Arctic Sea Ice in 2007: A Year to Remember

Julienne Stroeve, Sheldon Drobot, Shari Gearheard, Marika Holland, James Maslanik, Walt Meier, Ted Scambos, Mark Serreze http://nsidc.org

Summary

In summer 2007, the Arctic sea ice extent shrank by more than one and a half million sq-km. Compared to sea ice conditions in the 1950s to 1970s, this represents a 50% reduction in the area of the Arctic Ocean covered by sea ice at the end of the melt season. The cause for the decline appears to be largely driven by a thin ice pack that decayed rapidly in response to the anomalously warm, sunny and windy summer. Global climate models have long predicted complete disappearance of the Arctic summer sea ice cover if greenhouse gas concentrations in the atmosphere continue to increase at the rates they presently are. In addition, these models reveal that this transition towards a seasonally ice free Arctic state may occur rather abruptly. Analysis of conditions in 2007 suggests the Arctic may be on the verge of fundamental transition towards a seasonal ice cover.

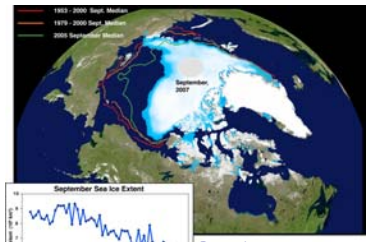

Figure 1. September sea ice extent time-series (left) and 2007 September sea ice concentration (top) along with Arctic Ocean median sea ice extent from 1953-2000 (red line), 1979-2000 (orange line) and for September 2005 (green line).

- Between 2006 and 2007, 1.6 x 10^6km^2 of ice was lost.
- Compared to the previous record set in 2005, there was an ice loss of 1.3 x 10^6km^2, or a 23% reduction.
- September 2007 represents a 3 standard deviation departure from the mean
- September linear trend from 1953-2007:-8.1%/dec
- September linear trend from 1979-2007:-10.7%/dec

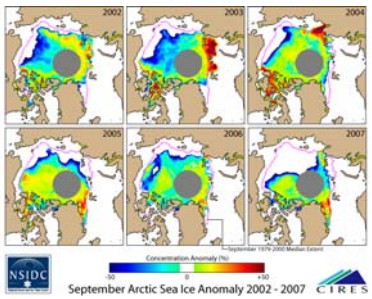

Figure 2. Arctic September sea ice anomaly for 2002-2007. Areas in white within the average sea ice edge contour are regions where ice normally is found but is not present during the given year. The gray circle around the pole is not imaged by the satellites.

Factors Contributing to Extreme Ice Loss in 2007

While the causes of this extreme summer ice loss remain to be fully understood, it appears that key factors include superposition of an unusual pattern of atmospheric circulation upon a rather thin ice pack.

High Pressure over Central Arctic, Low Pressure over Siberia

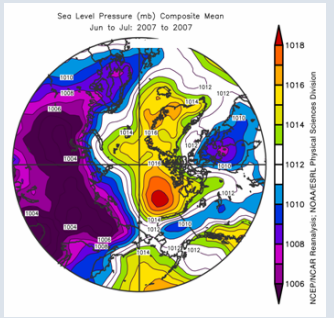

Figure 3(a). June to July 2007 averaged sea level pressure.

Very Warm Arctic

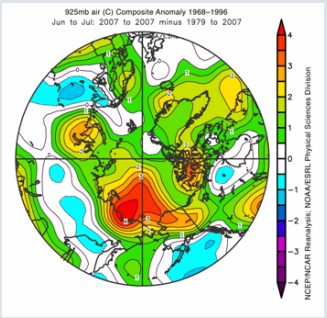

Figure 3(b). June to July 2007 925 mb air temperature anomalies relative to 1979-2007.

Clear Skies

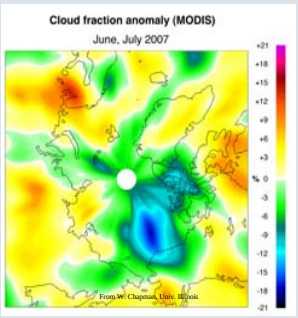

Figure 3(c). June to July 2007 cloud fraction anomalies from MODIS.

Strong Offshore Ice Motion

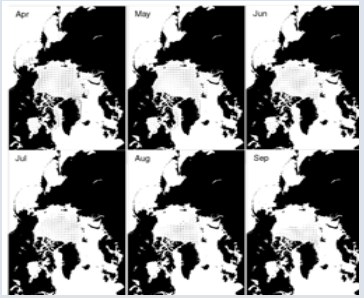

Figure 4. AMSR-E derived monthly mean ice motion fields for April through September 2007.

Unusually High SSTs

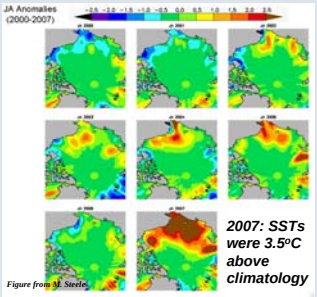

Figure 5. July to August sea surface temperature (SST) anomaly fields from MODIS thermal infrared observations.

Arctic Sea Ice is Becoming Younger and Thinner

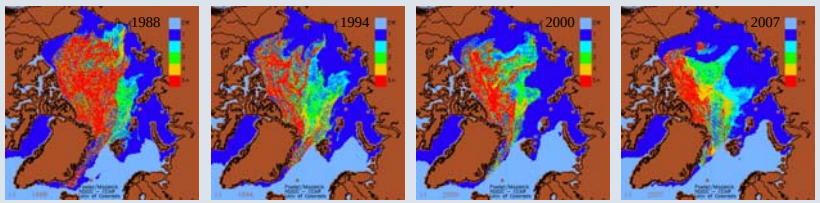

Figure 6. Ice age for March derived from an ice tracking algorithm for 1988, 1994, 2000 and 2007. Younger ice implies thinner ice (see Maslanik et al., 2007).

Implications for Future of the Ice Cover

The IPCC climate models are failing to capture the rapid decay

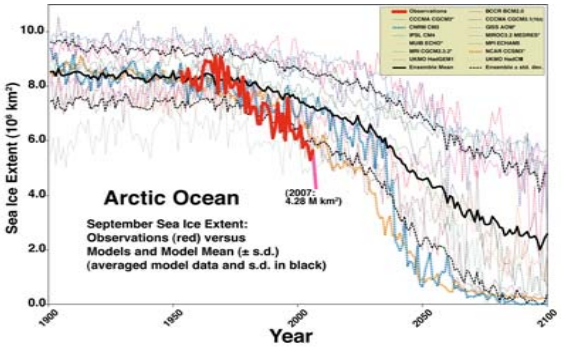

Figure 6. Time-series of September sea ice extent from 13 IPCC climate models and from observations (shown in red). Ensemble mean from all the models is indicated by the thick black line, and one standard deviation from the mean is given by the dotted black line.

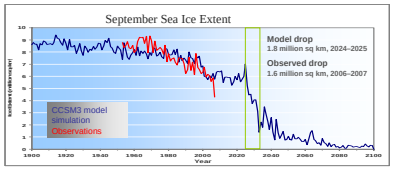

Figure 7. NCAR CCSM3 simulated September sea ice extent showing how abrupt transitions can occur once the ice cover has sufficiently thinned and becomes vulnerable to a "kick" from natural variability.

Set-up was Right for Rapid Decay

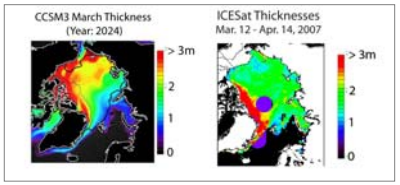

Figure 8. Ice thickness during March based on the NCAR CCSM3 simulation prior to abrupt summer ice loss (left) and ICESat GLAS-derived ice thickness during spring 2007 (right).

2008?

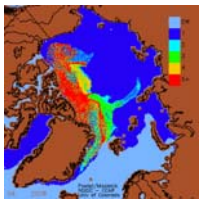

Figure 9. Ice age for 4th week in January 2008. Pronounced ice losses are likely this coming summer.

Summary

- Record ice loss in 2007 resulted from a thin ice pack that was vulnerable to an unusual atmospheric circulation pattern, thereby allowing large areas to melt out.
- All models participating in the IPCC AR4 show declining Arctic ice cover from 1953-2007, suggesting a strong role of GHG in the observed decline. However, none of the IPCC model simulations show trends comparable to observations over this time-period.
- Our view is that a seasonally ice-free Arctic Ocean might be realized as early as 2030.