Clouds are a major source of uncertainties in current climate models. These uncertainties arise from the difficulty to establish parameterizations to integrate properly the radiative properties of clouds in climate models. To improve and optimize these parameterizations, it is necessary to collect a large amount of information on macrophysical and microphysical cloud properties. The determination of these properties is mainly based on the comparison of satellite measurements to simulations from radiative transfer models in cloudy atmosphere.

This study focuses on the upper tropospheric clouds of one of whose characteristics is to be mainly composed of ice crystals with various shapes and sizes. To better understand radiative properties of these kind of clouds, it is necessary to study the interactions of electromagnetic radiation with these ice particles. For this, we developed several algorithms based on approximations of geometrical optics and wave optics.

On the other hand, cloud radiative properties depend on their macrophysical and microphysical characteristics such as geometric thickness and altitude, optical thickness and size and shape of cirrus ice crystals. Airborne campaigns of in situ measurements have shown that these clouds could have a significant vertical variability of the crystal size distribution. It is therefore important to assess the radiative impact of this vertical variability in deciding whether and how it should be taken into account in the models. To answer this question, we developed a model of cirrus to describe this heterogeneity. Then, we showed, from the evaluation of the sensitivity of the radiative properties of these clouds to the vertical profile, that it is important to take into account this heterogeneity and how to find some information on the vertical profile by passive remote sensing.