Master 2: Research Training 2023-2024

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Eventually CaPPA Work Package: **WP3 - Aerosol properties and multi-scale variability derived from innovating spaceborne observations**

Improvement of CO2 products in scattering atmosphere and determination of particle's microphysical properties from the measurements of the MicroCarb instrument.

Understanding the lower troposphere up to the tropopause region, is a major challenge to better understand and simulate climate change. This is true for temperature, water vapor or greenhouse gases (GHG), including CO_2, but also for clouds or aerosols whose radiative forcing remains one of the major unknowns of the current climate system.

Advances in the evolution of the state of the atmospheric column are based on the close coupling between modelling and observation. The atmospheric parameters retrieval such as GHGs (CO_2, CH_4) using hyperspectral measurements has been the subject of numerous studies, and has led to (1) a massive use of these measurements in order to improve the forecasting models, or (2) a monitoring of the evolution of the atmospheric composition. However, the majority of this work only concerned pixels labelled "clear sky", which is easier to process, in order to obtain information on atmospheric parameters such as temperature profile or concentrations of certain gases. However, scattering particles (aerosols or clouds) contaminate a large majority of the measurements, which are then either rejected, because they are more difficult to process, or processed by ignoring the effect of the scattering layer on the restitutions.

The advantage of high spectral resolution measurements for the study of scattering layers lies in their high sensitivity to the presence of this layer when appropriate absorbing bands are used to avoid the signal coming from the surface. Moreover, if the spectral resolution is sufficient and the spectral range used has a set of different absorption lines (which is the case in the A band of oxygen for example), additional information on the thickness of the layer is possible. The use of spectral regions sensitive to microphysics such as 1.6 μm or around 2 μm also provides information on the nature, concentration or size distribution of cloud and aerosol particles.

The objective of this Master internship will thus be to demonstrate the feasibility of using high spectral resolution measurements such as those of MicroCarb, and more particularly the pixels contaminated by fine ice clouds or aerosols, in order to find the microphysical and optical properties of the latter, as well as the vertical position and thickness of the layer. Initially, an information content study will be conducted in order to better determine the potential of this type of observation to retrieve the parameters of the scattering layer. Then, an algorithm based on the optimal estimation method will be developed in order to test the restitution capacities of the particles properties and the CO_2 columns simultaneously. This subject is selected by CNES for PhD funding

Key words: remote sensing, satellite, CO2, aerosols, clouds, climate