Geophysical Research Abstracts
Vol. 19, EGU2017-16417-3, 2017
EGU General Assembly 2017

Downscaling the Local Weather Above Glaciers in Complex Topography

Johannes Horak (1), Marlis Hofer (1), Ethan Gutmann (2), Alexander Gohm (1), and Mathias Rotach (1)

(1) University of Innsbruck, Institute of Atmospheric and Cryospheric Sciences, Innsbruck, Austria, (2) Research Applications Laboratory, National Center for Atmospheric Research, Boulder, Colorado, USA

Glaciers have experienced a substantial ice-volume loss during the 20th century. To study their response to climate change, process-based glacier mass-balance models (PBGMs) are employed, which require a faithful representation of the state of the atmosphere above the glacier at high spatial and temporal resolution.

Glaciers are usually located in complex topography where weather stations are scarce or not existent at all due to the remoteness of such sites and the associated high cost of maintenance. Furthermore. the effective resolution of global circulation models is too large to adequately capture the local topography and represent local weather, which is prerequisite for atmospheric input used by PBGMs.

Dynamical downscaling is a physically consistent but computationally expensive approach to bridge the scale gap between GCM output and input needed by PBGMs, while statistical downscaling is faster but requires measurements for training. Both methods have their merits, however, a computationally frugal approach that does not rely on measurements is desirable, especially for long term studies of glacier response to future climate.

In this study the intermediate complexity atmospheric research model (ICAR) is employed (Gutmann et al., 2016). It simplifies the wind field physics by relying on analytical solutions derived with linear theory. ICAR then advects atmospheric quantities within this wind field. This allows for computationally fast downscaling and yields a physically consistent set of atmospheric variables.

First results obtained from downscaling air temperature, precipitation amount, relative humidity and wind speed to $4 \times 4\,\mathrm{km}^2$ are presented. Preliminary ICAR is applied for a six month simulation period during five years and evaluated for three domains located in very distinct climates, namely the Southern Alps of New Zealand, the Cordillera Blanca in Peru and the European Alps using ERA Interim reanalysis data (ERAI) as forcing data set.

The evaluation is based on determining the added value of the ICAR simulations - with ERAI output as a reference – in representing the local-scale weather measured at several automatic weather stations. For precipitation amount in particular, data by the Global Precipitation Measurement project are used in a fuzzy verification approach. The results indicate that ICAR provides added value for the Southern Alps of New Zealand in the case of precipitation and relative humidity, for the Cordillera Blanca and the European Alps for wind speed and, at certain locations in the European Alps, for precipitation.

In order to more comprehensively investigate the physical plausibility of skill obtained for specific weather situations, the spatio-temporal evolution of the wind field resulting from the ICAR dynamics is analysed for individual case studies. To the authors knowledge this is the first study that specifically investigates the multi-variable consistency of ICAR for different climates, an important prerequisite for all applications which require multi-variable or multi-site input.

References:

Gutmann, E., Barstad, I., Clark, M., Arnold, J., and Rasmussen, R. (2016). The Intermediate Complexity Atmospheric Research Model (ICAR). *Journal of Hydrometeorology*, 17(3), 957-973.