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A comparison of continental actual evaporation estimates for Africa to improve hydrological drought forecasting

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Evaporation is a key process in the development of hydrological and agricultural droughts. Although distributed drought indicators are often calculated using estimates of evaporation or soil moisture, the estimation of continental evaporation fluxes is complex and typically relies on continental-scale hydrological or land-surface models. However, it appears that most global or continental-scale hydrological models underestimate evaporative fluxes in some regions of Africa, and as a result overestimate stream flows. On the other hand, other studies suggest that land-surface models may overestimate evaporative fluxes. In this study, we computed actual evaporation for the African continent using a continental version of the global hydrological model PCR-GLOBWB, which is based on a water balance approach. Results are compared with other independently computed evaporation products; the evaporation results from the HTESSEL model and ERA-Interim (both based on the energy balance approach), both the MOD16 evaporation product (largely derived from MODIS remote sensing images), and the GLEAM product (derived from satellite observations). Three alternative versions of the PCR-GLOBWB hydrological model were also considered. In the first the model structure was amended by introducing an irrigation scheme, while in the second and third forcing data (precipitation and potential evaporation) were modified to assess the impact that the choice of forcing has on the actual evaporation fluxes simulated by the model. This resulted in eight products of actual evaporation, and derived drought indices were compared in distinct regions of the African continent spanning different climatic regimes. Annual totals, spatial patterns and seasonality were studied and compared through visual inspection and using statistical methods. The comparison indicated that the representation of irrigation areas has an insignificant contribution to the actual evaporation at a continental scale with a 0.5° resolution. The choice of meteorological forcing data has a larger effect on the evaporation results; especially in the case of the precipitation input, which has a significant contribution in some of the studied regions. ERA-Interim evaporation is generally the highest of the selected products followed by HTESSEL evaporation. The satellite based products (GLEAM and MOD16) do not show a consistent behaviour compared to the other products, though this depends on the region and the season considered. The results from this study allow for a better selection between the available products in each climatic region. Through an improved understanding of the causes of biases between these products, this study can lead to an improved evaporation product for the African continent, which may ultimately assist in improved forecasting of hydrological droughts.