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Nonstationarity in Global Hydrological Water Budget, Evidence-based on GRACE Satellite Mission

Emad Hasan, Himanshu Save, Mark Tamisiea, and Srinivas Bettadpur
Center for Space Research, University of Texas at Austin

Anthropogenic climate change (ACC) has led to a significant shift in the hydrological water budget natural balance. The human-induced modifications in water systems, land cover, and land use have introduced the notion of "*nonstationarity*" in the hydrologic system. The concept implies significant changes in the hydrologic systems' intra-annual and interannual variabilities with a time-variant mean, variance, and non-uniform density distribution. Under nonstationary conditions, extreme weather and climate events became frequent. Their magnitudes, durations, and frequencies are outside the historically observed ranges. A nonstationary system displays a volatile memory that hinders any reliable future projections. We revaluate the nonstationarity in global hydrological systems using gravity measurements from the GRACE (Gravity Recovery and Climate Experiment) mission. We utilized GRACE mascons (mass concentration blocks) solutions of RL06 from the Center for Space Research (CSR) between April 2002 to June 2017. We employed the KPSS and the ADF tests for stationarity in deterministic and periodic components, respectively. The KPSS test identified 25 hotspots globally that are nonstationary around the deterministic trend. These hotspot locations have undergone extensive anthropogenic activities on the available freshwater resources. The ADF test mapped the nonstationary systems around the mean and the variance components in 11 hotspot locations. These locations are noted by the KPSS test as nonstationary systems around the trend as well. Understanding the nonstationary state in hydrologic systems will enhance our awareness and preparedness to mitigate future extremes.