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An Evaluation of the Climate Prediction Center's Analog Forecasts During the 2020–21 Meteorological Winter

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Abstract

The Climate Prediction Center (CPC) is the branch of the National Oceanic and Atmospheric Administration's (NOAA) National Weather Service (NWS) that specializes in climate monitoring and prediction, which are crucial tasks that influence how the United States prepares for impending weather conditions. Analog forecasting—which is making predictions about future weather patterns based on past dates with similar, or analogous, patterns—is one method that's applied by the CPC; an example of this is the CPC's two daily-issued outlooks for 8 and 11 days in advance respectively. This project evaluates how well their two outlooks verified during the 2020–21 meteorological winter. Notable about this winter is its deviation from other pattern predictors such as the El Niño-Southern Oscillation (ENSO), which provides a point of interest for how well the CPC's analogs fared against other established forecasting methods.

Background

Analog forecasting, which is a method of predicting future weather patterns by analyzing dates with analogous weather patterns, is used by the Climate Prediction Center (CPC) for their two daily-issued outlooks forecasting 8 and 11 days in advance respectively. These outlooks are based on weather model ensembles, which are groups of weather simulations that highlight the range of possible weather patterns that are weighted by the forecast creators based on their verification performance. The weighted models are then compared to a set of climatological data, from which the ten dates with the most similar weather patterns are chosen based on their correlation to the input 500 mb geopotential height field. The importance of this height field is that it corresponds with the ridges and troughs that influence our weather at the ground, making it a useful tracer for identifying weather patterns. The purpose of this study is to evaluate the performance of the CPC's analog-based outlooks in order to highlight to what extent this forecasting method may outperform others. Specifically, the 2020-21 meteorological winter is analyzed as a case study of the CPC's outlooks and their performance. Notable about this winter was its deviation from the weather patterns

associated with its El Niño Southern Oscillation (ENSO), an interannual pattern in the equatorial Pacific that often influences the weather in North America. While this winter's ENSO suggested features such as a ridge in the southeastern United States and more arctic troughing, the patterns that occurred were frequently near-mirror images of the traditional pattern.

Methods

To collect the data for this study, images of the CPC's outlooks were saved nearly daily during the 2020-21 meteorological winter, spanning from the beginning of December to the end of February. From here, the analog dates for each saved outlook were extracted in order to produce 500 mb geopotential height maps for each corresponding day during the aforementioned time period. To numerically represent the ridges and troughs on the geopotential height maps, two pattern indicators the Arctic Oscillation (AO) and the Pacific/North American Pattern (PNA) teleconnections—were used as proxies; positive AO values correspond to arctic troughing, and positive PNA values correspond to western U.S. ridging, with negative values of the teleconnections representing arctic ridging and western U.S. troughing respectively. These teleconnection values were averaged within the ten analog dates for each analyzed 2020-21 winter day, and were then plotted against the observed AO and PNA values for the 2020–21 winter days to depict the correlation between the analogs and the observations. A Pearson correlation was then calculated between each set of analog data to the observations to numerically determine how well the analogs predicted the patterns that occurred during the winter.

Results/Discussion

The 6–10 and 8–14 day analog forecasts correlated poorly for the AO teleconnection, with weak r2 values of 0.373 and 0.197 respectively, whereas the 6–10 and 8–14 day analog forecasts performed moderately well with r2 values of 0.608 and 0.508. One hypothesis for the poor AO forecasting performance during this winter is due to the anomalously low observed AO values—particularly during the string of near-record low values in mid-February—meaning that the observed data would fall outside of historical records. Conversely, the PNA values during this winter were within historical averages, potentially resulting in better analog performance for this pattern indicator.

Future Goals

The AO and PNA are helpful, yet limited indicators for describing weather patterns in the northern hemisphere. For this reason, future research may explore developing a method for correlating the 500 mb geopotential height maps themselves, rather than using teleconnections that approximate the patterns on them. In addition to this, future research may involve comparing and contrasting the analog performance from the 2020–21 winter to another season in order to illuminate the strengths and weaknesses of the CPC's analog forecasts. Finally, another point of interest is if recurring analog dates in one month may be used to signal the subsequent pattern in following months.

Appendix

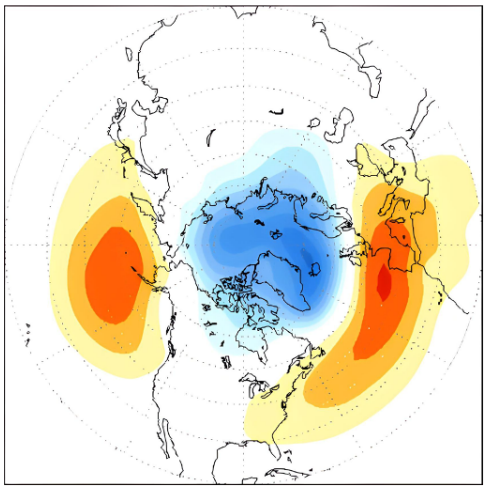

Figure 1. Map of the ridge and trough pattern associated with a canonical positive AO (*Leading EOF (19%)...*)

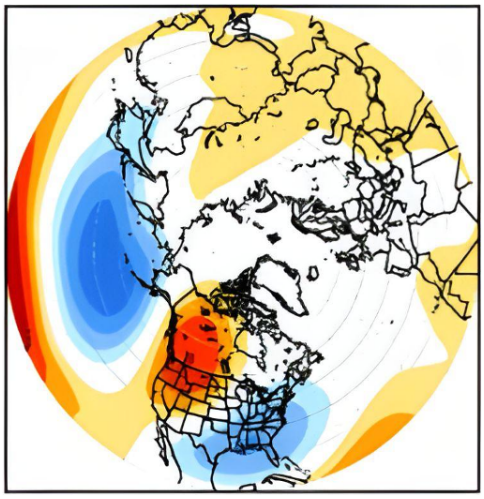

Figure 2. Map of the ridge and trough pattern associated with a canonical positive PNA (*PNA loading pattern for January*).

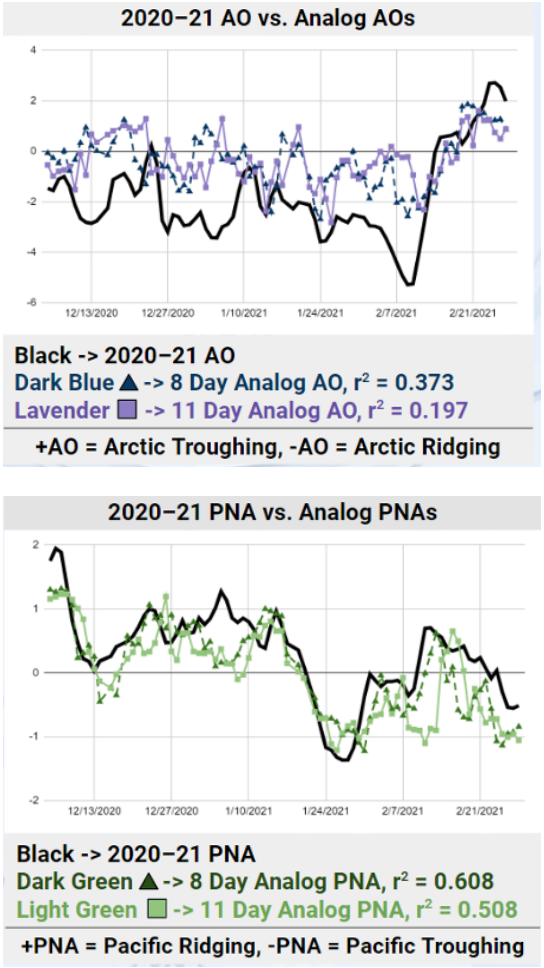

Figure 3. Plots of observed AO and PNA values during the 2020–21 meteorological winter versus the analog AO and PNA values for the corresponding forecast day.

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