September 2009 Regional Sea Ice Outlook: June Report
Regional: Beaufort and Chuckchi Seas, High Arctic, and Northwest Passage
By: **Charles Fowler, Sheldon Drobot, James Maslanik**

Contact Information
James Maslanik: James.Maslanik@colorado.edu
University of Colorado

1A. Extent Projection

Predicted minimum extent based on data to date is 4.89 million sq. km. Estimated confidence interval for this estimate is +/- 0.39 million sq. km.

As noted below, the potential exists for more extensive ice loss if the large expanse of 2nd.-year ice in the central Arctic does not survive or if substantial amounts are transported northward toward the Canadian Archipelago or through Fram Strait. This is in part due to the fact that so little of the older, thicker multiyear ice exists at present in the Arctic Basin compared to previous years.

2A. Method

This estimate is based on a statistical regression model that uses passive microwave derived sea-ice concentrations, and estimates of ice age and thickness regressed against the minimum ice extents over the past 26 years. The ice age and thickness information used are derived from Lagrangian tracking of ice regions, with a different mean ice thickness assigned to each ice age category of multiyear ice, for 2nd.-year through 10th.-year ice. This is combined with a simple temperature-driven ice growth model and melt parameterization to estimate first-year ice thickness. In this implementation, "open water" is defined as less than 40% ice concentration.

3A. Rationale

The approach assumes relationships between ice disappearance and concentration, age, and thickness. In this approach, the model does not directly factor in the removal of ice due to transport. Instead, the parameters relate mostly to ice melt. To the degree that the parameters influence susceptibility to transport though, the statistical model probably captures some of these indirect affects. For example, assuming that thinner ice and/or first-year ice is more affected by ice kinematics and transport, then the model would include such effects indirectly.

A key driver for the prediction is extent of ice of different ages. Figure 1 shows our estimate of ice age at the end of April, 2009 (panel 4) along with the ice age coverage at the end of April for the three previous years. The main points to take from these maps are the relatively small coverage of the older, thicker age classes, and the extent of 2nd.-year ice within the central Arctic Basin. This ice is less susceptible to melt than first-year ice but still presumably more susceptible to loss than the older ice classes. In addition, our data suggest a considerable amount of first-year ice mixed in with the 2nd.-year ice in this area, perhaps predisposing the region toward greater melt and convergence. A switch to positive NAO wind patterns could also drive this 2nd.-ice northward, exposing more open water within the central Arctic Ocean, perhaps extending to the vicinity of the North Pole.

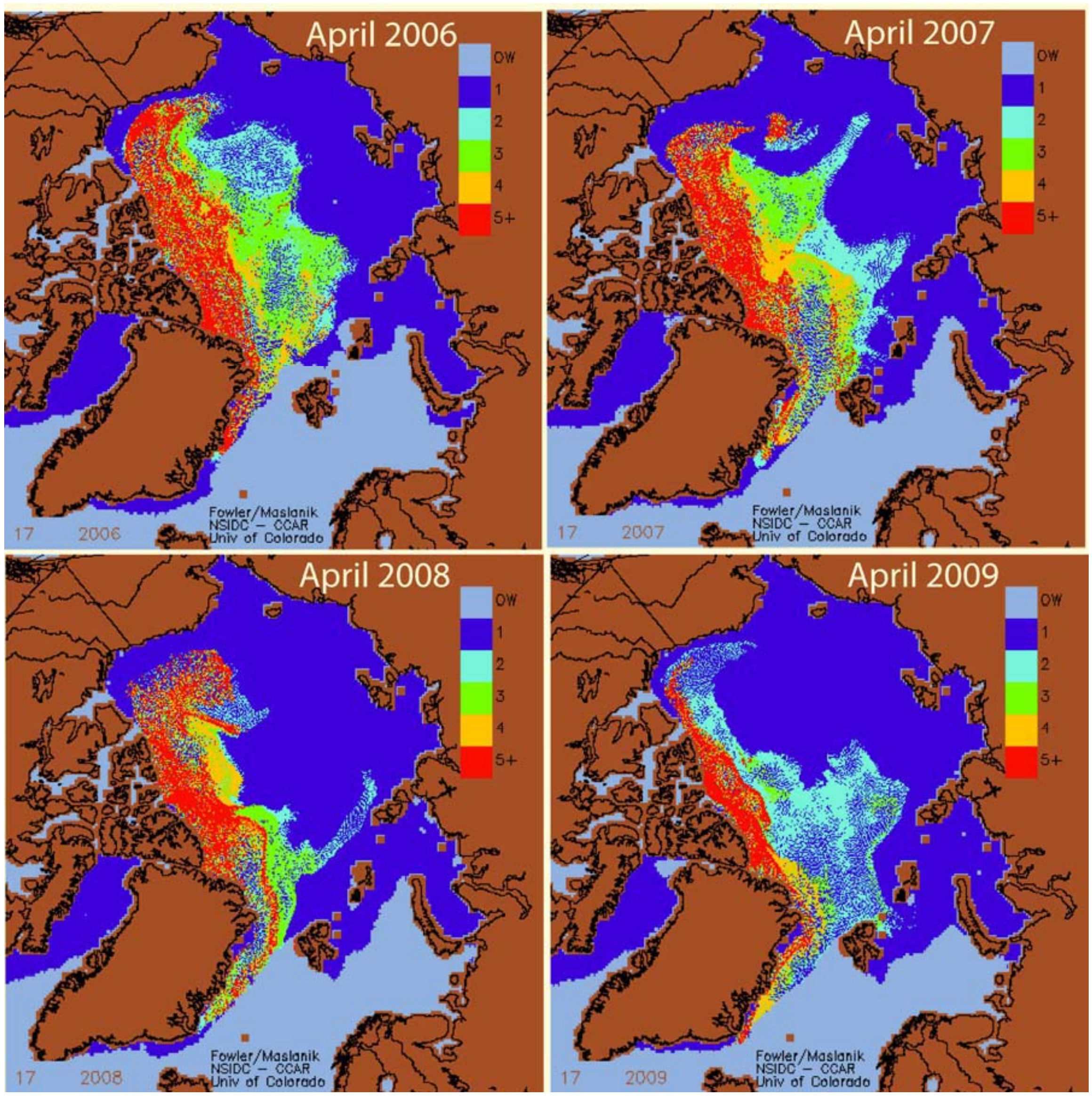

Figure 1. Estimated ice age for the end of April for 2006-2009.

1B. Estimates of Ice Conditions in Specific Regions

Two discussions are provided. The first draws from ice-pack opening dates that we have estimated for each 25km grid cell in the Arctic. Here, we limit the opening-date results to the Beaufort and Chukchi seas. The full grid of opening dates is available, but our confidence in performance for other areas is considerably less. The second discussion addresses distributions of multiyear ice of different ages and the possible effects on ice conditions through summer.

1B. 1. Opening Dates in the Beaufort and Chukchi Seas

Estimated opening dates are shown in Figure 2.

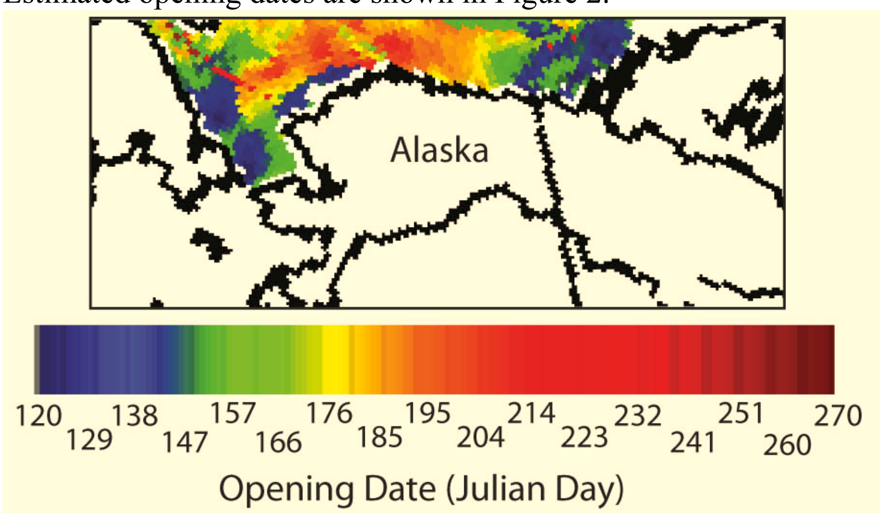

Figure 2. Estimated opening dates in the western Arctic.

At the time of this writing (end of May), open water has formed in the southern Chukchi Sea – reasonably consistent with the dates in Figure 2. The eastern Beaufort Sea is still mostly ice covered (albeit with reduced concentration), so the our estimated opening dates for that area were too early.

1B.2. Distribution of Multiyear Ice Types

Beaufort and Chukchi seas

As indicated in Figure 1, the most recent ice age map suggests that some multiyear ice is present further south in the Beaufort Sea than during the past 2 years. However, this ice appears to be predominantly 2nd.-year ice, in contrast to previous years (including years earlier than those shown in Figure 1) when the multiyear ice in the Beaufort Sea was some of the oldest and presumably thickest ice in the Arctic Basin (as a result of ice transport from the Canada Basin and central Arctic). The mixture of 2nd.-year and first-year ice is also more diffuse than previously, so as melt progresses through summer, it seems likely that scattered, isolated multiyear floes will persist, but within otherwise open-water areas. It is also likely that the remaining 2nd.-year floes will disappear faster due to melt than was the case in summer 2008, when multiyear ice persisted in small bands, particularly north of Barrow. Last year's multiyear ice was likely to have been older, thicker ice though, as noted above, so this summer's multiyear ice in the area may not last as long. As in recent years, we expect that the remaining multiyear ice in the Beaufort Sea will melt out as in moves westward into the Chukchi Sea, with virtually none of this ice recirculating into the Canada Basin to replenish the loss of multiyear ice due to melt.

<u>High Arctic (Central Arctic/Canada Basin)</u>

Our data show the western sector of the High Arctic (along with most of the Canada Basin) region to be covered nearly entirely by first-year ice, unlike any previous spring over the 1979-present satellite record. We anticipate that most of this area will become ice free by the end of summer. The High Arctic areas adjacent to the Canadian Archipelago continues to experience reductions in coverage of the oldest ice types, with the remaining oldest ice compacted against the Archipelago coast.

The remainder of the High Arctic north of 85 deg. is covered by predominantly multiyear ice, but this ice is mostly 2nd-year ice. Based on climatological conditions though, it is unlikely that under “normal” conditions, this ice would melt out, so heavy ice may remain in this area throughout summer. The most likely scenario for a retreat of this multiyear ice edge would be if atmospheric circulation produces persistent and strong southerly winds that reduce ice extent through ice transport.

<u>Northeast Passage</u>

Also depending on ice transport patterns (for example, if the ice is pushed northward), the potential exists for the remaining first-year ice to melt out along the Northeast Passage. (Caution: As noted above, our definition of “open water” is an ice coverage of 40% or less. So, there may be ice present even in areas that we describe as open – a significant distinction for operations in areas that satellite products such as ours define as “open water.”)

<u>Other</u>

More multiyear ice is present along the northeastern Svalbard coast than is typical. Ice free dates may therefore be delayed in this area, although wind patterns will probably be the main factor affecting the date due to the relatively short distances the ice edge needs to retreat to free the Svalbard coast.

2B. Methods

The opening dates are estimated by regressing the opening dates for the past 10 years against the above-described ice thickness/age conditions and 2-m air temperatures for the end of April 2009.

The discussion of the location and significance of multiyear ice types is based on the ice age data noted above.

3B. Rationale

The basis for the opening date results is the same as for the extent prediction above. For the discussion of multiyear ice, we rely on subjective interpretations of conditions in previous years and on general knowledge of ice behavior in different locations.