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Chimie
Mathématiques
Sciences de l'Univers
Physique

Ecole Doctorale des Sciences Fondamentales

Title of the thesis

Title of the thesis: Effects of clouds heterogeneity on data provided by spaceborne and airborne lidars and radars.

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Summary:

Clouds have a significant effect on the Earth radiation budget. They reflect the solar radiation and reduce the warming of the Earth (albedo effect). They also create a greenhouse effect by trapping the thermal radiation emitted from the Earth's surface, reducing the radiative cooling of the Earth.
Lidars (Light Detection And Ranging) et radars (Radio Detection And Ranging) are and will be employed to infer the global distribution of clouds, their properties, and their diurnal, seasonal and interannual variability. The resulting datasets and analysis products aim to study the role of clouds in climate, both their effects on radiative energy exchanges and their role in the global water cycle.
The lidar CALIOP and the radar CPR belong to the so-called 'A-train' constellation of six Earth observation satellites. The planned mission EarthCARE will employ the following active sounding systems: High-spectral resolution and depolarization Lidar (ATLID) and Doppler Cloud Profiling Radar (CPR). Other French projects (DYCECT, MESCAL) involve lidars and radars.
Measured lidar/radar data as well as retrieved characteristics depend on a large set of instrumentation and cloud parameters even in the case when the single scattering approximation is valid. The interpretation of data became much more complex when multiple scattering has to be accounted for. 3D cloud heterogeneity plays an important role as well.

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Scientific contributions that deal with lidar systems and inhomogeneous clouds are few in number. First study of effects of cirrus heterogeneity on lidar data measured was performed within the doctoral thesis by Alaa Alkasem (2013-2017). The proposed thesis is extension of that work. At the beginning, the PhD student will use the existing software (3DCLOUD and McRALI) to generate 3D cloud fields and to simulate lidar and radar signals, especially, in view of EarthCARE products.

Study of sensitivity of spaceborne and airborne lidars and radars data to 3D distribution of microphysical, optical and dynamical properties of clouds is one of the priority parts of the thesis. The sensitivity study will be performed in view of inverse problem algorithms applied to measured data.

Along with that, the PhD student will participate in preparation of the field campaign EUREC4A (2020). He/she will model airborne lidar and radar signals from trade-cumulus.

Keywords: clouds, heterogeneity, lidar, radar, modelling, sensitivity study.

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