2013 PAN-ARCTIC OUTLOOK
June Report based on May Data

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Executive Summary.
September extent is predicted using an estimated minimum value of the PIOMAS arctic sea ice volume and a simple model for volume~extent relationship.

Extent Projection.
Mean September 2013 ice extent is estimated to be 3.6 million km^2, with a 95% confidence interval of +/- 0.9 million km^2.

Methods/Techniques.
The method is statistical, based on mean September ice extent and minimum September ice volume. The ice volume data used here is the Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS) calculated by the Polar Science Center at the Applied Physics Laboratory of the University of Washington. (Zhang and Rothrock, 2003).

Rationale
Both volume and extent have been declining in the last decade, but volume has the highest signal to noise ratio. This makes it somewhat easier to predict volume than extent. If the relation between extent and volume is known, the extent may be predicted with better accuracy than a statistical model based on extent alone.

Detailed Description

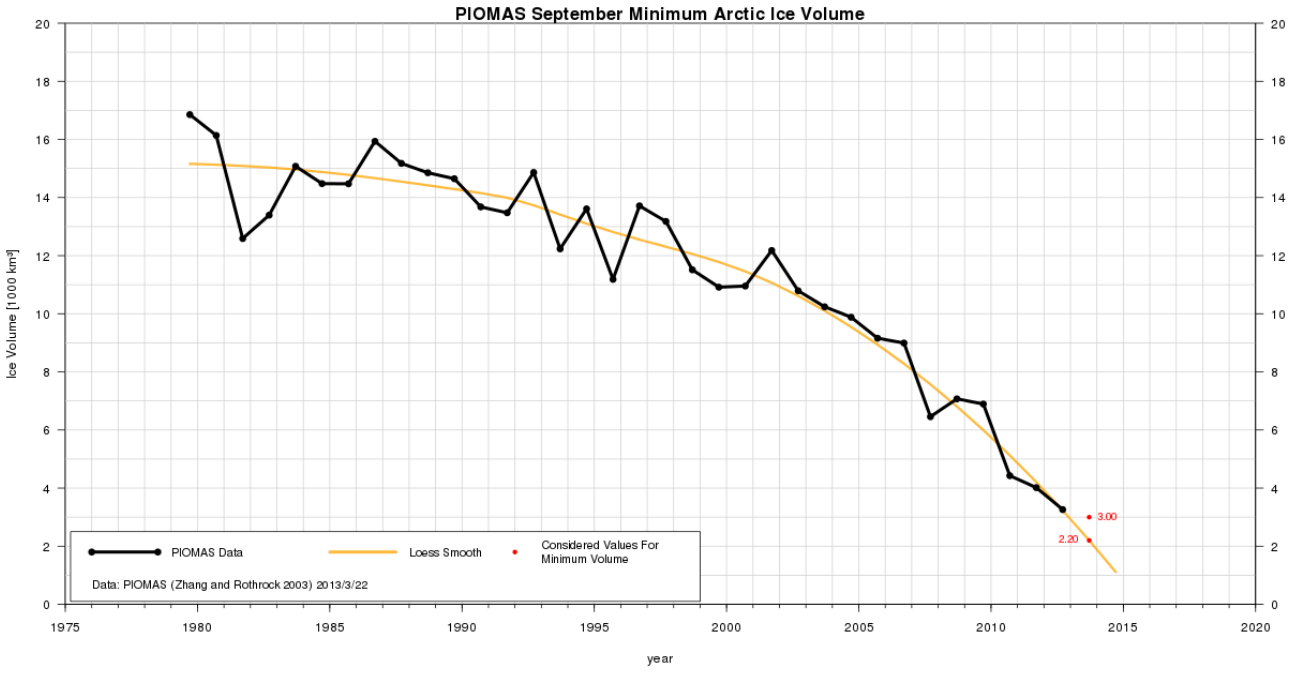

Figure 1. PIOMAS minimum ice volume has decline more than 75% since 1979. Assuming this decline continues, this would result in a 2013 minimum of nearly 2,200 km^3. For this submission a slightly lower decline is held most likely.

The first step is to make a prediction for the minimum 2013 ice volume (as calculated by PIOMAS), see figure 1.

A Loess fit is shown with a most likely value for 2013 minimum ice volume 2,200 km^3. Other possible

models (quadratic, exponential, linear limited to the last 10 years) yield similar results.
Looking at the current seasonal decline in ice volume, the latest available data (May 31, 2013) indicates a slower (by about 900 km^3) decline than 2012. If the slower decline continues, a final minimum value of 3,600 km^3 could be reached.
For now I estimate the 2013 minimum volume to be 3 +/-1 [1000 km^3]

Next the relationship between extent and volume is explored.

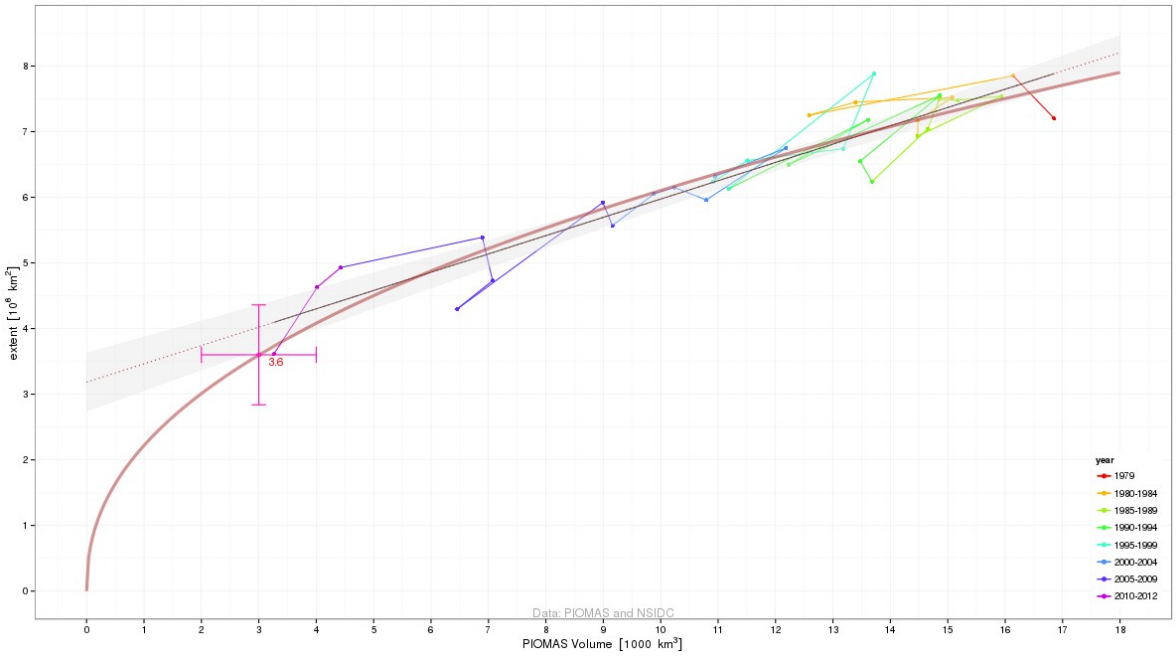

Figure 2. Plot of NSIDC September arctic sea ice and PIOMAS minimum volume. Linear and power fits are shown. The 2013 prediction is shown with error bars for volume and extent

Mean September ice extent and minimum volume for 1979-2012 are shown in figure 2.
Over this time frame the data can be modeled by a linear relationship, shown as the straight line with shaded area.
Although the linear relationship is statistically sound, it has a serious unphysical property: as volume approaches zero, extent should as well.
A simple power based model is proposed:

$$extent = A\ volume^{B} \qquad (1a)$$

or alternatively in terms of average thickness:

$$thickness = 1/A\ volume^{1-B} \qquad (1b)$$

with a constant factor B.

A least square fit yields a factor 0.44, and solving for an estimated minimum volume of 3,000 km^3 gives an estimation for September extent of 3.60 +/- 0.76. The fit is shown as the brown line in figure 2.

Combining the uncertainties of the estimate in volume and the extent~volume relationship gives the final result: 3.6 +/- 0.9 [Mm^2]

Finally solving for a final minimum volume of 2,200 km^3 (the decline will need to speed up considerable for this, even more than it did in 2012) an extent can be calculated as 3.14 +/- 0.76 [Mm^2].