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Fram Strait ice area export and its influence on Arctic sea ice thickness

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Arctic sea ice loss is one of the most visible changes related to global warming. A number of processes can contribute to Arctic Sea Ice variability, and one of them is changes in the ice export between Svalbard and Greenland in the Fram Strait. We study long-term changes in Arctic Sea Ice thickness from 1871 - 2012, using a coupled air-ice-ocean column model of the deep Arctic Ocean.

Using monthly mean sea level pressure observations from Svalbard from the Norwegian Meteorological Institute, and from Greenland from the Danish Meteorological Institute, Fram Strait ice area export has been estimated from 1935 - 2012. High resolution ice drift velocity across 79°N from 2004 to 2010 has been derived from radar satellite data. A linear regression between ice drift velocity and geostrophic wind from pressure observations resulted in an ice drift velocity being 1.1% of the geostrophic wind, with the East Greenland current contributing with a constant speed of 8.5 cm s^{-1}. We use geostrophic winds derived from pressure observations also to estimate the Fram Strait ice area export from 1935 - 2012, finding that the ice export has been increasing 1.5 $\pm$ 1.1 % per decade. This increase led to a negative trend in the annual mean Arctic Sea Ice thickness of -1.4 $\pm$ 0.2 % per decade from 1950 - 2012, from approximately 3.6 m to 3.25 m.

Using mean sea level pressure data from the 20th Century Reanalysis Project, Fram Strait ice drift velocity was found to be 1.3% of the geostrophic wind, with a constant term of 7.6 cm s^{-1}. The resulting ice area export was calculated from 1871 - 2011, giving no overall trend. We find that the annual mean Arctic Sea Ice thickness decreased approximately 50 cm from late 1920's to mid 1990's, and has been slightly increasing in recent years. The long-term trend from 1900 - 2011 is -1.0 $\pm$ 0.1 % per decade, and the trend from 1950 - 2011 is -0.3 $\pm$ 0.3 % per decade. The annual mean Arctic Sea Ice thickness based on reanalysis is lower than that based on observed surface pressure for 1935 - 2005, but similar for the last few years. Fram Strait ice export is thus an important contributor to Arctic Sea Ice loss over the last century.