1. Introduction and Motivation

Arctic sea ice underwent profound changes in recent years. Between 1979 and 2010 the annual mean sea ice extent decreased by 4.3 ± 0.3%/decade (Fig.1) and summer extent by 12 ± 2%/decade. Sea ice thickness decreased by 1.6 m or 53% for the ICESat period (2003–2008) compared to early submarine measurements between 1958–1976.

Fig.1: Yearly mean arctic sea ice extent from SMMR and SSM/I microwave radiometry

In this study we address the following questions:

(1) Are there trends in sea ice drift speed retrieved from satellite data between 1992 to 2009 and what is the spatial structure of these trends?

Up to now positive ice drift trends between 1979–2007 of 8.5%/decade were derived from drifting buoys [Rampal et al., 2009]. The spatial structure and the causes of these trends remained unclear. The speed of sea ice drift is determined by (I) the surface wind speed, (II) the ocean currents, and (III) the internal ice stress, which again depends on the ice thickness and compactness. As the ice got thinner and less compact during recent years and no clear indication of wind forcing was found, it was assumed that the increase in ice drift speed is driven by sea ice cover changes. Our second question therefore is:

(2) Are there trends in surface wind speed over sea ice during 1992–2009 and can we exclude wind as a contributor to the observed increase in ice drift speed?

3. Connection to Wind Forcing

Trends in surface (10 m) wind speed from four different atmospheric re-analyses (JRA, ERA-Interim, NCEP, and NCEP-2) are analyzed. For 92–09, Oct.–May all four reanalyses show small positive wind speed trends (5 to 14 cm/s/decade or 0.8% to 2.2%/decade) inside the Arctic Basin (shown for NCEP in Fig. 4a). Compared to the increase in ice drift speed these trends are small and a simple wind–ice drift relationship alone can not explain the Arctic-wide ice drift trend. In the Central Arctic, however, collocated with the highest ice drift trends, all four reanalyses show strong positive wind trends (up to 20%/decade, Fig. 4b–e). The spatial cross-correlation coefficients between wind and ice drift speeds are about 0.5 and show that wind is a likely contributor to the observed ice drift speed increase and explains about 25% of the spatial drift trend variance.

4. Conclusions

The Arctic Basin sea ice drift speed increase between 1992 and 2009 is much larger (10.6%/decade) than the wind speed increase (∼1.5%/decade). For many regions (e.g., the Central Arctic), however, wind speed trends play a role in the observed drift speed changes. In other regions (e.g., near coastlines), where the wind trend is negative or neutral, changes in the ice cover, e.g., a thinner, less compact and weaker ice cover, are a more likely cause for the observed ice drift speed increase. The ice drift trend is strongest in the second half of the observed period (+2.7%/decade during 2000–2009; increases to +4.6%/decade after 2004), concurrent with a strong reduction in sea ice extent and thickness. The Arctic Basin-wide wind trend during that time period is at most +5%/decade, however, it reaches up to +20%/decade in the Central Arctic. Rampal et al. [2009] conclude that wind is not a major contributor to the observed ice drift speed trend and that changes in the sea ice cover play the dominant role. Our analysis points to a role for wind forcing, especially in the Central Arctic and in the latter half of our period.

References:


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