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# Hyperspectral IR cloudy radiances and jacobians simulations: comparison between RTTOV-12 and LIDORT

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## Objectives

■ Evaluate the scattering approximation of RTTOV V12 (Saunders et al., 2017) in infrared for cloudy radiances and jacobians

2 RTMs:

■ RTTOV v12 : « Chou scaling » scattering approximation (Chou et al., 1999) , no solar contribution

■ LIDORT (Spurr, 2006) : Full scattering model, 16 streams, solar contribution

## Method

■ Configuration:

LIDORT inputs: RTTOV transmittances, surface emissivities (IREMIS over ocean and UWIREMIS over land), cloud optical properties (ice and liquid), Lambertian surface, pseudo-spherical geometry and cloud fraction = 1, Solar contribution SZA=40°for LIDORT

■ Atmospheric and cloud profiles datasets :

NWP SAF profiles dataset at 137 atmospheric levels (ECMWF vertical grid)

## Cloud profiles selection

▪ Profiles have been selected from a database of 5000 profiles coming from ECMWF short-range forecast:

- Temperature, water vapor, ozone, ice and liquid water content.
- Latest ECMWF 137 levels.
- One year period.

▪ This dataset is available at https://nwpsaf.eu/site/.

Positions of the selected profiles are shown in Figure 1.

▪ The total number of profiles is given in Table 1.

| Case | Ice | Liquid | Mixed |
|---|---|---|---|
| Nb profiles | 212 | 985 | 3151 |

Table 1. Number of selected profiles

▪ Clouds are well distributed all over the globe

▪ Ice cloud profiles only represent 4%, liquid cloud profiles only represent 20% and mixed clouds profiles represent 63 %.

▪ Liquid clouds only are seen mostly in areas of lower level marine stratocumulus fields (see jacobian peak).

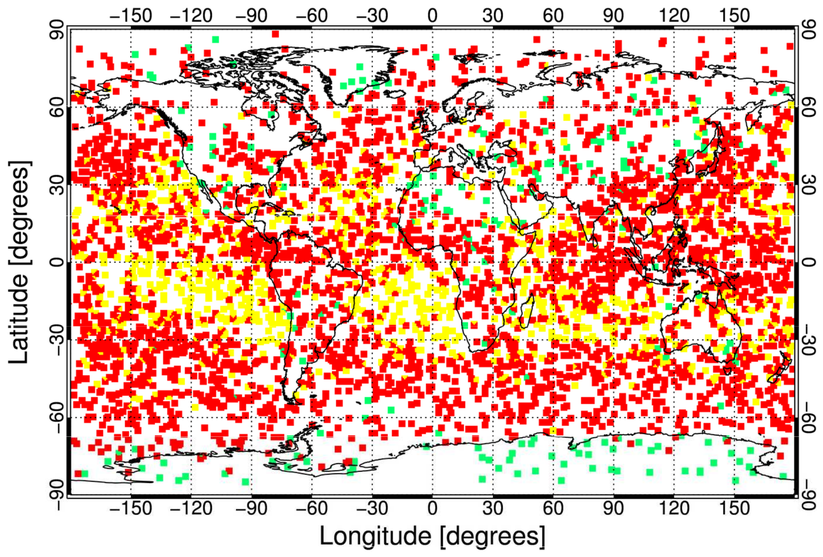
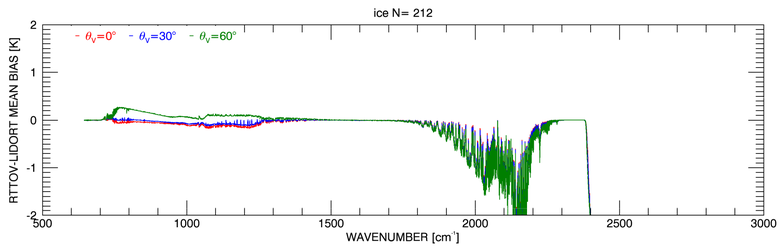
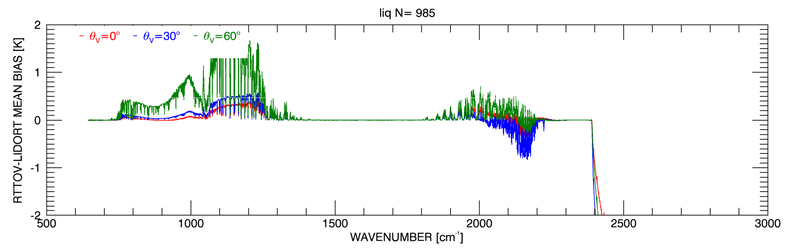
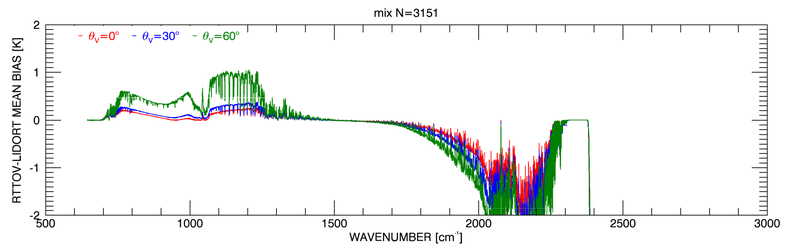



Figure 1. Locations of the selected profiles

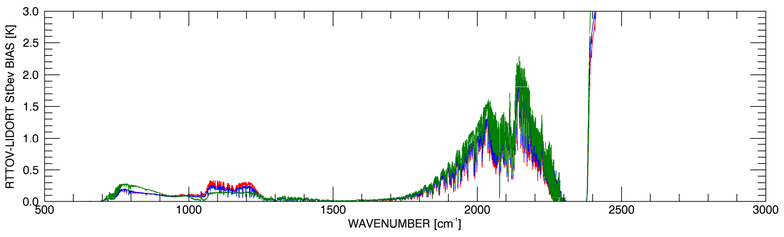
## Results for three viewing geometries (nadir, 30° and 60°) and Jacobian at 960.75 cm$^{-1}$



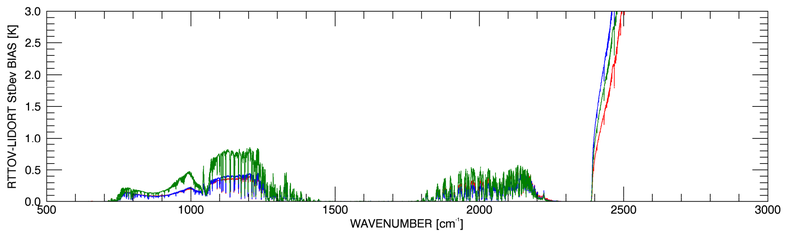



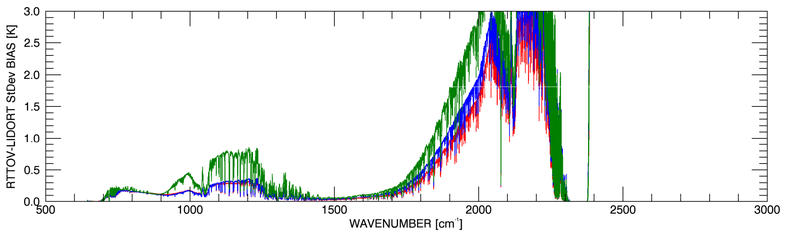

ICE CLOUDS ONLY: RTTOV-LIDORT MEAN BIAS ↑ RTTOV-LIDORT STDEV ↓




LIQUID CLOUDS ONLY: RTTOV-LIDORT MEAN BIAS ↑ RTTOV-LIDORT STDEV ↓




MIXED CLOUDS ONLY: RTTOV-LIDORT MEAN BIAS ↑ RTTOV-LIDORT STDEV ↓




**For radiances:**

▪ Mean bias and sigma < 0.5K out of solar contribution and for SZA ≤30°.

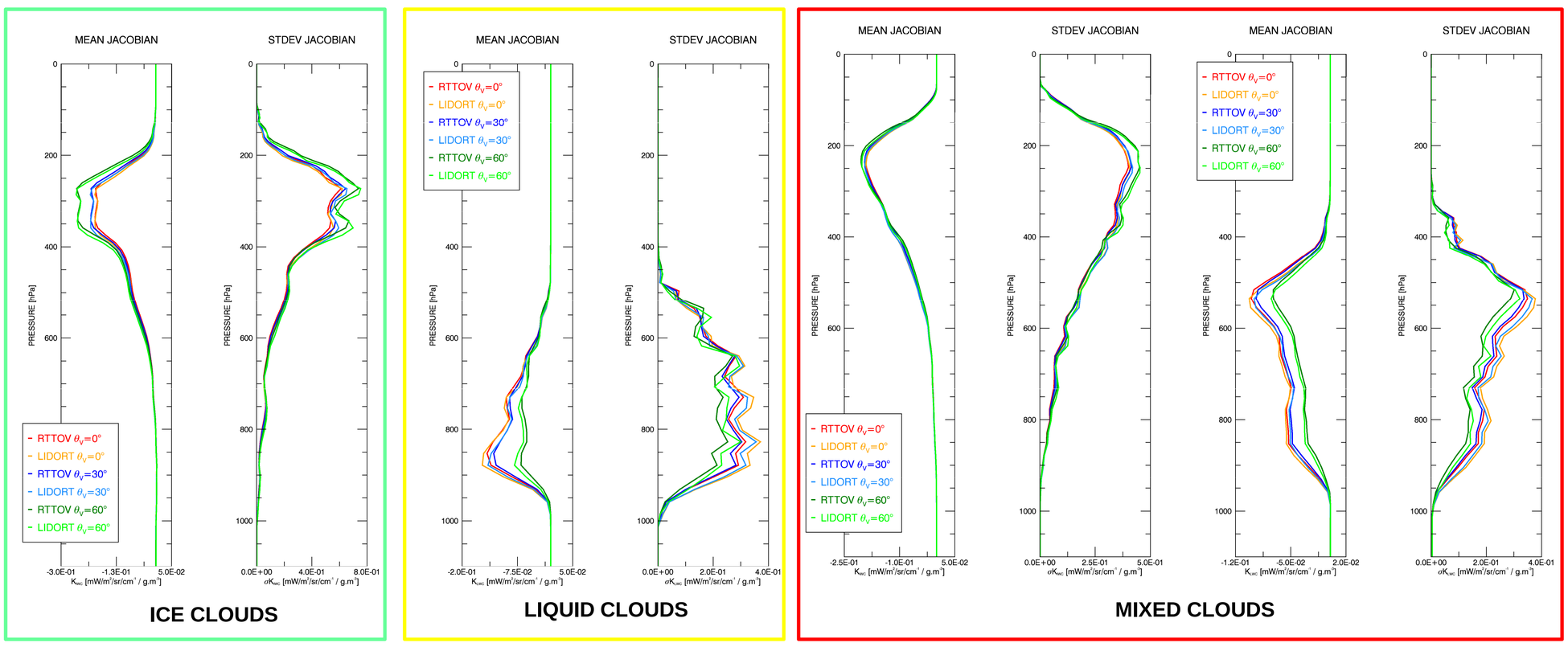
▪ Bias and standard deviation increase with VZA.

▪ In SWIR bias and goes up to 2K for liquid clouds at VZA=60°.

**For Jacobians**:

▪ Very good agreement between RTTOV and LIDORT

▪ Jacobians increase with VZA for ice cloud and decrease with VZA for liquid and mixed clouds.




**Conclusions: 1) The « Chou scaling » scattering approximation of RTTOV in the IR is very efficient for both IR cloudy radiances and jacobians in window channels. 2) Errors from liquid clouds are more important than for ice clouds. 3) Jacobians increase with VZA for ice cloud and decrease with VZA for liquid and mixed clouds.**

*References:*
*Saunders R, et al. 2017. `RTTOV-12 Science and validation report,` EUMETSAT NWP-SAF Report.*
*Chou, M. D., K. T. Lee, S. C. Tsay, and Q. Fu (1999), Parameterization for Cloud Longwave Scattering for Use in Atmospheric Models, J. Climate, 12, 159–169.*
*Spurr, (2006): VLIDORT: A linearized pseudo-spherical vector discrete ordinate radiative transfer code for forward model and retrieval studies in multilayer multiple scattering media, JQSRT ,102, doi:10.1016/j.jqsrt.2006.05.005.*