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THE GREENLAND SEA ICE SEASON 2002 –
THE OBSERVED EXTREMES SEEN FROM
ICE CENTER PERSPECTIVES

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1. INTRODUCTION

Operational monitoring and mapping of the sea ice in the Greenland Waters based on data from Radarsat SAR, NOAA-AVHRR and DMSP-SSM/I showed unusual sea ice distributions through the 2002 season. The ice season was generally mild, and especially the summer season showed an extraordinary minimum sea ice distribution, probably not observed lower in at least a century. Three important features were identified in 2002 (see also Figure 2):

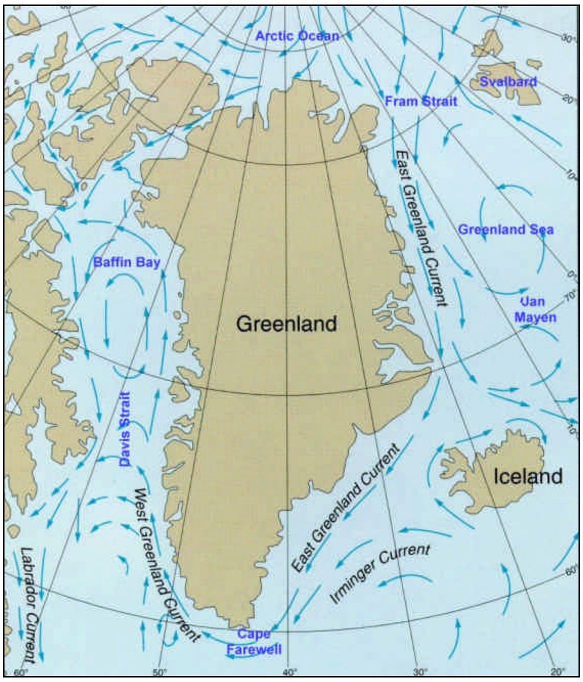

Figure 1. Surface ocean currents and major place names near Greenland

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- Eastern Baffin Bay break-up was in Mid-June (normal early August) and the East Greenland sea ice retreated to north of 78ºN (normal 70º-71ºN).

- On the other hand the ice sea season in South Greenland was short but extremely intense and characterized by heavy multi year ice about 5-6 meters thick (normally about 3 meters).

- The East Greenland Waters north of 65ºN were free of sea ice before the waters to the south.

A fourth bullet could be added in respect of a very late freeze up near both shores of Greenland in late 2002. The freeze up near West Greenland was delayed 2-3 weeks. Normally the East Greenland ice reaches the southern tip of Greenland in late December, but at this time in 2002 the southern ice limit was located 5-600 km to the north.

2. INVESTIGATIONS OF THE 2002 SEASON

Especially the late summer melt of all the multi year ice along the entire East Greenland shore south 78ºN is remarkable. Through the summer season the amount of sea ice in the Greenland Sea is determined by three important factors:

1) The inflow from north through the Fram Strait

2) Melt processes in the Greenland Sea

3) The outflow to the south between Greenland and Jan Mayen

The sea ice drift in the East Greenland Current is controlled both by the surface winds and the underlying currents, however the local and distant wind pattern play an important role for the sea ice distribution in the Greenland Sea. As a rough approximation the local sea ice drift is a result of the current and about 2% of the geostrophical wind (strength and direction). This may reduce or intensify the local sea ice drift dependent on the surface air pressured distribution. Northerly surface winds over several days increase the ice flux and reduce sea ice melt due to reduction of leads or open water areas

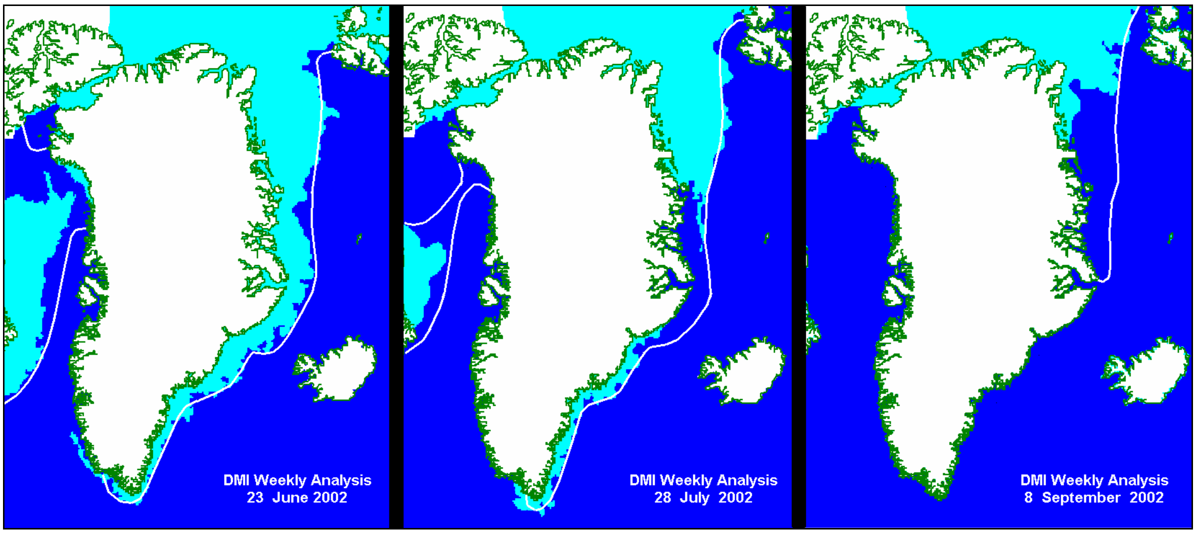

Figure 2: The sea ice distribution around Greenland (Source: DMI weekly ice analysis). Normal ice edge positions are indicated (Source: DMI, Canadian Ice Service and WMO Global Digital Sea Ice Data Bank).

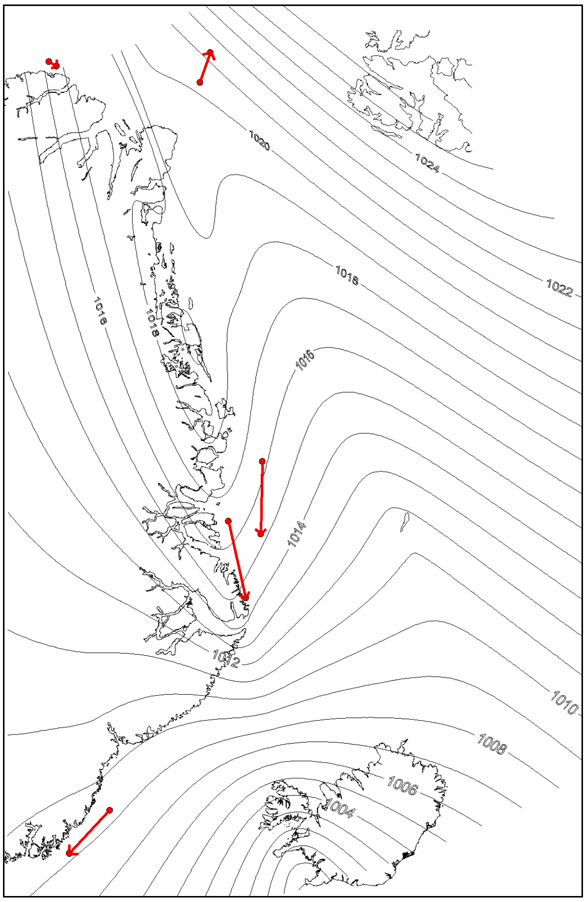

Figure 3: Average sea level air pressure 21.-31. May 2002. Red arrows are drift vectors for the same period for 5 satellite tracked ARGOS buoys on top of ice floes (deployed through the International Arctic Buoy Program).

(geostrophical wind component from northeast towards the Greenland shore).

This wind pattern frequently related to high surface air pressure over Greenland and the Arctic Ocean and low pressure activity in the North Atlantic. This is a typical winter situation. On the other hand several weeks with low pressure activity over the Arctic Ocean significantly affects the sea ice drift, and may cause a reverse of the clockwise surface circulation (the Beaufort Gyre) i.e. [Seereze et. al. 1989] and reduce the southward ice flux through the Fram Strait. Arctic Ocean lows are often associated with southwesterly winds over the Greenland which scatters the local sea ice and speed up melt processes. Analysis of data from weather stations shows that surface air temperatures were not unusually high in 2002 and cannot have caused the

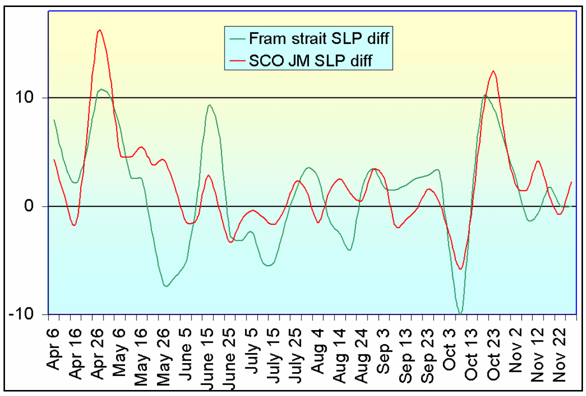

Figure 4: Sea level air pressure difference (averaged over 11 days along 78ºN (Fram Strait) and between Scoresbysund and Jan Mayen / Iceland (weighted). Positive values indicate highest air pressure on the Greenland shore. Units are in hPa.

melt away of sea ice along the Northeast Greenland shores. However, the studies of satellite imagery, sea level air pressure and trajectories of satellite tracked ARGOS buoys show remarkable results. Anomalies in the fresh water input, ice thickness distribution, thermohaline circulation in the Arctic Ocean and the North Atlantic as well as snow cover on top of the ice prior to the 2002 season will never be known in details. All the physical features 1), 2) and 3) seems to have been connected in positive feedback processes as early as in late May 2002 remarkably related to the distribution through the summer 2002 (see figure 3 and 4).

The preliminary studies indicate that the inflow of sea ice from north was low through several months, while significant amounts of ice drifted out the Greenland Sea to the south. This also explains that higher latitudes were free of sea ice prior to southern areas. This combined with melt processes seem to be one of the important reasons for the extreme loss of the East Greenland multi year ice. The influence of long term climatic variability is not included in the above considerations.

3. THE 2002 ICE SEASON IN CLIMATIC PERSPECTIVE

The 2002 observations near the Greenland shores may of course raise the question about relations to climatic variability. The DMI sea ice annals (reference) for Greenland back to 1893 were investigated to classify the 2002 season in the Greenland Waters. With respect to the lack of information before satellites and aircraft were utilized, it was found that the 2002 season was extremely mild and only a couple years may be classified as similar in "severity" to 2002. (see figure 5)

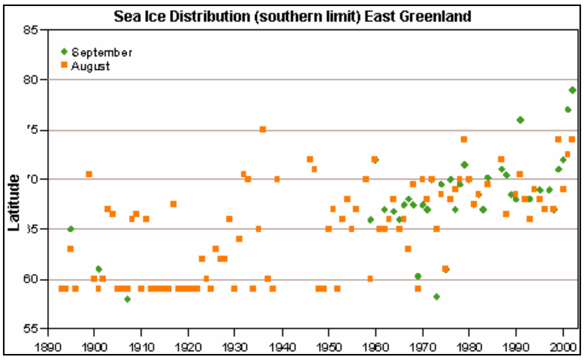

Figure 5: The southernmost East Greenland sea ice limit for August and September 1893-2002, except the war years 1939-45. (Prepared by Henriette Skourup DMI)

4. CURRENT AND FUTURE ICE INFORMATION FOR GREENLAND

The DMI Ice Center serves primarily commercial and coast guard vessels operationally. Due to the locations of the Greenland cities and the normal presence of the sea ice cover, the majority of the ship activities are focused on the ice infested waters near Cape Farewell and in eastern Davis Strait. The 2002 ice season also addresses the question of potential changes in the Ice Centre service and clients need for new sea ice products. In the years prior to 2002 Greenland had normal or relatively mild ice seasons. Many commercial or coast guard operations were accomplished as planned, and even tourists in sailing boats have in recent years visited high latitude locations normally considered as only accessible in ice classed vessels. The past ice season raises several questions about the future ice service activity, i.e. will ship planners extend operation areas and seasons? Would an increased number of tourists at distant places cause more frequent SAR operations? And what would happen when severe ice seasons occur? There is no indication that less sea ice around gives less activity because the ice center readiness for the primary areas is slightly changeable, with or without ice.

5. REFERENCES

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http://www.dmi.dk/vejr/ice/iskort/index.html