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Large-Scale Controls of the Coupled Water and Energy Balance over Land

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On climatological time scales, water availability in a catchment is determined by the percentage of precipitation that is evaporated or transpired, thus consuming energy. The Budyko framework analytically describes the coupled water-energy balance over land. A widely used solution to this framework describes evapotranspiration (ET) as function of precipitation, potential evapotranspiration, and one free parameter (ω) that encompasses all other potentially influencing factors. Numerous regional studies have analyzed the relationships between the ω parameter and factors such as vegetation, topography, climate variability, etc; however results are ambiguous. A clear understanding of the primary controls over the ω parameter—and thus ET—is yet to be achieved, especially at a global scale. A new dataset with empirical evidence on ω, information about possible controlling factors, and a relatively good global coverage was obtained from a comprehensive and systematic review of the literature. A total of 1461 catchments from all continents, except Antarctica, are included in the dataset. Latitude, catchment size, mean annual temperature and precipitation, vegetation density, catchment slope, seasonality of precipitation and potential ET, and snow influence were among the examined possible explanatory variables for ω. The validity of several previously proposed hypotheses about the dominant factors controlling ω (ET) was assessed using the new dataset. Furthermore, generalized linear models were used to identify which factors can significantly explain the ω values from our gathered data. This study provides new insights on the global picture of relevant factors controlling how precipitation in a catchment is partitioned into ET and runoff, and consequently allows for improved estimates of water availability.