P1.24 ASSOCIATIONS OF APRIL BARENTS SEA ICE EXTENT WITH THE ARCTIC OSCILLATION INDEX, 1950-2001

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1. MOTIVATION

Shapiro and Colony (2003) reconstructed the historical record of mid-April Barents Sea ice extent from 1850-2001, and have shown the temporal and spatial variability of Barents Sea ice extent over multi-decadal time scales. This study examines the 1950-2001 record of Bering Sea ice extent for basic statistical associations of the temporal and spatial variability of the Barents Sea ice edge with the corresponding time-series of the Arctic Oscillation Index (AOI) described by Thompson and Wallace (1998), and sea ice response to the AOI identified by Rigor *et al.* (2002). Associations at levels greater than chance may serve as the basis for hypotheses of physical causation of Barents Sea ice edge extent variability. These hypotheses will be tested in a future phase of this study.

2. DATA

The "ice edge" is defined as the 30-40% ice concentration isopleth. The selected isopleth is an historically relevant threshold, as it represents the greatest ice concentration generally navigable by vessels.

A full description of data sets used for this study is contained in Shapiro and Colony (2003), and are summarized here. From 1950 to 1966, Soviet reconnaissance aircraft routinely overflew the Barents Sea ice edge in pursuit of national security objectives. The ice edge was mapped as a single line on a Barents Sea chart, and was published in the Environmental Working Group Joint US-Russian Sea Ice Atlas (Arctic Climatology Project, 2000). From 1966 to 2001, ice edge was charted routinely by the Norwegian Meteorological Institute (DNMI), by the U.S. Navy/NOAA Joint Ice Center (now National Ice Center) since 1972, and by the U.K. Meteorological Office. Satellite data were used by these agencies from 1979 onwards. Vinje (2001) provides a more comprehensive description of this ice chart series.

Monthly AOIs for the study period were downloaded from the Climate Prediction Center of the National Centers for Environmental Prediction web site (Climate Prediction Center, 2003).

3. TECHNIQUE AND RESULTS

Following the technique of Shapiro and Colony (2003), a mean Barents Sea ice edge position was constructed for the 1950-2001 time period. Ice edge anomalies were computed for each year in the study period at points spaced 25 km apart along the mean ice edge resulting in a time-series of ice edge anomalies distributed over distance.

3.1 Temporal Distribution of Ice Edge Anomalies

The summation of ice edge anomalies over the ice edge was correlated to the computed AOI for the corresponding April. Because the net April ice edge anomalies over the study period were associated with the corresponding April AOI at a level no greater than chance, 12 follow-up experiment lagged the AOI by one month increments and correlated the lagged AOI time series with the net ice edge anomaly for the following April to determine the time

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scale over which ice response was most closely associated with the lagged AOI.

Figure 1 shows two maxima in the correlation coefficient between April net ice edge anomaly and the lagged AOI: one maxima corresponds to a 3-month lag (e.g, April ice edge anomaly associated with the AOI of the preceding January, Fig. 2), and a second corresponding to a 9-month lag (e.g., April ice edge anomaly associated with the AOI of the preceding July, Fig. 3). Figs. 2 and 3 show that although the ice edge anomaly-lagged AOI association is statistically significant at the 95% confidence level, the association is not particularly strong.

3.2 Spatial Distribution of Ice Edge Anomalies

Figures 3 and 4 show the spatial distribution of April mean ice edge anomaly for the extreme AOI events in the preceding January (Fig 3) and the preceding July (Fig 4). The extreme negative January AOIs occurred in 1977, 1966, 1969, and 1985; the extreme positive January AOIs occurred in 1989, 1957, 1962 and 1975. Similarly, the extreme negative July AOIs occurred in 1969, 1959, 2001, and 1958; the extreme positive AOIs occurred in 1990, 1965, 1997 and 1982.

Fig. 3 shows that the greatest difference in April ice edge anomaly between extreme negative and extreme positive antecedent January AOI years occurs from 1200 km along the ice edge (the zero km datum is on the west coast of Svalbard) to the Novaya Zemlya coast at approximately 2400 km along the ice edge). In this region, positive January AOIs (dashed line) are associated entirely with substantial negative April ice edge anomalies, while negative January AOIs (solid line) are associated entirely with large positive April ice edge anomalies. From 200 km to 1200 km, the April ice edge anomaly is independent of either the sense or the magnitude of the antecedent January AOI.

Fig. 4 shows that the greatest difference in April ice edge anomaly between extreme negative and extreme positive antecedent July AOIs occurs over a broad area along the mean April ice edge. From 200 km to 1100 km, extreme positive AOIs (dashed line) are associated with very small anomalies (< 50 km) while extreme negative AOIs (solid line) are associated entirely with substantial positive anomalies. We note here that this zone of maximum difference in ice position for antecedent July AOIs is in essentially the same place as the zone of minimum difference in ice position for the antecedent January AOIs.

The differing geographical patterns demonstrated in Figs. 3 and 4 suggest that differing processes embodied in the AOI are at work in the antecedent July than in the antecedent January. This pattern is, to a first approximation, consistent with the findings of Rigor et al. (2002).

4. REFERENCES

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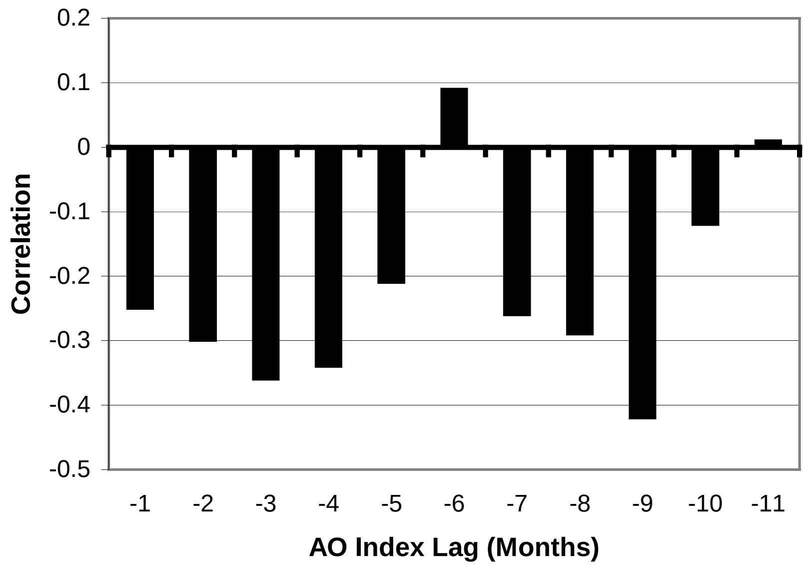

Fig. 1: April ice edge anomaly correlation with lagged AOI. A lag of –1 is the antecedent March AOI, a lag of –2 is the antecedent February AOI, etc. The associative maxima occur at a lag of –3 and –9 months, corresponding to the antecdent January and July respectively.

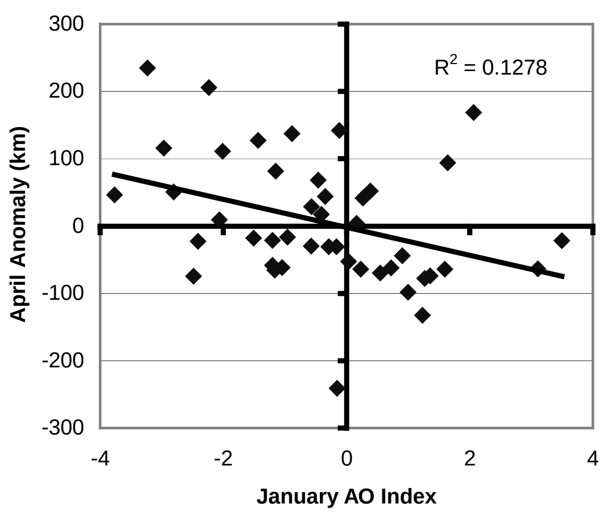

Fig 2: Scatter plot of April ice anomaly vs. January AOI. Note the negative correlation. Trend line R-squared is 0.1278

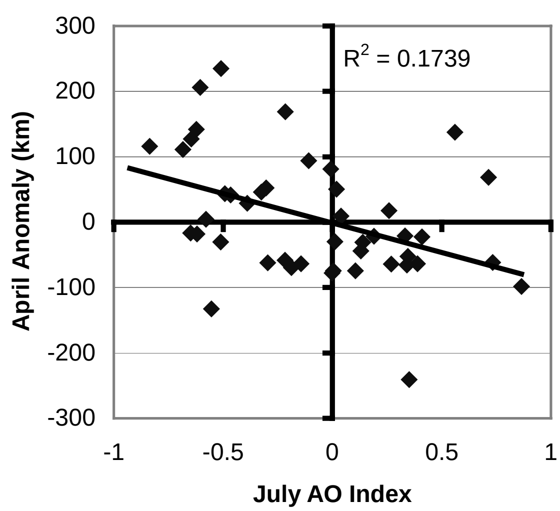

Fig. 3: Scatter plot of April ice anomaly vs. July AOI. Note negative correlation. Trend line R-squared is 0.1739.

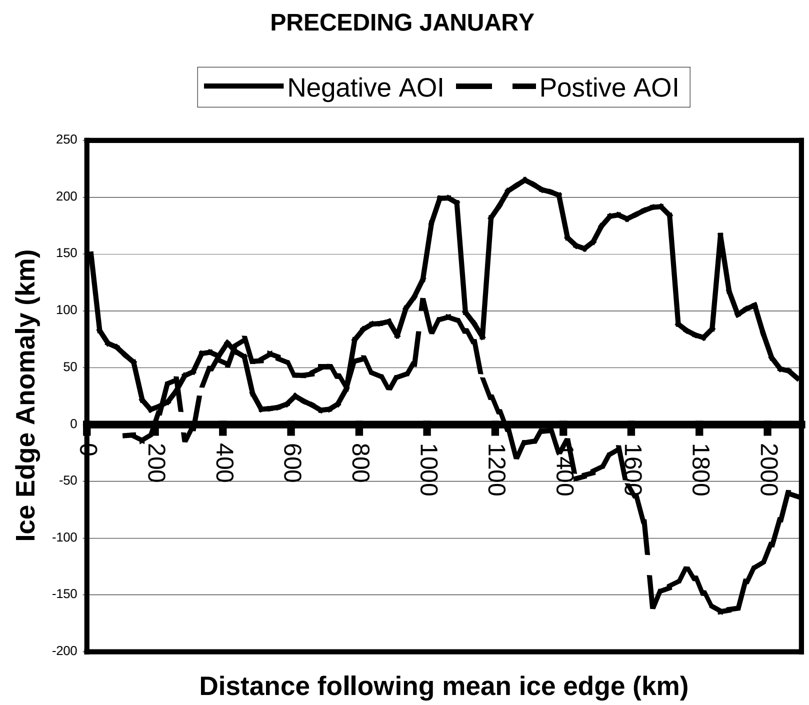

Fig. 4: Distribution of April ice edge anomalies for extreme negative AOIs (solid line), and extreme positive AOIs (dashed line) for the antecedent January along the April mean ice edge 1950-2001. The 0 km datum is on the west coast of Svalbard; the 2200 km distance is on the east coast of Novaya Zemlya. See Shapiro and Colony (2003) for depiction of ice edge.

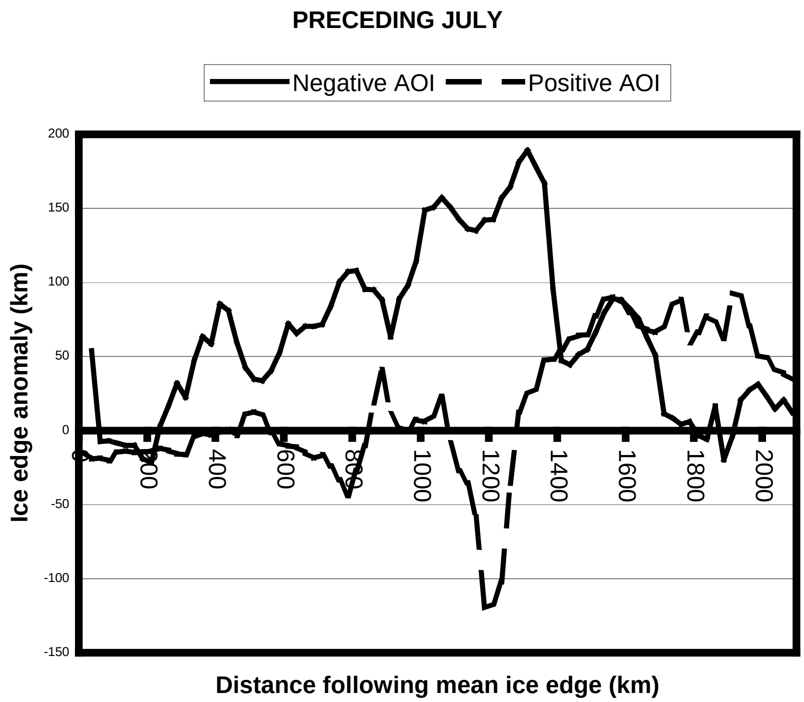

Fig. 5: Distribution of April ice edge anomalies for extreme negative AOIs (solid line), and extreme positive AOIs (dashed line) for the antecedent July along the April mean ice edge 1950-2001. The 0 km datum is on the west coast of Svalbard; the 2200 km distance is on the east coast of Novaya Zemlya. See Shapiro and Colony (2003) for depiction of ice edge