Ph.D. Defense Announcement
Marie McGraw
March 15, 2019 at 1:30pm

Marie McGraw
Ph.D. Defense

Friday, March 15, 2019
1:30pm

Defense
ATS Large Classroom (101 ATS)

Post Defense Meeting
Riehl Conference Room (211 ACRC)

Committee:
Elizabeth Barnes (advisor)
David Randall
Russ Schumacher
Karan Venayagamoorthy (Civil and Environmental Engineering)

APPROACHING ARCTIC-MIDLATITUDE DYNAMICS FROM A TWO-WAY FEEDBACK PERSPECTIVE

Arctic variability and the variability of the midlatitude circulation are closely intertwined. Although these connections are interrelated and bi-directional, and occur on a variety of timescales, they are not often studied together. Modeling studies generally focus on a single direction of influence--usually, how the midlatitude circulation responds to the Arctic. Studying these relationships in a two-way feedback perspective can offer new insights into these connections, providing information on how they feed back upon each other.

This work approaches Arctic-midlatitude dynamics from a two-way feedback perspective, built around the ideas of causal discovery, particularly Granger causality. Particular emphasis is placed on the influence of midlatitude circulation variability upon the Arctic, as this direction of influence is less-studied than the converse pathway. Most of these two-way Arctic-midlatitude relationships are considered in the context of added variance explained, or added predictive power. That is, these relationships are characterized by comparing how much an additional predictor improves predictability beyond autocorrelation. Limiting the ability of autocorrelation to color these results emphasizes added variance explained--how much additional variance in the circulation can be explained by Arctic temperature variability, and vice versa? The circulation variability in many regions, including North America, the east Pacific and Alaska, and Siberia, drives Arctic variability far more than it is driven by Arctic variability. These relationships exhibit substantial regional variability, stressing the important role of an analytical approach that incorporates this spatial heterogeneity. The circulation response to sea ice loss also drives changes in Arctic moisture fluxes, with moisture flux out of the Arctic increasing more than moisture flux into the Arctic.

Ultimately, this research seeks to offer a different perspective on analyzing climate dynamics, with an emphasis on two-way feedbacks. While targeted climate modeling studies offer great physical insights, and provide substantial opportunities to explore and test physical mechanisms, they are often limited to exploring only one pathway of influence. In reality, these relationships do go in both directions, and a comprehensive understanding of such large-scale interactions between different parts of the atmosphere must ultimately consider the two-way relationships. The causal discovery methods used in much of this research can be used in conjunction with modeling studies to better understand these two-way relationships, and improve interpretation of results. While this research has focused on the relationships between the Arctic and the midlatitude circulation on sub-seasonal timescales, the broad framework and ideas presented within can be more widely applied to many other questions in climate variability studies. Thus, this work has also put a special emphasis on describing and implementing these causality-based methods in a manner that is accessible and interpretable for atmospheric and climate scientists.