Monitoring infrared satellite radiance biases using the ECMWF model

Cristina Lupu, Marco Matricardi and Anthony P. McNally

ECMWF, Shinfield Park, Reading, United Kingdom

Aim

Assess in the ECMWF's IFS the most recent release of RTTOV (v11.2) based on the line-by-line model LBLRTM 12.2. This includes better spectroscopy for CO_2, H_2O, O_3, CH_4, a more realistic (i.e. present day) CO_2 trace gas concentration and enhancements of the number of levels the atmosphere is divided into (54 levels).

Motivation

Inconsistency of regression coefficient files used in ECMWF operations due to:

- different line-by-line models, various profile training sets and different number of vertical pressure levels (Table 1);
- assumed CO_2 fixed mixing ratios.

Table 1. The IR regression coefficients currently used in ECMWF operations.

IR sensors	Line-by-line model	Profiles training set	Number of vertical levels:
MET-7	GENLN2	43 profiles set	44
IASI, AIRS, GOES-13	kCARTA	52 profiles set	44
CrIS MTSAT-2	LBLRTM 11.1	83 profiles set	51 44
GOES-15, MET-10 HIRS (Metop-A)	LBLRTM 12.1	83 profiles set	51

RTTOV simulations: LBLRTM 12.2 vs. kCARTA

- Differing spectroscopy and assumed CO_2 concentrations can have a significant impact on atmospheric radiative transfer calculations.

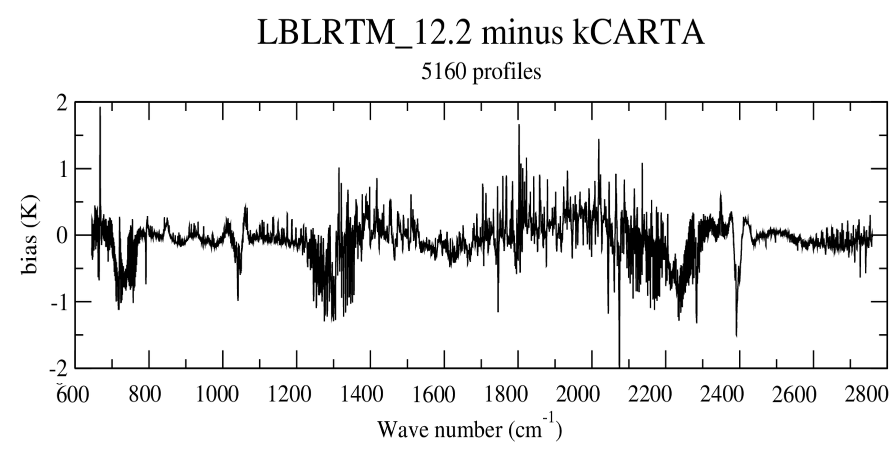

Figure 1. Mean value of the difference between LBLRTM 12.2 and kCARTA RTTOV simulations.

Experiments set-up

- Two experiments have been run with infrared radiances passively monitored using regression coefficients based on different line-by-line models (current vs. new LBLRTM 12.2).
- IASI, AIRS and CrIS infrared radiances are compared to radiances simulated using version 11.2 of the RTTOV fast forward model over a 10 days period from the 10th June to the 20th June 2014.

Results

- The bias and standard deviation of fit against model first-guess (FG) fields for channels currently processed in ECMWF operations (i.e., 420 IASI channels, 312 AIRS channels and 331 CrIS channels) are used to evaluate the accuracy of the RTTOV computations and the quality of the spectroscopic databases on which the RTTOV coefficients are based.

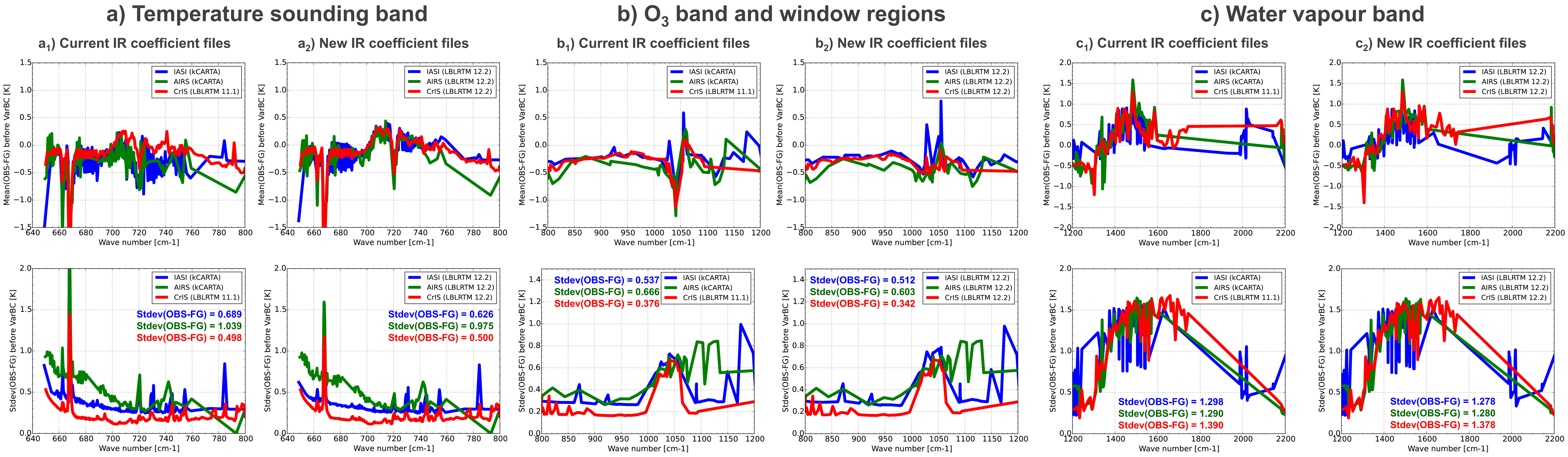

Figure 2. The mean (upper plots) and the standard deviation (lower plots) of the difference between observations and simulated radiances are overlaid for IASI (blue line), AIRS (green line) and CrIS (red line). Results are shown for three spectral regions (600-800 cm^{-1}, 800-1200 cm^{-1} and 1200-2200 cm^{-1}) for the current RTTOV simulation based on the operational IR coefficient files (a_1, b_1, c_1) and for the new IR coefficient files (a_2, b_2, c_2) and are based on spatially- and temporally coincident clear-sky (aerosol- and cloud-free) radiances.

Discussion

- The use of LBLRTM 12.2 in conjunction with more realistic CO_2 concentrations reproduces IASI and AIRS observed spectra better than simulations based on kCARTA .
  - The largest change in the mean(OBS-FG) residuals is observed in the range 700-750 cm^{-1}; there is more consistency between the residuals obtained using the same set of LBLRTM 12.2 coefficients;
  - Smaller (OBS-FG) biases and standard deviations are seen in the ozone sounding band and in the water vapour band.

LBLRTM 12.2 also show better performance than LBLRTM 11.1.

  - Overall, CrIS LBLRTM 12.2 (OBS-FG) standard deviations are improved.

References

Eresmaa, R., 2014: Imager-assisted cloud detection for assimilation of Infrared Atmospheric Sounding Interferometer radiances. *Q.J.R. Meteorol. Soc.*, 140: 2342–2352. doi: 10.1002/qj.2304

Matricardi, M., 2009: An assessment of the accuracy of the RTTOV fast radiative transfer model using IASI data. *Atmos. Chem. Phys.*, **9**, 6899–6913, doi:10.5194/acp-9-6899-2009.

Acknowledgements

Cristina Lupu is funded through the EUMETSAT NWP-SAF programme. Discussions with Reima Eresmaa and Julie Letertre-Danczak are gratefully acknowledged. The authors would like to thank Simon Witter for his help with the design of this poster.

e-mail: cristina.lupu@ecmwf.int