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Winter in Antarctica: dark, windy, and .... wet? The impact of present-day and future wintertime surface melting

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We know that increased surface melt, driven by atmospheric warming, contributed to the collapse of ice shelves in the Antarctic Peninsula. This has led to grounded-ice acceleration and increased ice discharge. You may associate surface melt with the austral summer, with plenty of solar radiation driving the melt. However, we will present observations from 2015-2017, of frequent snow surface melt in the dark Antarctic winter, in the previously unsurveyed Cabinet Inlet, Larsen C ice shelf, Antarctic Peninsula.

Snowmelt is observed in situ by an automatic weather station, and simulated with a high-resolution weather model. The presence of entire meltwater lakes is confirmed by Sentinel satellite radar images. Surface energy balance modelling reveals that peak intensities of this winter melt even exceed summertime values. These multi-day melt events occur when when warm and dry föhn winds descend from the Antarctic Peninsula mountains. The high-resolutions weather model confirms that these winds generate turbulent fluxes of sensible heat, leading to melt fluxes in excess of 200 W m-2. Between 2015 and 2017, about 23% of the annual melt in Cabinet Inlet was produced in winter.

Satellite radar images show that winter melt occurs on many more places in the Antarctic Peninsula. It happens every year, although a survey of satellite scatterometry data from 2000 to 2017 shows that winter melting is much more widespread in some years than in others. We think that winter melt matters as its refreezing warms the snow and increases snow density. In this way, winter melt preconditions the ice shelf for more extensive surface drainage, potentially leading to meltwater-driven instability.

Winter melt occurs during westerly föhn, which in turn is more frequent when the Southern Annular Mode (SAM) is in its positive phase. As winter SAM is projected to become more positive in this century because of increased greenhouse gas concentrations, we can thus expect more winter melt in this century.