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# Exchange processes of a natural bog vegetation; SLIMM measurements

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## Abstract

The Surface Layer Integration Measurement Modelling project (SLIMM) is set up to determine the soil-vegetation-atmosphere exchange of momentum, heat, water vapor and carbon dioxide at a regional scale. Starting point of the joint experiment is that the exchange processes above a heterogeneous landscape is not a simple weighed sum of these processes above the homogeneous parts of the composing elements. Therefore an experiment is set up during which the exchange processes of the different components are measured.

## 1. INTRODUCTION

The experimental area is in the region from Appelscha to Norg in the north of the Netherlands. The site of the Wageningen Agricultural University (WAU) is located at the prevailing windward end of the experimental area, above a bog landscape type. The continuous experiment takes place during a two year's period (1994-1995). During this period flux measurements, representative for the bog area, will be performed as good as possible on a routine basis. In addition to the continuous measurements, three more detailed so called Intensive Field Experiments (IFE) are planned. The main goal of the IFE's is to provide insight into the mechanisms that are responsible for the areal fluxes from the complex bog area as for the total fluxes of the whole measurement site.

The contribution of the WAU to the SLIMM project include a continuous monitoring of the surface fluxes of radiation and profile measurements of temperature and wind speed. Second, simultaneous monitoring momentum, heat, water vapor and carbon dioxide fluxes during the two year's period. Third, temperature, water vapor and carbon dioxide fluctuations and mean water vapor and carbon dioxide concentration will be measured, and four, a detailed description of the temporal changes of the architecture of the vegetation and soil features. These points will be discussed here.

## 2. STANDARD METEOROLOGICAL MEASUREMENTS

Two masts are placed at a representative location within the bog area (20 meters apart). To reduce shading effects, the radiation sensors are spread out over the two masts. All components of the radiation balance are measured using radiometers (Kipp & Zonen, CM 5) for short-wave incoming and reflected radiation (Albedo), a Funk net radiometer (Middleton) and a pyrgeometer (Kipp & Zonen, CG1) for longwave radiation. Figure 1, shows an example of the measured radiative fluxes.

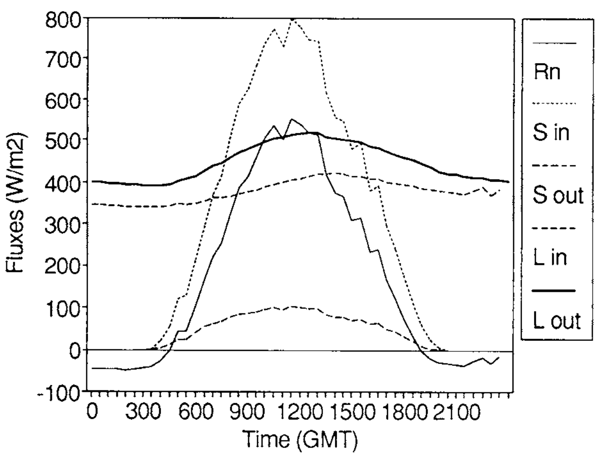


Figure 1: Radiative fluxes measured at the 3rd of August 1994. $Rn$ = Net, $S_{in}$ = Short wave incoming, $S_{out}$ = Shortwave outgoing, $L_{in}$ = Longwave incoming and $L_{out}$ = Longwave outgoing radiation.

Apart from the radiation measurements, the following standard meteorological quantities will be measured: dry and wet bulb temperatures (aspirated Pt-100 psychrometers) at three heights as well as wind speeds at the same heights (sensitive cup anemometers, length constant 1m), at four depths soil temperature using Pt-100 thermometers (0.05, 0.2, 0.5 en 1 m) and soil heat flux using a TNO - transducer (WS 31 CP). A wind vane is used to measure the mean wind direction. The profile measurement of temperature and wind enable, by using various meteorological techniques (for example: the aerodynamic and Bowen ratio energy budget approach), to make assessment of fluxes of momentum, heat and water vapor.

## 3. SURFACE FLUXES

To make a comparison of the surface fluxes calculated with the Bowen ratio or aerodynamic technique and direct measurements of the surface fluxes, an eddy-correlation system has been installed. The system consists of an ultrasonic anemometer/thermometer (Gill Instruments Ltd.), a fast response thermometer and a $CO_2$ /$H_2O$ infrared gas analyzer (LiCor, Li 6262). This technique also allows us to add two relatively new techniques to the measurement program, namely:

1. The standard deviation or fluctuation technique [1] for heat, water vapor and carbon dioxide.
2. The structure parameter method [2] for heat, water vapor and carbon dioxide.

Figure 2 shows the surface fluxes as measured with the eddy-correlation system and the net radiometer.

Large errors can occur when the covariances are directly calculated from the measurements, so several corrections should be carried out to obtain the correct values (eg. Axis rotation and frequency response correction). These corrections are important, and should be carefully looked at in this experiment [3,4].

## 4. CARBON DIOXIDE

The increase of carbon dioxide is the main cause for global warming, possibly resulting in climate change. The global carbon dioxide cycle is only partly understood [5], as the exchange between the atmosphere and oceans and vegetated soils is still poorly quantified. A main aim of the SLIMM project is to obtain further insight into $CO_2$-exchange processes.

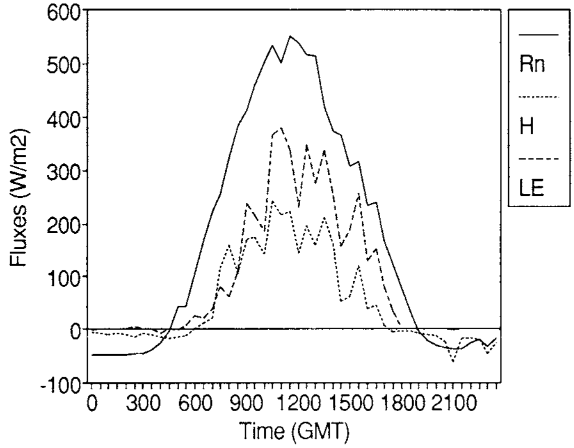


Figure 2: Measured sensible heat (*H*) and latent heat (*LE*) flux and net radiation (*Rn*) on the 3rd of August 1994.

Carbon dioxide is a so-called spore gas. This means that measuring the $CO_2$ flux density very serious errors emerge for which correction should be carried out. When $CO_2$ fluctuations are directly correlated to the vertical wind component fluctuations by eddy-correlation, density fluctuations affect the vertical velocity fluctuations. Density fluctuations are caused by heat and water vapor quantities. To be able to carry out the corrections properly, together with the $CO_2$ flux the fluxes of heat and water vapor have to be measured.

A so-called fast suction technique is used for taking air samples. These air samples are directly analyzed in the field for their water vapor and $CO_2$ components and the results are correlated with the vertical wind component near the sampling intake at 7 meters above the soil surface. Density corrections or Webb-corrections are applied later [6]. The $CO_2$ concentration and flux will be measured all year round, so some estimates of the soil contribution to the total flux could be made.

## 5. SURFACE CHARACTERISTICS

Throughout the growing season the state of the vegetation will be monitored.

This means that at representative locations within the bog area the leaf area index (LAI) and the vertical distribution will be estimated. Moreover estimates will be made about the horizontal variability. For the LAI measurements two techniques will be used; first, a direct method where leaf area is measured optically (PC hand scanner), second an indirect technique where the extinction of direct irradiation within the canopy is measured (Delta-T sunfleck ceptometer).

By selecting a representative measurement site for the meteorological station, the obtained data will provide adequate information about two important surface characteristics: the roughness length, $z_0$ and the displacement height, d and their courses during the experiment. Moreover estimates will be made of the roughness length for heat, $z_{0H}$, for this characteristic can differ much from the $z_0$ for momentum.

At various locations in the bog area, soil samples will be taken to obtain assessment of important soil parameters like: thermal conductivity, moisture content, soil composition and heat capacity.

## 6. CONCLUSIONS

Because the measurements have just started, but will continue for an other year no hard results can be shown here. Some of the results are used for canopy simulation models and will be used in a numerical boundary layer study.

It's clear that the eddy correlation method is not a very straight forward method but significant corrections should be applied. Especially when $CO_2$ fluxes are measured, the Webb corrections are of major importance. Attention should be given to soil and vegetation cycle and their contribution to and influence on the surface fluxes.

## 7. REFERENCES


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