Evaluation of the Arctic Atmosphere Using Cycled Data Assimilation and a High-Resolution Global Model

Chris Riedel
University of Oklahoma

In recent decades, the duration of skillful forecasts in global models has steadily increased in the mid-latitudes. Much of this improvement can be attributed to the development of higher resolution models, advances in data assimilation techniques, and – perhaps more importantly – growing understanding of physical processes associated with various atmospheric phenomena. However, forecasts in polar regions are not experiencing an equivalent increase in skillful forecast duration even with these improvements. The poles pose a unique modeling challenge that may perhaps be due to a relative dearth in the coverage of conventional observations, which places more weight on satellite remote sensing observations with higher uncertainty for forecast analyses and scientific studies. Additionally, atmospheric features are inherently smaller in the polar regions due to the Earth's rotation, implying that higher resolution, more computationally expensive NWP model grids are needed to resolve features of equal geographic size in the midlatitudes. Thus, understanding of key polar processes associated with polar weather features is only in its infancy and potentially not well-accounted for in current models. Recent studies highlight the influence polar regions can have on forecast skill in the mid-latitudes, which suggests improved understanding of key polar processes could help extend the current forecast barrier.

In this study, we focus on a predominantly Arctic feature called a tropopause polar vortex (TPV), which are features that can persist for many days to months. The location of TPVs on the tropopause and the known impacts that water vapor has on their growth and evolution leads to poor observational sampling and high forecast uncertainties associated with them. An overview and evaluation of a new research tool called Model for Prediction Across Scales (MPAS) with ensemble Kalman Filter data assimilation from the Data Assimilation Research Testbed (DART), or MPAS-DART configured for Arctic studies will be discussed.

The ability of MPAS-DART to represent key characteristics of TPVs is investigated along with potential biases that might degrade TPVs in the cycling system. Using observations and analysis increments, initial evaluation of MPAS-DART suggests the existence of systematic model biases in the Arctic. We apply the mean initial tendency and analysis increment method to further quantify these systematic biases. This method provides a way to identify potential model errors associated with either model dynamics or physical parameterizations. A moisture bias is identified in the upper-troposphere lower-stratosphere region, which leads to increased cooling near the tropopause. Special dropsonde observations from the North Atlantic Waveguide and Downstream Impact Experiment are used in order to evaluate the impact of this identified systematic bias and help elucidate TPV forecast sensitivity to initial states.

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Refreshments 3:15pm

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