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The relative skill of sea surface salinity and temperature for predicting precipitation on land

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When water evaporates from the oceans, it causes an increase in the Sea Surface Salinity (SSS). A significant portion of this evaporated water precipitates onto land. This provides a solid connection between change in SSS and precipitation on land. Currently, it is more typical to use sea surface temperature (SST) as a predictor for land precipitation. SSS is rarely included as a predictor because anomalies in SSS and in SST are often highly correlated and caused partially by the same phenomena, resulting in multi-collinearity in the model.

Here, we use a Linear Regression Model to fit the observed precipitation across the continental U.S. as an example using SSS and SST at lags on the scale of several months to evaluate and understand their relative merits and contributions to predictive skill. We use Density-Based Spatial Clustering of Applications with Noise (DBSCAN) to find regions in the ocean that, when aggregated over for SSS or SST, can be used as predictors for precipitation in the U.S. In addition, we propose a way to combine these SSS and SST predictors, accounting for the cross correlation between them. We also provide additional analysis on the locations and persistence of these predictors, which ensures the predictive relationships are physically meaningful and based on a dynamical understanding of modes of variability in the Atlantic and Pacific, such as the El Niño-Southern Oscillation, and their respective teleconnection patterns.

We create separate models for each month of prediction for sub-regions in the U.S. defined by distinct seasonal patterns. Our focus is on building a generalized and objective process of building features that can be applied to model the precipitation in any month or any region, and avoiding using model-specific methods wherever possible. Case studies highlight the method's utility and implications for the prediction of extreme precipitation events will be discussed as well, building on previous work for the U.S. Midwest and African Sahel regions.