Teleconnections between major climate indices and polynya dynamics Martin Rogers, AI Lab,

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Background

Polynyas are areas of open water surrounded by sea ice that are important locations for new sea ice production and for controlling the transfer of heat between the ocean and atmosphere. They are formed by the upwelling of warm water from deeper parts of the ocean as well as from the mass movement of sea ice driven by winds and currents. Understanding the key causes of the formation and location of polynyas that encircle the entire Antarctic continent remains an important goal for understanding the response of polar regions to changing climatic conditions.

Method

This project investigates the teleconnections between large-scale climate indices, including the El-Nino Southern Oscillation (ENSO) and Amundsen Sea Low (ASL), and the extent and characteristics of polynyas in the Antarctic derived from remote sensing analysis. We propose employing Fourier and wavelet analysis, combined with linear machine learning methods, to explore the relationship between these features. This project will also seek to investigate the dynamics leading to pan-Antarctic polynya variation through causal analysis. Methods such as linear regression, well-known causal inference analysis such as Granger Causality, and advanced graphical time-lagged algorithms such as the PCMCI algorithm, will be used. These will allow causal links between key climate indices and Antarctic polynyas to be better understood. This will allow discovery of timescales, strengths, and potential mechanisms for Antarctic polynya variation, improving our scientific understanding of these critical processes.

Approximate timeline:

- Week 1-3: Wavelet analysis
- Week 4-7: Casual analysis
- Week 8- Project write up.

Background reading:

Swathi, M., et al. 2023. Spatiotemporal evolution of sea ice and its teleconnections with large-scale climate indices over Antarctica. https://doi.org/10.1016/j.marpolbul.2023.114634

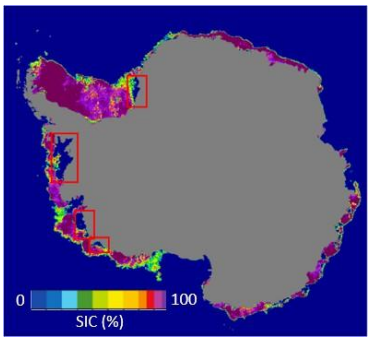
Holland, M., et al. 2018. The regional, seasonal, and lagged influence of the Amundsen Sea Low on Antarctic sea ice. https://doi.org/10.1029/2018GL080140

Coggins, J.H. and McDonald, A.J., 2015. The influence of the Amundsen Sea Low on the winds in the Ross Sea and surroundings: Insights from a synoptic climatology. https://doi.org/10.1002/2014JD022830

Requirements

Students should have computer programming experience, ideally with Python. Experience of using high performance computing systems is preferable. A knowledge of sea ice dynamics is not necessary, but an eagerness to learn about this domain is necessary.

Example of Polynya in Antarctica. Photo Credit Jan Lieser, ACE CRC, Australia



Example Passive Microwave Data Image showing Sea Ice Concentration (SIC) across Antarctica. Examples of polynyas shown in red boxes.