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How föhn events of different type characterize the local climate of Southern Patagonia

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The local climate of Southern Patagonia is strongly influenced by the interaction between the topography and persistent westerlies, which can generate föhn events. These events are characterized by warm, dry and windy conditions in the lee together with an increase in solar radiation, all factors that can strengthen local glacier ablation. The upstream flow regime influences the generation of different types of föhn which dictate the lee-side atmospheric response regarding the strength, spatial extent and phenomenology. On the basis of the phenomenological character of föhn types, inferences may be drawn on the spatial variability of the local climate and thus also on the glacier impact.

We use a combination of observational data from four automatic weather stations (AWSs) and high-resolution numerical modeling with the Weather Research and Forecasting (WRF) model for a region in Southern Patagonia (48° S–52° S, 72° W–76.5° W) including the Southern Patagonian Icefield (SPI). In order to resolve the complex topography of the region, the model was set up using one-way grid nesting over three domains, which increases the resolution from 20 km in the parent domain to 4 km and 1 km in the nested domains. The final model parametrizations were selected based on 20 sensitivity runs. Evaluation of WRF model surface variables against the AWS data showed that overall the atmospheric fields and the föhn signals were well reproduced, however we found an overestimation in wind velocities.

The application of a föhn identification algorithm to a 10-month study period (June 2018–March 2019) reveals 81 föhn events in total. A simulation of three events of differing flow regimes (supercritical, subcritical, transition) suggests that a supercritical flow regime leads to a linear föhn event with a large spatial extent but moderate intensity. In contrast, a spatially limited but locally strong föhn response is induced by a subcritical regime with upstream blocking and by a transition regime with a hydraulic jump present. Our results imply that the hydraulic jump-type föhn event (transition case) is the most critical for glacier mass balances since it shows the strongest warming, drying, wind velocities and largest solar radiation increases over the SPI. The consideration of flow regimes over the last 40 years shows that subcritical flow occurs most frequently (78%), however transitional flow occurs 14% of the time, implying the potential impact on Patagonian glaciers.