EMS Annual Meeting Abstracts
Vol. 12, EMS2015-294, 2015
15th EMS / 12th ECAM

From cloud to precipitation: a case study of layered mixed-phased cloud using WRF and remote sensing and surface observations.

Victoria Sinclair (1), Dmitri Moisseev (1), Ewan O'Connor (2,3), and Tuukka Petäjä (1)

(1) University of Helsinki, Division of Atmospheric Sciences, Department of Physics, Helsinki, Finland (Victoria.Sinclair@helsinki.fi), (2) Finnish Meteorological Institute, Helsinki, Finland, (3) Department of Meteorology, University of Reading, UK

In Finland, a high-latitude country, the majority of precipitation is initiated by ice-phase processes which are often complex and not well represented in numerical weather prediction models. During "Biogenic Aerosols - Effects on Clouds and Climate (BAECC)", the U.S. Department of Energy's Atmospheric Radiation Measurement (ARM) Program deployed the ARM Mobile Facility 2 (AMF2) to Hyytiälä, Finland, for an 8-month intensive measurement campaign from February to September 2014. By combining the ground-based active remote sensing capacity of the AMF2 radars and lidar systems with extensive surface precipitation measurements and with model simulations we investigate cloud-to-precipitation processes during the cold season. Here we present an in-depth analysis of one case study in which mixed-phase layered cloud due to a frontal system was present. Precipitation from the upper layer of cloud interacted with the lower cloud layer and appeared to enhance the surface precipitation via a seeder-feeder type of mechanism. This case was simulated with WRF V3.6.1 to determine (1) how well multiple mixed-phased cloud layers and their microphysical properties could be represented by WRF, (2) how the upper cloud layer modifies the lower cloud layer, and (3) how the type and intensity of the surface precipitation are related to cloud and precipitation processes occurring above in the vertical column. WRF performs well in simulating the bulk characteristics of the multiple cloud layer case but certain details of the hydrometeors and precipitation, especially at the surface, are not simulated well by WRF. For example, the model results show reasonable agreement in the cumulative precipitation when the entire frontal system is considered, yet the model simulates the precipitation to be lighter and occur over a longer period of time than what was observed. The measured and simulated number concentration of ice / snow particles were also compared quantitatively at the surface and qualitatively at upper levels by utilising radar observations. At upper levels reasonable agreement was found between observations and WRF but in the lower troposphere and at the surface notable discrepancies were detected. Thus, the WRF simulation highlights the challenges models face in correctly simulating precipitation amounts and properties of hydrometeors at the surface.