Simulating Supercooled Clouds for Antarctic Atmospheric Rivers with Polar WRF

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Supercooled liquid is common in clouds near coastal Antarctica and occasionally occurs at temperatures near -30°C. Similar clouds are observed in the Arctic. The common microphysics in climate and mesoscale models, however, will glaciated out clouds at frigid temperatures. Thus, models can underrepresent liquid in such clouds. Conversely, ice multiplication processes in supercooled clouds may increase the number of ice particles and contribute to higher ice concentrations. Such complicated physics are at work in mixed-phase clouds in the both the Arctic and Antarctic that are often observed with a liquid layer near cloud top. Previously, we simulated the frigid mixed-phase clouds observed during two 2016 cases periods at McMurdo during the Atmospheric Radiation Measurement (ARM) West Antarctic Radiation Experiment (AWARE). Simulations were conducted with the polar-optimized version of the Weather Research and Forecasting model (Polar WRF). We used the state-of-the-art two-moment Morrison-Milbrandt P3 microphysics scheme. Observations over the Southern Ocean and Antarctica often show pristine conditions with extremely low ice nucleating particle (INP) concentrations. When the ice physics in the Polar WRF simulations was adjusted for small INP concentrations the cloud liquid increased and more realistic liquid water paths were achieved. Simulated liquid cloud layers near cloud top were produced for both the March 2016 and November 2016 cases. Accurate representation of INP amounts appears to be critical for simulation of Antarctic clouds. Our more recent work includes studies and simulations of Antarctic mixed-phase clouds associated with atmospheric rivers. Three atmospheric rivers impacting the Antarctic Peninsula were observed during the very recent targeted observing period during May 2022. We are conducting experiments with Polar WRF to study the supercooled cloud physics during these atmospheric river events. Special enhancements are included in the Morrison microphysics scheme. In particular, we are interested in the impact secondary ice production on the mixed-phase clouds.