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An new algorithm to detect blowing snow from ground-based remote sensing ceilometer observations in Dronning Maud Land, East Antarctica.

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Surface mass balance (SMB) strongly controls spatial and temporal variations in the Antarctic Ice Sheet (AIS) mass balance and its contribution to sea level rise. Currently, the scarcity of observational data and the challenges of climate modeling over the ice sheet limit our understanding of the processes controlling AIS SMB. Particularly, the impact of blowing snow on local SMB is not yet constrained and is subject to large uncertainties.

Tho assess the impact of blowing snow on local SMB, we investigate the 15-sec attenuated backscatter profiles from 910 nm ceilometers at two East Antarctic locations in Dronning Maud Land. Ceilometers are robust ground-based remote sensing instruments that can withstand harsh conditions unmanned and produce data continuously. In addition to yielding information on cloud base height and vertical structure, these instruments also provide information on the particles present in the boundary layer. We developed a new algorithm to detect blowing snow (snow particles lifted by the wind from the surface to substantial height) from the ceilometer attenuated backscatter. The algorithm routinely detects the presence of blowing snow if 1) a certain threshold is be exceeded at the range bin closest to the ground (signaling a large concentration of scatterers), and 2) if the intensity of the signal decreases with height (signature of the presence of a blowing snow layer). The algorithm successfully allows to detect strong blowing snow signal from layers thicker than 15 m at the Princess Elisabeth (PE, 72°S, 23°E) and Neumayer (70°S, 8° W) stations in Dronning Maud Land, East Antarctica. Moreover, we combined the ceilometer with automatic weather stations to understand key conditions for blowing snow at the study locations.

Results show a very good match between the blowing snow events detected by the new algorithm and visual observations at Neumayer station. Applying the algorithm to PE station, we retrieve the frequency and annual cycle of blowing snow. Finally, the analysis of the automatic weather station data enables to distinguish key meteorological parameters for blowing snow conditions: wind speed, wind direction, relative humidity and temperature inversion (boundary layer stability). These parameters can then be used as input in snow models resolving blowing snow and for validation of the blowing snow schemes in climate models.