Forecasting Major Pattern Changes at the Climate Prediction Center via the Regime Change Prognostic Tool

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Over the last few years, the United States has experienced several abrupt changes in weather regimes. For example, during December 2022, an abrupt, severe Arctic Air outbreak occurred that was quickly followed by an equally abrupt change to much above normal temperatures. The magnitude of these temperature swings were amongst the greatest experienced during winter in the last 30 years. Also during the winter of 2022-23, California experienced significant precipitation regime changes, going from dry conditions in early December to extremely wet conditions in late December and early January. A similar evolution in precipitation regimes in California again occurred later that winter.

These events amongst other events over the past few years have motivated researchers to understand the physical drivers that produce regime changes and their predictability at subseasonal-to-seasonal (S2S) timescales. Operational centers, like the Climate Prediction Center (CPC), are interested in this research, as stakeholders often seek guidance as to when weather regimes will begin or end due to their high impact nature and visibility to the public. In fact, CPC has recently provided Key Messages and Impact-based Decision Support Services (IDSS) to stakeholders when significant pattern changes are expected.

While CPC has a large suite of teleconnection monitoring and forecast tools that are informative of the physical drivers of potential regime changes, there is a gap in directly applicable tools that objectively show the timing, location, and the historical magnitude of changes in temperature, precipitation, and 500-hPa heights as forecast by the ensemble suites of the S2S dynamical models. This deficiency is felt greatest at leads of two to four weeks, as the forecaster on duty often ponders if and when a regime change will occur during their forecast valid period. Thus, guidance that CPC provides to stakeholders on regime changes at S2S leads is currently sub-optimized.

The existing suite of dynamical models used for forecasting at CPC provides adequate data to potentially improve objective regime change guidance to support forecasters and improve messaging to stakeholders. Here, we develop and verify a Regime Change Prognostic Tool that explicitly identifies when and where significant regime changes in temperature, precipitation, and 500-hPa heights are forecast to occur by the ensemble suite of dynamical models. We demonstrate the tool’s usefulness for significant regime changes over a recent, retrospective period.