Snowfall, Redistribution, and Accumulation over Antarctic Sea Ice

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Snow cover plays a crucial role in Antarctic sea ice mass balance, sea ice surface properties and sea ice ecosystem dynamics, but the governing mechanisms controlling patterns of snow distribution are poorly constrained. Precipitation over the Southern Ocean is expected to increase as a consequence of atmospheric warming, and several studies have suggested a direct link between precipitation and sea ice extent in the Antarctic. However, the role such a precipitation increase might play in sea ice mass balance is complicated by many factors. Deep snow cover may inhibit thermodynamic growth by insulating the underlying sea ice, or it may promote ice growth through the formation of snow ice. Using the results of a field study of snow redistribution to inform a preliminary study using a blowing snow model, we show that over the entire Southern Ocean roughly half of the precipitation over sea ice can be lost to leads.

Modeled wind-borne snow erosion was greatest in the outer pack, particularly in the Ross Sea and between 90 ºE and 120 ºE. In these regions, high wind speeds outweighed the higher drift threshold and reduced transport rates caused by the warmer air temperatures. There are also substantial losses in the western Bellingshausen Sea, consistent with field observations. Snow redistribution may be even more important in the interior pack due to low temperatures and diminished precipitation rates close to the Antarctic continent. Our results suggest that in regions near the continent, most precipitation could be lost to leads due to wind redistribution. Large-scale model predictions of future Antarctic sea ice and ice-ocean-atmosphere response to climate warming that do not take aeolian processes into account may thus misrepresent the response of these processes to climate change.