Sea Ice Outlook Contribution, 30 June 2014

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Type of Outlook projection: Statistical

Average Prediction: 4.76 $\pm$ 0.79, range 3.66 to 5.66 10^6 km^2

Executive Summary

Our July Outlook contribution represents a slight reduction in the predicted September extent from the June Outlook. As before, we use the survival of ice of different ages to statistically predict the 2014 minimum and use the last 5 years of survival rates as a predictor for this summer. This gives an average estimate of 4.76 $\pm$ 0.79 10^6 km^2, and a range from the summer with the lowest (2012) and highest (2009) survival rates within the last 5 years of 3.66 10^6 km^2 to 5.25 10^6 km^2.

Overview

Ice age fields are based on the ice age algorithm of *Fowler et al.* [2003]. The ice age product is based on a 15% sea ice concentration threshold to be consistent with the threshold used for mapping overall sea ice extent. In addition, the use of a 15% threshold captures greater detail within the marginal ice zone. Using this approach and taking into consideration that the survivability of ice during the summer melt season has changed in recent years, gives an estimate of 4.76 $\pm$ 0.79 10^6 km^2 using an average of ice survival rates from the last 5 summers (2009-2013). This is slightly below the linear trend value of 4.79 10^6 km^2. The predicted extent increases to 5.24 $\pm$ 1.05 10^6 km^2 using an average from the last 10 years. Because the summer atmospheric circulation pattern plays an important role in how much ice survives each summer, the predictive skill remains low during anomalous years. To estimate a range, we used estimates from the summer with the lowest (2012) and highest (2009) survival rates within the last 5 years, giving an expected range of 3.66 10^6 km^2 to 5.25 10^6 km^2. We still do not predict a new record low will occur in 2014.

Method

At any time of the year, the total sea ice area can be defined as the sum of the areas of the individual ice age classes, such that the total ice area (SI) is defined as:

$$SI = F_1 + F_2 + F_3 + \ldots + F_n$$

Where F_1 is the area fraction of first-year ice, F_2 is the area fraction of second year ice, etc. The amount of ice left over at the end of summer (SI_{sep}) then depends on the survivability of the spring ice cover (SI_{spr}) which can be defined as the survivability of the ice of different ice age classes, i.e. s_1 equals the survivability of the spring first-year ice fraction (F_{spr_1}). Thus, SI_{sep} equals:

$$SI_{sep} = s_1*F_{spr\_1} + s_2*F_{spr\_2} + \ldots + s_n*F_{spr\_n}$$

where the survivability for a specific ice age class (e.g. s_1) is equal to the ratio of the September to spring (in this case June) fraction of that age class (e.g. F_{sep_1}/F_{spr_1}). In this context, survivability includes melt and transport components.

As we did last year, we account for survival rates as a function of latitude to compensate for the fact that over the past few years', first-year ice has been found at much higher latitudes than has been typical during previous years. Breaking up the analysis into 2-degree latitude bands, the total September ice area is then the sum of all survival rates for each ice age category and for each latitude band. One problem with this approach however, is that the ice age data are restricted to open ocean areas only, where ice motion can be resolved with the satellite passive microwave data. Thus, this data set does not cover the passages in the Canadian Archipelago. In order to take into consideration the sea ice area of the Canadian Archipelago, we add the survival rate of the region for each year.

Computing this for every year, using each year's survival rates together with the ice age distribution from the end of 2014 and the "extra" ice not mapped by the ice age data gives the results show in **Figure 1**, which shows the predicted minimum September extent for 2014 as a function of individual yearly survival rates, ordered by high to low predicted values. For reference, the blue line indicates the observed 2012 minimum and the red line the 1981-2010 climatology mean September extent. These predictions indicate that it is not forecasted that the extent will break a new record low, but that it is likely the extent will remain well below climatology.

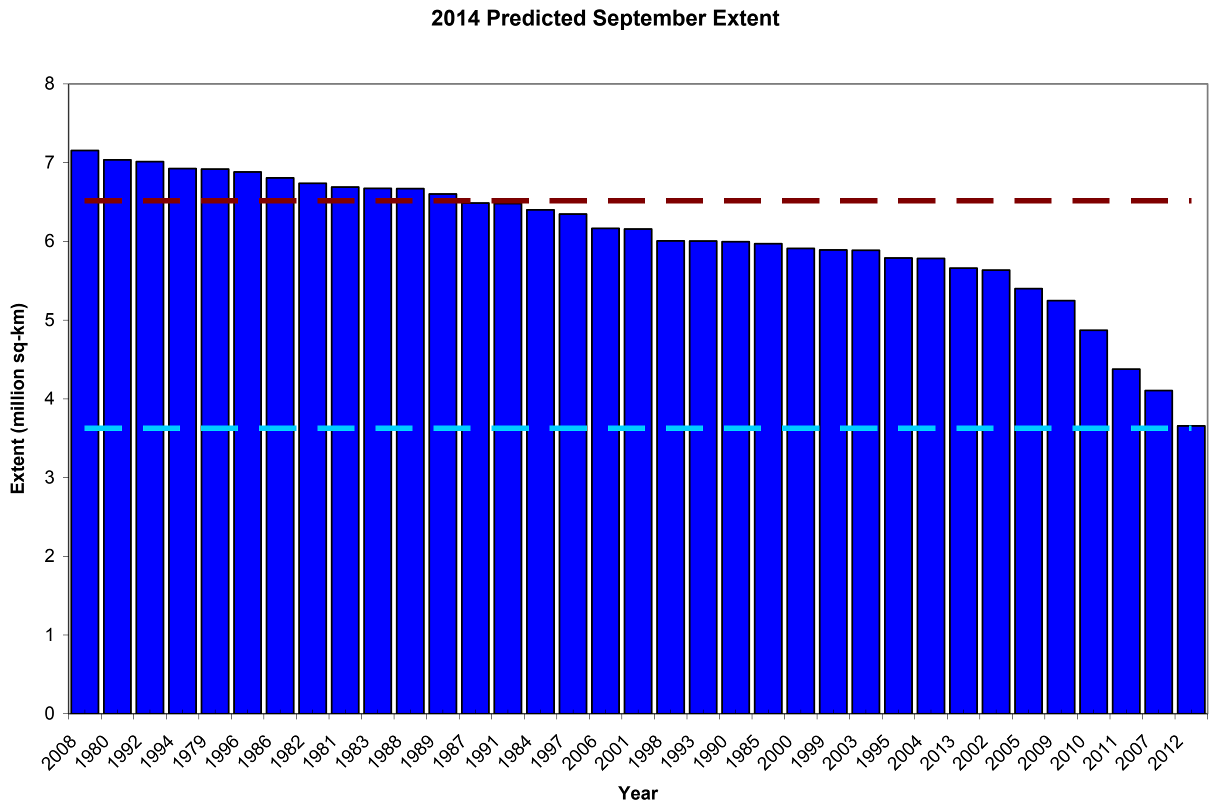

Figure 1. Estimated 2014 minimum extent based on ice age survival rates from previous years between June and September 1979 to 2013. Blue line shows the observed 2012 September extent, red line shows the observed 1981-2010 climatology for reference.

Discussion

The first result is that given the distribution of ice age this June (**Figure 2**), a new record minimum is not predicted, though if the 2012 survival rates for the rest of the summer are valid, this summer would result in the second lowest September extent. This of course is difficult to predict. One factor towards more September ice this year is that during the past winter, there has been an increase of old ice within the Beaufort Sea that will likely continue to slow ice loss in that region. Additionally, there is a tongue of 2nd year ice extending from the central Arctic Ocean towards the E. Siberian Sea. Interestingly, this summer, the ice is slow to retreat in the Kara/Barents seas. In this region air temperatures have been colder than normal, helping to slow ice loss.

The overall fraction of the Arctic Ocean covered by multiyear ice at the end of June is 34% compared to 25% in 2013 which may suggest more retention of ice this year. However, at the end of June in 2007, 36% of the Arctic Ocean was covered by multiyear ice and yet a record low was reached that year. If the rest of the summer were to see similar survival rates as 2007, we would expect slightly less ice at the end of September than we saw in 2007 (4.11 10^6 km^2 vs. 4.30 10^6 km^2).

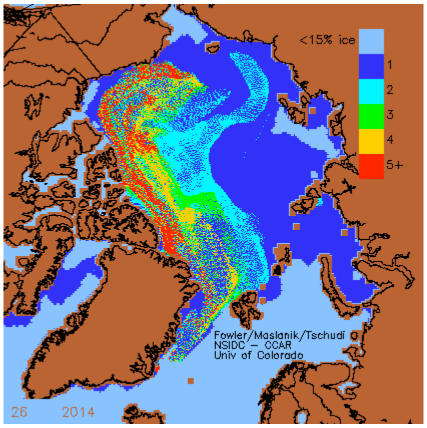

Figure 2. Map of ice age from week 26 (end of June 2014) based on the Fowler et al. 2003 algorithm.

The second result is that if we took an average of survival rates over the entire data record, the minimum is forecasted to be 6.07 $10^6 km^2$, still below the September climatological ice extent from 1981-2010 of 6.51 10^6 km^2. However, it is clear that climate conditions have changed during the last several years, which impacts on the survivability of the spring ice cover. The Arctic atmosphere has warmed in all months during the last decade [e.g. *Stroeve et al*., 2012], melt onset begins earlier in the year and the ice freezes later [e.g. *Stroeve et al*., 2014; *Markus et al*., 2009], resulting in an enhanced the ice-albedo feedback [*Perovich et a*l., 2011] and increased the sensible heat content of the ocean. In addition, there is evidence that the old ice has thinned.

References

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