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Global quantifiction of vegetation rooting depth for hydrological modelling

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Plant rooting depth (Zr) is a key parameter in hydrological and biogeochemical models, yet the global spatial distribution of Zr is largely unknown due to the difficulties in its direct measurement. Moreover, Zr observations are usually only representative of a single plant or several plants, which can differ greatly from the effective Zr over a modelling unit (e.g., catchment or grid-box). Here, we provide a global parameterization of an analytical Zr model that balances the marginal carbon cost and benefit of deeper roots, and produce a climatological (i.e. 1982-2010 average) global Zr map. To test the Zr estimates, we apply the estimated Zr in a highly transparent hydrological model (i.e. the Budyko-Choudhury-Porporato (BCP) model) to estimate mean annual actual evapotranspiration (E) across the globe. We then compare the estimated E with both water balance-based E observations at 32 major catchments and satellite grid-box retrievals across the globe. Our results show that the BCP model, when implemented with Zr estimated herein, optimally reproduced the spatial pattern of E at both scales and provides improved model outputs when compared to BCP model results from two already existing global Zr datasets. These results suggest that our Zr estimates can be effectively used in state-of-the-art hydrological models, and potentially biogeochemical models, where the determination of Zr currently largely relies on biome type-based look-up tables.