Initial ice thickness and ice type in the region between Ellesmere Island and the North Pole at the outset of the 2008 summer

Christian Haas, University of Alberta, Edmonton, Canada

Data

Ice type

The developmental history of the ice can be obtained from satellite radar data as well as from buoy drift measurements. Backscatter maps obtained by QuickScat show a continued decrease of the fraction of old ice in the Arctic Ocean, and in the region of the North Pole a replacement of second-year ice by first-year ice, a major regime shift which had occurred during the summer of 2007 (Figure 1).

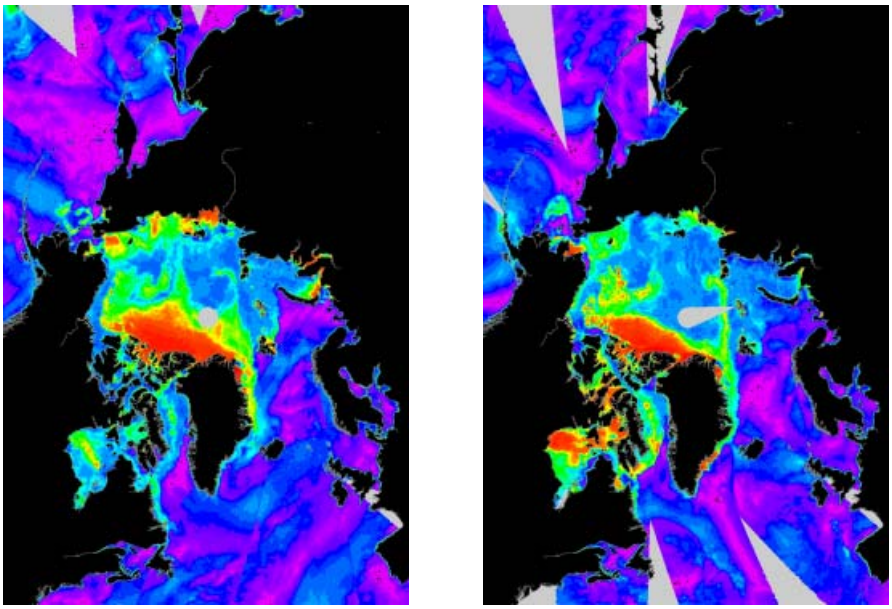

Figure 1: Quickscat HH backscatter maps of the Arctic provided by Leif Toudal (at www.seaice.dk), May 23 2007 (left) and 2008 (right). Red to green indicates high backscatter and multiyear ice in the Arctic Ocean proper, blue and purple indicates low backscatter and first-year ice in the Arctic Ocean proper (Haas & Eicken, 2001).

Ice thickness

A 3.5 km long ground-based EM thickness profile was obtained on April 12 2008 close to the North Pole at 88º20'N, 15ºE (Figure 2). Its modal and mean snow-plus-ice thickness was 2.08±0.58 and 1.95 m. Mean snow thickness was 0.14±0.10 m, with a mode of 0.1 m. This can be compared with a similar, 1.7 km long profile obtained at 89º30'N, 19ºW on April 22, 2007, which resulted in a mean and modal thickness of 3.31 ± 1.51 m and 2.35 m. Note that there was a

secondary mode at 1.65 m representing first-year ice. Overall, the ice was considerably thicker in April 2007 than in April 2008. The thinner ice in 2008 can be mainly explained by the absence of second-year ice. However, note that the first-year ice snow-plus-ice thickness in April 2008 was 0.30 m thicker than in 2007, despite a thinner snow cover. This is remarkable, as the delayed ice formation after the record minimum ice summer in 2007 would have left much heat in the mixed layer, which could have retarded first-year ice growth.

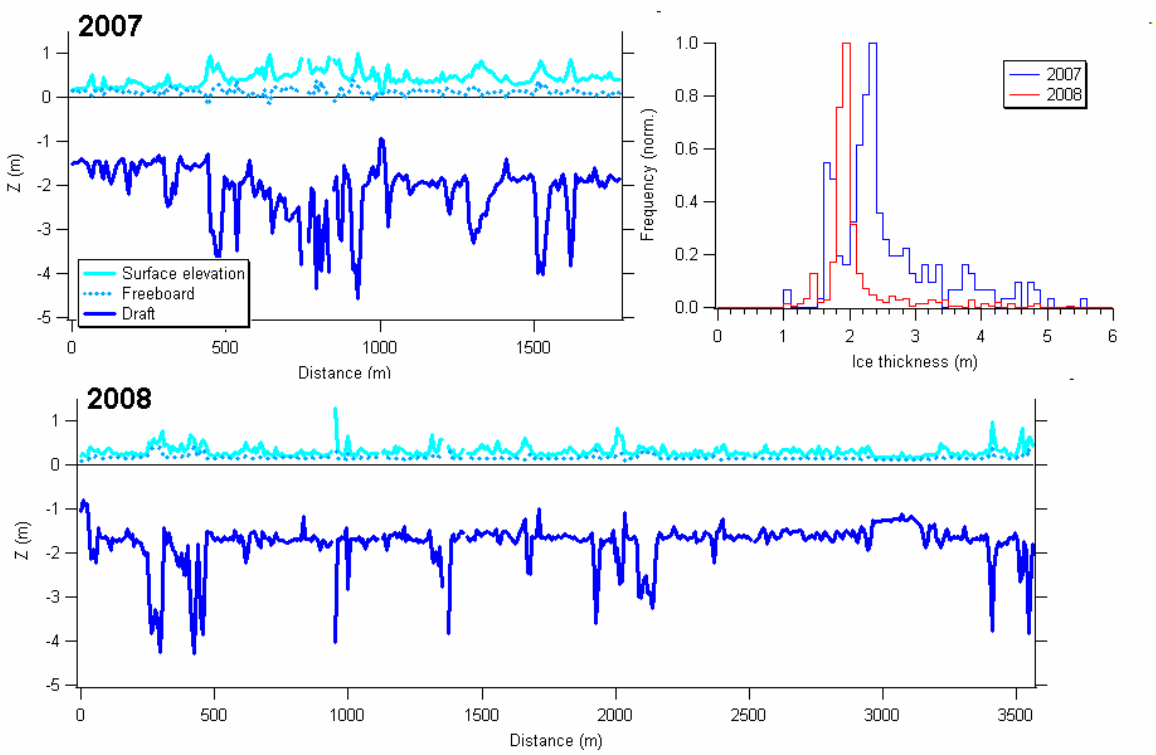

Figure 2: Ice thickness profiles and distributions close to the North Pole, April 2007 and April 2008.

Airborne EM surveys north of Ellesmere Island showed a significantly thinner ice in April 2008 than in previous years. Preliminary results indicate that there was a strong thickness gradient with modal thicknesses decreasing from > 4 m at 82.5°N, to 2.5 m and 84°N. This thinning is probably a result of the presence of much thinner ice in the region due to the narrowing of the older ice area between Ellesmere Island and the North Pole (cf. Figure 1).

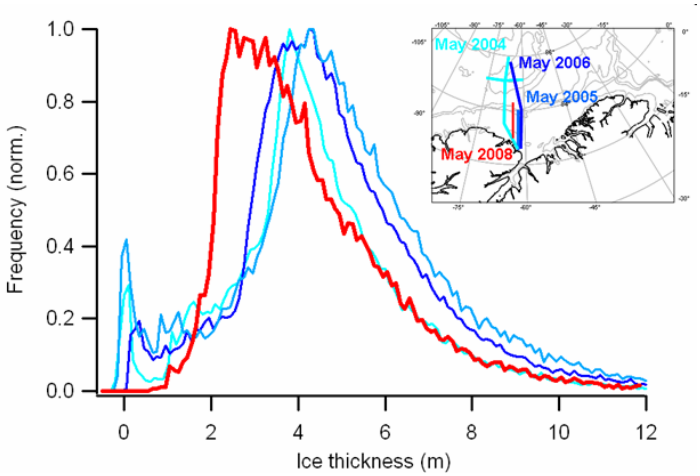

Figure 3: Ice thickness distributions between Ellesmere Island and 86°N in May 2004, 2005, 2006, and 2008, observed by airborne EM profiling. Note significantly reduced ice thickness in 2008.

Outlook

Typical summer melt rates in the high Arctic Ocean range between 0.3 and 0.8 m, depending on oceanic and atmospheric heat fluxes. Therefore, it is unlikely that any of the surveyed ice will completely melt during the 2008 summer. However, this requires that the sampled ice fields remain in the Central Arctic Ocean.

Therefore, it will depend on the actual ice drift in the coming months if the North Pole will become ice free of not. Summer ice conditions in the high Arctic Ocean depend strongly on the atmospheric circulation regime during the months June to August, which is on average characterized by low sea level pressure over the Arctic with a reversal of the mean annual drift. This was demonstrated by Haas & Eicken (2001) for the 1995/1996 summers, when a year with minimum ice extent and thickness (1995) was followed a year with maximum ice extent and absent melt ponds (1996). 1996 was characterized by low sea level pressure over the central Arctic Ocean, which led to ice divergence into the marginal seas, and prevented the advection of warm air from southern regions.

Overal reductions of MYI thickness and area point to a likelihood that the MYI area will further decrease during the summer of 2008.

Additional data requirements

A more sophisticated outlook would require improved estimates of the development of atmospheric circulation patterns during June, July, and August. More extensive ice thickness observations would allow judging the vulnerability of ice in larger and more widespread regions to disappearing completely by melting.

Acknowledgement

Stefan Hendricks, Jean-Louis Etienne, and Emmanuelle Périé contributed to the data gathering in 2008. Leif Toudal provided QuickScat backscatter maps.

Reference

Haas, C., Eicken, H. (2001).Interannual variability of summer sea ice thickness in the Siberian and central Arctic under different atmospheric circulation regimes, Journal of Geophysical Research, 106, (C3), 4449-4462.