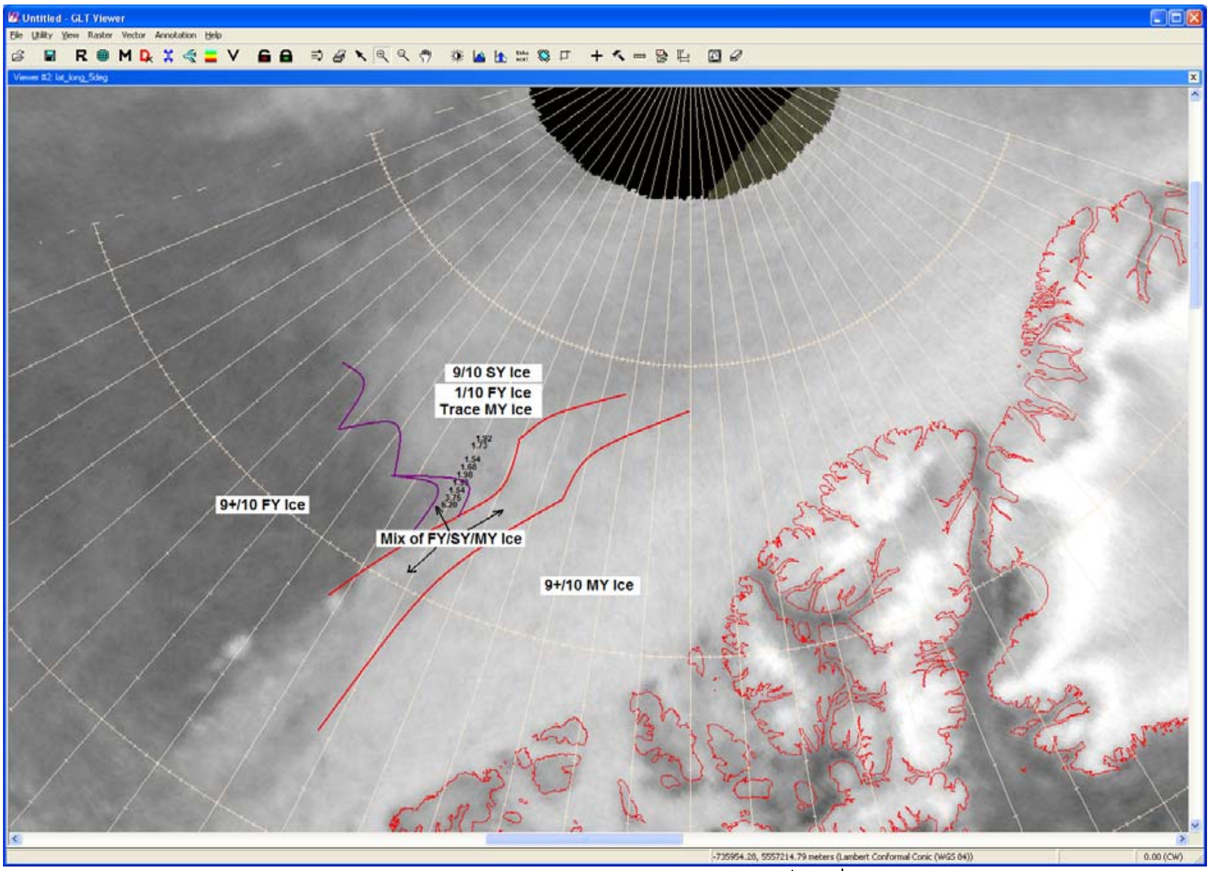
Ice Report 14.4.09

Summary

The results collected in the first month of the Catlin Arctic Survey point to an unexpected lack of thicker Multiyear Ice.

Ice Thickness

The ice thickness measurements that Pen and the team have been able to phone in imply that they are travelling over predominantly thick first-year ice. Satellite imagery of the area, especially passive microwave imagery (e.g. AMSR and QuikScat data), indicates the area is indeed covered primarily with first-year ice and a scattering of multi-year ice floes. According to the imagery, the team is now moving into an area of predominantly second-year ice, however, also containing a scattering of multi-year ice floes. This transition can also be seen in the slight increase in average ice thicknesses being reported by the team.



Backscatter radar image showing 1st, 2nd and Mulityear ice from NOAA

First year ice is ice that is less than a year old, having formed during the current winter season. Multi-year Ice is ice that has survived through at least one summer melt-season and which has continued to thicken over time. Multi-year ice can be further divided into Second-year ice and Old ice.

First year ice is typically thinner than 2 m, while Multi-year ice is generally thicker than 3 m.

The amount of multi-year ice in the Arctic Ocean is an indication of how much sea ice remained at the end of the last summer melt-season. Because it's thicker, multi-year is more likely to survive the summer season than first-year ice (which is thinner).   Multi-year ice that is thinner than expected, however, may not survive a summer melt-season.

The Catlin Arctic Survey's route was specifically designed so that the team would begin the expedition on multi-year ice, transit briefly through a region primarily covered with first-year ice, then enter a region in which second-year ice now prevails. It is hoped that this transect will provide ice thickness information about all three types, with a focus on: 1) the "health" or thickness of the oldest remaining multi-year ice; and 2) the thickness of the newest multi-year ice (i.e. the second-year ice near and over the North Pole). The second-year ice was formed from the area of first-year ice that did not melt away last summer as predicted.

Pen Hadow drilling and measuring sea ice

High resolution radar satellite imagery (Radarsat courtesy of MDA) of the area immediately around the team corroborates the information from the passive microwave sensors (see above). The fact that initial ice thickness results indicate that they have been travelling over first year ice, almost right from the start, indicates that the extent of the multi-year ice is much reduced and is now confined to a narrow swath east of 130W along the northwest Canadian Arctic Archipelago / Greenland coasts.

NASA studies have shown that the multi-year ice extent in the Arctic Ocean has been decreasing consistently since 2002, by up to 40% according to the most recent figures. There is still debate as to how much of this reduction is directly attributed to dynamic forces, like ice-redistribution, (e.g. ice being crushed together, reducing the extent but not the volume of ice) and ice-export (e.g. ice drifting out of the Arctic Ocean), and how much is the direct result of thermodynamic forces (e.g. ice melting).

Dr Laxon's team at the Centre for Polar Ocean Monitoring at UCL are collating Backscatter data from NASA's QuickScat satellite. Backscatter data shows the roughness of the ice surface and is an indicator of ice age. Multi-year ice, because it has been subject to deformation / crushing over a longer period of time than first-year ice, is therefore rougher and so reflects more energy back to the satellite sensor.

Snow Thickness

Snow thickness, measured by the team during the first 2 weeks of March, shows an average snow depth of around 11 centimeters. Since then the average has risen to around 16cm.

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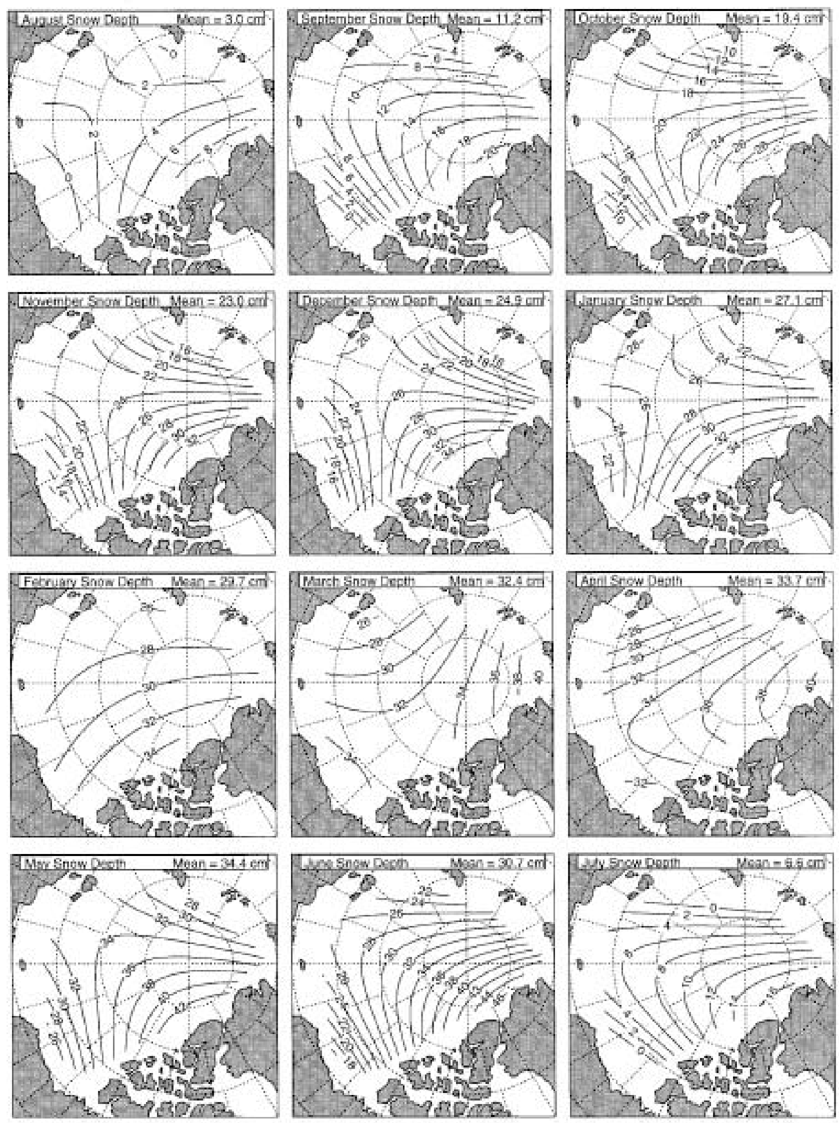

FIG. 9. Mean snow depth for 1954–91 on multiyear sea ice at drifting stations for each month, in cm of geometric depth. A two-dimensional quadratic function was fitted to all the data available for each month, irrespective of year. Coefficients for the fits are given in Table 1.

Courtesy of American Meteorological Society, Journal of Climate

Information about snow depth is important because it contributes to the apparent ice thickness as measured by satellite altimeters. The thickness of the snow layer must be subtracted from this apparent ice thickness in order to calculate the true ice thickness. Furthermore, snow insulates the ice beneath from the cold air above. A thick layer of snow will prevent significant ice growth / thickening.

Snow also reflects solar radiation, (dramatically) slowing ice melt. It's an important factor used in many ice thickness prediction models. Currently scientists use contour maps published by Stephen G Warren (Journal of Climate, 1999) as a reference guide to snow thickness for any given month. Warren's climatology suggests that, on average, March snow depths in this area should be 32-34 cm on multi-year ice. The difference between the CAS measurements and Warren's climatology could be due to natural variability and the small sample size, or to changing meteorological patterns, or a combination of these reasons. The most likely is reason for the discrepancy, however, is ice age. The heaviest snowfalls occur at the start of autumn, when first year ice hasn't yet formed, so snow-depths and accumulations will be greater on older, multi-year ice.

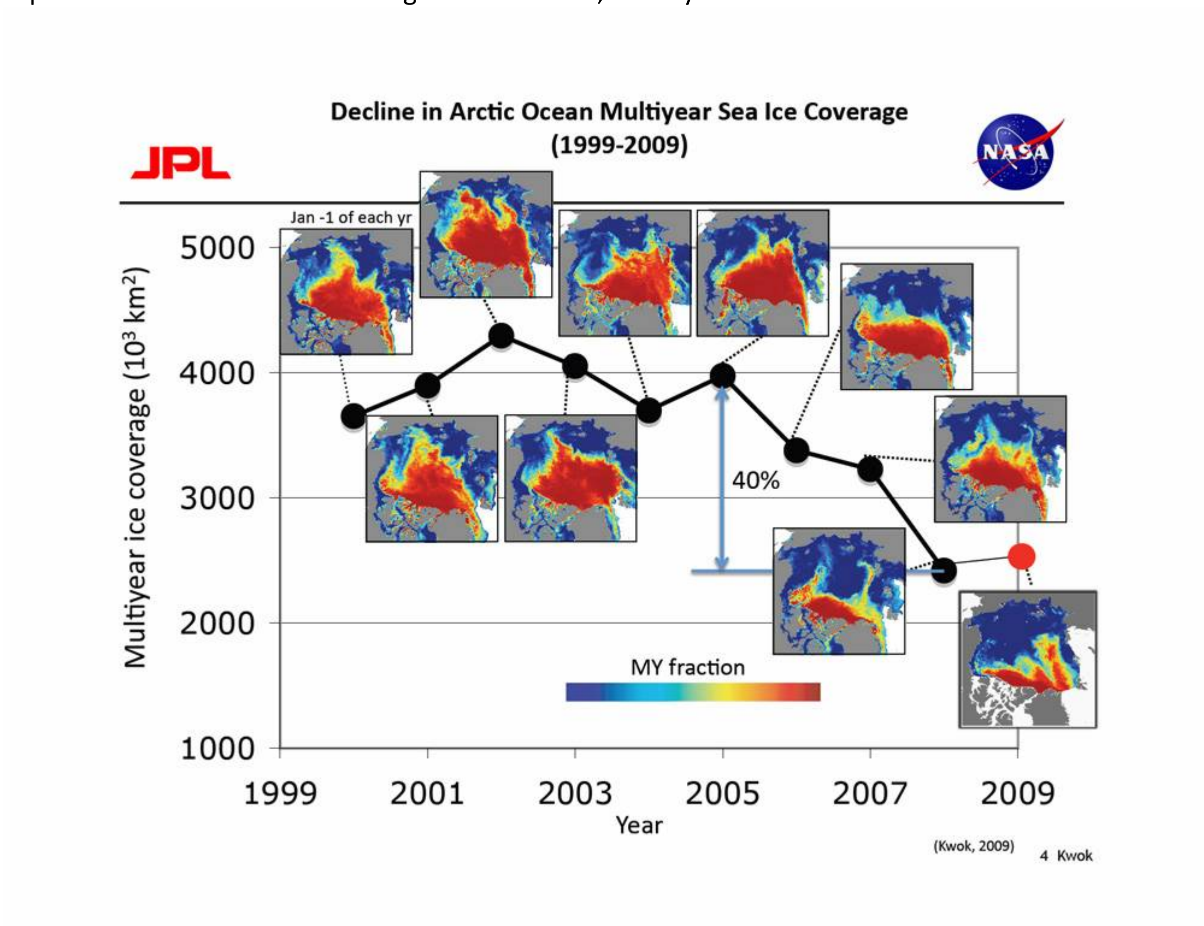

Image courtesy of Ron Kwok, JPL, NASA

Combining Ice and Snow Measurements

One further consideration, when interpreting the ice thickness measurements made by the CAS team, is navigational bias. The team systematically seeks out flatter ice because it is easier to travel over and camp on. Typically, the surface of first-year ice floes is flatter than that of multi-year ice floes. However, satellite imagery of their route suggests that navigational bias is not a factor in this case, and that in fact they have been surrounded by ice with a consistent age (from 82°30’N northwards – the high-resolution radar imagery does not cover the start near 82°N).

Satellite backscatter data, complemented by the ice thickness dataset that the Catlin team will continue to gather until they reach the pole, will help to answer many questions.