Carbon and Water Cycles in the Mississippi River Basin: Implications for the Northern Hemisphere Residual Terrestrial Sink

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The hydrologic cycle plays an important role in carbon cycling, due to the coupling of vapor release and CO_2 uptake during photosynthesis. This coupling, expressed as Water Use Efficiency or Transpiration Ratio, can provide an inexpensive alternative for estimating the Net Primary Productivity (NPP) of terrestrial ecosystems. The D/H and $^{18}O/^{16}O$ trends of river water in the Mississippi basin are mostly indistinguishable from those of precipitation. This, combined with isotopic mass balance relationships, suggests that direct evaporation of surface water is small in the Mississippi River basin. The evapotranspiration flux from the basin therefore consists mostly of interception and transpiration, with the former approximated from field studies.

The calculated water flux associated with transpiration is 1500.8 km^3 (77.3 % of the evapotranspiration flux). Utilizing the average Water Use Efficiency of 864 moles H_2O for each mole of CO_2, the NPP of the Mississippi River basin amounts to 1.16 Pg C/y, similar to the model estimates of the heterotrophic soil respiration flux of 1.12 Pg C/y. This does not favor the postulated existence of a major sink for atmospheric CO_2 in the temperate northern hemispheric ecosystems of the conterminous United States.

Key words: hydrologic cycle, carbon cycling, the Mississippi River basin isotope mass balance relation, CO_2 sink

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