Catastrophic reduction of sea-ice cover in the Pacific sector of the Arctic Ocean

Koji Shimada[1]; Takashi Kamoshida[1]; Motoyo Itoh[1]; Shigeto Nishino[1]; Eddy C. Carmack[2]; Fiona A. McLaughlin[2]

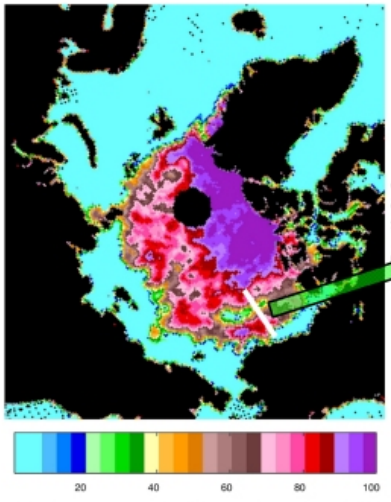
[1] IORGC, JAMSTEC; [2] IOS,Canada

http://www.jamstec.go.jp/arctic/

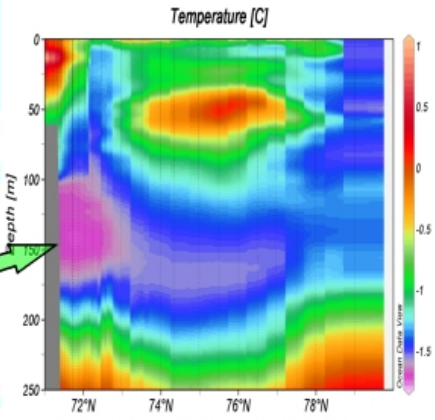
In the summer of 2006, a large open-ocean polynya was observed in the Canada Basin, suggesting the influence of warming of the upper ocean. The emergence of the open-ocean polynya was visually sensational phenomena, especially in news media, but serious Arctic change caused by the oceanic warming has already initiated about a decade ago.

Recently observed reduction in sea ice cover in the Arctic Ocean was not spatially uniform but rather was disproportionately large in the Pacific sector of the Arctic Ocean. The spatial pattern of ice reduction was similar to the spatial distribution of warm Pacific Summer Water (PSW) that interflows the upper portion of halocline in the southern Canada Basin.

Before 1997, sea-ice concentration in the southern Canada Basin gradually decreased at approximately -0.6% per year, similar to the rate of sea-ice decrease observed across the entire Arctic Ocean. From 1997 to 1998, however, there was a substantial decrease in late summer sea-ice concentration from 60-80% to 15-30% simultaneously with the anomalous warming of PSW in the Canada Basin. After that it has not subsequently recovered to pre-1997 levels. This abrupt decrease in late 1990s and absence of rebound suggests there has been a catastrophic change initiated by warming of the upper ocean. The warming of the upper ocean in the Canada Basin was not directly correlated with the variation in upstream temperature in the vicinity of the Bering Strait, but was caused by the increase of heat transportation associated with the strengthening of anticyclonic upper ocean circulation driven by anticyclonic sea ice motion in early winter. The reason why the sea ice motion was accelerated was in the change in boundary condition of sea ice cover along the coast. After the catastrophic change, wintertime sea ice concentration near the coast has been decreased. This condition reduced the stress from the coastal boundary and thus allowed a more efficient coupling of wind forcing to the upper ocean via the sea ice motion. We propose a positive feedback mechanism whereby the delayed sea-ice formation in early winter, reduced internal ice stresses and thus allowed a more efficient coupling of anticyclonic wind forcing to the upper ocean. This, in turn, increased the flux of warm PSW into the basin and caused the catastrophic changes.



Sea ice concentration on Aug. 27. 2006



Vertical section (white line in the left figure) of temperature along 150W from CCGS Louis S. St-Laurent.