Geophysical Research Abstracts
Vol. 21, EGU2019-9006, 2019
EGU General Assembly 2019

Mapping global water stress from GRACE satellite data

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The Gravity Recovery And Climate Experiment (GRACE) satellite mission recorded time-variability in Earth's gravity for more than a decade, which can be directly related to changes in water stored near the surface of the Earth. GRACE maps of water mass change are available at monthly time scale, and have been used to validate hydrology models, close regional water budgets, estimate groundwater changes, and map water stress. Usually the GRACE time series is decomposed into a linear trend and a periodic signal, and then the magnitude of the trend is used to infer the severity of water mass in a region. In this study, we show that such an approach is misleading because catchment scale hydrology also contains inter-annual signals with decadal frequencies and that are also recorded by GRACE. Since the quality-controlled GRACE record is only about 13 years long, the long wavelength inter-annual signal cannot be co-estimated and will contaminate estimates of linear trend. Furthermore, the inter-annual behaviour of each catchment is different, and therefore, a catchment should not be evaluated against other catchments but with respect to its natural variability. Therefore, to quantify water-stress comprehensively, we propose a novel metric for water stress that uses GRACE trend and inter-annual variability from a calibrated 62 years long hydrology model time series. We obtain a global water stress map that differs markedly from previous GRACE assessments. We assess that more than a third of the human population that depend on river catchments is facing severe water stress.