

## Arctic Sea Ice Disappearance - Indications of a Tipping Point

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### The Yearly Reduction of Arctic Sea Ice Area

We have wanted to investigate whether something fundamental, apart from the overall downward trend, has changed in the variation of the Arctic sea ice area. In this context we have looked into the yearly change of the sea ice area. This would be a first order indication of the fraction of ice that melts. Since it is the area that is measured this does not account the variation of sea ice thickness which is needed to understand the total melt. All the data used are taken from <http://arctic-roos.org/>.

The simplest way to look at this is to take the difference between the maximum winter sea ice area ( $A_w$ ) and compare it with the minimum area ( $A_s$ ) the following summer season. Fig. 1 shows the value  $(A_w - A_s) / A_w$  from 1979-2010.

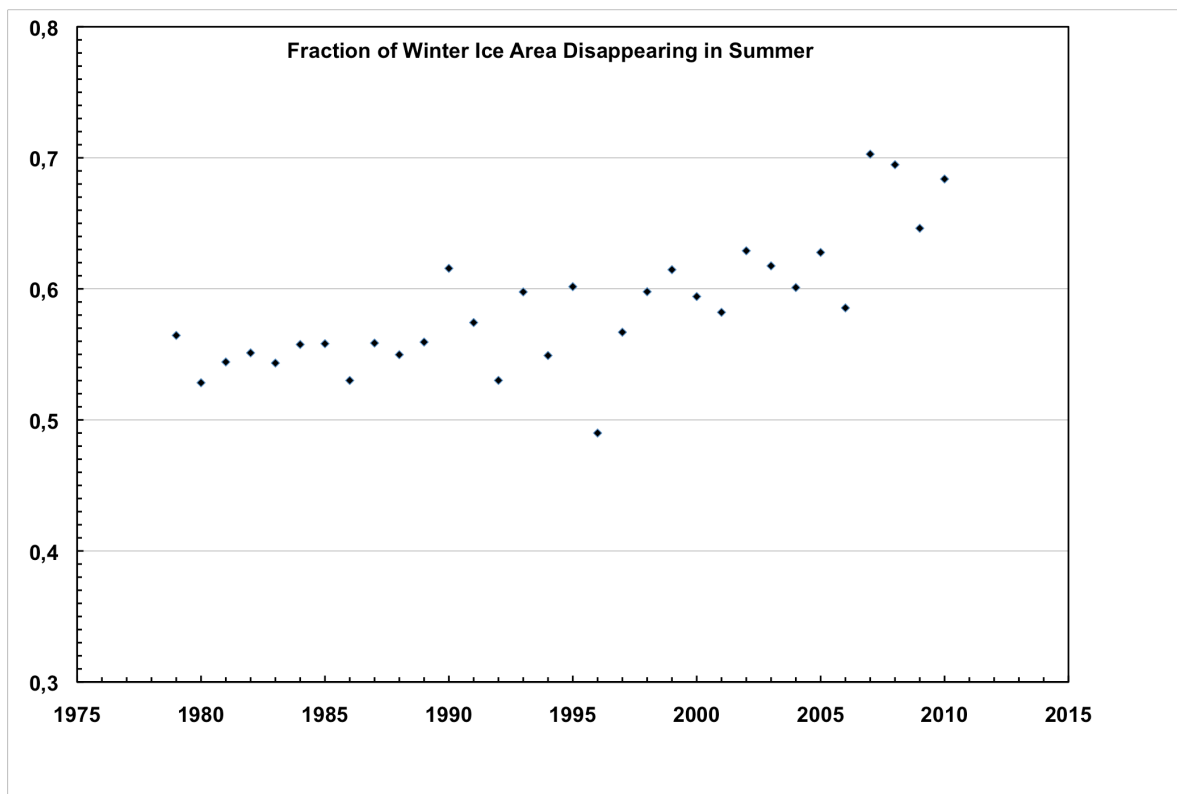


Fig. 1: The fraction of the winter ice area that disappears in a melt season is shown  $((A_w - A_s) / A_w)$ .

Two observations can be made from the results shown in Fig. 1. Firstly, from 1979 until 2006 the fraction of the decrease in area was approximately between 0.52 and 0.62 with a slight upward trend. Secondly, the fraction of area decrease changed abruptly upward in 2007 and has maintained this high level for the two consecutive years.

The slow increase in the seasonal area reduction from 1979 to 2005 is about 3%/decade. This is in accordance with the long-term change in both summer and

winter sea ice area. However, what is more interesting is that the high level of seasonal area reduction is maintained for 2007-2010 in spite of large absolute differences in the total ice area for both winter and summer in these years. The mean value of the fraction of sea ice area disappearing in these four years is 0.68.

This result could indicate that the strong decrease in the sea ice area in 2007 may have perturbed the overall freeze-melt regime. Should this be the case, this situation could be a means to predict the minimum sea ice area in the coming melt season.

### **Prediction 2011**

This small investigation has in a simple manner looked into the relationships around the melting and freezing of the Arctic sea ice. There seems to be a clear indication that for the last four years (2007-2009) the fraction of the winter ice that melts has increased significantly and may have reached a new quasi-stable level. The time span is too short to distinguish this possibility from an impulse function like change.

However, assuming this is a quasi stable situation the minimum sea ice area in the Arctic should be approximated with  $A_s = A_w - 0.68 A_w$ . With a low maximum area in the spring of 2011 of about 13.1 mill. km<sup>2</sup> (<http://arctic-roos.org/>) we should get a minimum area in 2011 of 4.1 . km<sup>2</sup>. This is between the low values of 2007 and 2008.