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Statistical downscaling of Global Reanalysis Precipitation Products: A comparison of parametric and non-parametric approaches over CONUS

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Hydrologic impact assessment requires accurate estimates of precipitation at temporal and spatial scales suitable to run distributed hydrologic models. In this context, multiyear global atmospheric reanalysis datasets form an important source of information in ungauged areas, mostly due to their global coverage and available record lengths that typically exceed 30-35 years. However, their coarse spatial resolution (i.e. on the order of 0.25 - 0.5 deg) introduces significant error in distributed hydrologic simulations, which propagates in the assessment of flood risk at basin scale. The later shortcoming can be remedied using high-resolution weather radar-based rainfall estimates, with record lengths that typically do not exceed 10-18 years, being too short for risk applications. In this study, we investigate the option of combining the strengths of these two datasets: i.e. the long record lengths offered by global reanalysis datasets, and the high resolution information of radar-based rainfall estimates. We do so for the case of Connecticut River Basin (CRB) located in Northeast Continental US (CONUS), using NLDAS (North American Land Data Assimilation Systems) hourly reanalysis data at $\sim$14 km spatial resolution, and hourly MRMS (Multi-Radar/Multi-Sensor) rainfall estimates at 1km spatial resolution. Statistical downscaling is conducted using two alternative approaches: 1) the parametric statistical scheme of Mamalakis et al. (2017), and 2) its widely used non-parametric variant based on empirically derived Q-Q (quantile-quantile) correction relationships. The performances to the two approaches in generating rainfall estimates at high spatial resolutions are compared in terms of commonly used statistical error metrics, using independent calibration and validation periods. The latter are obtained by bootstrapping the available 10 years where MRMS and NLDAS data overlap. We find that while the two approaches present similar skill in modeling mean rain rates, the parametric approach is considerably less sensitive to outliers, demonstrating significantly better skill in modeling rainfall extremes even for short calibration periods (down to 1 year).

Reference:
Mamalakis, A., A. Langousis, R. Deidda, and M. Marrocu (2017), A parametric approach for simultaneous bias correction and high-resolution downscaling of climate model rainfall, Water Resour. Res., 53, doi:10.1002/2016WR019578.