

Background

The forest tree vegetation, because of its longevity and high evaporative capacity, has a great influence on the water cycling: it can transpire about 80% of the potential evapotranspiration (PET, mm) under high evaporative demand. The presence of a shallow water table increases the water's availability to root uptake from deep layers. In the scenario of a water table polluted with radionuclides, identifying the sources of water used by the forest vegetation (precipitation vs groundwater) is necessary to correctly predict the rhythm at which radionuclides will be absorbed by trees and further recycled into biosphere.

Objectives

This study aims at understanding and quantifying the forest vegetation and water table interactions. Through the soil-tree-atmosphere *continuum*, the water fluxes were monitored in parallel to the element cycle, the biomass compartments and the ecophysiological response of a Scots pine stand during 2005 growing season.

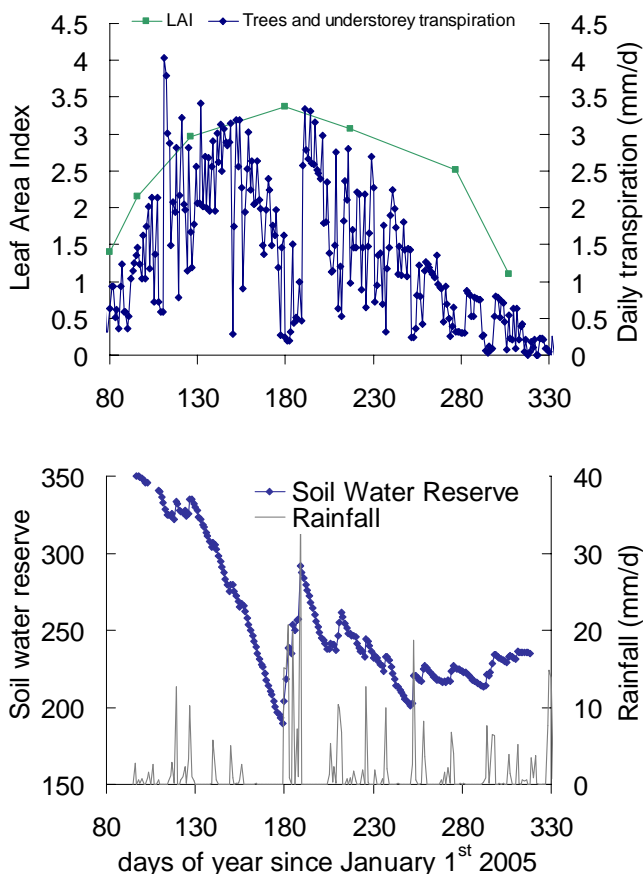


The results will then be integrated in a model, to simulate the uptake of RN from groundwater by the forest vegetation and their further allocation to forest biomass and return to soil surface.

Principal results

Vegetation functioning drives the soil water reserve dynamic

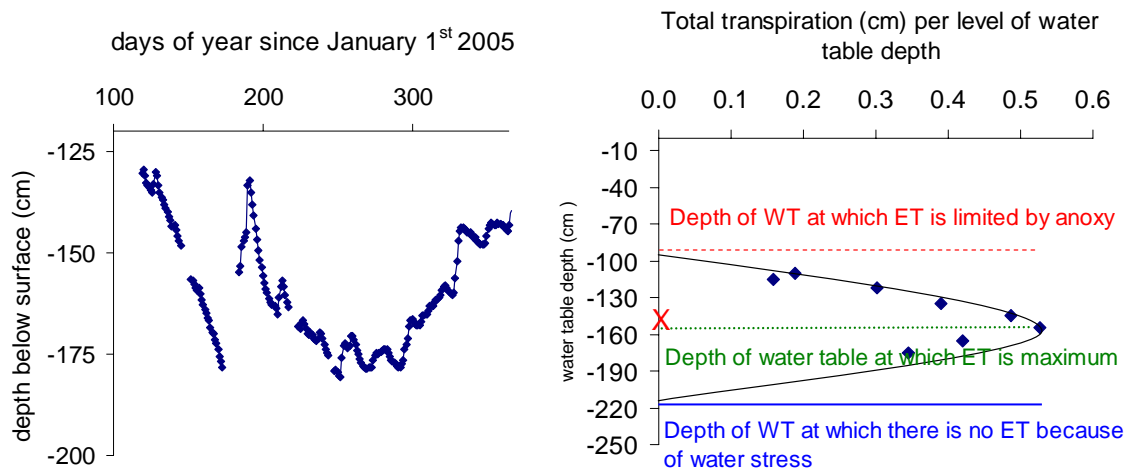
The forest canopy and the soil rooted zone are the two most important interfaces driving the water fluxes from soil to tree to atmosphere: the Leaf Area Index controls rainfall interception (about 35% in our case) and drives the transpiration capacity of the trees. The soil rooted zone delimits the available soil volume in which water (and elements) can be directly absorbed (in this case, it was 140 cm). The seasonal dynamics of soil water reserve in that zone is highly dependent upon those two interfaces, because its variations are mainly due to interception rates and evapotranspiration (ET) fluxes.



Water table dynamics and evapotranspiration fluxes are inter-dependent

The water table seasonal cycle is highly dependent upon the vegetation interface. The winter recharge is a direct consequence of the dormancy of the forest vegetation. The discharge of the water table starts with the budburst of the understorey and trees in spring. This interaction is also visible daily, with a discharge during daylight hours and a recharge at night.

By coupling the actual ET measurements and the water table measurements, it is possible to construct the "water table-ET curve" for the studied plot: below a depth of 210 cm, no ET could occur, and above a depth of 90 cm, the ET would be limited as well but because of anoxic conditions. The maximum ET fluxes occur when the water table is at a depth corresponding to the maximum rooted depth (X).



Water table contribution to stand evapotranspiration

Pines transpiration contributed to 20% of the stand ET, whereas understorey contributed to 36%. During the May-November period, the water table contributed to 26% of the stand ET.

	May-November		June drought	
	Pine transpiration	Understorey transpiration	Pine transpiration	Understorey transpiration
mm	140.3	254.4	16.9	39.4
ET/PET	0.20	0.36	0.24	0.56

	May-November	June drought
Total transpiration (mm)	394.6	57.1
Throughfall (mm)	292.5	0.2
(Total transpiration-Throughfall)	102	56.1
Water table net variation (mm)	199	74.5
Water table contribution to transpiration	26%	64%

For a 3.5 week period in June with no rain, the water table contribution was calculated to be 64% of ET (99% if the soil was dry to the wilting point at the beginning of the drought).

Future developments

A coupling of the transpiration fluxes and the element concentration in sapwood has to be done to estimate a potential uptake of radionuclides by trees. The data and the processes acquired will be used to conceptualize and parameterize a lumped model, coupling water fluxes, element cycle and biomass production. For further development and validation, a new plot will be investigated, focusing this time on a broad-leaved stand (*Q. robur*) in the SCK-CEN forest domain.

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Main reference

Vincke, C., Thiry, Y., Water table is a relevant source for water uptake by a Scots pine (*Pinus sylvestris* L.) stand : Evidences from continuous evapotranspiration and water table monitoring. Submitted to Agric. Forest Meteorol. in May 2006.