



Bring the catchment hydrology and carbon science together: a simple ecosystem water use efficiency model

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Water use efficiency (WUE) defined as carbon uptake per unit of water loss by plants or ecosystems is one of most important functional properties in plant sciences. While theory of WUE is quite advanced at leaf-scale, but quite limited at ecosystem scale because of the complexity of interactions among vegetation, soil and climate. In this study, we developed one simple equation for estimating ecosystem WUE with 2 parameters and 5 variables. Using this simple model, we can explain why ecosystem WUE peaks at about 60N, 20N and tropical region globally. Estimated global ecosystem WUE agrees very well with other independent estimates in both magnitude and spatial variability. We also demonstrated that this model can be used to predict quite accurately the global gross primary production (GPP) when estimates of ecosystem water use are available. We estimated global mean annual GPP as 120.7 ± 10.1 Pg(C) year⁻¹ based on 7 independent estimates of global evapotranspiration. Further analysis shows both global ecosystem WUE and GPP have increased over the last three decades. About 90% of the increased trend in WUE is attributed to increased atmosphere CO₂. Increases in GPP is largely driven by increasing WUE. Therefore this simple model provide an important link of catchment hydrology with carbon science community and as an independent approach for estimating ecosystem photosynthetic carbon production from traditional catchment hydrological measurements.