Title: Statistical study of inconsistencies between infrared and microwave cloudy simulations

Authors: Ethel Villeneuve, Philippe Chambon, Nadia Fourrié

Affiliation: CNRM, Université de Toulouse, Météo-France, CNRS, Toulouse, France

---

Modelling of scattering properties is of major interest in cloudy data assimilation. Across the spectrum from the IR to the MW, these properties have been modeled with various assumptions (hydrometeors shapes, particle size distribution, dielectric properties ...) and methodologies (DDA, T-matrix, ...). They are then used within fast radiative transfer codes like RTTOV or CRTM. Thus, it can imply inconsistencies between simulations of the different spectral ranges. The study aims at providing quantitative results to evaluate the importance of simulating consistent radiative properties across the spectrum, with respect to the numerous uncertainties within microphysical parameterizations. In this study, different sources of inconsistency between infrared and microwave simulations are investigated.

A fully simulated framework is used. Observations and first guess are simulated with lagged forecasts from the Météo-France ARPEGE global model, for the three future instruments onboard MTG-I (Meteosat Third Generation) and MetOp-SG-B (MetOp Second Generation): the infrared Flexible Combined Instrument (FCI), the MicroWave Imager (MWI) and the Ice Cloud Imager (ICI). These three instruments are sensitive to various and complementary quantities within clouds and precipitation.

The so-called "1D-Bayesian + 4D-Var" assimilation method (Duruisseau et al., 2019) is used for the cloudy MW observations at Météo-France. It consists of a Bayesian inversion of the brightness temperatures, that retrieves atmospheric profiles from satellite radiances which are then assimilated in the 4D-Var of the global model ARPEGE. Here we use the same assimilation method for the IR data.

Inconsistencies could come from errors in the radiative transfer assumptions or in the model parameterizations. Different settings will be considered. The first setting will be refered as "perfect": the same radiative transfer is used to compute the retrieved profiles and to generate the observation. The same model configuration is used for every computation. This first setting will be the control experiment to determine the error related to the inversion method itself. The second one refers to a modified radiative transfer used for the computation of the Bayesian inversion; the model remains "perfect". The third one refers to a modified microphysics in the model ARPEGE; the radiative transfer remains perfect. The last two settings allows to determine which source of inconsistency is predominant.

Statistical results, covering a wide sample of profiles from ARPEGE forecast model, will be shown to compare the model ability to retrieve correct hydrometeors profiles among the different settings in order to quantify how the different hypothesis between IR and MW involve significant errors.