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Vegetation control on water and energy balance within the Budyko framework

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Budyko's framework has been widely used to study basin-scale water and energy balances and one of the formulations of the Budyko curve is Fu's equation. The curve shape parameter ϖ in Fu's equation controls how much of the available water will be evaporated given the available energy. Previous studies have found that land surface characteristics significantly affect variations in the parameter ϖ. In this study, we focus on the vegetation impact and examine the conditions under which vegetation plays a major role in controlling the variability of ϖ. Using data from 26 major global river basins that are larger than 300,000km^2, the basin-specific ϖ parameter is found to be linearly correlated with the long-term averaged annual vegetation coverage. A simple parameterization for the ϖ parameter based solely on remotely-sensed vegetation information improves predictions of annual actual evapotranspiration by reducing the root mean square error (RMSE) from 76 mm to 47 mm as compared to the default ϖ value used in the Budyko curve method. The controlling impact of vegetation on the basin-specific ϖ parameter is diminished in small catchments with areas less than 50,000km^2, which suggests a scale-dependence of the role of vegetation in affecting water and energy balances. In small catchments, other key ecohydrological processes need to be taken into account in order to fully capture the variability of the ϖ parameter in Fu's equation.