Ecole Doctorale - 104
Sciences de la Matière, du Rayonnement et de l'Environnement
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UNIVERSITY: Lille , Faculty of Sciences and Technologies

Scientific domain: Optics and Lasers, Chemical Physics, Atmosphere.
Title of the thesis: Retrieval of high clouds ice water content from high spectral resolution measurements in the Infrared from the IASI spaceborne instrument.

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ABSTRACT

The knowledge of the low limit troposphere on one hand, and the region of the tropopause on the other hand is a major task to better understand and improve the climate modelisation. This is true for the temperature as well as for the water vapor (in particular in the low layers), but also for clouds or aerosols from which the climatic forcing remains one of the major unknown of the current climatic system.

Advances concerning the evolution of the atmospheric column depend on a close coupling between modelling and observation. Numerous studies have shown the advantages of using hyper-spectral measurements in the infrared to get information on atmospheric parameters. It results, for example, in a massive use of these measures to initialize forecast models.However, the majority of these studies focused only on pixels labelled "clear", easier to treat, to obtain an information about atmospheric parameters such as the temperature profile or some gases concentration. Moreover, the great majority of the measures being contaminated by scattering particles (e.g. aerosols or clouds) as been classified as « non-clear », and are therefore not treated because more difficult to handle.

The advantage of infrared measurements for the study of high clouds holds in their high sensitivity to the presence of fine clouds when the difference of temperature between the cloud and the underlaying surface is large. Futhermore, the high spectral resolution would allow to obtain, by using the appropriate absorption chanel, an information about the height as well as about the thickness of the cloudy layer.

Thus, the objective of this PhD thesis will be to demonstrate the feasibility of using high spectral resolution measurements in the infrared to retrieve information on labelled « non-clear » pixels, in particular pixels contaminated by ice clouds. We will focus on ice cloud parameters such as their total ice water content (IWP), their altitude and geometrical thickness. In a first step, an information content theory (Shanon, 1949) will be used in order to quantify the distribution of the information between these parameters coming from the observing system. In a second step an algorithm based on an optimal estimation theory (Rodgers, 2000) will be developped and apply to the measures of the IASI instrument. Because time computation would be one of a major concern, the radiative transfer code model RTTOV will be used as a forward model. This model has proved very good comparisons (e.g. radiance as well as Jacobians) with the well known LIDORT model which solves the multiple scattering in exact way. The cloud microphysics will be modeled by the ensemble model from Baran et Labonnote (2007).

After the undeniable contribution of the IASI instrument for the characterization of clear atmospheres, the major goal of this PhD thesis will be to demonstrate the capacity of this instrument (and his futur successor IASI-NG) to better characterize and modelize ice cloud in forecast models.

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