EGU21-12662
https://doi.org/10.5194/egusphere-egu21-12662
EGU General Assembly 2021

Improvements to an intermediate complexity atmospheric model for high-resolution downscaling in very complex terrain.

Dylan Reynolds[1], Bert Kruyt[1], Ethan Gutmann[2], Tobias Jonas[1], Michael Lehning[1], and Rebecca Mott[1]

[1]SLF, Davos Platz, Switzerland

[2]National Center for Atmospheric Research (NCAR), Boulder, USA

Snow deposition patterns in complex terrain are heavily dependent on the underlying topography. This topography affects precipitating clouds at the kilometer-scale and causes changes to the wind field at the sub-kilometer scale, resulting in altered advection of falling hydrometeors. Snow particles are particularly sensitive to changes in the near-surface flow field due to their low density. Atmospheric models which run at the kilometer scale cannot resolve the actual heterogeneity of the underlying terrain, resulting in precipitation maps which do not capture terrain-affected precipitation patterns. Thus, snow-atmosphere interactions such as preferential deposition are often not resolved in precipitation data used as input to snow models. To bridge this spatial gap and resolve snow-atmosphere interactions at the sub-kilometer scale, we couple an intermediate complexity atmospheric model (ICAR) to the COSMO NWP model. Applying this model to sub-kilometer terrain (horizontal resolution of 50 and 250 m) required changes to ICAR's computational grid, atmospheric dynamics, and boundary layer flow. As a result, the near-surface flow now accounts for surface roughness and topographically induced speed up. This has been achieved by using terrain descriptors calculated once at initialization which consider a point's exposure or sheltering relative to surrounding terrain. In particular, the use of a 3-dimensional Sx parameter allows us to simulate areas of stagnation and recirculation on the lee of terrain features. Our approach maintains the accurate large-scale precipitation patterns from COSMO but resolves the dynamics induced by terrain at the sub-kilometer scale without adding additional computational burden. We find that solid precipitation patterns at the ridge scale, such as preferential deposition of snow, are better resolved in the high-resolution version of ICAR than the current ICAR or COSMO models. This updated version of ICAR presents a new tool to dynamically downscale NWP output for snow models and enables future studies of snow-atmosphere interactions at domain scales of 100's of kilometers.