

## The Current State of Arctic Sea Ice

Gregory J. Deemer<sup>1</sup>, Uma S. Bhatt<sup>1</sup>, Hajo Eicken<sup>2</sup>, Jennifer Hutchings<sup>3</sup>,  
Pamela Posey<sup>4</sup>, Rick Allard<sup>4</sup>, Gary Hufford<sup>5</sup>, and Robert Raye<sup>6</sup>

<sup>1</sup>Department of Atmospheric Science, University of Alaska Fairbanks, Fairbanks, AK

<sup>2</sup>Geophysical Institute, University of Alaska Fairbanks, Fairbanks, AK

<sup>3</sup>International Arctic Research Center, University of Alaska Fairbanks, Fairbanks, AK

<sup>4</sup>U.S. Naval Research Laboratory, Stennis Space Center, MS

<sup>5</sup>NOAA's National Weather Service Alaska Region Headquarters, Anchorage, AK

<sup>6</sup>Shell Global Solutions, Houston, TX

### 1. Introduction

Arctic sea-ice extent reached a new record minimum in 2012. Although shattering the previous record set in 2007 was not entirely unforeseen, the swift return to a record year places increased attention on our polar regions. This report discusses long-term trends that have led up to today's conditions of a younger and thinner ice cover, and thus an ice cover that is more vulnerable to rapid and record summertime retreat.

### 2. Discussion

#### a. Rapid and record summer retreat, 2012

One of the simplest methods used to characterize the state of the ice cover is the extent, or the area of ocean covered with at least 15% sea ice coverage. Figure 1, displays five months of the annual Arctic sea ice cycle and shows that the extent near the onset of the breakup season in 2012 was within two standard deviations of the 20-year base period. But as the melt season progressed, the departure from the long-term average became increasingly large. The Arctic also experienced a large sea-ice loss event in early August before reaching the new record minimum of 3.41 million km<sup>2</sup>. The new record is approximately 50% below the climatological mean minimum extent and surpassed the previous record minimum values by over 760 thousand km<sup>2</sup>.

#### b. Substantial losses of multiyear ice

Another descriptor of the state of the ice cover is ice age, which commonly serves as a proxy for ice thickness, as the oldest ice in the Arctic basin is often the thickest ice. Figure 2 displays a satellite-derived ice age product showing the progression of loss of the oldest ice types within the Arctic. A precipitous decline of multiyear ice is notable beginning around the year 2002, and has continued over the past decade.

The distribution of individual ice age classes that contributes to the total Arctic ice extent (Figure 3) indicates that the oldest ice classes are nearly depleted. Because of

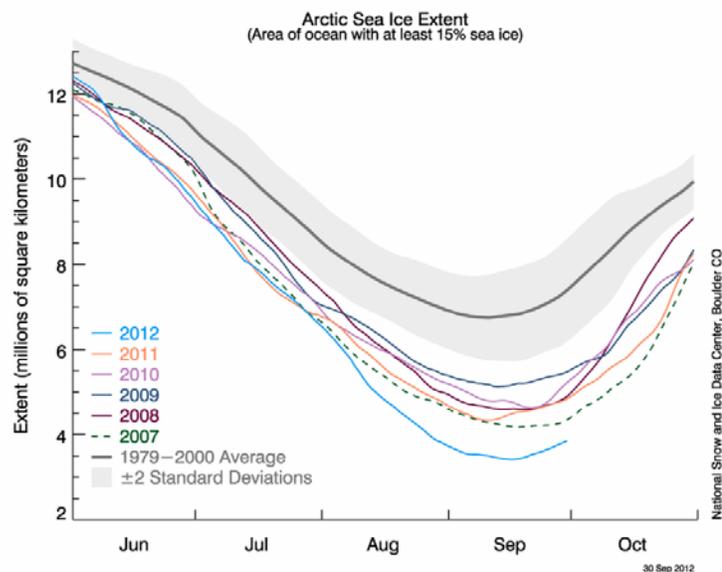
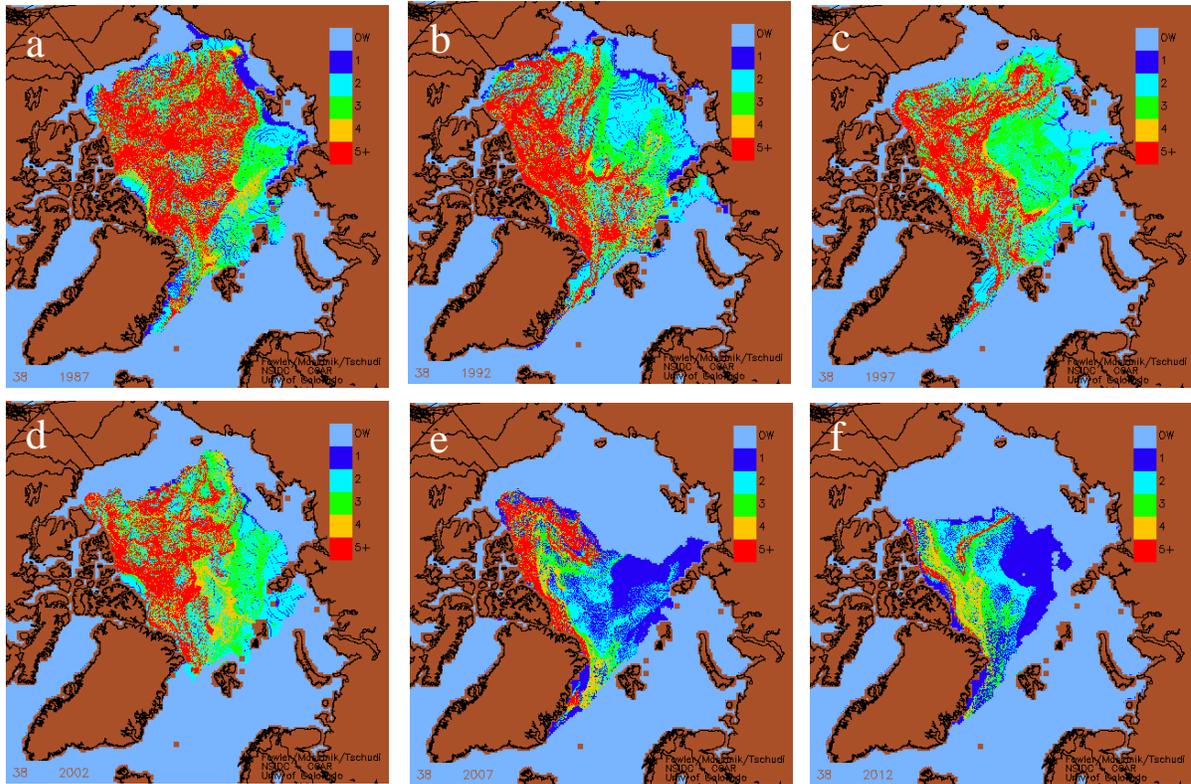


Fig. 1 Arctic sea ice extent progression (Source: NSIDC Arctic Sea Ice News and Analysis, 30 September 2012).



**Fig. 2** Ice age product, courtesy of Fowler, C., Maslanik, J., Tschudi, M., Dept. of Aerospace Engr., Univ. of CO, Boulder, CO. Each panel shows Week 38, corresponding to the typical September minimum ice extent for a) 1987, b) 1992, c) 1997, d) 2002, e) 2007, and f) 2012, respectively. The oldest ice (5+years) is in red.

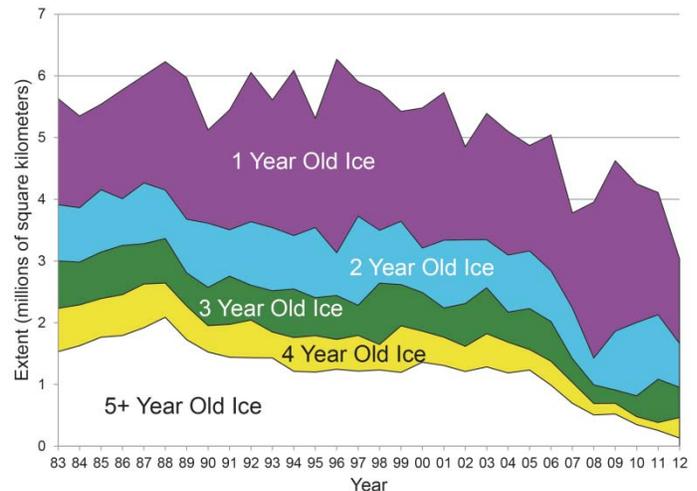
substantial losses of multiyear ice, the Arctic now contains more thin, first-year ice that is more susceptible to export by dynamical forcing and often melts entirely by the end of the summer retreat.

### c. Declining trend in sea ice volume

The most important variable in describing the state of the sea ice cover on a climate-scale is the ice volume. Accurate sea-ice thickness measurements needed for the assessment of ice volume are in short supply, but there are a number of different guidance products that have been created by the modeling community. The output from one of the better-known models, the Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS) indicates a declining trend in total ice volume of 2 – 4 thousand km<sup>3</sup> per decade (Figure 4). In the most recent years, ice volume has repeatedly dipped below the second standard deviation of the long-term trend during the melt season. This indicates that not only are large losses of sea ice occurring in the Arctic, but the Arctic is also losing much of its multiyear ice cover.

### d. The Arctic storm of 2012

An intense Arctic cyclone that developed in northern Siberia may be the cause of the large ice loss event, which occurred in early August



**Fig. 3** Changes in multiyear ice extent from 1983 to 2002. (Source: NSIDC Arctic Sea Ice News and Analysis, 2 October 2012).

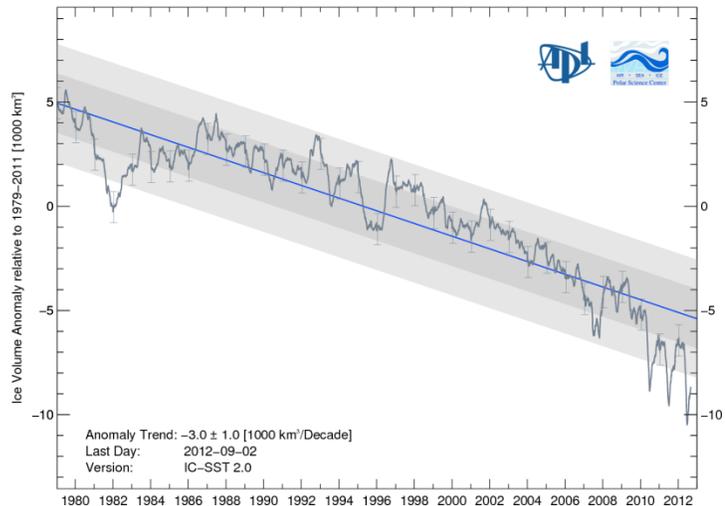
(Figure 1). After formation, the system ejected off the northern coast of Chukotka where it quickly intensified to reach a minimum central pressure of 964 hPa. The storm reached its peak intensity before encountering the ice edge located in the north-central Beaufort Sea and then began to fill. This event was associated with high winds and seas, warmer temperatures, and dense cloud cover; processes that favor sea-ice destruction. Ground-truth verification of the effects that this storm had on the state of the ice cover in 2012 are difficult to quantify due to data scarcity, and the contribution of this event to the total ice loss will for now be left to speculation.

### 3. Summary

Long-term trends of Arctic sea-ice thinning preconditioned 2012 for record retreat. Much of the oldest ice within the Arctic has been lost, which leaves a thinner more mobile ice cover that is subject to rapid export and melt. This year, a strong Arctic cyclone impacted the Pacific sector of the Arctic and is a likely candidate for rapid sea ice retreat in August but exact effects of the storm have yet to be fully apportioned.

### References

- Arctic Sea Ice News & Analysis, 2012: Poles apart: A record-breaking summer and winter.  
<http://nsidc.org/arcticseaicenews/2012/10/poles-apart-a-record-breaking-summer-and-winter/>
- Polar Science Center, 2012: Arctic sea ice volume anomaly, version 2.  
<http://psc.apl.washington.edu/wordpress/research/projects/arctic-sea-ice-volume-anomaly/>



**Fig. 4** Pan-Arctic Ice Ocean Modeling and Assimilation System (PIOMAS) Arctic sea ice volume and trend (Source: University of Washington – PSC web page).