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Using time series analysis to study the relationship of precipitation to other climate characteristics across different time scales

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Fine temporal resolution precipitation forecasts are necessary for accurate prediction of the potential impacts of climate change on runoff generation, infiltration, and erosion, among other processes. However, characterization of short time scale precipitation trends and their dependency on other climatic conditions (temperature, relative humidity, air pressure, etc) over different temporal scales remain poorly characterized, hindering modeling capabilities. Conventional precipitation generators typically fit bootstrapped occurrence probabilities to observations, but avoid exploring the physical causes of precipitation. In this paper, we use cluster analysis strategies to derive more nuanced precipitation occurrence probabilities derived from physically-based theories of precipitation occurrence. These statistical relationships are derived from 50+ years of hourly climatic data from six large coastal cities of the US Northeast. Specifically, the absolute value and gradient of different combinations of climate variables are used to define different precipitation occurrence conditions. These climatic conditions are then statistically related to individual precipitation events, as defined using inter-event dry periods and the historical record. Cluster analysis strategies are then used to discern and statistically characterize distinct types of precipitation events. The results are presented on 3D chart plots.