GENERAL INFORMATION

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ABSTRACT

During the solar eclipse of 11 August 1999, measurements of sap flow at branch and stem level were made in a 75-year-old beech tree which was 27 m high growing near Ghent, Belgium. The sky was relatively free from clouds during the eclipse which reached its maximum at 10.26 h GMT (=10.36 h True Solar Time). Measurements also included short-wave radiation, air temperature and vapour pressure deficit. The daily variation of the sap flows and of short-wave radiation and vapour pressure deficit were compared to a reference based on mean diurnal cycles. During the eclipse short-wave radiation, air temperature and vapour pressure deficit showed a maximum reduction between the pre-eclipse maximum and the following minimum of respectively 439 W/m^2, 3.0 °C and 0.27 kPa. The reduction of the solar energy resulted in the formation of a temporary temperature inversion above the canopy. At the time of maximum eclipse the sap flow rates at branch level and at stem level were reduced by 92 and 76 %, respectively, indicating non-stationary flow conditions in the beech tree. Due to the eclipse, the tree reduced its water loss from transpiration by 32.0 kg of water, being about 25 % of the total amount which is transpired by the beech tree during a sunny day in August. Regression analysis indicated that both short-wave radiation and vapour pressure deficit changed in a nearly linear fashion during the eclipse. Sap flow rates were given by an exponential equation, allowing the description of sap flow dynamics in terms of time lag and rate of change.

MATERIALS & METHODS

study area	5n (scientific zone)
time period	11 August 1999
goal	Describe how the solar eclipse of 11 August 1999 modified the microclimate surrounding a mature and full-grown beech tree, and how the sap flow inside the tree responded to these changes.
set-up	beech tree: branches vs stem
data collection	meteorology - 10 sec measurements, 10 min mean data - incoming and reflected short-wave radiation: 10 m above the canopy layer - relative humidity and vapour pressure deficit: 2 m above the canopy layer - air temperature: 2 m above the canopy - free field precipitation: 35 m

	<u>sap flow</u> - beech tree next to the measuring tower - 3 branches at 9, 16, 22 m height (d = 13, 13.6, 14 mm; direction N W S) o sap flow with heat balance sensors o total leaf area per branch above the sensors (measured on neighbouring branches) - stem at 1.3 m o thermal dissipation probe o sap wood area with methylene blue and Pressler auger
remarks	Steppe_2000_th

RESULTS

The solar eclipse of 11 August 1999 affected both the microclimate around and the sap flow in the beech tree. The maximum reduction of incoming short-wave radiation was 439 W m^{-2}, which resulted in a minimum intensity of 18 W m^{-2}. Because of the decrease in solar energy, the atmosphere was more stable during the eclipse: air temperature and wind speed dropped, and the vertical temperature gradient above the crown layer was reversed.

At branch level, the sap flow stopped about 10–20 m after the moment of maximum solar eclipse. The stem flow rate was 1.5 g s^{-1} at the maximum eclipse and reached a minimum value of 0.8 g s^{-1} at 30 min after. The water loss was reduced by 32 kg, about 25 % of the total amount of water transpired by the beech on a sunny day in August.

Both short-wave radiation and vapour pressure deficit changed nearly linearly during the first and second phase of the eclipse. The sap flow rate did not follow the theoretical exponential equation: the calculated time constant was smaller than the observed, which may be due to the relatively large time step of the data and the lack of replicas.