Submitted Abstract

ID IMC22-FSAbstr- 457

First Author First Name Last Name	Dylan (1) Reynolds
Submitting Author First Name Last Name	Dylan Reynolds
Correspondence	dylan.reynolds@slf.ch
Co-Authors >> E-Mails will be not listed	Kruyt, Bert (1); Gutmann, Ethan (2); Jonas, Tobias (1); Lehning, Michael (1,3); Mott, Rebecca (1)
Organisations	1: SLF, Switzerland 2: NCAR, Boulder, CO 3: EPFL, Lausanne, Switzerlannd
Country	Switzerland
Region	Western Europe
Title	Hicar: An Intermediate-Complexity Atmospheric Model Capable Of Resolving Ridge-Scale Snow Deposition Processes Over Large Mountain Ranges.
Keywords	Snow, Atmosphere, Winds, High-Resolution
Type	List Of Focus Session
Focus Session ID	82

Abstract

Snow models rely on accurate meteorological input data at the spatial scales at which they operate. However, even the highest resolution operational atmospheric models often run at horizontal resolutions at least an order of magnitude coarser than most snow models. Different downscaling techniques can be employed to bridge this scale gap, typically being sorted into either statistical or dynamical techniques. Recent efforts have been made to optimize dynamic downscaling techniques, reducing computational demand while maintaining physical accuracy of predicted variables as well as the interdependency of downscaled variables such as winds and precipitation. The Intermediate Complexity Atmospheric Research (ICAR) model recently demonstrated an ability to match precipitation patterns from WRF, but with computational costs at least two orders of magnitude lower. While promising, these results from a 4km comparison did not translate to finer spatial resolutions often needed as input to snow models.

Thus, we introduce the High-resolution Intermediate Complexity Atmospheric Research Model (HICAR), a new variant of the ICAR model developed for spatial resolutions as high as 50m. Relative to a traditional atmospheric model like WRF, HICAR maintains the orders-of-magnitude reduction in computational demand which ICAR displayed, while resolving terrain-induced effects on the wind field not seen in ICAR. This is achieved through a novel combination of adjustments to a background wind field based on terrain descriptors with a wind solver. The solver enforces a mass-conservation constraint on the 3D wind field. These modifications successfully mimic dynamic effects such as flow blocking, ridge-crest speed up, and lee-side recirculation to be captured in the resulting wind field. These features are of particular importance for resolving snow deposition patterns, where the snow particles are particularly susceptible to advection by the near-surface flow field. We validate the accuracy of HICAR's flow features using a wind LiDAR deployed in complex terrain and show a comparison between flow fields from HICAR and WRF at a horizontal resolution of 50 m. These comparisons demonstrate HICAR's ability to resolve terrain-induced modifications to the flow field which result in increased heterogeneity of ridge-scale snowfall patterns. To this point, preliminary comparisons of snow deposition patterns in complex terrain between the HICAR model and snow accumulation during the 2021/2022 winter are presented. With this new model, physically-based downscaling of precipitation and other atmospheric variables which preserves their interdependencies is made available for high-resolutions (100m) and large-spatial extents (10,000 km2) which are often demanded by operational land-surface models.