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Snow-atmosphere coupled simulation at Dome C, Antarctica

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Using a snow-atmosphere coupled model, the evolution of the surface and near-surface snow temperature is modelled at Dome C, Antarctica, during a well documented period extending from 20 January 2010 to 30 January 2010.

In a first stage, the detailed multi-layer snow model Crocus is run in a stand-alone mode, with meteorological input forcing data provided by local meteorological observations. The snow model is able to simulate the evolution of surface temperature with a good accuracy (rms equal to 1.16 K). It even reproduces reasonably well the observed downwards propagation of the diurnal heat waves into the top 50 cm of the snowpack. The respective contribution of the different components of the energy balance of the surface snow layer is discussed in details but its analysis cannot explain the formation of the loose snow layer which has been observed during the period.

In a second stage, a fully-coupled 3-D snow-atmosphere simulation is performed with the AROME regional meteorological model at 2.5 km resolution, for which the standard uni-layer snow parametrization is replaced by the multi-layer snow model Crocus. In spite of a poor simulation of cloudiness, the surface and near-surface snow temperatures are correctly simulated, showing neither significant bias nor drifts in the departures. The model reproduces particularly well the decrease of the diurnal amplitude of air temperature from the surface to the top of the 45-m instrumented tower.

This study assesses the ability of snow-atmosphere coupled models to simulate the detailed components of the surface energy balance over a location which is representative of a large part of the Antarctic Plateau. It also highlights the needs to improve cloud micro-physics and data assimilation over polar regions.