NSIDC Recap of 2011 Outlook Season

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Overall, NSIDC two projection methods did well. Both the ice age survival rate and the post-July extent loss rate projection were close to the final. The ice age survival rate method, using the initial proportion of ice age types within the Arctic and typical survival rates in recent years yielded an estimate of 4.7 million square kilometers, less than 100,000 square kilometers from the actual September monthly average of 4.61 million square kilometers. This method was based on the spring ice age distribution and was not further updated through the season.

The second method initialized extent at a given time and then projected the trajectory of the loss through the end of September using daily loss rates from previous years. Daily projected extent values in September were averaged to obtain a monthly estimate. Before July 1, there is too much variability in the summer ice loss rates for the method to provide a useful projection. However, the method does allow revised projections every day if one desires. Also, the uncertainty range (based on one standard deviation of the projections from each year's decline rate) decreases as the forecast time gets shorter.

The initial projection, beginning on July 1, also yielded an estimated of 4.7±0.6 million square kilometers. Due to relatively fast decline in July, the August 1 projection yielded a lower estimate of 4.5±0.4 million square kilometers. The two estimates essentially bracketed the actual September monthly extent. Further fast decline in August, lowered the estimate to 4.45±0.1 million square kilometers. However, the loss rate slowed quickly in September and the minimum occurred relatively early compared to recent years. Thus, the final projection was actually the least accurate and the actual value fell just outside of one standard deviation.

Discussion of the conditions related to the evolution of the summer ice cover have been discussed in NSIDC's Sea Ice News and Analysis, a NASA-funded project, particularly in the October 4, 2011 post: http://nsidc.org/arcticseaicenews/2011/100411.html. Some issues are also discussed in response to the questions below.

1. How would you characterize the success of Outlook predictions this year and any differences between methodologies? (See the August report at http://www.arcus.org/search/seaiceoutlook/2011/august)

The median ice extent in August was essentially what the minimum ended up at for the month of September. Thus, based on that metric, the predictions did quite well. Three of the five modeling efforts basically nailed the minimum this year, as did several of the statistical methods, although with many predictions having rather large uncertainties, $\pm$ 0.2 to as high as $\pm$ 1.2 million km^2, it appears that very few of the contributions did not succeed. Overall it does appear that the statistical and modeling methods performed better than the heuristic ones.

It does seem that as the Outlook moves forward it would be a good idea to perhaps separate out the public contributions from the more rigorous science contributions, and perhaps also make a separate distinction based on the methodology applied.

2. What were the main factors driving the minimum extent this year?

The melt season started out with anomalously low sea ice extent (second lowest March in the satellite data record) combined with a young and thin ice pack that was vulnerable to melting out in summer. Air temperatures over most of the Arctic Ocean were above normal during winter, helping to limit sea ice growth. After the winter maximum, sea ice however was slow to decline in most regions except in the Kara and Barents seas where melt began more than 30 days earlier than normal. Ice loss in the Kara Sea was particularly rapid in June, resulting in June 2011 being the second lowest June extent in the satellite data record.

An Arctic Dipole anomaly type circulation returned again this summer, but with the centers of the pressure systems displaced from in 2007 such that there wasn't strong northward advection of sea ice. However, the circulation this year did bring warm air temperatures into the region. The ice continued to decline at a fast pace through the middle of July while the high sea level pressure over the Beaufort persisted, leading to ice conditions below that seen in 2007. However, the Beaufort high broke down during the second half of July, significantly slowing ice loss. Nevertheless, July 2011 set a new record low in the satellite data record. Had the dipole anomaly persisted like it did in summer 2007, it is likely that 2011 would have seen a new record minimum in August and September as well

A tongue of old ice extending from near the pole towards the Siberian coast helped to slow ice loss in the E. Siberian and Laptev seas, while the tongue of old ice in the Beaufort Sea melted out as it did in summer 2010. The inability of ice to survive summer melt in recent years in the Pacific sector appears to be a key factor towards continued decline in the summer ice cover.

3. What are the implications of this year[1]s minimum for sea ice extent in the future?

A key factor behind continued summer sea ice minima appears to changes in ice survivability in the Pacific sector. Old ice that used to be re-circulated in the Beaufort Gyre is now melting out in summer. It appears (though it remains to be quantified) that the ice cover in the region is more diffuse with thick, multiyear floes interspersed with thinner first-year ice. As the summer progresses, the first-year ice melts completely allowing ocean heat to substantially melt multiyear floes. If this continues in future years, it will be very difficult to build up thicker, old ice. Thus the region that used to be a nursery for old ice is now becoming a graveyard.

4. What additional data or data products (including data integration) would be useful for improving outlooks in the future, including any critical gaps in field observations?

Ice thickness observations are key, particularly for initializing model runs in the spring. Thickness observations will also benefit at least some statistical methods. A better map the energy balance of the Arctic Ocean is needed, particularly in the Pacific sector. Basal and lateral melt from buoy data would help to better characterize the ocean's contribution to sea ice loss, so any near-real-time data access to all the buoy data in the Arctic would be a big help. Satellite mapping of melt ponds would be important as well. More detailed information on the state of the

ice cover as well as weather conditions are important for improving outlooks in particular regions.

5. What can the regional patterns this year tell us about in sea ice extent?

It's interesting to look more at the Canadian Archipelago as this region continues to become ice-free for some time during summer. What are the main drivers for this, what are the implications for the rest of the sea ice cover? Another interesting region is the Beaufort and Chukchi seas, where multiyear ice continued to be lost due to melt.

6. Are there any other "lessons learned" from this year?

This year was the second lowest in the satellite record, slightly aboe 2007. However, conditions were more moderate than in 2007. In 2007, there was strong early season melt in the Beaufort and Chukchi due to high solar input (fewer clouds) and a strong Arctic Dipole pattern that pushed ice from the shore toward the pole, advecting the ice edge northward. This year, there were not unusual cloud or circulation conditions, yet the ice cover still was very low. Unlike in 2007 where the ice edge was very compact, this year the edge was diffuse, particularly in the Beaufort, Chukchi, and East Greenland seas, resulting in many regions of low concentration ice. This suggests that the ice cover is thinner and more broken up overall than in 2007 and the decline in the overall quality of the ice cover continues.

QUESTIONS ON "IMPROVING THE OUTLOOK PROJECT"

Please provide your thoughts and ideas on how the Outlook can be improved in the future. Specifically:

1. How could the Outlook be used to better evaluate predictive models of arctic sea ice?

There needs to be some specific metrics to evaluate the models – e.g., skill level of model relative to a relevant baseline (e.g., linear trend or persistence). Next year, a hindcast analysis should be encouraged for submitted methods – i.e., test the method over previous years and evaluate the skill for past year.

Another important element is to encourage submission of quantitative uncertainties for each submission. Preferably they should be narrow enough to provide a useful range for evaluating performance.

2. How can we make the Outlook more relevant or usable for a wide variety of users and stakeholders?

Different stakeholders have different requirements. For the public, the Outlook as it stands now is probably sufficient. For modelers, quantitative evaluation of model performance would be

useful. For operational users (seasonal planning), regional forecasts will probably be more relevant.

3. How could we use the Outlook as a community-building tool to further develop a network of sea ice researchers and others?

One opportunity would be to develop social networking to link together researchers. This could be a wiki-blog, discussion forum, or even Twitter and Facebook. This could be a forum for people to have a conversation on conditions as they evolve through the summer. There could also be occasional web meetings (e.g., Google, etc.) for groups to discuss conditions, e.g., one hour meetings once a month or so. Twitter and Facebook would perhaps be best used for outreach to the wider-community.

4. What other changes, additions, or activities would make the Outlook a better product?

There are no additional comments beyond what has been discussed earlier.