NOTES AND CORRESPONDENCE

Variation of Antarctic Sea Ice: An Update

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ABSTRACT

Analysis of Antarctic sea ice area for the period 1973 to the 30th week of 1982 showed that after a decrease from 1973 to 1980, the total sea ice area had increased. Sea ice area in the Atlantic sector decreased from 1973 to 1977, but increased afterward. Sea ice area in the Pacific and Indian Ocean sectors decreased from 1973 to 1980. By 1980, sea ice area anomalies in these ocean sectors have rebounded and increased to above average values by the end of 1981.

1. Introduction

Sea ice is an important climatic variable. A review of the interactions between sea ice and atmospheric and oceanic processes is given by the Polar Group (1980). Sea ice variations in the Northern Hemisphere have been examined by Kukla (1978), Zakharov and Strokina (1978) and Walsh and Johnson (1979). Because of the severity of weather conditions, and the small number of island stations, sea ice observations in the Southern Hemisphere have been fragmentary. The advent of satellite imagery in the late sixties provided a synoptic description of the ice field. From 1967 to 1972 there is partial satellite coverage, and from 1973 on, full coverage of the Antarctic ice field. A thorough review of the post-satellite sea ice data and sea ice-weather relationships in the Southern Hemisphere is given by Ackley (1980).

Kukla and Gavin (1981) examined weekly ice charts of Antarctica issued by the Navy-NOAA Joint Ice Center for the period 1973–80. They found decreases of $\sim 2.54 \times 10^6$ km^2 in the total sea ice area during this period. Chiu (1983) partitioned the sea ice area into the Atlantic, Pacific and Indian Ocean sectors and found that while decreases of 1.5×10^6 and 1×10^6 km^2 are found in the Pacific and Indian Ocean sectors, respectively, over this period, the Atlantic sector showed no trend at all. Because sea ice is known to vary with time scales of 2–10 years (Zakharov and Strokina, 1978), the decrease is probably part of a short-term oscillation and not indicative of a carbon dioxide signal (Chiu, 1983).

In this report, the time series of Antarctic sea ice area from the beginning of 1973 to the 30th week of 1982 is presented. It is shown that the total sea ice area anomaly rebounds in 1981 to above normal values and stays positive for most of the time in 1981 and 1982, indicating that a carbon dioxide signal has yet to be detected in the record.

2. Data and method of analysis

A description of the data and method of analysis is given earlier (Chiu, 1983). Briefly, the data consist of weekly charts of Antarctic ice issued by the Navy-NOAA Joint Ice Center (1973–82). Areas south of 50°S are partitioned into 5° latitude by 10° longitude grids. The fractional area in each grid box where the sea ice concentration exceeds 10% is read off. The boxes are then grouped by longitude into the Atlantic (70°W–30°E), Pacific (160°E–70°W) and the Indian Ocean sectors (30–160°E). The sea ice area within each ocean sector is obtained by summing the fractional ice cover weighted by the appropriate area. There are six missing weeks in this period. The missing weeks are the 10th week of 1973, 29th of 1975, 19th of 1977, 44th of 1978 and 24th and 36th weeks of 1979. The missing data were linearly interpolated.

3. Results and discussions

The seasonal variations of the total sea ice area and the sea ice area for three ocean sectors separately computed for the period from 1973 to the 30th week of 1982 are shown in Fig. 1. It is interesting to note that although the Atlantic sector occupies only 100° longitude, the sea ice there shows the largest seasonal variation.

The weekly departures from the seasonal means, both for the total sea ice area and the three ocean sectors, are presented in Figs. 2 and 3. The total sea ice area showed general decreases during 1973 to 1980. By late 1980 there were already signs of rebound, and by the middle of 1981, the total sea ice

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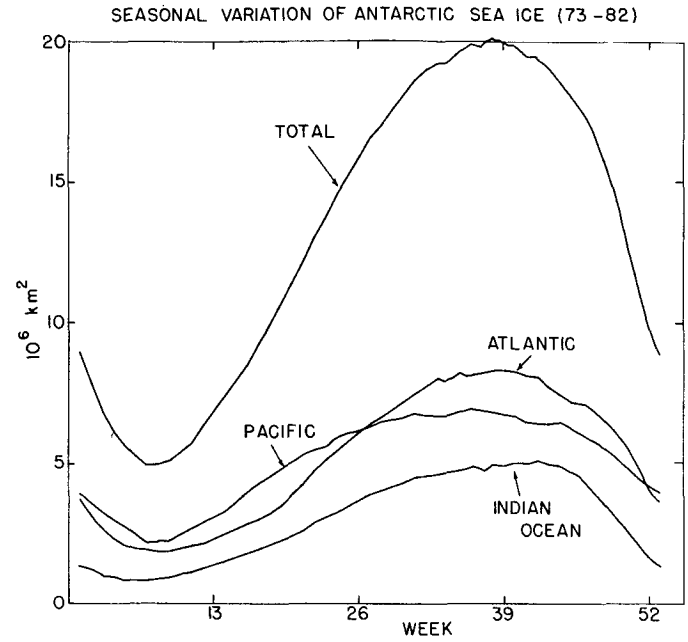

FIG. 1. Seasonal variations of total Antarctic sea ice area (upper curve) and of sea ice area in the Atlantic (70°W–30°E), Pacific (160°E–70°W) and Indian Ocean sectors (30–160°E).

area was above the 1973–82 mean and stayed above the mean for most of the period that followed. Sea ice areas in the Pacific and Indian Ocean sectors reached a minimum in mid 1980 but have increased since. In the Atlantic sector, the sea ice area decreased from 1973 to 1977, but increased from 1977 to 1980. The ice area anomalies stayed slightly negative for the first half of 1981 and 1982, but were positive during the second half of 1981.

Variations in the sea ice extent are intricately related to various dynamic and thermodynamic processes. For instance, Gordon and Taylor (1975) and Streten and Pike (1980) related the seasonal variation of sea ice to the seasonal wind field; and Gordon (1981) related it to atmospheric and oceanic heat fluxes. Through the geostrophic relation, there is a correspondence between wind field and pressure gradient. Using eight years of data, Chiu (1983) found a positive correlation between the sea ice area and an index of the Southern Oscillation. The index is defined as the pressure difference between Easter Island and Darwin. The result implies that a stronger zonal Walker Circulation is associated with larger sea ice extent. On the discussion of the Southern Oscillation, Walker (1923) suggested an Antarctic origin of the Oscillation and discussed the relation between ice and pressure conditions (Walker, 1924). Excursions of the limits of sea ice are associated with movements of storm tracks. The storm tracks also depend on the locations of main blocking anticyclones in midlati-

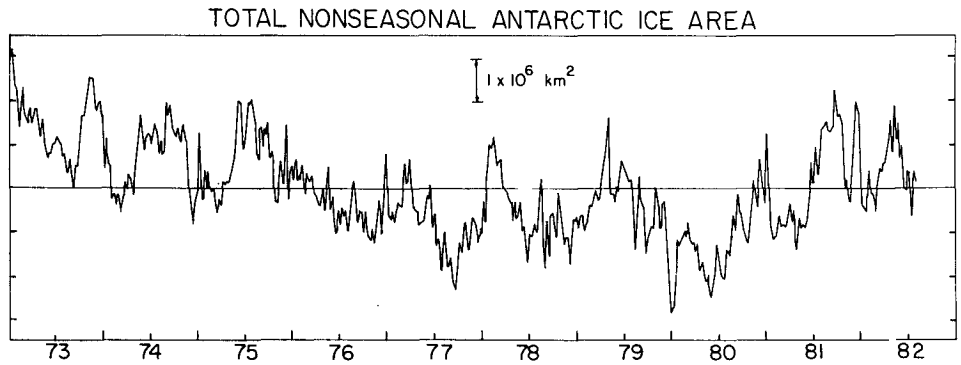

FIG. 2. Weekly departure of total Antarctic sea ice area from the 1973–82 means. The long ticks on the x axis denote the first week of the year. The first week of 1973 is denoted by the y axis.

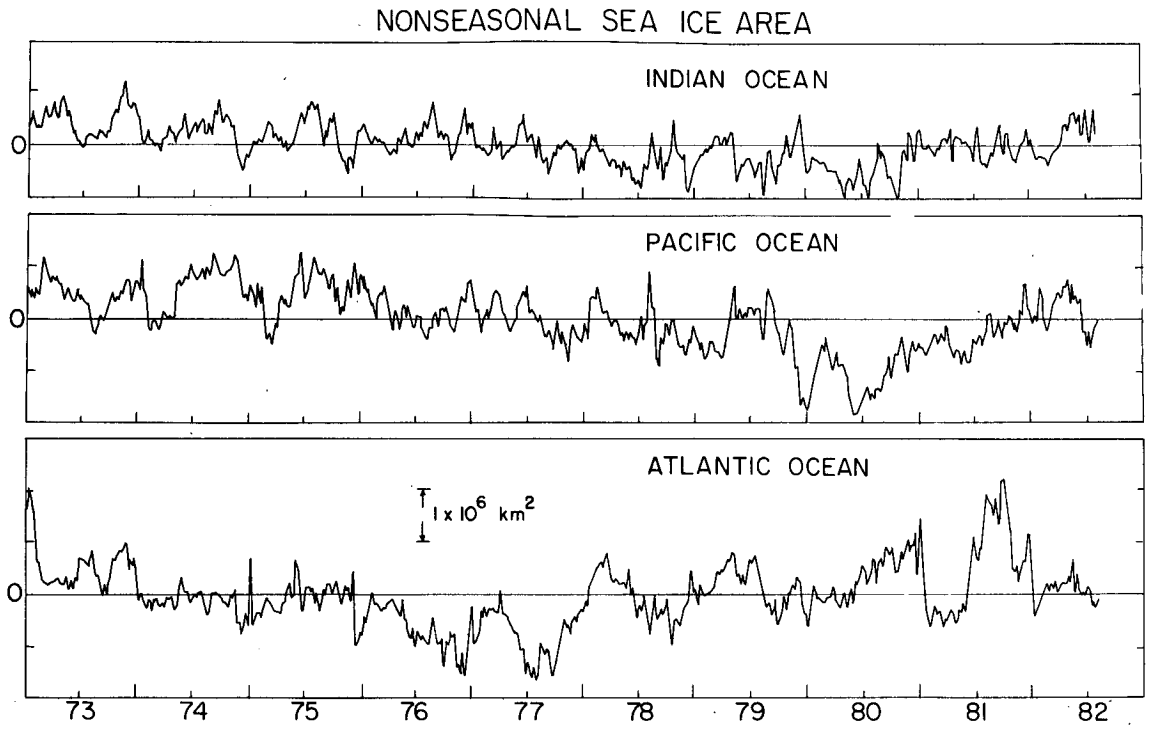

FIG. 3. Weekly departure of sea ice area in the Indian Ocean (upper), Pacific Ocean (middle) and Atlantic Ocean sectors (lower). The long ticks on the x axis denote the first week of the year. The first week of 1973 is denoted by the y axis.

tudes over the oceans. Thus, there is a direct link between ice extent and the Southern Oscillation via midlatitude anticyclones. Because the period used in Chiu's study is relatively short compared to the Southern Oscillation period, a full assessment of Walker's hypothesis must await analysis of a longer record.

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