A SOM-based approach for analyzing daily precipitation extremes over the North American Arctic

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We analyze daily extremes of precipitation produced with a polar-optimized version of the Weather Research and Forecasting (WRF) model that simulated 19 years on the domain developed for the Regional Arctic Climate System (RACM) model. Analysis focuses on three North American sub-regions, which are defined using climatological records, regional weather patterns and geographical/topographical features. In order to understand the circulation characteristics conducive for extreme precipitation events, we use self-organizing maps (SOMs) to find general patterns of circulation behavior. The SOM algorithm employs an artificial neural network that uses an unsupervised training process. In our analysis, we use both mean sea level pressure (MSLP) and 500-hPa geopotential height anomalies to train the Master SOM.

Using the SOM procedure, we map daily widespread extreme precipitation events, defined as at least 25 grid points experiencing 99th percentile precipitation, onto the Master SOM. This mapping process aids in the determination of which nodes are being accessed at higher frequencies, and hence, which circulations are more conducive to extreme events. We show that there are multiple circulation patterns responsible for extreme precipitation. Additionally, we plot composites of the top 10 extreme events as well as for highly accessed SOM nodes. Composites of individual nodes (or of adjacent nodes in SOM space) produce more physically reasonable circulations as opposed to composites of all extreme events, which can include multiple synoptic circulation regimes. Thus, our analysis lays the groundwork for diagnosing differences in atmospheric circulations and their associated widespread, extreme precipitation events.