EMS7/ECAM8 Abstracts,
Vol. 4, EMS2007-A-00466, 2007
7th EMS Annual Meeting / 8th ECAM

Coupling of water vapor and carbon dioxide fluxes via the terrestrial biosphere: regional-scale estimates of evaporation and plant transpiration

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The distribution and vitality of terrestrial ecosystems is largely determined by water availability, although the fluxes of moisture from the biosphere may, in turn, affect regional patterns of precipitation. Despite the significance of terrestrial moisture fluxes, which represent one of the largest movements of mass and energy in the Earth's outer spheres, the relative contributions of abiotic water vapor fluxes and fluxes regulated by the physiology of plants remains a contentious and poorly constrained issue. These estimates, derived from the closure of the annual water balance for fifteen large watersheds in North America, South America, Africa, Australia, and New Guinea, indicate that approximately two-thirds of the annual water flux from water-limited ecosystems typical of high latitude regions could be attributed to plant transpiration. In contrast, in high-rainfall regions of the tropics, the transpiration flux is relatively stable and independent of the amount of precipitation. Further, these regional estimates of transpiration co-vary with annual water input by precipitation in a manner similar to that observed for primary productivity, implying that water vapor and carbon dioxide fluxes are coupled. Although the estimates are admittedly first-order, they offer a broadly conceptual perspective on the dynamics of energy exchange between terrestrial systems and the atmosphere, where the carbon cycle is essentially driven by solar energy via the water cycle intermediary.