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Application of a K-Nearest Neighbor Simulator for Seasonal Precipitation Prediction in a Semiarid Region with Complex Terrain

Wanli Wu (1), Yubao Liu (1), Gael Descomes (1), Ming Ge (1), Tom Warner (1), Scott Swerdlin (1), Dorita Rostkier-Edelstein (2), Pavel Kunin (2), and Amir Givati (3)

(1) Research Application Laboratory, National Center for Atmospheric Research, Boulder, Colorado 80301, United States of America, (2) Israel Institute for Biological Research, P. O. Box 19, Ness Ziona, Israel, (3) Israel Hydrological Service, Israel Water Authority, Israel

Seasonal precipitation prediction has significant societal and economic impact, particularly for arid and semiarid regions. Current seasonal predictions generally rely on general circulation models (GCMs), which have coarse resolution (∼300km). The GCM forecasts provide overall guidance in terms of large and synoptic scale perspectives, but are lack of regional and local details and accuracy that are needed by hydrological applications and water resources planning and management. On the other hand, high-resolution (∼10s km) limited-area models have their own issues for operational seasonal forecasting due to unavailability of reliable large-scale drivers and unaffordable computational costs. Thus statistical and dynamical downscaling techniques have emerged to overcome scale mismatch between GCM products and regional (and local) application needs. In this study, a K-Nearest Neighbor (KNN) simulator is used to derive local precipitations based on NCEP Climate Forecast System (CFS) seasonal forecasts and historic rainfall observations. The KNN algorithm is an analog-type approach that queries days within a specified temporal window similar to a given weather feature vector in a GCM forecast. K nearest neighbors is then rank-weighted to derive daily precipitation with the historic observed precipitations. This study focuses on the semiarid area along the southeastern Mediterranean coast. This region is strongly influenced by the Mediterranean climate and complex terrain. Annual precipitation displays strong seasonality and spatial variability. Enhanced seasonal precipitation prediction with local details would benefit the regional hydrological service. Archived CFS seasonal forecasts (1981-2009, and up to 9 months ahead of the initials) are built as our database for weather pattern matching, and observed daily precipitations at stations within the region are compiled from different sources to minimize errors and missing in the observations. Four variables (500 hPa geopotential, sea level pressure, precipitation rate and precipitable water) in CFS output are used as predictors for the KNN daily precipitation forecasts. Monthly precipitation is then simply calculated from the KNN daily products. The analog patterns obtained from the KNN algorithm are cross-examined by another pattern classification tool: Self-organizing Maps (SOM). Seasonal precipitation forecasts (monthly rainfalls) are evaluated using statistics like bias, uncertainty range, and spatial covariability between stations as a measure of forecast skill. Observation incompleteness in the region presents challenge to the KNN application. Thus, retrospective dynamical downscaling with a WRF-based four-dimensional data assimilation system is conducted to reconstruct the regional precipitation climate. The reconstructed precipitations are then used for KNN seasonal rainfall prediction application. Discussion on the downscaling algorithms and results will be presented.