Correlated Trends in Western Arctic Snow Cover and Sea Ice Distribution

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Previous studies document the advance in the annual date of snow disappearance (melt date) at the CMDL Barrow Observatory (BRW). A record early melt in 2002 followed by a moderately early one in 2003 further corroborate earlier analyses. Both 2002 and 2003 were also years when ice covering the western Arctic Ocean retreated early, and the duration of the melt season was longer than average. Coincident anomalies in adjacent regions suggest physical links between the disposition of sea ice and factors that affect the annual cycle of snow cover. To investigate, passive microwave (PMW) data from polar orbiting satellites were used to evaluate the duration of the melt season at sea compared with a snowmelt record representative of northern Alaska. Over a large region northwest of Alaska the duration of the melt season is anti-correlated with the annual disappearance of snow at BRW. This region is highlighted in shades of red in Figure 1, where melt duration has increased by as much as a month since 1988. During the same period, the melt date at BRW has advanced by several days. Basin-wide, sea ice has declined by about 7% since 1979 partly because of the changing cycles of melting and freezing.

Diminishing snow and ice cover in the high northern latitudes is one of the most alarming indicators of climate change because of a radiative perturbation know as the "temperature-albedo feedback." Rising temperatures melt snow and ice, reducing surface albedo and increasing solar absorption which accelerates further warming. Variations in snow cover and ice distribution of the Western Arctic can be partly attributed to changing patterns of atmospheric circulation, especially during spring. This is demonstrated by comparing subsets of "early" versus "late" years of melt at BRW in conjunction with the PMW results and associated synoptic wind patterns. For example, the dipole pattern of Low and High pressure centers indicated in Figure 1 favors an early melt because the northward advection of warm, moist air is enhanced. Early onset tends to lengthen the melt season, resulting in an overall loss of ice volume. Concern arises as to whether or not the observed trends are manifestations of natural, low-frequency oscillations or are anthropogenically forced. A preliminary examination of a century-long record of snow depths at Barrow provides some intriguing insight.

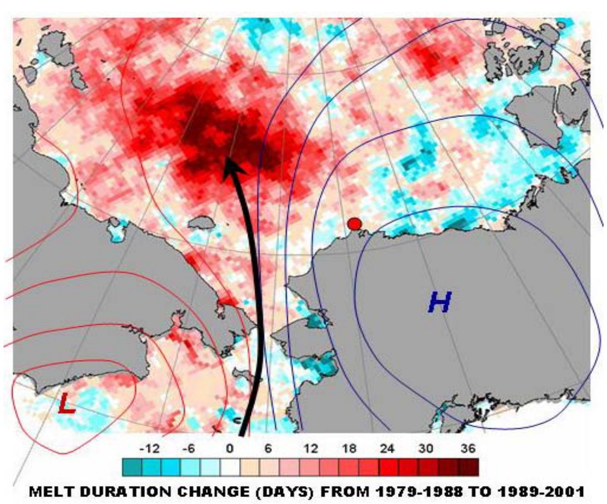

Figure 1. Change in Western Arctic sea ice melt season duration from 1979-1988 to 1989-2001 determined from passive microwave-derived melt onset and freeze onset dates in a region northwest of Pt. Barrow, Alaska (red dot). The geopotential height contours show, schematically, the composite synoptic pattern and associated prevailing wind (vector) at 850 hPa averaged for March, April, and May 1996, 1998, and 2002. Warm air advection associated with this pattern favors an early onset of snowmelt that lengthens the melt season. An overall decline of sea ice volume may result if such a pattern persists in a succession of years.