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Global hydrological drought measurement using GRACE terrestrial water storage deficit

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Hydrological droughts bring about great losses in agriculture, ecosystem and socioeconomics, so it is important to establish hydrological models or indicators to describe the occurrence, severity and duration of drought. But it remains challenging to obtain the whole relevant hydrological variables (e.g.., surface water, soil moisture, and groundwater) on the appropriate temporal and spatial scales. Now the Gravity Recovery and Climate Experiment (GRACE) satellite observations can provide realistic spatiotemporal variations of vertically integrated measurement of water storage (groundwater, glacier ice, soil moisture, surface water, snow water equivalent, permafrost, etc.) at large research area. Here we present a new GRACE-derived index (GNSI) to investigate drought conditions and evaluate its applicability. We obtain the Release-05 GRACE terrestrial water storage data from the University of Texas Center for Space Research and precipitation data in the high spatial resolution from the version 4.02 of the gridded Climatic Research Unit Time-series dataset from March 2002 to December 2016. We choose July 2010 in which drought occurred in many countries as an example to evaluate the performances of the drought indices. The GNSI and Standardized Precipitation Index (SPI) reach good agreement in the spatial distribution of drought conditions in south China, northern India, western Russia, middle Europe, west side of South America and Western Australia. However, the intensities among the two indices in some regions are different, such as in the middle of China, United States and Greenland. In the middle of China, the GNSI detects more normal area while SPI captures some dry conditions. In the northern part of the United States, the GNSI reveals two obvious drought regions whereas the SPI does not. Furthermore, GNSI is compared with SPI at different time scales. The GNSI shows time lag about three months compared with SPI.