

## Provisional Outlook for 2008 September Minimum

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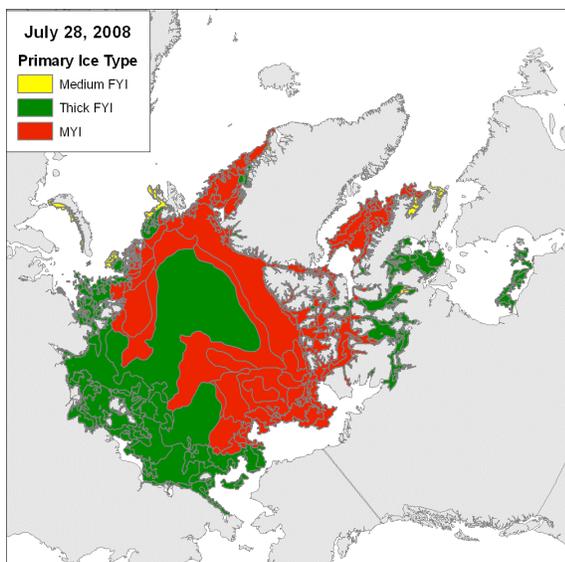
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### Overview:

This outlook was prepared by considering a NIC chart of Sea Ice Conditions for 28 July 2008. Any ice containing multiyear ice (MYI) was identified and classified by the partial amount (1/10, 2/10, etc.). All other ice was considered first year ice (FYI). As in the previous outlook (3 July 2008), much of the central Arctic is devoid of MYI, a situation not observed prior to 2008 in the satellite era. The summer minimum will depend on how much FYI melts out during August and September.



Sea ice conditions for 28 July 2008. First year ice is shaded in yellow (medium: 70-120cm thickness) and green (thick: >120cm thickness), while Multiyear ice is shaded red. Actual thicknesses may be lower than defined (see text).

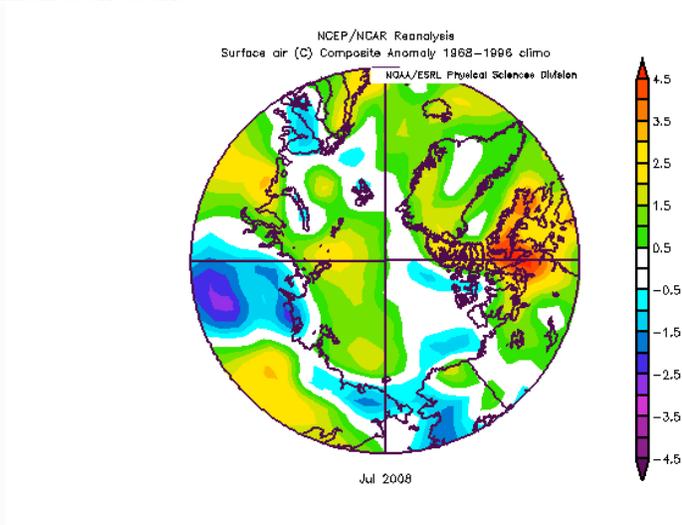
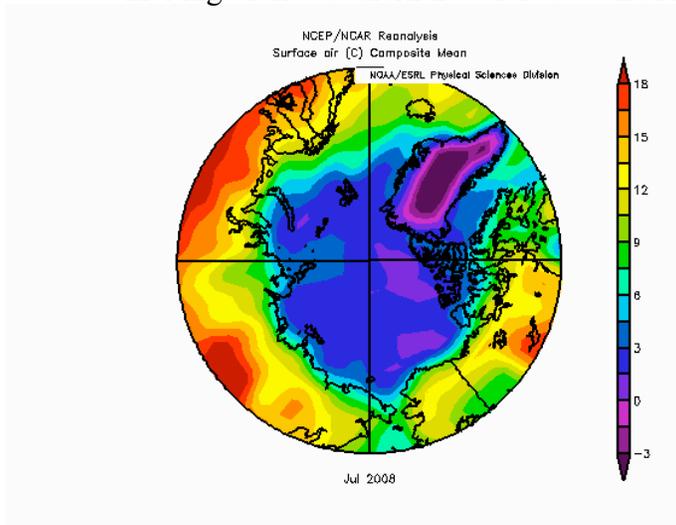
The overall ice extent (>1/10 concentration) is 7.71 million km<sup>2</sup>. The extent of ice containing MYI (red) is 3.85 million km<sup>2</sup>.

It should be noted that the primary ice types represent the final stages of development of the ice (based on a theoretical ice thickness model using cumulative freezing-degree days). For example, ice classified as thick FYI may not necessarily be thicker than 120 cm at present. Thus, the actual ice thickness may be much thinner than the primary ice type would indicate. Of

course, in some cases it could also be thicker than expected due to dynamic ridging and rafting of sea ice.

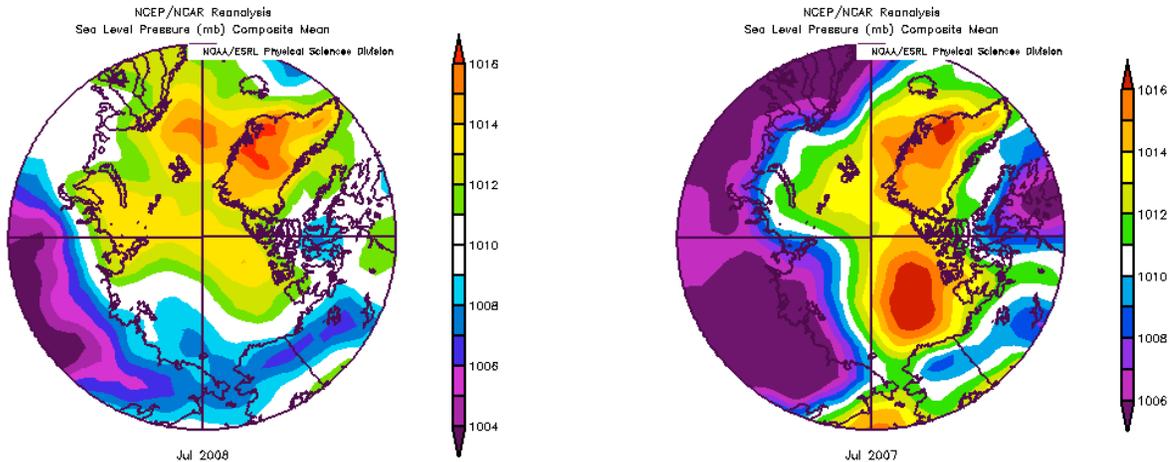
### **Meteorological conditions for July 2008:**

The Eurasian side of the Arctic basin experienced warmer than average temperatures (locally up to 3° C), while the North American side saw normal or below normal temperatures. Early July saw very warm temperatures over the Amundsen Gulf which, combined with the easterly winds, favored clearing of the southern Beaufort Sea and Amundsen Gulf. This influenced early melting of the southern Beaufort Sea and Amundsen Gulf.



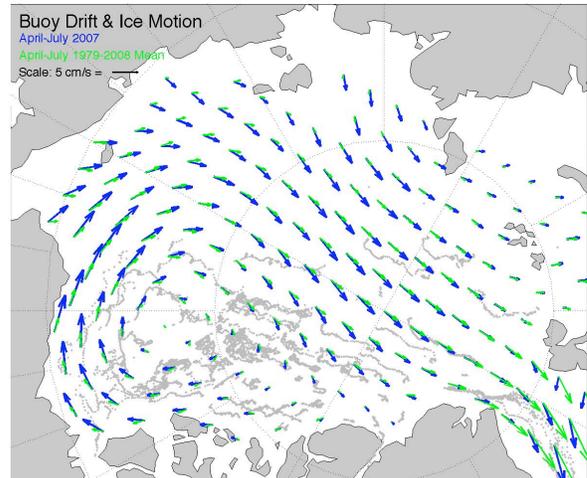
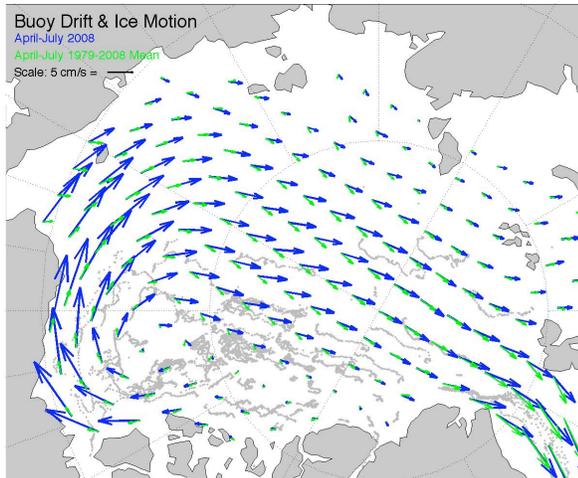
*July 2008 surface air temperature mean (left) and anomaly relative to 1968-1996 climatology (right), in degrees Celsius. (Source: NOAA Climate Diagnostic Center)*

The July 2007, sea level pressure (SLP) field indicated a forming “Polar Express” trans-arctic pattern was with transport of ice generally strongest from the Beaufort and Chukchi Seas toward the central Arctic and Kara Sea. In contrast, the July 2008 shows weaker overall atmospheric circulation, although ice has been transported from the Beaufort Sea west toward the East Siberian and Laptev seas.



Mean sea level pressure for July 2008 (left) and July 2007 (right), in millibars. (Source: NOAA Climate Diagnostic Center)

In fact, cumulative ice motions for April-July 2008 derived from drift buoys indicate the overall transport of ice out of the Beaufort Sea around the Beaufort Gyre to the central Arctic was actually much stronger than in 2007, but it appears to be converging (motion is slowing) over the Amundsen and Nansen Basins. In 2007 the cumulative transport was stronger from the Eurasian coast toward Fram Strait with a smaller region of convergence. On the other hand, ice that reaches Fram Strait (lower right of map) is exported faster in 2008 than in 2007.



Buoy-derived ice motion (blue) for April-July 2008 (left) and April-July 2007 (right). Mean motion from 1979-2008 is shown in green.

## Outlook for September 2008:

The primary question about summer 2008 continues to be the fate of the FYI in the central Arctic. The National Centers for Environmental Prediction (NCEP) 14-day atmospheric outlooks for mid-August suggest average surface air temperatures. However, these projections are based on NCEP models that assume that ice itself will continue to persist in the central Arctic. As the ice melts, absorption of solar radiation by the ocean will warm the surface layer and could contribute to an accelerated melting of the FYI. The effect of increased open water is not considered in the atmospheric projections.

Actual visual observations of sea ice recently made from aircraft during buoy deployment operations over the Arctic by the Naval Oceanographic Office and National Guard confirm that the ice cover is noticeably thinner and that it is more fractured than in previous years. Because of its relatively higher salinity, the dominant component of first year ice in the central Arctic ice pack is subject to melt at lower temperatures than the multiyear ice typically found in the region. A fundamental assumption by NIC is that this FYI will melt out in greater amounts than MYI.

For the outlook, the following initial assumptions were made by the NIC Science Team:

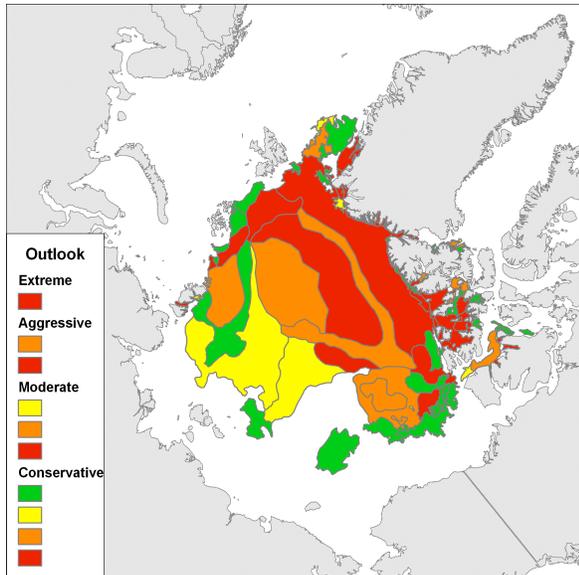
- 1) None of the existing ice in Baffin Bay or the southern Greenland Sea would survive
- 2) No multiyear ice of 1/10 or 2/10 concentration would survive except for ice in assumption (3).
- 3) Ice with thick FYI of 8/10 or greater concentration would survive.
- 4) No areas with primary ice type of medium FYI would survive.

The NIC hemispheric chart for 28 July 2008, was imported into ArcGIS and these areas were removed graphically, in the same manner as was done for the 3 July Outlook. The Operations Senior Analyst removed additional ice from the chart to reflect August 4 conditions. Four cases were then considered:

- 1) Conservative melt: All of the thick FYI in the central pack survives
- 2) Moderate melt: MYI with 3/10 or 4/10 concentration was removed if total ice concentration was less than 8/10. Peripheral areas with partial concentrations of thick and/or medium FYI greater than 4/10 were removed.
- 3) Aggressive melt: All peripheral ice with less than 8/10 total concentration removed. FYI remaining in central pack reduced.
- 4) Extreme melt: Areas remaining with MYI < 4/10 inside the basin, < 5/10 in the Canadian Archipelago and south of Fram Strait were removed. Remaining FYI in central Arctic reduced.

These 4 scenarios were presented by the Science Team to the Operations Senior Analyst. The analyst's assessment was that the most likely scenario was Moderate. This would give a minimum September ice extent of **3.32 million km<sup>2</sup>**. This value is below NIC charts last year's

record value of 3.98 million km<sup>2</sup> but above the 3 July assessment of 2.65 million km<sup>2</sup>. The chart below indicates the cumulative ice under each scenario. Although the assessment for the Extreme case is lower than in the 3 July outlook, the assessments for the other cases were above those made last month.

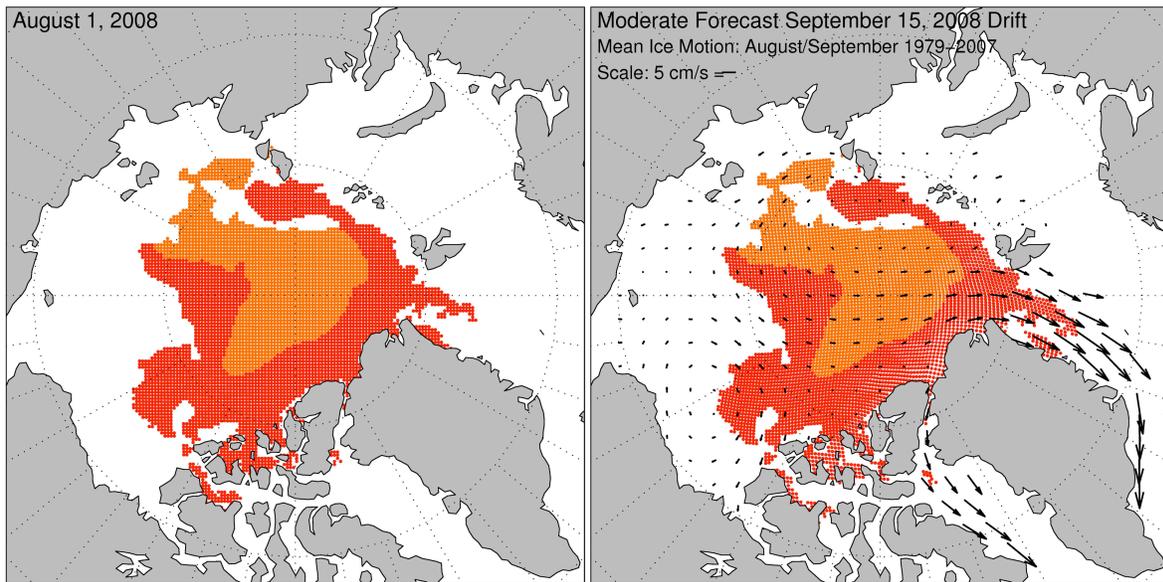


Projection of September 2008 minimums

- 1) Conservative: 4.02 million km<sup>2</sup>
- 2) Moderate: 3.32 million km<sup>2</sup>
- 3) Aggressive: 2.64 million km<sup>2</sup>
- 4) Extreme: 1.52 million km<sup>2</sup>

While these projections should not be considered as spatial outlooks, the lack of MYI in the lower Canadian Arctic Archipelago continues to suggest the possibility of the Northwest Passage becoming navigable in 2008, particularly the southern (shallow water) route.

A drift model using climatology from 28 years of buoy-derived ice motion for August and September was further applied to the Moderate scenario to create a spatial projection of ice for September 15, 2008. The model indicates some compacting of the ice pack against the Canadian Archipelago, as well as some MYI moving south through the islands. Export of ice through Fram Strait is also observed. However, because this is a 28-year average, the motions are somewhat slower than what will be observed this year (this is also apparent in the April-July 2008 cumulative ice motion, above). Particularly, the area of convergence seen in 2008 is not well represented by the climatology, nor is the strong Beaufort Gyre. Little motion is seen in the climatology along most of the Eurasian coast. Thus, we expect the actual conditions to be different, with more transport and compaction of the FYI in the central Arctic toward Fram Strait.



*Spatial projection of the Moderate Scenario using climatology of August-September ice motions and a dynamic sea-ice drift model. Left: Initial conditions assumed for August 1, 2008. Right: Final conditions on September 15, 2008. Areas containing MYI are red. Areas containing only FYI are orange.*

NIC will update this outlook on more time in early September based on August conditions.