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Projecting Northern Hemisphere Flow Regime Transitions: The Use of Integrated Enstrophy

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Abstract: Integrated enstrophy (IE) is the square of vorticity integrated over an entire hemisphere at a particular level in the atmosphere. Previous work has shown this quantity is correlated to the positive Lyapunov Exponent for hemispheric flow, and as such is a measure of flow stability or predictability. In this study, IE is calculated at 500-hPa over an area that encompasses 0° to 70° in the Northern Hemisphere. The data sets used were the 500-hPa initial and forecast fields for the Global Ensemble Forecasting System (GEFS) (on a 1o x 1o latitude-longitude grid) provided by the National Oceanic and Atmospheric Administration (NOAA) Weather Prediction Center (WPC) and the National Centers for Environmental Prediction / NOAA reanalyses (on a 2.5o x 2.5o latitude-longitude grid) archived in Boulder, CO. The GEFS forecast fields were provided every 24-h out to 240-h. By examining these forecasts over a year, it was found here that significant changes in IE values are a good predictor of flow regime transition, and several cases were found. We also found that the IE forecasts identified these regime transitions reliably out to about four days, however, the probability of detection and the skill decreased significantly after this time. Additionally, this work demonstrates that the changes in large-scale flow identified by IE can also signal large changes in the local weather and climate conditions.

Keywords: Integrated Enstrophy; weather prediction; models; dynamics; verification.