Geophysical Research Abstracts
Vol. 21, EGU2019-12616, 2019
EGU General Assembly 2019

Estimating irrigation water use over the contiguous United States by combining satellite and reanalysis soil moisture data

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Effective agricultural water management requires accurate and timely information on the availability and use of irrigation water. However, most existing information on irrigation water use (IWU) lacks the objectivity and spatiotemporal representativeness needed for operational water management and meaningful characterization of land-climate interactions. Although optical remote sensing has been used to map the area affected by irrigation, it does not physically allow for the estimation of the actual amount of irrigation water applied. On the other hand, microwave observations of the moisture content in the topsoil layer are directly influenced by agricultural irrigation practices, and thus potentially allow for the quantitative estimation of IWU. In this study [1], we combine surface soil moisture retrievals from the spaceborne SMAP, AMSR2, and ASCAT microwave sensors with modeled soil moisture from MERRA-2 reanalysis to derive monthly IWU dynamics over the contiguous United States (CONUS) for the period 2013-2016. The methodology is driven by the assumption that the hydrology formulation of the MERRA-2 model does not account for irrigation, while the remotely sensed soil moisture retrievals do contain an irrigation signal. For many CONUS irrigation hot spots, the estimated spatial irrigation patterns show good agreement with a reference data set on irrigated areas. Moreover, in intensively irrigated areas, the temporal dynamics of observed IWU is meaningful with respect to ancillary data on local irrigation practices. State-aggregated mean IWU volumes derived from the combination of SMAP and MERRA-2 soil moisture show a good correlation with statistically reported state-level irrigation water withdrawals but systematically underestimate them. We argue that this discrepancy can be mainly attributed to the coarse spatial resolution of the employed satellite soil moisture retrievals, which fails to resolve local irrigation practices. Consequently, higher resolution soil moisture data are needed to further enhance the accuracy of IWU mapping.

[1] Zaussinger, F., Dorigo, W., Gruber, A., Tarpanelli, A., Filippucci, P., and Brocca, L.: Estimating irrigation water use over the contiguous United States by combining satellite and reanalysis soil moisture data, Hydrol. Earth Syst. Sci. Discuss., https://doi.org/10.5194/hess-2018-388, in review, 2018.