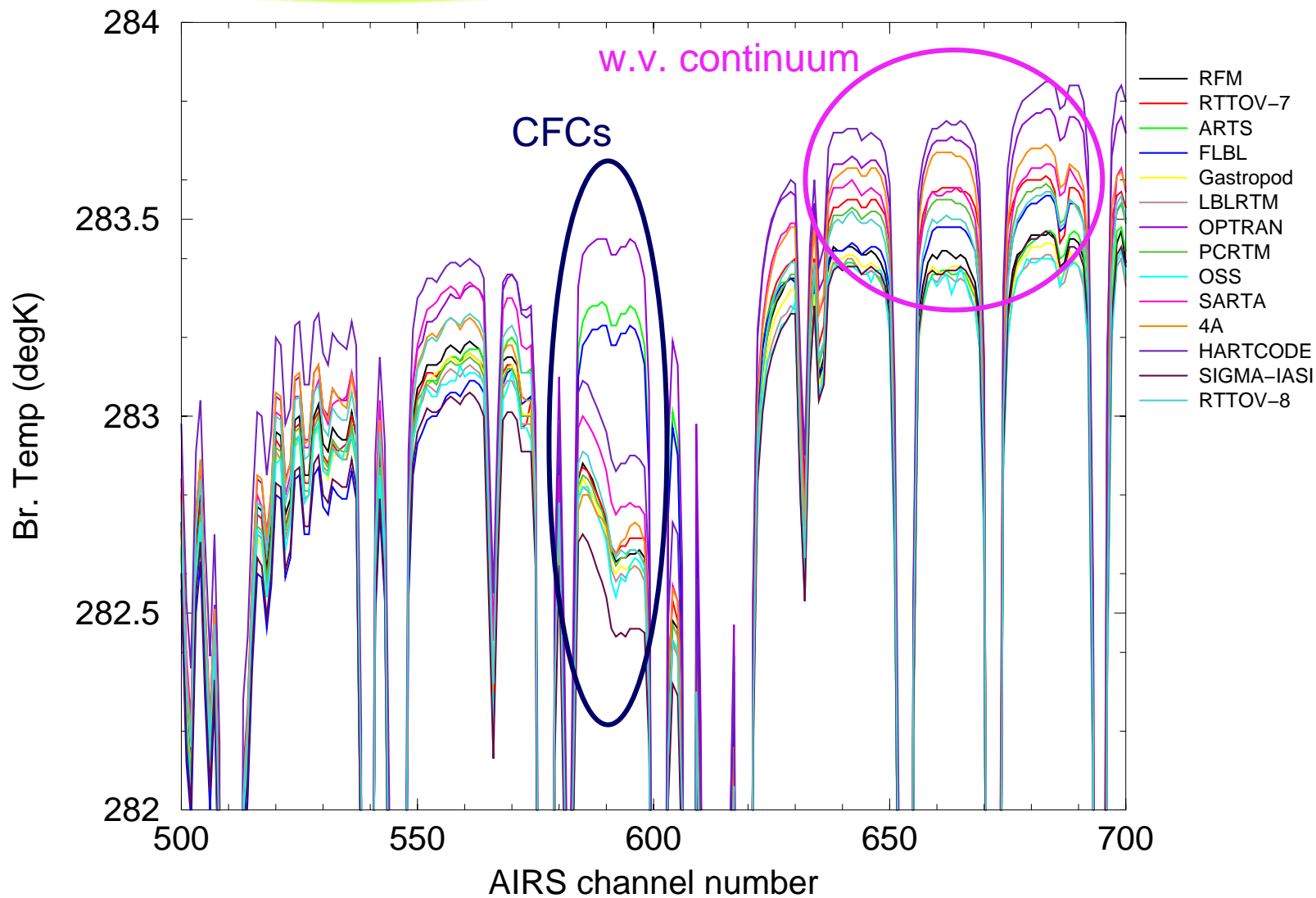
+ other models being added

Diverse ERA-40 52 Profile set

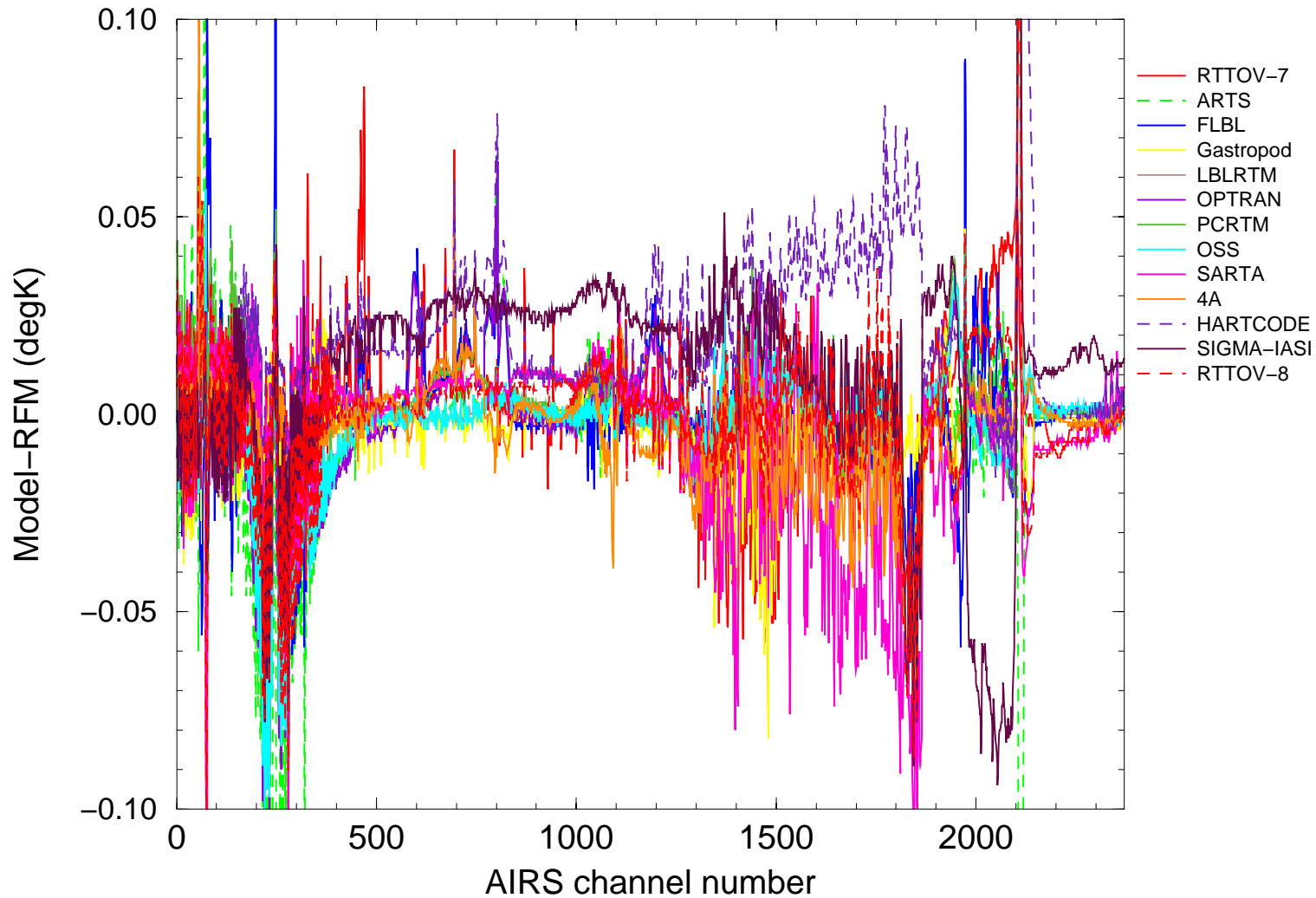


All 52 profiles dynamically consistent with all 3 variables

Comparison of AIRS forward models

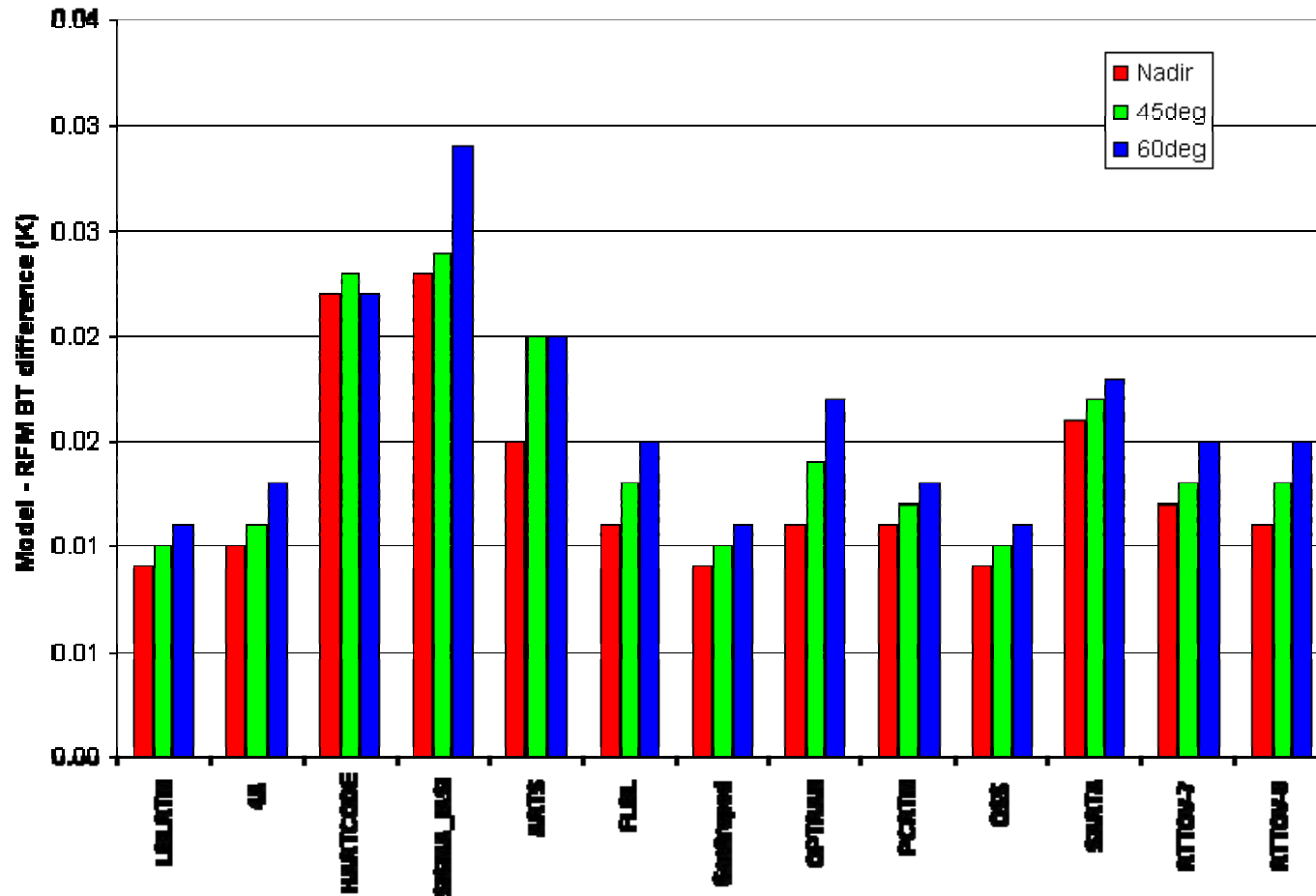


Mean bias for all 49 diverse profiles



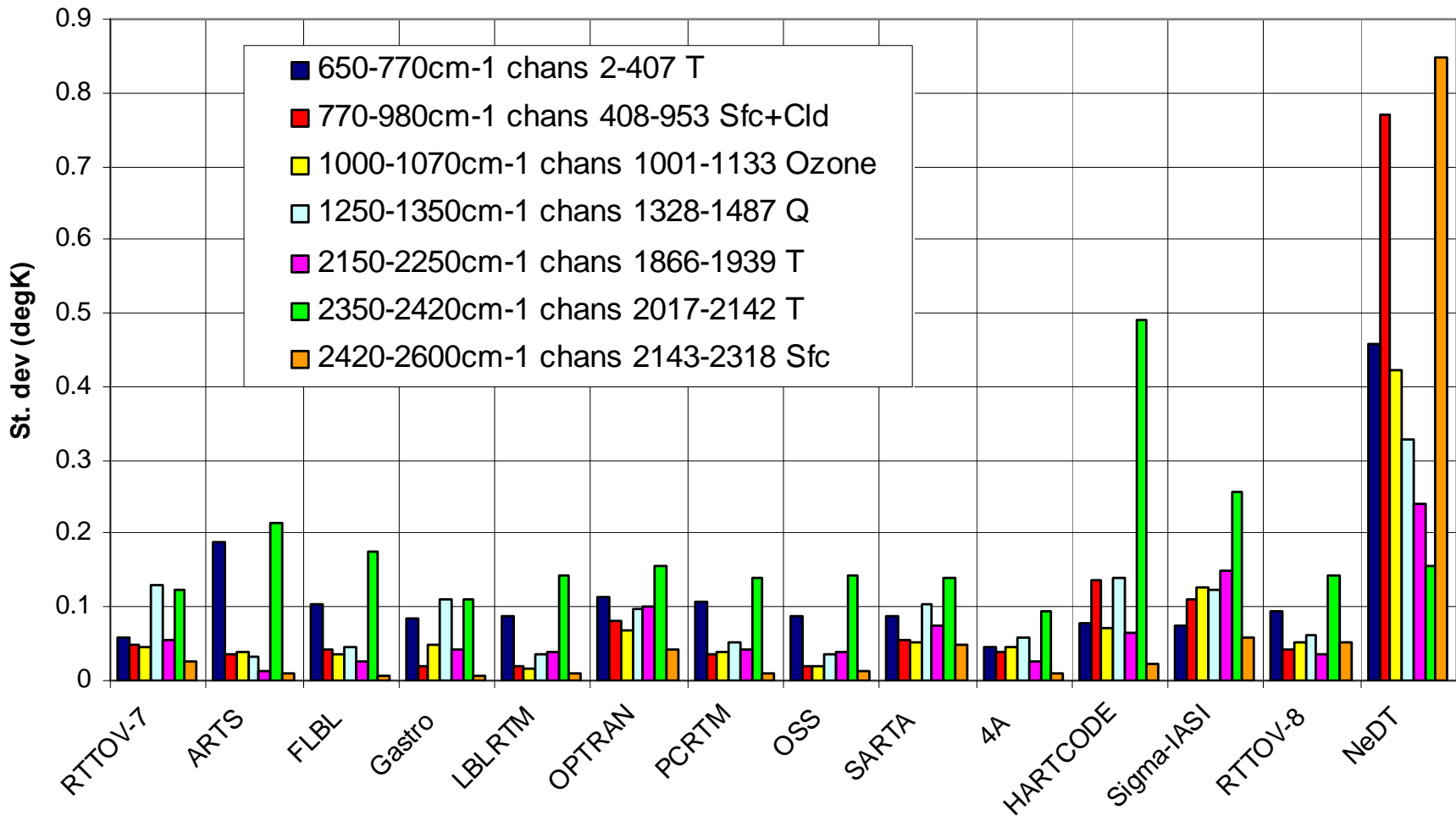
Bias averaged over channels

Mean bias averaged over all channels

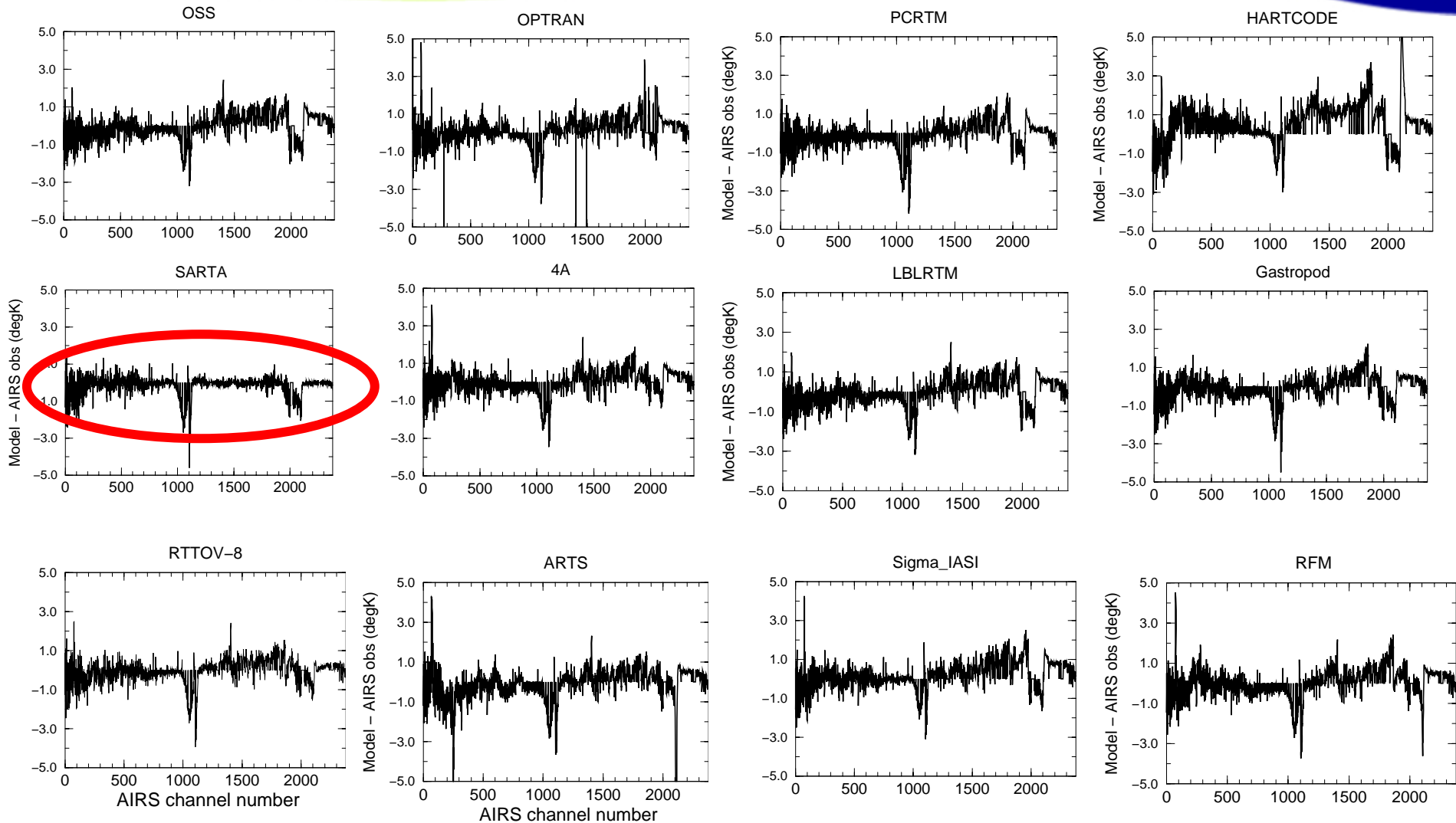


Model bias for different bands

Model-RFM for different spectral regions



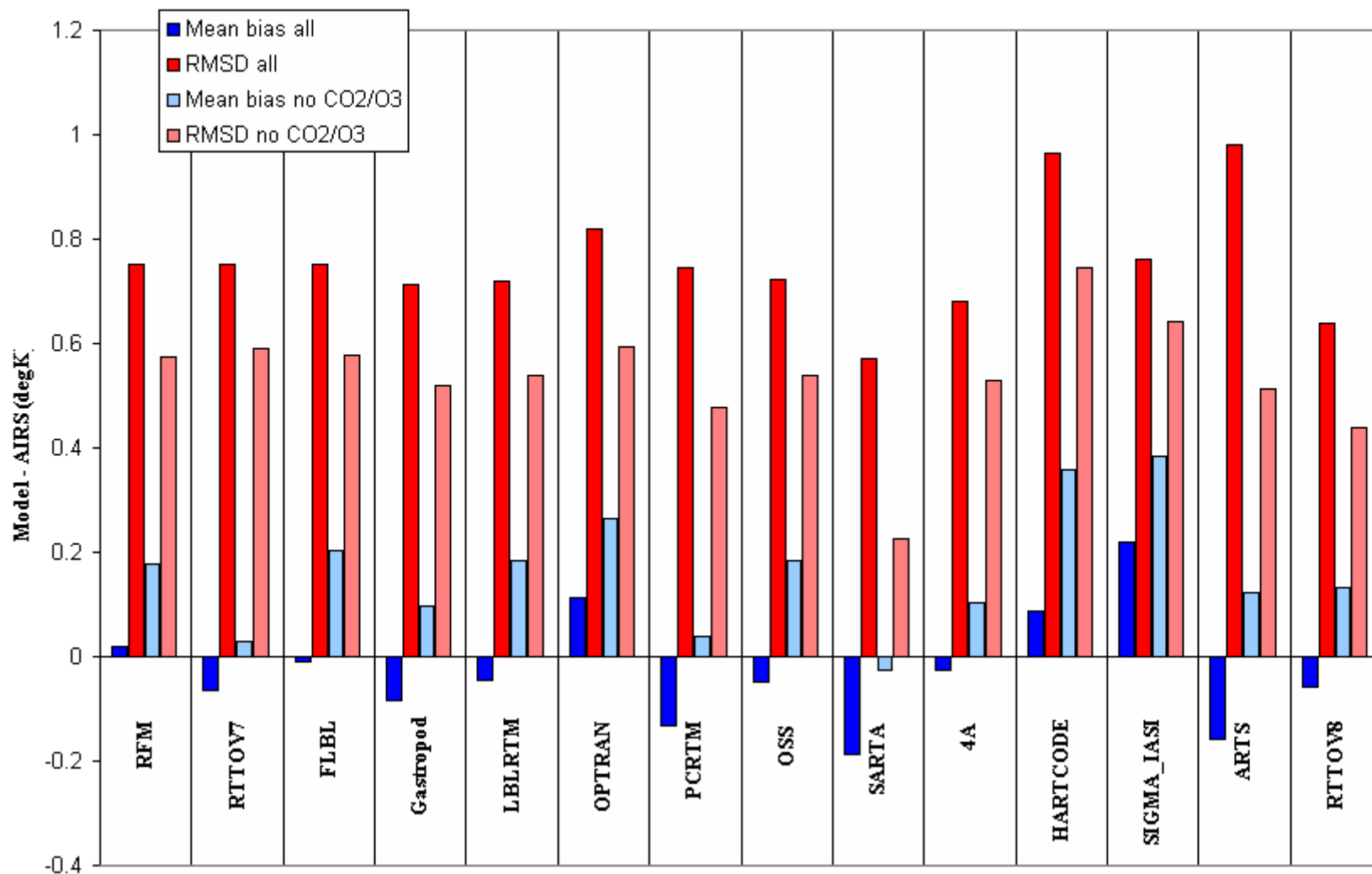
Comparison with observations



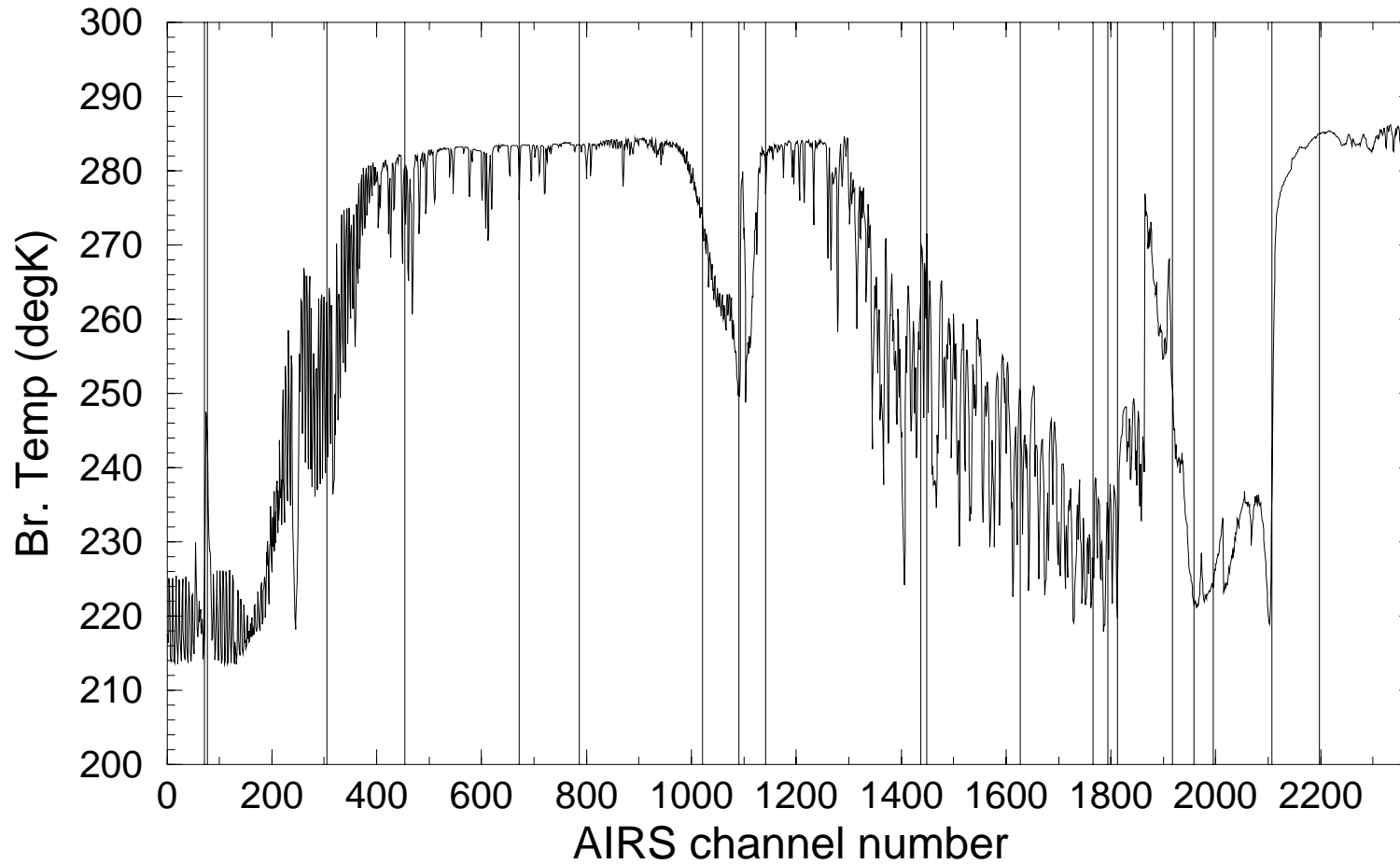
Summary of model –AIRS observations



Model - AIRS Obs



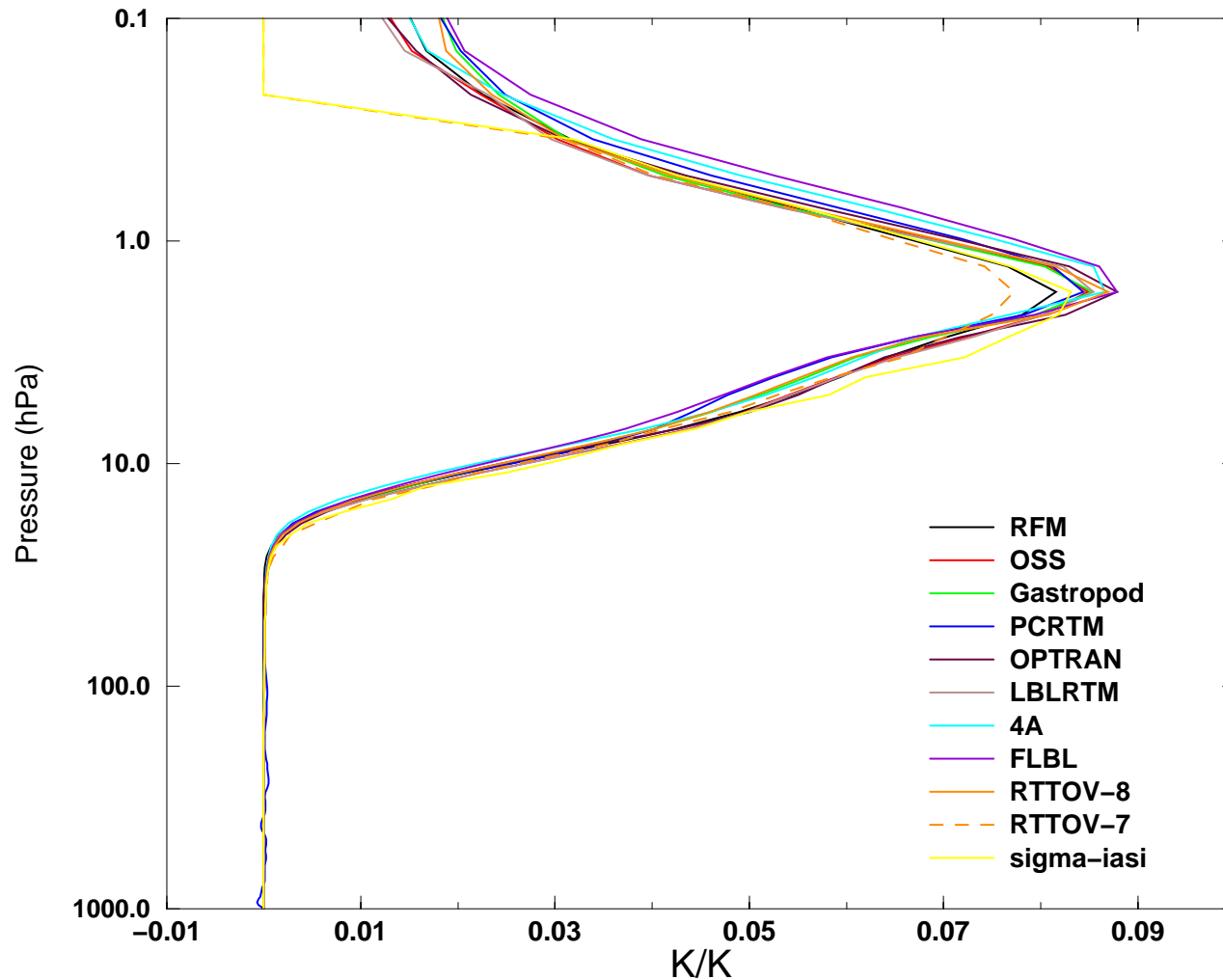
AIRS channels selected for jacobians



Comparison of Jacobians



Temperature jacobian
Profile 1 AIRS channel 77



For the jacobians the results from each model were differenced with RFM one of the line-by-line models in order to be able to conveniently examine the inter-model differences. For the jacobians the “measure of fit” adopted by Garand et. al., [2001] was used defined as:

$$M = 100 \times \sqrt{\frac{\sum (X_i - X_{ref})^2}{\sum (X_{ref})^2}}$$

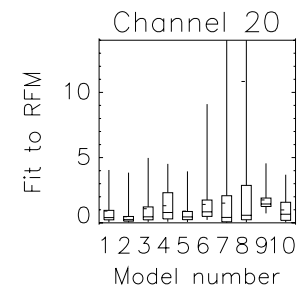
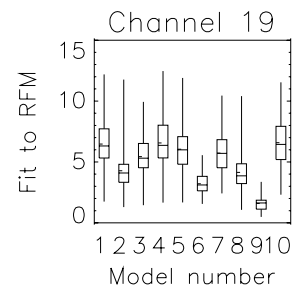
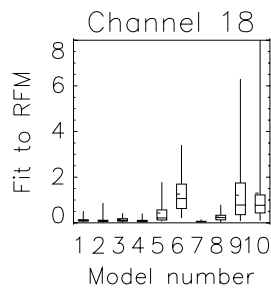
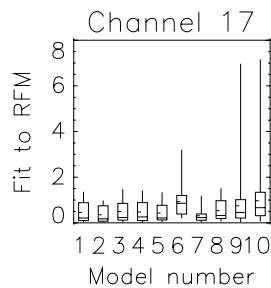
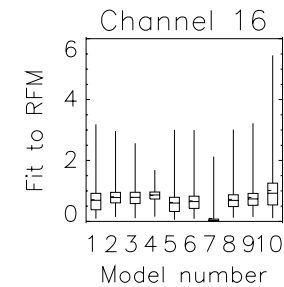
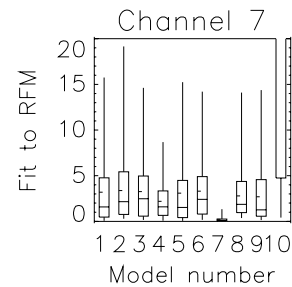
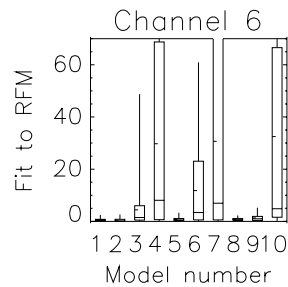
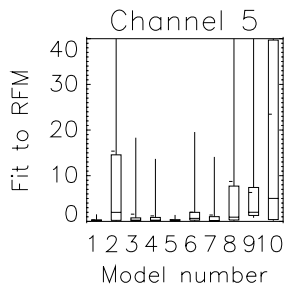
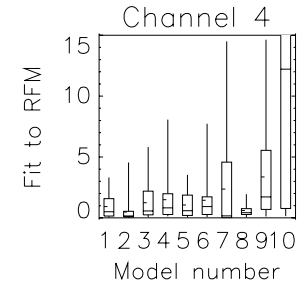
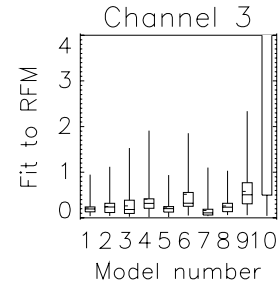
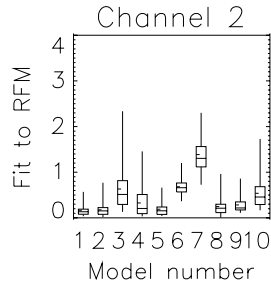
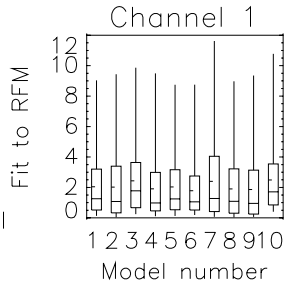
where X_i is the profile variable at level i and X_{ref} is the reference profile variable which was taken to be the RFM model profile for this study.

Comparison of temperature jacobians



Model Key

- 1 OSS
- 2 Gastropod
- 3 PCRTM
- 4 Optran
- 5 LBLRTM
- 6 4A
- 7 FLBL
- 8 RTTOV-8
- 9 RTTOV-7
- 10 Sigma-IASI

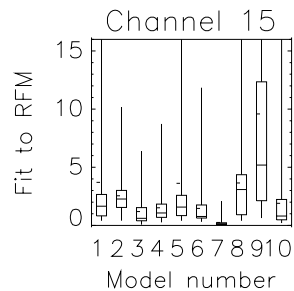
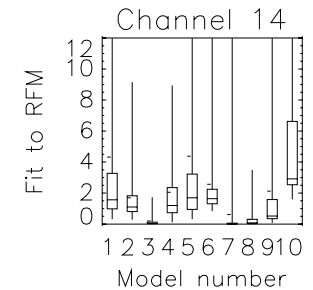
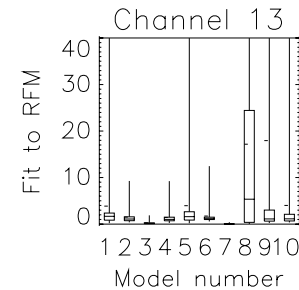
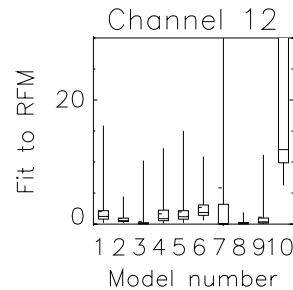
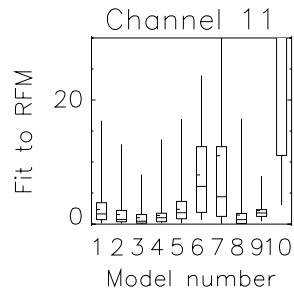
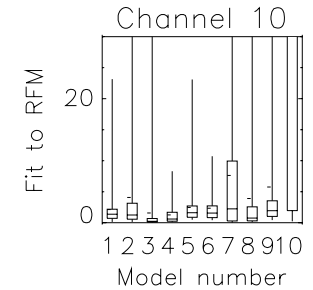
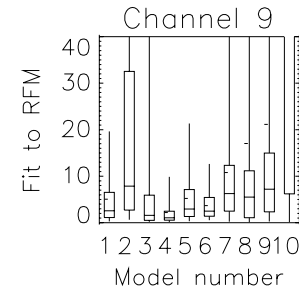
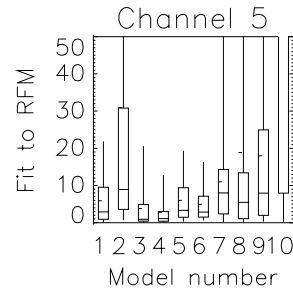
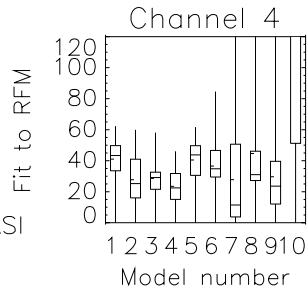


Comparison of water vapour jacobians

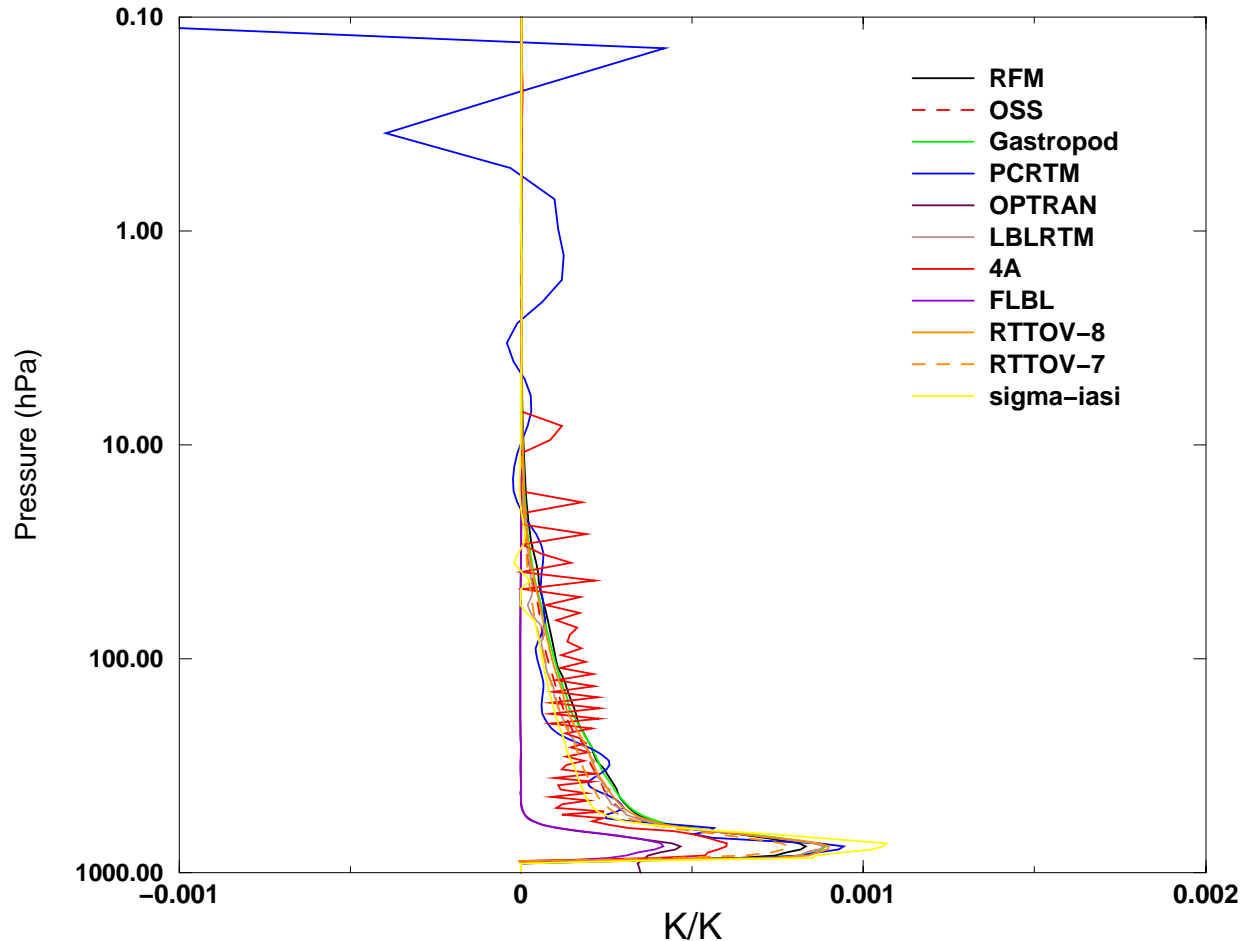


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- 9 RTTOV-7
- 10 Sigma-IASI



Temperature jacobian
Profile 22 AIRS channel 787



This is a weak temperature jacobian but some of the models (e.g. 4A, PCRTM) have very unphysical structures. Does this matter?

The measure of fit is not ideal for assessing these features.

Thanks any questions?

All results and some plots are
on the ITWG web page at:

<http://cimss.ssec.wisc.edu/itwg/groups/rtwg/rtairs.html>

Paper to appear in JGR soon