A Dynamical and Statistical Understanding of the North Atlantic Oscillation and Annular Modes

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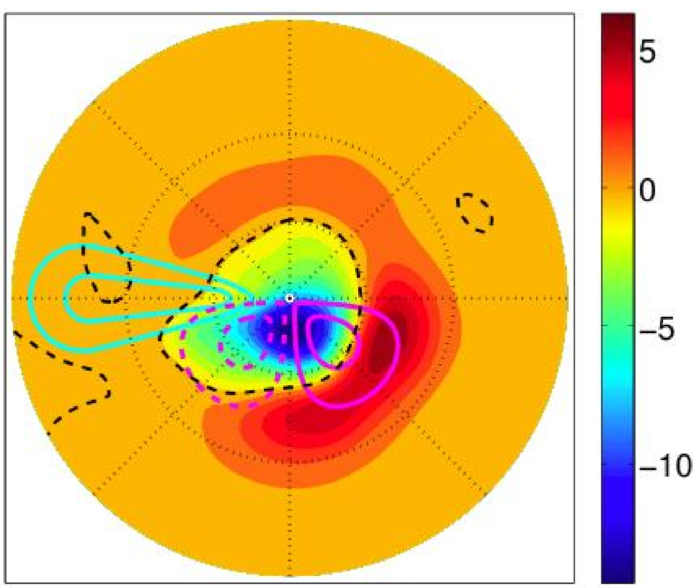
I constructed a hierarchy of idealized models of the North Atlantic Oscillation (NAO) and annular modes, the dominant patterns of intraseasonal variability in the extratropical atmosphere. These patterns characterize north-south shifts in the jet stream, and so are important for understanding and predicting weather in Europe and eastern North America, particularly in the winter months. They are ``intraseasonal" in that these shifts tend to occur on longer timescales than typical weather events, persisting on the order of 10 to 20 days. My models help isolate the dynamics governing the spatial and temporal structure of the patterns, and provide a framework for interpreting measures of the variability produced by different data analysis techniques. The simplest model is purely stochastic, and serves to explain conflicting interpretations of the weather patterns. A simple 1 layer model of the sphere, where the atmosphere is approximated as a 2-dimensional fluid, provides an overall framework for understanding the NAO and annular modes, and how they arise from eddy (typical midlatitude storms) interactions with the mean flow (the jet stream). Lastly, I worked with a fully 3-dimensional general circulation model to validate conclusions from the simpler models and focus on understanding the timescales on which the NAO and annular modes vary. Together, the models provide a coherent picture of these patterns of variability in the real atmosphere.



Our "idealized NAO," the first Empirical Orthogonal Function (or Principal Component) of sea level pressure in our three dimensional model. Units are in hPa, and correspond to a 1 standard deviation manifestation of the pattern. The light blue contours mark the position of a Gaussian mountain, similar in scale to the Rocky Mountains, and the dashed (solid) pink contours show the position of cooling (heating) anomalies that approximate land-sea contrast.