

Motivation

- RTTOV (currently at version 12, Saunders et al., 2018) is a worldwide used fast RTM for satellite data assimilation in numerical weather prediction (NWP) models and being more and more used for satellite retrievals, reanalysis or predicted satellite imagery. For these purposes RTTOV provides forward and adjoint models (as TL, AD or K).
- Extending RTTOV to FIR is challenging and very stimulating, currently RTTOV is simulating IR instruments between 3 and 20 microns.
- To do so, we need to test or extend many RTTOV capabilities: fast transmittance model, cloud and aerosol spectral optical properties and surface emissivity models.

RTTOV coefficient performance for FORUM

The left panel of Figure 1 shows the instrument spectral response function (ISRF) used for RTTOV transmittance coefficients calculation.

Coefficients were calculated using LBLRTM V12.2 with AER 3.2 and MTCKD 2.5.2.

The middle panel of Figure 1 shows the spectral statistics of the performance of the RTTOV predictors version 7 coefficients on 101 levels by comparing the TOA radiances simulated with RTTOV transmittances to TOA radiances simulated with LBL convolved transmittances.

Results are comparable to IASI (left panel of Figure 1). There are slightly less good below 300 cm⁻¹.

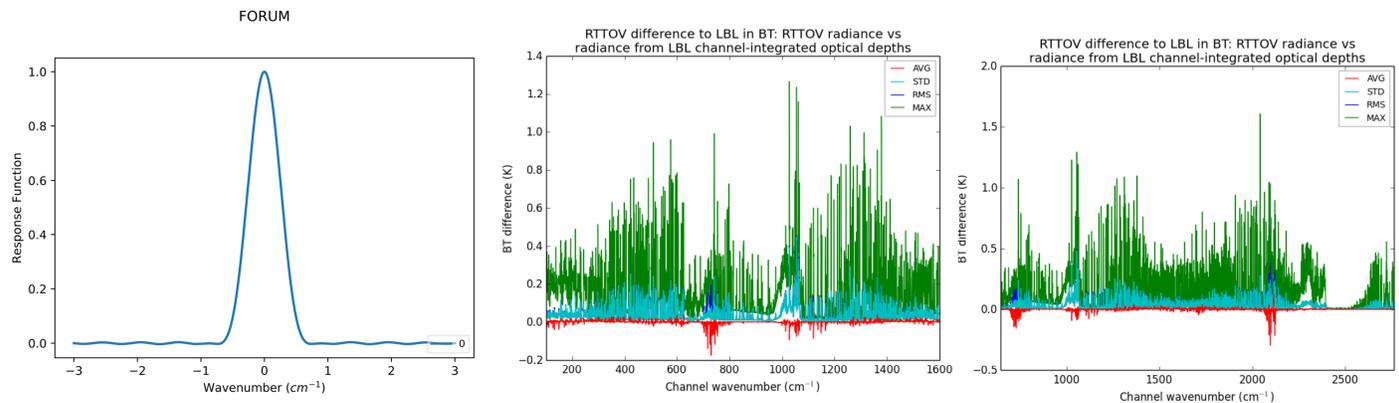


Figure 1. Left : FORUM ISRF. Middle: RTTOV vs LBL performance for FORUM. Right : same as middle for IASI

RTTOV-12 status for FIR

The following table provide the list of the different model currently available for FIR that are based on RTTOV IR.

Transmittance model	Cloud model		Surface model		Aerosol model
	Liquid	Ice	Ocean	Land	
Same as IR for predictors version 7, 8 and 9 (only version 7 have been tested).	2 databases: - OPAC models where the refractive index of water have been extended to FIR. - Effective diameter based optical properties	2 databases: - Baum optical properties - Baran parameterization (to be done)	2 models: - ISEM (viewing angle parameterization) - IREMIS (+ wind speed and skin temperature parameterization + improved salinity correction)	Default value of 0.98 No atlas available for FIR.	Need to be extended. OPAC, in situ based models and CAMS are currently available in IR.

Results

Examples of simulated FORUM spectra with RTTOV 12 are shown below for an ice cloud layer (left) and an liquid cloud layer (right). The inputs profiles comes from the NWP SAF 137 levels database for temperature, specific humidity, ozone (not show) and ice water content or liquid water content. The surface temperature and the cloud optical depth at 10 microns are given. The ice cloud model is Baum and the liquid cloud model is the cumulus maritime from OPAC. The surface emissivity comes from IREMIS. The simulation are done for clear-sky and cloudy-sky at three viewing angles (0°, 30° and 60°).

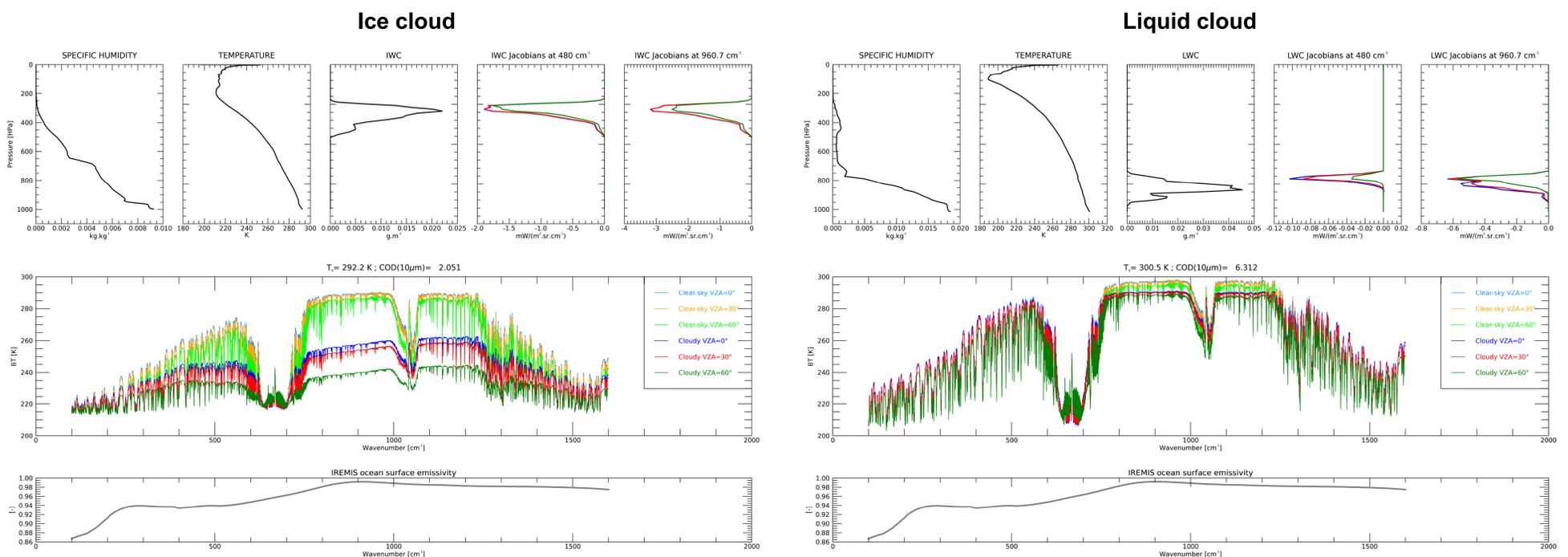


Figure 2. Results for ice (left) and liquid (right) cloud case. Top row are respectively specific humidity, temperature and IWC from NWP SAF 137 levels database, IWC (resp LWC) jacobians at 480 cm⁻¹ and at 960.7 cm⁻¹. middle row are clear-sky and cloudy-sky simulated spectra at three viewing angles. Bottom row is surface emissivity.

Conclusion and future plans

- RTTOV version 12 is now available for FORUM and ready for further study. The FIR implementations are based on RTTOV IR for transmittance model and where optical properties of clouds have been extended to FIR. The ocean surface emissivity models were already able to cover the FIR.
- First simulations for ice and liquid clouds look promising for both radiance/brightness temperature and jacobians.
- However, there are still some aspects that need to be developed for a complete used of FORUM observations. These are:
 - A land surface emissivity model or atlas.
 - An extended database of aerosol optical properties. RTTOV V13 will provide a tool for users to generate their own aerosol properties based on Mie theory.

References:

Saunders, R., Hocking, J., Turner, E., Rayer, P., Rundle, D., Brunel, P., Vidot, J., Roquet, P., Matricardi, M., Geer, A., Bormann, N., and Lupu, C.: An update on the RTTOV fast radiative transfer model (currently at version 12), Geosci. Model Dev., 11, 2717-2737, <https://doi.org/10.5194/gmd-11-2717-2018>, 2018.