Comparison of the atmospheric forcing and oceanographic responses between the Labrador Sea and the Norwegian and Barents seas

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Summary

A comparison of the mean conditions and variability in the climate and physical oceanographic characteristics between the Labrador Sea and surrounding shelves and the Norwegian and Barents seas is presented. Several climate and oceanographic variables, including air temperatures, eastward winds, heat fluxes, and the range of seasonal sea surface temperature range show a general latitudinal dependence within each of the two regions but with regional varying rates of change with latitude. The previously reported out-of-phase relationships on interannual to decadal time scales of air and sea temperatures and sea-ice conditions between the Labrador Sea and the Norwegian and Barents seas regions from the 1950s until the mid-1990s was found. This is owing to their opposite response to the variability in the North Atlantic Oscillation (NAO). However, from the mid-1990s, air and sea temperatures in both regions generally have been in phase, showing strong warming and reduced ice coverage. The cause of this change is related to changes in the spatial structure of the atmospheric pressure patterns, resulting in a general reduction in the importance of NAO forcing over the North Atlantic.

Introduction

As part of the Norway-Canada Comparisons of Marine Ecosystem (NORCAN) project (Drinkwater and Pepin, 2013), a comparative study of climate forcing and hydrographic responses in the Labrador Sea region within the Northwest Atlantic and the Norwegian and Barents seas region within the Northeast Atlantic was carried out. One of the main objectives was to examine the observed interannual to decadal co-variability of the climate and hydrography of the two regions and their relationship with the North Atlantic Oscillation (NAO; Hurrell, 1995). The two regions are strongly advective systems being influenced by both cold, low saline flows from the Arctic and warm, high saline flows from the Atlantic. However, Arctic flows are more dominant in the Labrador Sea region, especially on the shelves, while Atlantic flows dominate in the Norwegian and a large part of the Barents Seas.

Data and Methods

Climate and oceanographic data were obtained from various sources with similar types of datasets used for both the Northwest and Northwest Atlantic, where possible. The climate data included air temperatures, winds, and air-sea heat fluxes, and were obtained from ERA40 dataset as well as observed air temperatures. Oceanographic data included sea surface temperatures and salinities from the SODA dataset, observed temperatures and salinities, both surface and subsurface, and sea ice data. The ERA40 and SODS data were partitioned into 5 areas in the NW Atlantic (Grand Bank, NE Newfoundland Shelf, Labrador Shelf, Labrador Sea and West Greenland) and 4 areas in the NE Atlantic (Norwegian Sea, the southwest, north and east Barents Sea). An environmental index for both the NW and NE Atlantic regions was developed that averaged the normalized thermal, salinity and sea ice anomalies relative to means for the period 1971-2000. Regional normalized anomalies for the Labrador Sea and for the Norwegian/Barents seas were calculated by averaging the normalized anomalies over the available areas or observation sites within each region. Comparisons between the two regions and their subareas were carried out primary using correlation analysis with significance levels adjusted for autocorrelation.

Results and Discussion

Many of the climate and oceanographic variables, including air temperatures, eastward winds, heat fluxes, and seasonal sea surface temperature range, show latitudinal dependence within each of the two regions but with regional varying rates of change with latitude. We confirmed the previously reported out-of-phase relationship on interannual to decadal time scales of air and sea temperatures and sea-ice conditions between the Labrador Sea and the Norwegian and Barents seas regions from the 1950s until the mid-1990s (Hurrell, 1995; Deser, 2000). This relationship arises owing to their opposite responses to the variability in the North Atlantic Oscillation (NAO). However, from the mid-1990s, air and sea temperatures in both regions generally have been in phase, showing strong warming and reduced ice coverage (Fig. 1).

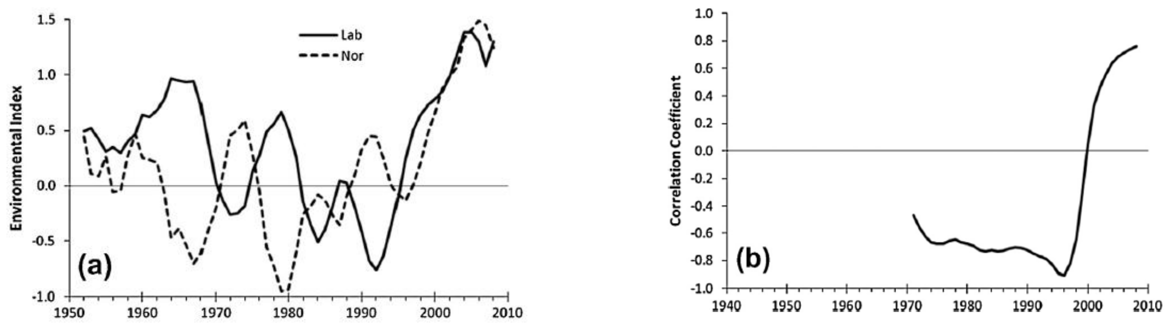

Fig. 1. (a) The time series of the 5-year running means of the Environmental Index (EI) for the Labrador and Norwegian/Barents seas regions. (b) The 20-year running means of the correlation coefficient between the 5 year running means of the EIs for the Labrador and Norwegian/Barents seas regions. The correlation coefficient is plotted at the end of the 20-year period.

The cause of the change in the mid-1990s is related to changes in the spatial structure of the atmospheric pressure patterns, resulting in a general reduction in the importance of NAO forcing over the North Atlantic.

References

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