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Cold Water off West Greenland - Teleconnection with EL NINO?

by

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Introduction

During autumn when the Irminger component of the West Greenland Current reaches maximum values and the influence of the Cold East Greenland component is minimal (Buch, 1982), water of relatively high temperature is found off West Greenland below 100 m. As shown recently (e.g. Stein and Buch, 1985), cold meteorological conditions in this area result in negative temperature anomalies of 1° to 2°C in the seasonal surface layer of the West Greenland Current.

Anomalous meteorological conditions during the 1970's and early 1980's led to unusual conditions in the distribution of ice and water masses in the Labrador and West Greenland areas. Wolford (1982) reported extraordinarily heavy ice conditions in 1972, 1973 and 1974, when 8,045, 4,904 and 7,218 icebergs were sighted in the International Ice Patrol area of the Northwest Atlantic. These numbers represent 27%, 16% and 24% of the total amount of bergs sighted between 1970 and 1981 in the area. Stein (1982) found that abnormally low temperatures prevailed in the early 1970's, especially in the Irminger part of the Labrador Current, with the largest anomalies occurring in 1972. Stein and Buch (1985) emphasized that 1983 stands out to be an unusual year off Labrador and West Greenland. According to Rasmusson (1984), mean monthly pressure in the region of the Aleutian Low also reached near-record low values during December 1982-February 1983, and the tracks of storms entering North America from the Pacific were at times displaced hundreds of miles southeastward, bringing destructive winds and tides to the California coast. The latter is likely the derivative of the northern hemisphere teleconnection between the Equatorial Pacific sea-surface temperatures and the circulation over the North Pacific and the North American continent. Anomalous warming of the surface waters in the Eastern Tropical Pacific marks the onset of an EL NINO event which, in December 1982, led to sea-surface temperature anomalies exceeding 4°C over a vast area of Eastern and Central Tropical Pacific (Rasmusson, 1984), which lasted until June 1983. Equador and Peru experienced the most prolonged and catastrophic EL NINO ever recorded in that region. Within the last 20 years, it only happened twice that two strong EL NINO-type events occurred in 2 successive years. This was in 1972/73 and 1982/83.

Yet, very little is known about the complex mechanisms which lead to teleconnection between the hemispheres. Maybe a first step in understanding these connections is to merely compare time series of ocean water properties with records of EL NINO-type events during the past. Time series available to the author are the observations made off Fyllas Bank, West Greenland, off Seal Island, Labrador, and a time series published by Rasmusson (1984), showing the intensity of EL NINO-type events from 1726 to 1983.

Materials

The hydrographic data were collected at the NAFO standard oceanographic station 4 at 63°53'N, 53°22'W (Fig. 1). This station which is located at the shelf break off West Greenland was occupied during autumn (mid-October to beginning of December), with the exception of 1978 when the data were obtained near the end of December. Off the Labrador coast at 54°38'N, 53°15'W, which is NAFO standard station 7 of the Seal Island section, the range of observations starts in 1971. At both stations, temperature and salinity profiles were measured (Stein and Buch, 1985; Stein, 1982). In the present paper mean temperature anomalies of the 0-200 m layer are discussed in conjunction with EL NINO event intensities.

Results and Discussion

The mean temperature anomalies for the 0-200 m layer on Fylla Bank and Hamilton Bank in 1963-84 and the intensity of EL NINO-type events are shown in Fig. 2. The intensity of the events have been adapted from Quinn et al. (1978) and are defined as follows: 1 = very weak, 2 = weak, 3 = moderate, and 4 = strong. The warm and cold periods during the last 20 years are clearly evident in Fig. 2A. Autumn conditions in the mid-1960's and mid-1970's off West Greenland show anomalously warm surface water at the monitoring station, whereas, in the early 1970's and especially since 1981, the temperatures were much below normal (nearly 2°C in 1983). On Hamilton Bank from 1971 to 1974, the trend is similar to that off West Greenland but not as strong in the early 1980's. As mentioned above, it happened twice during the past 20 years that two strong EL NINO-type events occurred in 2 successive years (Fig. 2B), with intensities of 4 in 1972, 1973, 1982 and 1983. Weak EL NINO events dominated during the mid-1960's and mid-1970's, and no events were reported during the "warm" years (1964, 1966 and 1977).

If "cold water" events of West Greenland are linked to strong EL NINO's, what is the nature of the linkage? Is it atmospheric coupling? If one considers climatic events during the past 2 decades, it is striking that the winters of 1970/71 to 1973/74 were colder than normal in eastern Canada and Greenland, with exceptionally severe ice conditions along the east coast of Canada in 1972, 1973 and 1974 (Saulesleja and Phillips, 1982). According to Cushing (1979), the shift of the mean position of the Icelandic Low leads to changes in mean wind direction. This in turn may have affected the strength of the Irminger Current, which is the major heat source for the waters between Greenland and Canada.

Thus, intensification of the polar component of the West Greenland Current system and the cold continental air from Canada could be a means of linkage. Whether this is steered by the eastward extension and southern displacement of the jet-stream, as observed during December 1982 (Rasmusson, 1984), remains questionable.

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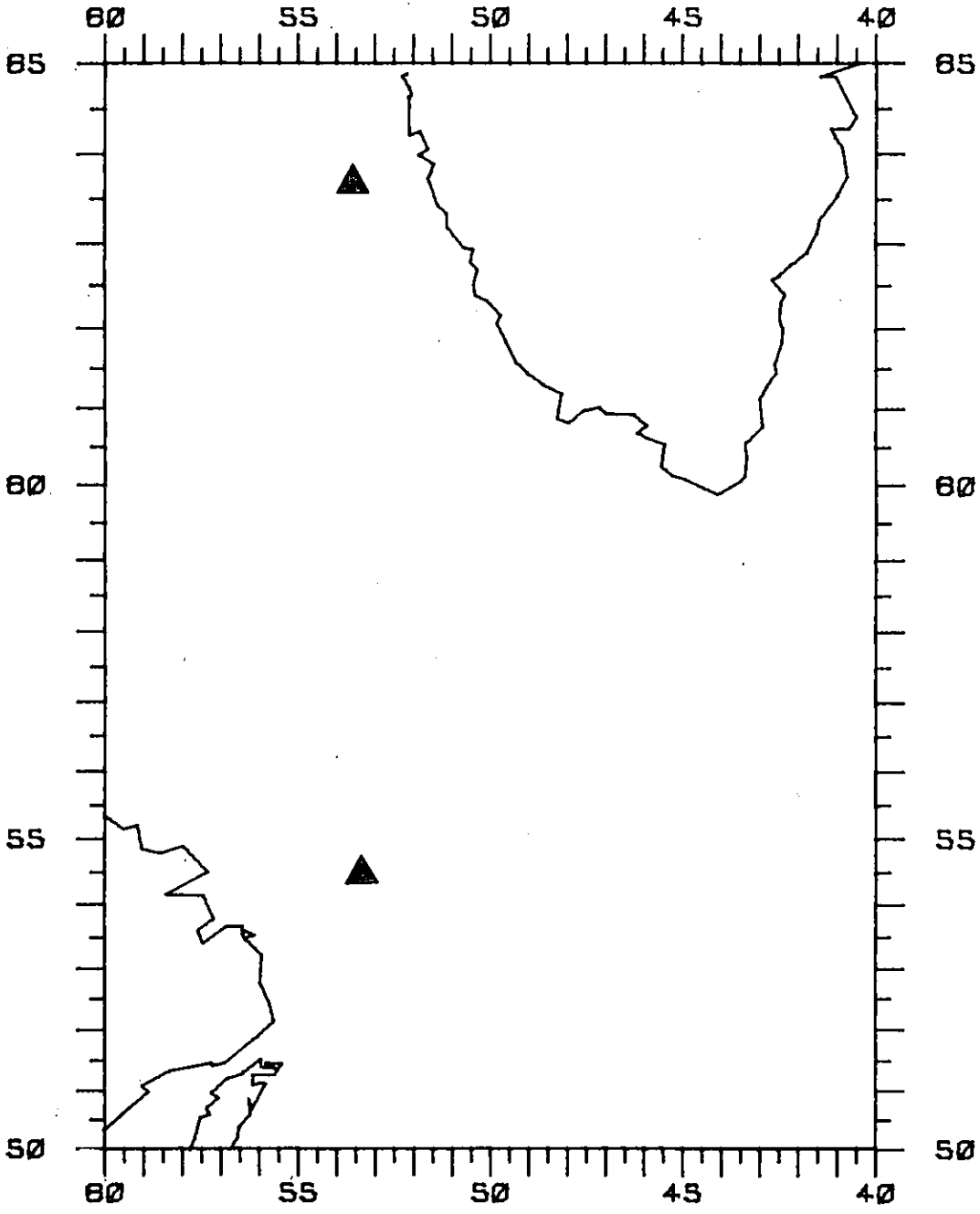

Fig. 1. Location of NAFO oceanographic station 4 off West Greenland and station 7 off Labrador.

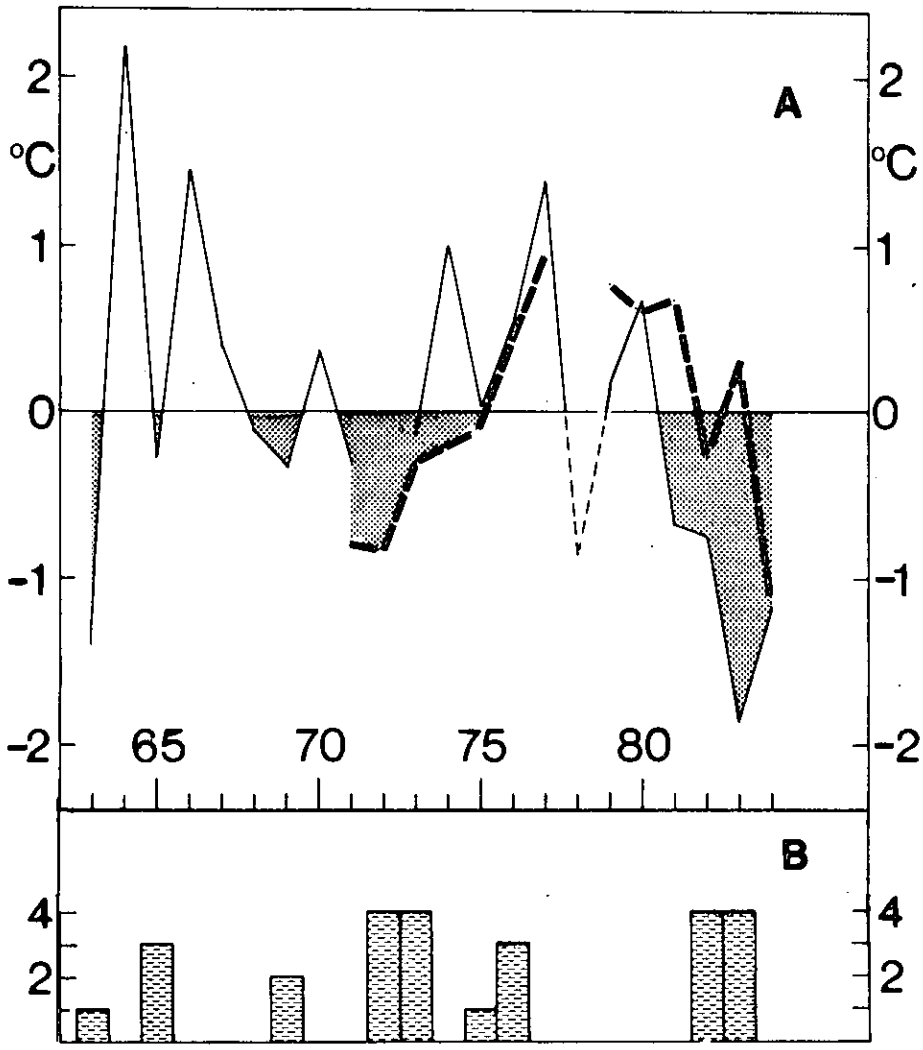

Fig. 2. (A) Mean temperature anomalies of the 0-200 m layer on Fyllas Bank and Hamilton Bank. (B) Intensity of EL NINO-type events.