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Supercooled liquid water and mixed-phase in Antarctic clouds

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Surface radiation biases of several tens of watt per square meters are derived in global climate models and high-resolution atmospheric models in the Antarctic. This points to major problems in the simulation of the cloud phase, and more particularly of the supercooled liquid water. In this remote region satellite observations appear as a crucial complement. Radar-lidar DARDAR satellite products were developed in order to take advantage of both radar (CloudSat/CPR) and lidar (CALIPSO/CALIOP) measurements which are used seamlessly to retrieve cloud properties at a horizontal resolution of 1.7x1.4 km and a vertical resolution of 60 m. We will present results of the analysis of Antarctic cloud thermodynamic phase using the most recent DARDAR products v2 over the period 2007-2010 between 60°S and 82°S. We investigate the seasonal and monthly evolutions of the thermodynamic phases' occurrences Antarctic-wide and over specific regions. The cloud fraction (occurrence frequency) is divided into the supercooled liquid water-containing cloud fraction and the all-ice cloud fraction (where no liquid is present in the considered atmospheric column). The low-level (< 3km above the surface) supercooled liquid water fraction varies according to temperature and sea ice fraction seasonality, and it is the largest over water. We demonstrate the agreement of our satellite observations of supercooled liquid on the outskirts of the Antarctic Plateau with published ground-based lidar observations made at South Pole in 2009. We show that, in East Antarctica, the supercooled liquid fraction decreases sharply polewards and that it is twice to three times higher in West Antarctica. The geographical distribution of all-ice clouds is shaped by the interaction of the main low-pressure systems surrounding the continent and the orography, with little links with sea ice fraction throughout the year. We demonstrate the largest impact of sea ice on the liquid-bearing cloud fraction (mostly mixed-phase clouds) in autumn and winter, while it is almost null in summer and intermediate in spring. The monthly variability of the marine mixed-phase clouds shows a distinct pattern from the one of the marine pure supercooled liquid layers, while it does not on the continent. Based on the literature, we relate the pattern of the monthly evolution of the marine mixed-phase clouds to the marine biological activity, which is known to produce efficient Ice Nucleating Particles.
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