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Modelling snowdrift on the Vestfonna Ice Cap, Svalbard

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In high arctic environments, redistribution of snow mass by wind blow has an important impact on the economy of glaciers. Particularly along the outer edges of ice caps, persistent katabatic winds often become strong enough to effectively remove snow from the slopes. A reliable spatio-temporal quantification of accumulation and snowdrift processes by measurements, however, provides a challenging task. The importance of snowdrift processes in the European Arctic has been early postulated by Ahlmann (1933) and eventually confirmed by more recent studies. The presented study deals with the dynamic redistribution of snow on the Vestfonna Ice Cap during the accumulation period September 2008 to May 2009 and provides a first quantification of snowdrift processes in this region. We have therefore specially designed the three-dimensional snow2blow snowdrift model, which allows to model snowdrift processes on ice caps on a regional scale. Since snow erosion and transport processes are inherently linked to the characteristics of air flow and snow properties, the snow2blow model explicitly resolves the turbulent boundary layer as well as the associated exchange processes at the snow-atmosphere interface.

Accumulation patterns from the mesoscale Weather Research and Forecast (WRF) model runs with 2 km resolution are downscaled to a high-resolution grid of 250 m using the snowdrift model. Finally, the spatial distribution of the snow thickness on Vestfonna Ice Cap in spring 2009 is validated using ground penetrating radio-echo soundings and sporadic snow pit data. The accumulation patterns show small-scale luv/lee patterns which are in good agreement with both the spatial structure of the radio-echo soundings and the in-situ snow pit measurements. In higher regions about 10-20% of the totally accumulated snow is redistributed by snow drift and blowing snow. Part of the eroded and suspended snow mass is later accumulated in the undulating northwestern forefield of the Vestfonna ice cap. In regions of disturbed flow, re-accumulation can be more than 0.1 m w.e for this period.