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Continental Drought Monitoring by Assimilating GRACE Data into Hydrological Models

Ehsan Forootan (1), Maike Schumacher (2), Mehdi Khaki (3), Albert IJM Van Dijk (4), Juergen Kusche (5), Ibrahim Hoteit (6), Ck Shum (7), Guillaume Ramillien (8), Joseph Awange (3), and Michael Kuhn (3)

(1) School of Earth and Ocean Sciences, Cardiff University, Cardiff, UK., (2) School of Geographical Sciences, University of Bristol, Bristol, UK., (3) School of Earth and Planetary Sciences, Discipline of Spatial Sciences, Curtin University, Perth, Australia., (4) Fenner School of Environment and Society, the Australian National University, Canberra, Australia., (5) Institute of Geodesy and Geoinformation, University of Bonn, Bonn, Germany., (6) King Abdullah University of Science and Technology (KAUST), Thuwal, Saudi Arabia., (7) Division of Geodetic Science, School of Earth Sciences, The Ohio State University, Columbus, OH, USA., (8) Universite de Toulouse, OMP-GET, UM5563, CNRS/IRD/UPS, 14 Avenue Edouard 5 Belin, 31400 Toulouse, France.

Global water resources are under threat as a result of climate change and the growing demands for freshwater. In particular, droughts with durations of months or years have been frequently reported to affect large areas and result in serious environmental, social, and economic devastations. The wealth of data from satellites, coupled with recent advances in large-scale hydrological modelling and seasonal climate model predictions have the potential to improve monitoring and prediction systems and to better assess potential impacts of such extreme events. In this study, we investigate the feasibility of various data assimilation approaches to use the Gravity Recovery And Climate Experiment (GRACE) derived Total Water Storage (TWS) data to tune or improve the World-Wide Water Resources Assessment (W3RA) model predictions. The integrated GRACE-W3RA is then applied for monitoring hydrological droughts in various regions such as South Asia, the Middle East, West and East Africa, and Australia. For these regions, particularly, we generate traditional precipitation-and soil moisture-derived drought indices, as well as a new multivariate hydro-meteorological drought index. To compute the latter, a probabilistic approach is implemented to combine monthly TWS, groundwater, and soil moisture water storage from GRACE-W3RA outputs with (net) precipitation records. Different drought characteristics of these regions including trends, occurrences, areal-extent, and frequencies corresponding to 3-, 6-, 12-, and 24-month timescales are extracted from the generated drought indices and their comparison results are discussed.
Keywords: GRACE; W3RA; Hydrological Droughts; Data Assimilation