On the synoptic-scale mechanisms of extreme precipitation events: The role of the anticyclone and a dynamically based event identification method

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While forecast skill of mass fields (e.g. 500-hPa geopotential height) has improved greatly over recent decades, Quantitative Precipitation Forecasting (QPF) skill still lags behind, especially for extreme precipitation events. Thus, greater understanding of the synoptic-scale precursors and characteristics of extreme precipitation events can aid the human forecaster in QPF.

Recent research has focused on quantifying the importance of cyclones in extreme precipitation events. However, other studies have found that the presence and intensity of the downstream anticyclone may be a critical distinguishing factor between extreme and lesser precipitation events.

First, the synoptic-dynamic importance of downstream anticyclones in producing extreme precipitation events in North America is discussed. Preliminary results indicate that a precursor downstream anticyclone is crucial to provide the necessary warm, moist, and low stability (high-θ_e) air inherent to extreme events, but not seen in lesser cases.

Second, a novel dynamically-based index, developed to identify extreme precipitation events from mass fields, will be presented. The Extreme Precipitation Index (EPI) is based on an equation found in the original notes of Fred Sanders:

$$\mathbf{P} = -\frac{1}{g}\int \omega \left(\frac{dr_s}{dp}\right)_{ma} dp$$

This equation relates the precipitation rate, P, to the integrated ascent, ω (assumed for the purpose of this work to be quasi-geostrophic [QG]), and to the incipient air mass (represented by dr_s/dp, where r_s is the saturation mixing ratio). Since there is more QG ascent for a given QG forcing in the presence of weaker static stability, the equation suggests that the most 'value for the dollar' is achieved with more ascent AND warmer, less stable air masses.