Weather Regime-Dependent Predictability: Sequentially Linked High-Impact Weather Events over the United States during March 2016
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Motivation

- High-impact weather events (HWEs), defined by episodes of excessive precipitation or anomalous temperature, can pose substantial predictability challenges on medium-range (8–10 day) time scales.
- This study introduces the North Pacific Jet (NPJ) phase diagram as a tool to characterize the large-scale flow pattern over the North Pacific.
- The NPJ phase diagram is applied to a period in late March and early April 2016 that was characterized by three sequentially linked HWEs:
  1. The 23–24 March 2016 Colorado Front Range snowstorm and Southern Plains severe weather outbreak.
  2. The 27–28 March 2016 Ohio River Valley severe weather outbreak.

Data

- 1.0° x 1.0° NCEP Global Forecast System (GFS) and Global Ensemble Forecast System (GEFS) analyses (available every 6 h).
- 0.5° x 0.5° NCEP Climate Forecast System Reanalysis (CFSR; available every 6 h) during 1979–2014.
- 1.0° x 1.0° ESPR/PSD GEFS Reforecast v2 dataset (available every 24 h) during 1984–2014.

Conclusions

- The predictability challenges that characterized the 23–24 March 2016 Colorado snowstorm were magnified because uncertainties in the positions of key weather features were concentrated near the Continental Divide.
- The evolution of the flow pattern prior to the onset of cold over the Northeast U.S. on 3 April 2016 is consistent with an antecedent environment conducive to extreme cold east of the Rocky Mountains.
- Jet Extension and Equatorward Shift regimes are more frequently characterized by reduced forecast errors than Jet Retraction and Poleward Shift regimes.
- Jet Extension regimes are favored during Phases 7 and 8 of the MJO and during El Niño. Equatorward Shift regimes are favored during El Niño.
- Predictability horizons can vary greatly as a function of weather regime and season. Consequently, regime-dependent predictability is an important science and operations problem, progress on which may improve the prediction of a variety of HWEs.

North Pacific Jet Phase Diagram

- The large-scale flow pattern over the North Pacific can be objectively characterized using the North Pacific Jet (NPJ) phase diagram.
- The NPJ phase diagram is constructed from the first two EOFs of Sept.–May 250-hPa zonal wind anomalies from the CFSR over the North Pacific (Fig. 1).

Large-Scale Flow Evolution: 20 March 2016 – 3 April 2016

- GEFS reforecasts initialized during Jet Extension or Equatorward Shift regimes are more frequently characterized by below-normal RMSE of 500-hPa geopotential height (Fig. 6a).
- Jet Extension regimes are favored during Phases 7 and 8 of the MJO. (26–31 Mar. 2016: MJO in Phases 7 and 8) (Fig. 6b).
- Jet Extension and Equatorward Shift regimes are favored during El Niño (Mar. 2016 Niño 3.4 = 1.68) (Fig. 6c).

Regime-Dependent Predictability

- GFS reforecasts initialized during Jet Extension or Equatorward Shift regimes are more frequently characterized by below-normal RMSE of 500-hPa geopotential height (Fig. 6a).
- Jet Extension regimes are favored during Phases 7 and 8 of the MJO. (26–31 Mar. 2016: MJO in Phases 7 and 8) (Fig. 6b).
- Jet Extension and Equatorward Shift regimes are favored during El Niño (Mar. 2016 Niño 3.4 = 1.68) (Fig. 6c).
- GFS forecasts with lead times greater than 120 h generally positioned the 500-hPa trough too far west (Fig. 7a).
- A subtle westward shift in the position of the 850-hPa geopotential height minimum and strongest 800–700-hPa warm air advection continued until 24 h prior to the event (Figs. 7b, 7c).
- The westward shift in both the geopotential height minimum and the band of warm air advection had important ramifications for where the strongest ascent would occur along the CO Front Range (Fig. 7d).