Geophysical Research Abstracts,
Vol. 10, EGU2008-A-07769, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-07769
EGU General Assembly 2008

Realising a partition of evapotranspiration into soil evaporation and plant transpiration using isotopes of water in controlled conditions

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Due to the large variability of rainfall in time and space, as well as the heterogeneity of the continental surfaces, rainfall recycling by evapotranspiration from land covers is certainly the most unknown component of the global water cycle.

Traditional measuring methods such as sap flow, micro lysimeter, water and energy balance estimation (Bowen ratio, eddy correlation) have been used since the 70s for a monitoring of real evapotranspiration fluxes over crops and others plant covers. A complementary method consists in using isotopic biogeochemistry: when making specific hypothesis, it is possible to identify and quantify the different sources of the atmospheric water vapour (vegetation and soil at different scales).

Analysis of the heavy stable isotopic ratios of water in both liquid and vapour phases: ^{18}O and ^{2}H can allow determining the history of the water in the soil since the last rainfall event (infiltration, re-evaporation) or more specifically the root extraction depths.

The study of all the interactions at the field scale is still very difficult due to the large number of controlling variables describing climate, vegetation and soil characteristics. A monolith experiment (including soil and growing plant) was carried out in a reactor called RUBIC (Reactor Used for Continental Isotopic Biogeochemistry, Bariac et al., 1991). Controlled conditions allowed a monitoring and regulation of climatic parameters (net radiation, air temperature, vapour pressure deficit, CO^2 partial pressure, and wind speed). It was also necessary to fix soil (structure, texture, and water content) and vegetation (specie and seeding density) parameters.

The collected data allow us to improve our understanding of the partition of evapotranspiration into soil evaporation and plant transpiration and to assess the hypothesis (often made in isotopic biochemistry) of a stationary state reached in the two reservoirs (soil and plant) for water.

These data also allow the evaluation of the hypothesis included in a transfer module of heavy stable isotopes of water within the bare soil and the plant (Braud et al., 2005). The latter is coupled to a SVAT model (Soil-Plant-Atmosphere Transfer) called SiSPAT (Simple Soil Plant Atmosphere Transfer model. Braud et al., 1995; Braud 2000; 2002) and was extended to take into account isotopes transfer within the vegetation (root extraction and transpiration).

The poster will present the experimental device RUBIC I. Then, we will emphasize the functioning mechanisms identified from data analysis and derived from the intrinsic properties of stable isotopes as natural tracers of water movement and history. We will also present our first modelling results of the partition between evaporation and transpiration simulated using SiSPAT_Isotope.