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Assessing the representation of the microphysics of Antarctic precipitation in a regional climate model using in-situ and radar observations in Adélie Land

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Given the paucity of in-situ and remotely sensed precipitation measurements over the Antarctic ice-sheet, the current assessment of the Antarctic surface mass balance relies on reanalysis products or climate model simulations. In some models, the simulated amount of precipitation has been compared to networks of accumulation data or to satellite-based precipitation products. However little, not to say nothing, is known about the ability of models to represent the microphysical processes governing the Antarctic precipitation.
This study makes use of recent ground-based precipitation measurements at Dumont d'Urville (DDU) station in Adélie Land to evaluate the representation of the precipitation microphysics in the limited-area atmospheric model Polar WRF. During two summertime snowfall event, simulations at 1-km resolution are compared to measurements from an X-band polarimetric radar and from a multi-angle snowflake camera (MASC). A radar forward operator and a MASC operator make it possible to compare similar observed and simulated variables. Radiosonde measurements and surface-meteorological observations also enable to constrain the representation of the regional dynamics by the model. Five different microphysics parameterizations have been tested.
The simulated temperature, wind and humidity fields are in good agreement with the observations. However the amount of simulated surface precipitation show large biases with respect to observations and it strongly differs between the simulations themselves, pointing to the critical role of the microphysics scheme. Comparison of the vertical profiles of reflectivity and the mixing ratio of various hydrometeor types evidence the importance of the representation of the near-surface sublimation process by the low-level dry katabatic winds coming from the interior of the ice sheet. By applying a hydrometeor classification method on both measured and simulated radar data and by comparing MASC and model particle size distributions, it is also possible to identify the microphysical processes involved and to pinpoint the failures within the tested parameterizations.
Beyond the presentation of an innovative method to evaluate microphysics schemes in models and the results regarding the simulation of precipitation over the Antarctic margins, this study paves the way for further sensitivity analyses of the Antarctic surface mass balance to the microphysics parameterization in atmospheric/climate models.