UNIVERSITY: Lille , Faculty of Sciences and Technologies

Scientific domain: Optics and Lasers, Chemical Physics, Atmosphere.

Title of the thesis: Remote sensing of water vapour above and around convective clouds

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ABSTRACT

According to the latest IPCC report (2013), the role of clouds in the climate system remains a challenge for climate modelling. The formation and development of clouds in the atmosphere depends largely on the amount of water vapor available and clouds, particularly those resulting from convective processes, contribute to redistributing water vapor in the atmosphere. Knowledge of the spatial and temporal variability of water vapor in a cloudy atmosphere is therefore an essential information to improve our knowledge of the mechanisms linking water vapor and clouds and thus constrain small-scale physical cloud models and numerical weather prediction models. It is also important to note that water vapor is the primary greenhouse gas in the Earth's atmosphere, so improving the representation of processes concerning its concentration and interactions in the atmosphere will help to improve climate predictions.

Currently, water vapor contents and profiles are obtained, generally in clear skies, using microwave or infrared sounders at spatial resolutions of about ten kilometers. A French-Israeli space mission project named C^3IEL (Cluster for Climate and Cloud Imaging of Evolution and Lightning) is currently under study and aims to retrieve the vertical development of convective clouds. The CLOUD imagers planned for this mission will allow multi-angle measurements (2 or 3 satellites) of the same cloud scene at a decametric resolution every 20s during 200s. These measurements will be carried out in the visible to allow stereoscopic restitution of the cloud tops and cloud vertical development but also in water vapor absorption channels. The presence of different channels at a resolution of about one kilometer should allow the retrieval of water vapor above and around the convective clouds.

The planned work will be divided in two stages. As a first step, a method will be developed to obtain the atmospheric integrated water vapor above and between clouds. The differential absorption method already implemented for other sensors such as MODIS or POLDER will be used. The second part of the work will consist on information content analysis of multi-angle measurements for the retrieval of vertical water vapor profiles. A tomographic approach for the restitution of water vapor profiles had been already studied for Phase 0 CNES studies, but only with a single platform and larger spatial resolutions. The development and validation of the algorithms will use realistic observation simulations obtained with the three-dimensional radiative transfer code, 3DMCPOL from cloud fields generated by a physical cloud model based on RAMS and using representative water vapor profiles performed by the microwave radiometer in the Laboratoire d'Optique Atmosphérique (LOA).

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