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Impact of Snow on Sea Ice Growth

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We study the evolution of sea ice thickness under the impact of snowfall. Using both an idealized 1-D model and a 3-D ocean model driven by reanalysis, we find that for a certain temporal distribution of snowfall sea ice that forms in open water can grow thicker if it forms later during the initial growth season. Moreover, we find that first-year ice (FYI) subject to snowfall can even outgrow multi-year ice (MYI).

These phenomena are due to non-linear effects of the insulating snow layer on the ice slab and the timing of the snowfall. Snow that falls before the formation of ice from open water falls into the ocean and can not contribute to the snow layer on top of the ice in that area. Therefore, FYI tends to have a thinner snow layer on its top than MYI in the same area, especially if the bulk of the snowfall takes place early in the growth season before the formation of new ice. The thin snow layer causes less insulation from the cold atmosphere and hence faster growth and possibly larger final thickness of the ice slab that formed later during the season.

Our results show that the impact of snow on sea-ice growth can constitute a negative feedback on sea ice cover that can counterbalance the effect of the positive ice-albedo feedback to some extent. Such negative snow-related feedback has according to our analysis contributed to the recovery of Arctic sea ice after the 2007 minimum and will be important for the future evolution of sea-ice extent in the Arctic as well as for the predictability of the future evolution of the Arctic sea-ice cover.