The upper tropospheric (UT) cold cirrus ice clouds, covering up to 30% of the global sky, are important climate regulators, because they impact on the incoming solar and outgoing terrestrial radiation, and supply surfaces for heterogeneous reactions destructing UT ozone and regulating UT water vapor content, to name only a few. Polar stratospheric clouds (PSCs) play a crucial role in the ozone depletion events during polar winter/spring time. The observations and laboratory studies indicate that PSCs are formed by the freezing of aqueous aerosol containing inorganic H2SO4 and HNO3 species, whereas the UT ice cirrus clouds by the freezing of aqueous aerosol containing both inorganic and organic species. Despite the intensive studies of the past there remain large gaps in the understanding of the formation mechanisms and microphysics of UT cirrus clouds and PSCs. The microphysical parameters such as size, composition, phase state (solid, liquid, or mixed-phased), habit and orientation of cold cloud particles (ice crystals) can be used in general circulation models (GCMs) of Earth's climate for the estimation of the stratospheric ozone loss, the predictions of its future recovery, and the impact of the UT ice clouds on climate. The output of GCMs is sensitive to the assumptions concerning the microphysical parameters of these clouds. In contrast to macrophysical characteristics such as the vertical and horizontal extensions of clouds, which can relatively easily be gained by satellite and ground-based sensing techniques, the knowledge of cloud microphysics requires in situ observations which are used complicated aircraft instrumentation. However, for the time being, the used instrumentation cannot determine with certainty the composition and phase state of cloud particles. For example, it cannot determine whether young and small cloud particles (~5 - 10 µm) are liquid or mixed-phased: an ice core + a residual solution coating. This knowledge is important because the phase state of particles determine the rate of the stratospheric and UT ozone loss and the radiative properties of UT ice cirrus. Therefore, elaborated laboratory measurements, which can time-trace the phase transformations of aqueous aerosol droplets on microphysical level, are needed to fill in the gaps in our understanding of the microphysical properties of PSCs and UT cirrus ice clouds. Such measurements are going to be performed during the accomplishment of this project.