Ecole Doctorale - 104
Sciences de la Matière, du Rayonnement et de l'Environnement
EDSMRE

Université de Lille

Thesis title :

Stereo-imagery and Radar data for Convective Cloud Characterization

University : University of Lille , Faculty of Sciences and Technologies

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ABSTRACT

Convective cloud systems are of great importance in meteorological forecasting as they are the basis for the development of severe thunderstorms that can cause considerable material and human damages. However, evolution of convective cloud systems remains very difficult to predict because of the various spatial and temporal scales involved in their formation and maintenance. It is therefore essential to progress in the knowledge of convective processes, and in particular in the relation between their dynamical development and their close environment.

Recently, two satellite trains have been proposed to characterized the dynamics of cloud development. One named C^{3}IEL (Cluster for Cloud evolution, CIImatE and Lightning) focuses on the 3D dynamics of the cloud envelopes at high spatial and temporal resolutions through the successive observations of visible stereo images, supported by water vapor and electrical activity measurements. The other one, INCUS (INvestigation of Convective UpdraftS) consists in vertical Ka-band reflectivity profiles separated by few tens of seconds and passive microwave observations dedicated to dynamics of the convective updrafts inside the clouds occurring during the formation of convective storms.

Each of the two missions have their own objectives but a coordinated mission combining the two sets of observations could achieve much more than the sum of the two missions separately. Indeed, the relation between the in-cloud dynamics and the 3D development of cloud envelop, consisting in a cascade of eddies visible with cauliflower structure, is not straightforward. The convective mass flux inside the clouds can indeed be converted into cloud vertical development, cloud horizontal divergence, detrainment and precipitation according to a poorly known partition.

The objective of the thesis will be to explore the potential of having these two sets of observations in order to make the most of the synergy of the two missions. To achieve this, fine-scale simulations using numerical atmospheric models will be generated according to different environmental conditions. Realistic observations of the two missions will be derived from these simulations : stereo-images using a three-dimensional radiative transfer model and synthetic reflectivity profiles from the hydrometeors optical properties using a radar simulator. From these synthetic observations, the inversion algorithms already developed, will be applied. Study of the relations between the retrieved cloud development velocity from C^{3}IEL and the retrieved in-cloud convective mass flux from INCUS will be achieved according to the environmental conditions and the cloud microphysics .