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Improvement of evapotranspiration estimates over arid and semi-arid regions with a physically based water stress constraint scheme

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In the arid and semi-arid regions, the bare soil evaporation dominates the total evapotranspiration (ET). To date, in most of the process-based ET models, the constraint on the actual evaporation from bare soil due to water stress is either related to an empirical function of near-surface humidity or represented by a water stress factor linked with surface soil moisture. However, the relative humidity (RH) shows a hysteretic effect on the ET event, and the relationship between soil water stress and soil moisture is nonlinear, usually leading to the overestimation of ET in arid and semi-arid regions. In this study, we plan to improve the ET estimates on dry land by implementing a physically-based water stress constraint method, which is developed by parameterizing the Buckingham-Darcy's law and yielded an excellent performance with laboratory data. The physically-based water stress constraint scheme is further incorporated into two different ET models (i.e. PT-JPL, MOD16) to generate the global ET estimates, whereby the latest ERA5-land reanalysis data and MODIS NDVI\LAI is adopted as model inputs. We not only validate the simulated ET with available flux observations but also intercompare the performances of different schemes in estimating ET in the arid and semi-arid regions. This study will provide a new way to characterize the regional soil water stress on the ET estimates especially in the arid and semi-arid conditions.