FIRE: THE FIRST-YEAR INNOVATION & RESEARCH EXPERIENCE
CLIMATE COMPUTING

IMPACT OF EXTREME ARCTIC OSCILLATION ON THE NORTHERN ATLANTIC OCEAN

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INTRODUCTION

As climate changes, understanding natural climate oscillations remains vital to understanding the relationships between components of the climate system. This modeling study investigates the long-term impacts of repeated extreme high and low-pressure patterns of the Arctic Oscillation (AO) on ocean dynamics in December, January, and February. We compare the difference between surface heat flux (SHF) and sea surface salinity (SSS) under extremes in the AO to better understand how the AO impacts the Northern Hemisphere, especially the North Atlantic Ocean.

METHODS

- Community Earth System Model (CESM2.2.2)
- Coordinated Ocean Research Experiments version 2 (CORE2) input data
- Component Set: GIAF -- POP2/CICE/data atmosphere set-up
- Resolution: f19_g17
  - f19: atmosphere and land grid with a resolution of 1.9° latitude by 2.5° longitude
  - g17: ocean and sea ice grid with a resolution of 1/7° in both latitude and longitude

TOOLS AND DATA

- Control : Simulate AO with an AO index near 0 for the months of December, January, and February
- Test: Simulate AO with an extreme negative and positive AO index over the same months using cycling forcing for 4 years, where the AO data is repeatedly applied in a loop.
  - Negative AO Index Values:
    - Dec 1985: -2.074
    - Jan 1986: -3.767
    - Feb 1986: -2.010
  - Positive AO Index Values
    - Dec 1988: 1.679
    - Jan 1989: 3.106
    - Feb 1989: 3.279
- We used netCDF operators to create files to understand the differences between the test and control cases.

DISCUSSION

Surface Heat Flux :

- Figure B shows a loss of ~100 w/m^2 of heat (to the atmosphere) at 60 N between 30 and 60 W, meaning that when AO is negative, the water there is cooler than when AO is near 0.

Sea Surface Salinity:

- Figures D, E, and F indicate that when AO is higher, salinity is lower in the region by 120 N 80 E, so water here will sink as AO gets higher.

RESULTS

Surface Heat Flux [W/m^2]

Figure A:

Surface Heat Flux (Positive minus Zero)

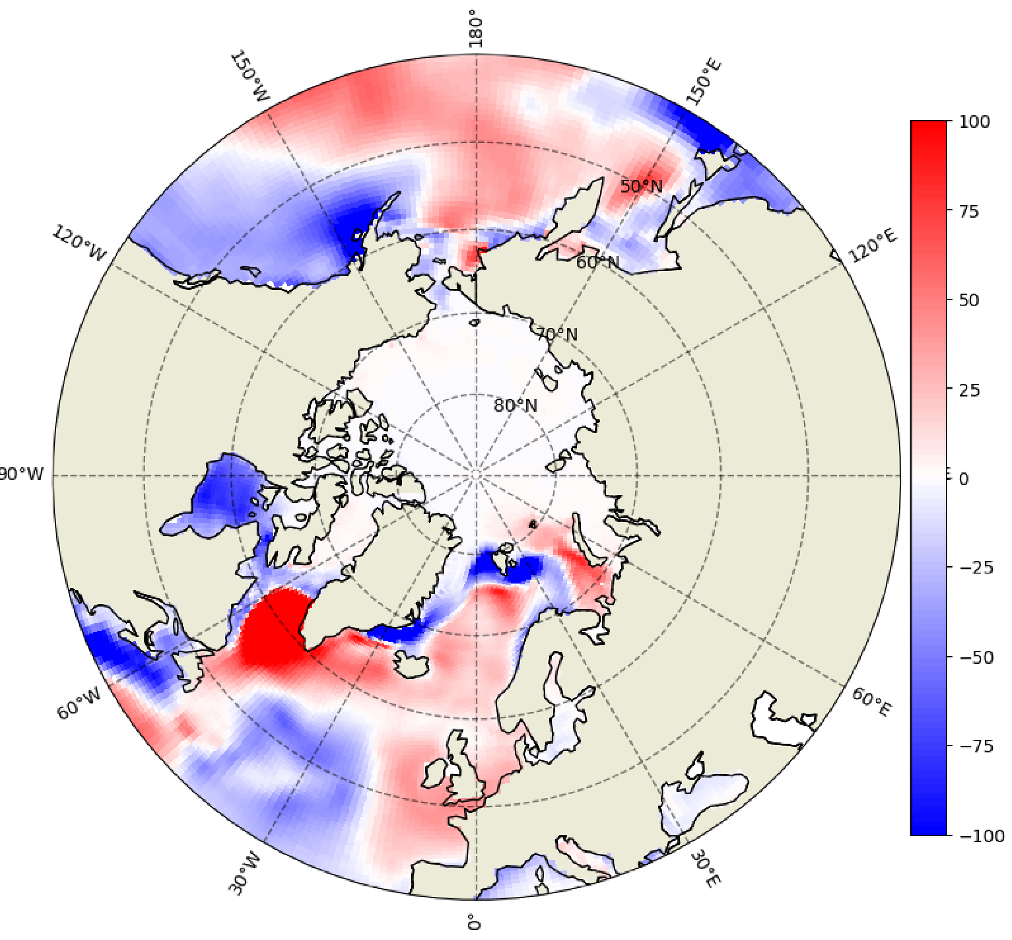


Figure B:

Surface Heat Flux (Zero minus Negative)

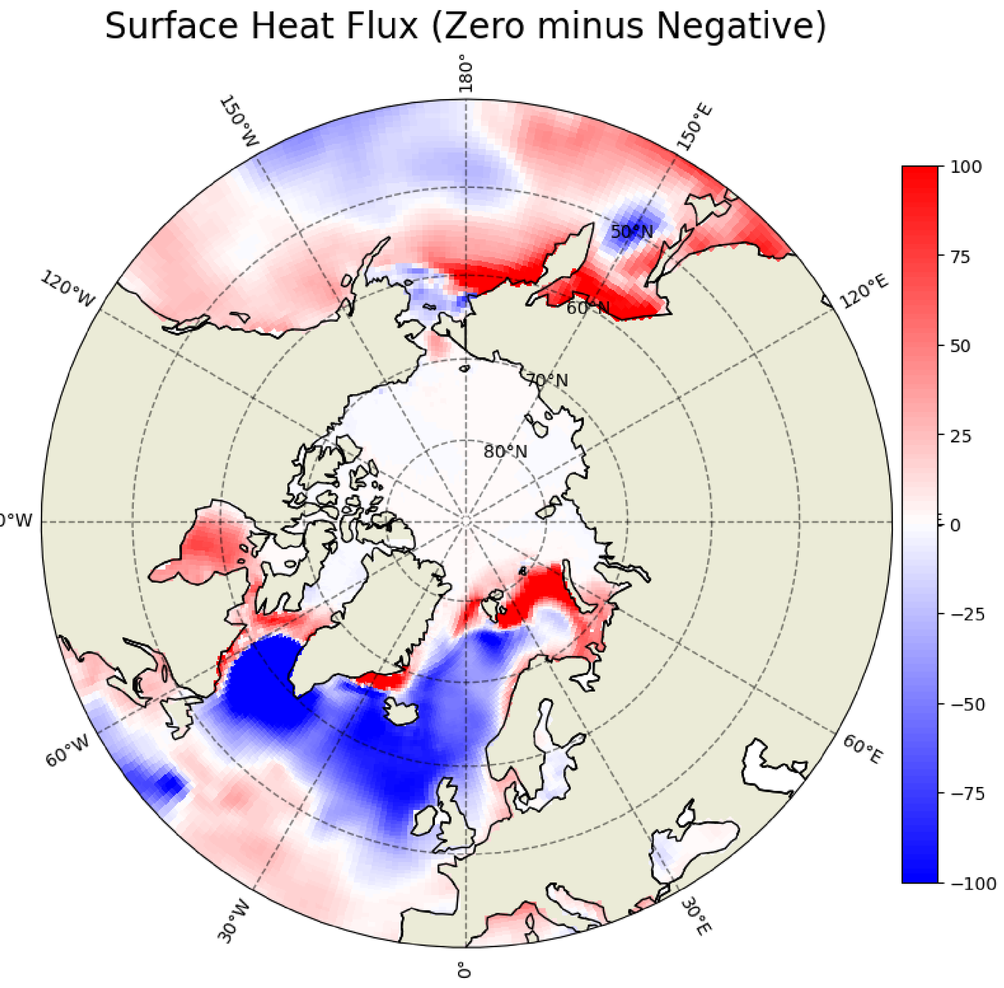
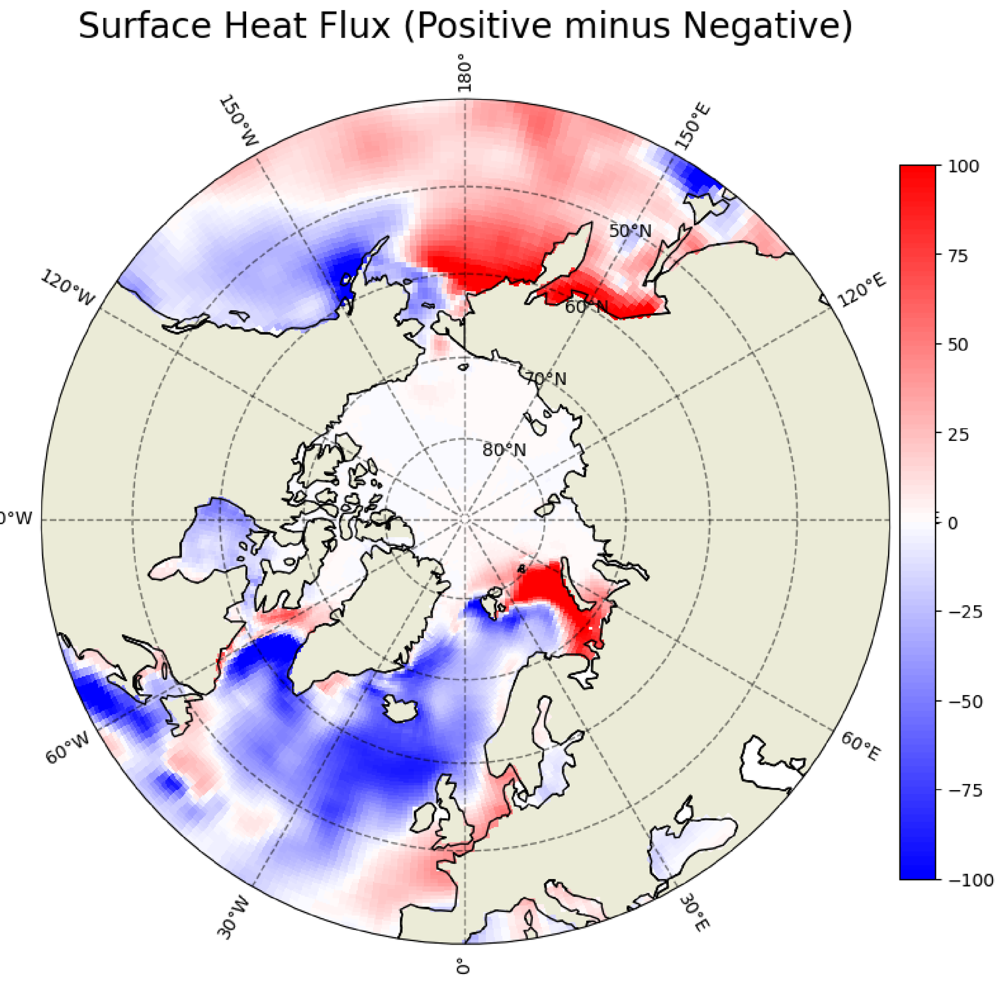


Figure C:

Surface Heat Flux (Positive minus Negative)



Sea Surface Salinity [g/kg]

Figure D:

Sea Surface Salinity (Positive minus Zero)

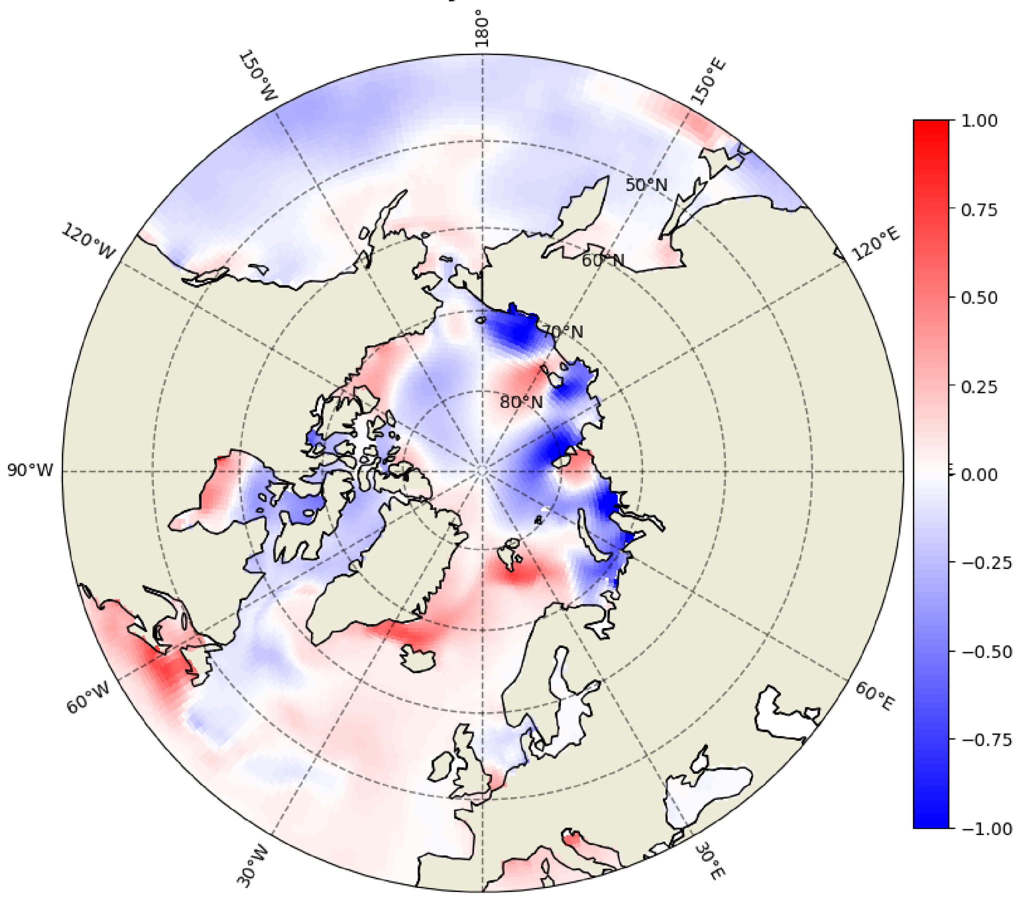


Figure E:

Sea Surface Salinity (Zero minus Negative)

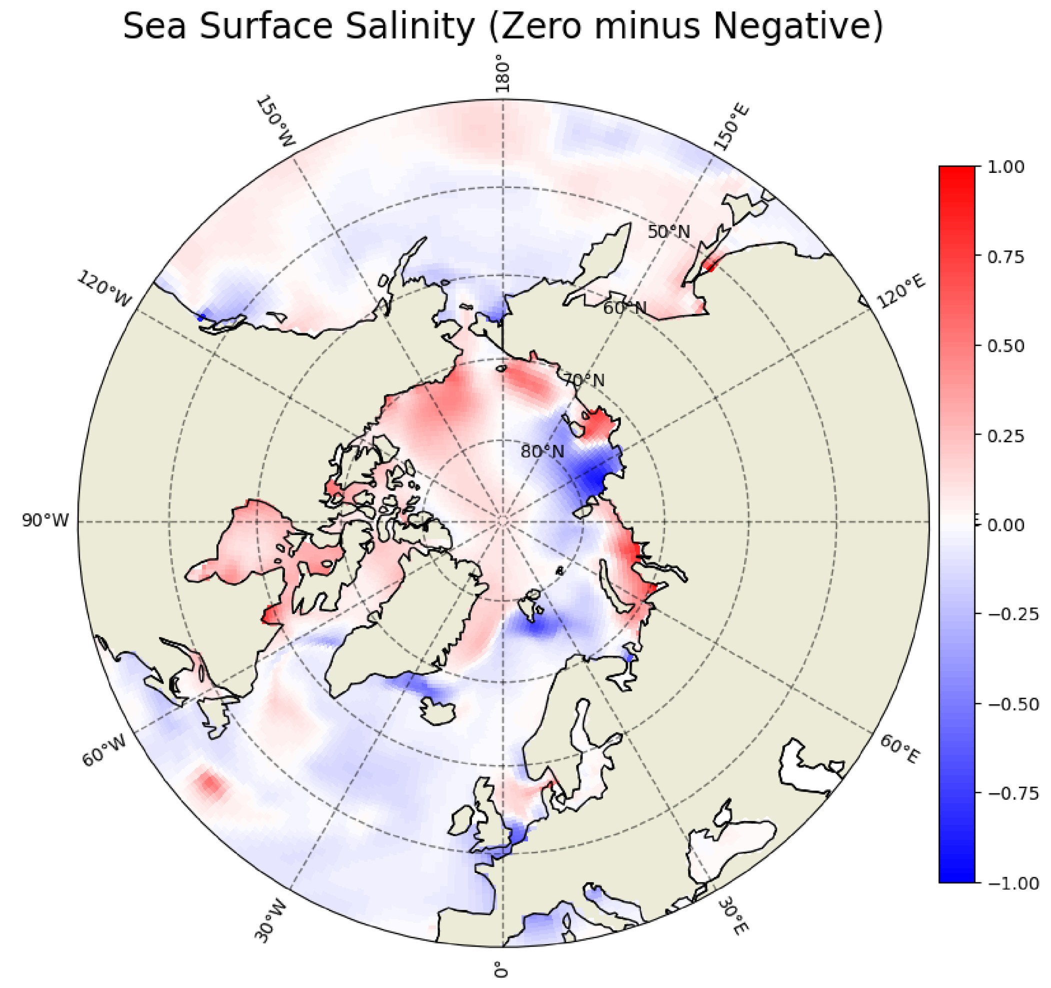
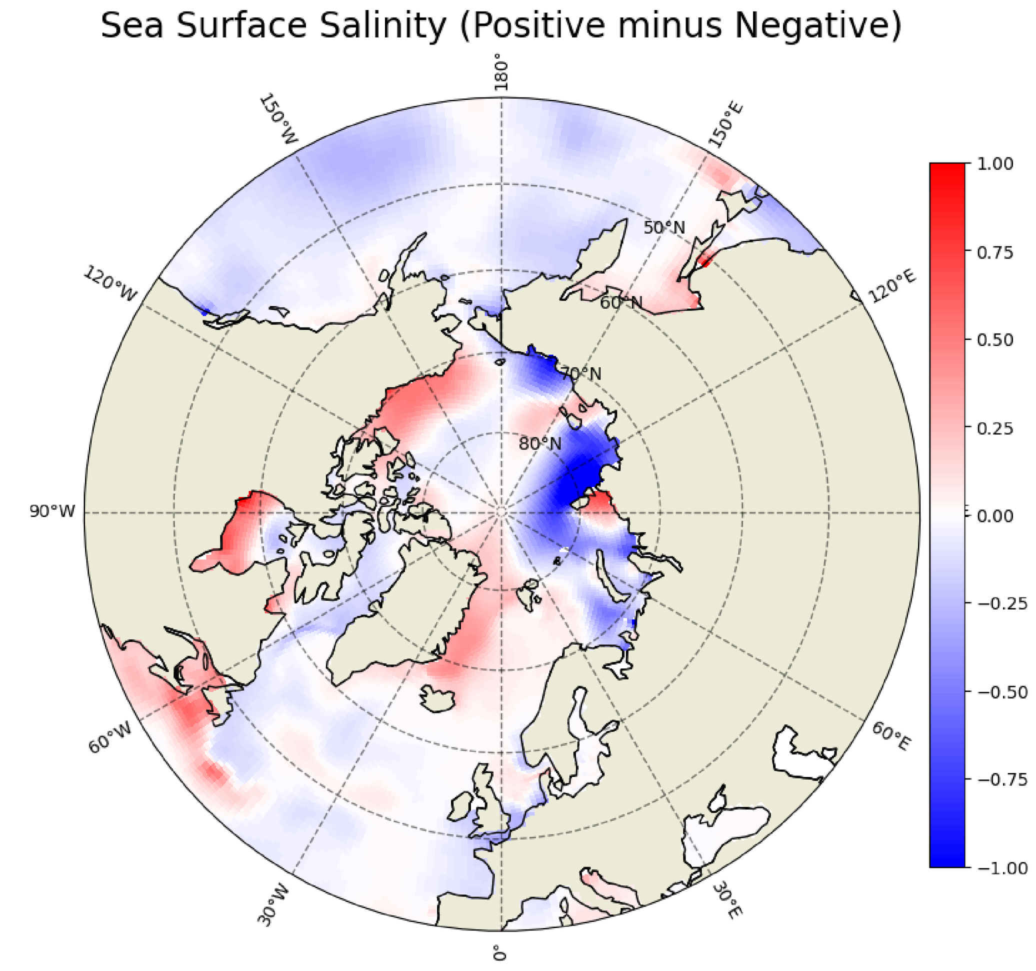


Figure F:

Sea Surface Salinity (Positive minus Negative)



FUTURE WORK

- Analyze different variables related to the atmosphere to understand the impact of extreme high and low-pressure patterns of the AO on the weather outside of ocean and sea ice.
- Simulate the AO for more than 4 years to analyze long-term impacts and potential feedback mechanisms in the system

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