EGU2020-8217
https://doi.org/10.5194/egusphere-egu2020-8217
EGU General Assembly 2020

The calibration-free complementary relationship (CR) approach aids large-scale ET estimation

Ning Ma[1], Jozsef Szilagyi[2], and Yinsheng Zhang[1]
[1]Institute of Tibetan Plateau Research, Chinese Academy of Sciences, Beijing, China (ningma@itpcas.ac.cn)
[2]Department of Hydraulic and Water Resources Engineering, Budapest University of Technology and Economics, Budapest, Hungary

Having recognized the limitations in spatial representativeness and/or temporal coverage of (i) current ground evapotranspiration (ET_a) observations, and; (ii) land surface model (LSM) and remote sensing (RS) based ET_a estimates due to uncertainties in soil and vegetation parameters, a calibration-free nonlinear complementary relationship (CR) model is employed with inputs of air and dew-point temperature, wind speed, and net radiation to estimate monthly ET_a over conterminous United States during 1979–2015. Similar estimates of three land surface models (Noah, VIC, Mosaic), two reanalysis products (NCEP-II, ERA-Interim), two remote-sensing-based (GLEAM, PML) algorithms, and the spatially upscaled eddy-covariance ET_a measurements of FLUXNET-MTE plus this new result from CR were validated against water-balance-derived results. We found that the CR outperforms all other methods in the multiyear mean annual HUC2-averaged ET_a estimates with RMSE = 51 mm yr^{-1}, R = 0.98, relative bias of −1 %, and NSE = 0.94, respectively. Inclusion of the GRACE data into the annual water balances for the considerably shorter 2003–2015 period does not have much effect on model performance. Besides, the CR outperforms all other models for the linear trends in annual ET rates over the HUC2 basins. Over the significantly smaller HUC6 basins where the water-balance validation is more uncertain, the CR still outperforms all other models except FLUXNET-MTE, which has the advantage of possible local ET_a measurements, a benefit that clearly diminishes at the HUC2 scale.

Because the employed CR method is calibration-free and requires only very few meteorological inputs, yet it yields superior ET performance at the regional scale, we further employed this method to develop a new 34-year (1982-2015) ET_a product for China. The new Chinese ET_a product was first validated against 13 eddy-covariance measurements in China, producing NSE values in the range of 0.72–0.95. On the basin scale, the modeled ET_a values yielded a relative bias of 6%, and an NSE value of 0.80 in comparison with water-balance-derived evapotranspiration rates across ten major river basins in China, indicating the CR-simulated ET_a rates reliable over China. Further evaluations suggest that the CR-based ET_a product is more accurate than seven other mainstream ET_a products. During last three decades, our new ET_a product showed that annual ET_a increased significantly over most parts of western and northeastern China, but decreased significantly in many regions of the North China Plain as well as in the eastern and southern coastal regions of China. This new CR-derived ET_a product would benefit the community for long-

term large-scale hydroclimatological studies.