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Arctic sea ice thickness observed in Fram Strait: 1990-2011

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The spatial and temporal resolution of Arctic sea ice thickness data sets available to document long term thinning does not allow for a detailed dissection of the ice thickness distribution. Often the mean ice thickness is the only summary statistic at hand to document long term thickness change. The Arctic sea ice thickness distribution is typically bimodal and heavy-tailed, a reflection of how different processes operate differently in different segments over the range of ice thicknesses. These segments of ice thicknesses are associated with different ice categories. With only the mean ice thickness available to document thinning it is difficult to conclude on which ice category has changed, and why.

Here we present time series (1990-2011) of monthly ice thickness distributions obtained by moored sonars in the Transpolar Drift in Fram Strait. The site naturally lends itself to long term monitoring of ice thickness, as sea ice is steadily delivered to the site by the Transpolar Drift. The primary region of origin is the Siberian shelf seas. The resolution of the data allows us to present thickness change in the ice categories old level ice and deformed ice, and the combined effect on the mean ice thickness. We also show how the seasonal cycle of these quantities behave over time. Furthermore, we present an attempt to quantify the volumetric change in composition of the sea ice cover, in terms of the relative fractions of first-year ice, old level ice, and ridged ice.

The annually averaged modal thickness was reduced from 2.8 m during the 1990s, to 2.1 m following 2007. Correspondingly the annually averaged fraction of (ridged) ice thicker than 5 m was reduced from 15 % during the 1990s, to 5 % by 2011. The combined effect on the mean ice thickness is a reduction from an annual average of 2.8 m during the 1990s, to 2.0 m by the end of the record.

There is shift in the seasonal cycle of the modal and mean ice thickness towards lower values. However, the amplitude of the seasonal cycle remains unchanged between the 1990s and the post 2007 period.

The relative amount of selected ice categories were quantified in terms of the relative fraction of ice thinner than the modal thickness range (first-year ice), ice in the modal peak range (old level ice and thin deformed ice) and ice thicker than the modal thickness range (ridged ice). There is significant interannual variability in the composition. The amount of ridged ice increased over the 1990-2007 period, at the expense of first-year ice. Following 2007, the trend was reversed. We also quantify how these three categories contribute to the mean ice thickness. Ridged ice dominates the mean ice thickness, contributing on average 66 % of the total mean.