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Studying the influence of temperature and pressure on microphysical properties of mixed-phase clouds using airborne measurements

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One cloud type for which the formation and evolution process is not well-understood is the mixed-phase type. In general mixed-phase clouds consist of liquid droplets and ice crystals. The temperature interval within both liquid droplets and ice crystals can potentially coexist is limited to 0 °C and - 40 °C. Mixed-phase clouds account for 20% to 30% of the global cloud coverage. The need to understand the microphysical characteristics of mixed-phase clouds to improve numerical forecast modeling and radiative transfer calculation is of major interest in the atmospheric community. In the past, studies of cloud phase composition have been significantly limited by a lack of aircraft instruments capable of discriminating between the ice and liquid phase for a wide range of particle sizes. Presently, in situ airborne measurements provide the most accurate information about cloud microphysical characteristics. This information can be used for verification of both numerical models and cloud remote-sensing techniques. The knowledge of the temperature and pressure variation during the airborne measurements is crucial in order to understand their influence on the cloud dynamics and also their role in the cloud formation processes like accretion and coalescence. Therefore, in this paper is presented a comprehensive study of cloud microphysical properties in mixed-phase clouds in focus of the influence of temperature and pressure variation on both, cloud dynamics and the cloud formation processes, using measurements performed with the ATMOSLAB - Airborne Laboratory for Environmental Atmospheric Research in property of the National Institute for Aerospace Research "Elie Carafoli" (INCAS). The airborne laboratory equipped for special research missions is based on a Hawker Beechcraft - King Air C90 GTx aircraft and is equipped with a sensors system CAPS – Cloud, Aerosol and Precipitation Spectrometer (30 bins, 0.51-50 μm) and a HAWKEYE cloud probe. The analyzed data in this work is acquired during 2 flight hours on the 23th of October 2014 in mixed clouds formations over Romania (Craiova, Lat 44°19', Lon 23°48'). The temperature variation during the cloud sounding was between -14 °C and -2 °C, with a maximum altitude in the cloud of 4863 m and a minimum altitude of 3353 m. In total 6 horizontal lines of 10 minutes each where performed recording ice crystal number concentrations (using the CIP – Cloud Imaging Probe) between 10 to 20 particles/cm3 outside the cloud layer and over 100 particles/cm3 inside the cloud layer and a number concentration of small droplets, aerosol and small ice crystals (using the CAS – Cloud Aerosol Spectrometer) between 150 particles/cm3 outside the cloud layer and 1600 particles/cm3 inside the cloud layer, this values confirms also the presence of IN (ice nuclei) in the atmosphere between the cloud layers. The results in respect with size distribution of cloud's particles and LWC show to be controlled by the temperature and pressure variations.