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2 Site description

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4 Summary

5 Hydrology

Effect of different land use and water availability on biosphere-atmosphere exchange of savannah ecosystems and agriculture in Burkina Faso, West Africa

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Description of monitoring sites and first results

C. Brümmer, E. Lehmann, H. Kunstmann, N. Brüggemann, R. Wassmann, H. Papen

Outline

1. Overview and field setup of campaigns 2005 and 2006
2. Site description
3. Results and current state of analysis
 - Manual chamber measurements
 - Eddy covariance measurements
 - Hydrological measurements
4. Summary and additional activities



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Research objectives:

- Determination of biosphere-atmosphere exchange of GHG (N_2O , CH_4 und CO_2) on rain-fed agricultural fields (most common fruits in Burkina Faso) and a near-natural savannah ecosystem (Bontioli natural park)
 - Quantification of the net ecosystem exchange of carbon (NEE_C) and energy in a near-natural savannah ecosystem (Bontioli natural park)
 - Analysis of the surface runoff
 - Determination of the interaction between the water availability and biosphere/atmosphere exchange (Application and validation of a coupled atmosphere-biosphere-hydrosphere model system)
- 2 major field campaigns covering the bulk of vegetation periods:
- May – September 2005
 - April – September 2006



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Overview of field campaigns 2005 and 2006:

Field setup:

1) Manual chamber measurements:

- Determination of soil-driven CH_4 -, N_2O - and CO_2 -fluxes
- Analysis of air samples by gas chromatography (GC) system
- Locations:
 - Bontioli:
 - savannah site (natural park)
 - sorghum
 - Dano:
 - sorghum
 - cotton
 - peanut



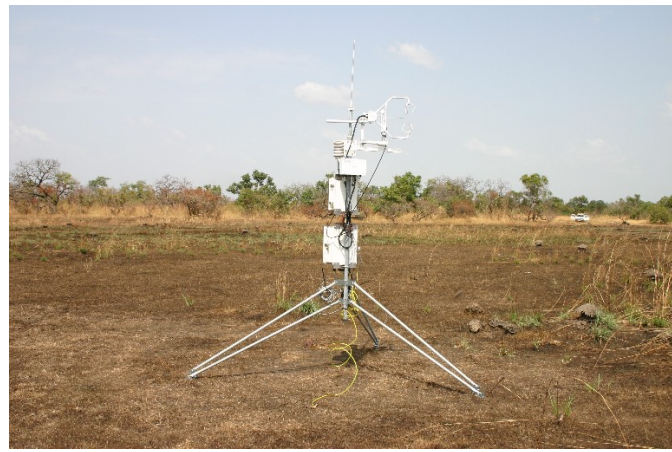
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Overview of field campaigns 2005 and 2006:

Field setup:

2) Eddy covariance (EC) measurements:

- Determination of CO₂-, water vapour fluxes and radiation components
- Location:
 - Savannah site (Bontioli natural park)



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Overview of field campaigns 2005 and 2006:

Field setup:

3) River discharge monitoring

The aim of our work is to estimate the surface runoff in order to quantify the regional water balance in the watersheds where the flux emission monitoring stations are located.

Why?

To calibrate a Coupled Hydrological and Biological Model in Savannah Environment.

How?

Installation of divers to monitor the water level :

- along small rivers where discharge measurements are conducted,
- next to small weirs build across small rivers,
- upstream of dams.

Aim?

To build water level/discharge relation graph

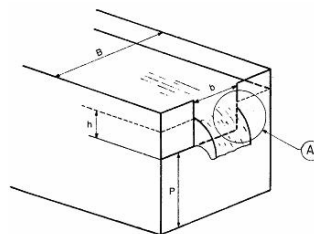


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Overview of field campaigns 2005 and 2006:

Field setup:

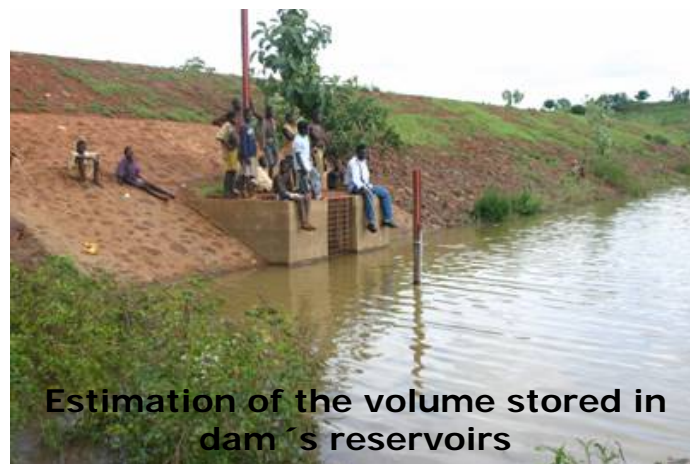
3) River discharge monitoring : 3 techniques
Water level monitoring plus ...



Installation of small weirs $Q = f(h)$



Direct monitoring with a currentmeter



Estimation of the volume stored in dam's reservoirs

Site description:

Investigated land-use types

	I Réserve Bontioli	II Sorghum Bontioli	III Sorghum Dano	IV Cotton Dano	V Peanut Dano
Management	- Natural park - No farming - No tillage	- Agriculturally used since 15 years	- Agriculturally used since several decades	- Agriculturally used since several decades	- Agriculturally used since several decades
Soils	- Subtropical brown soils, rich of nutrients on clayey base material	- Subtropical ferruginous soil, partly leached, on sandy base material	- Subtropical ferruginous soil, leached, on sandy base material	- Subtropical ferruginous soil, leached, on sandy base material	- Subtropical ferruginous soil, leached, on sandy base material

Dry season



Rainy season



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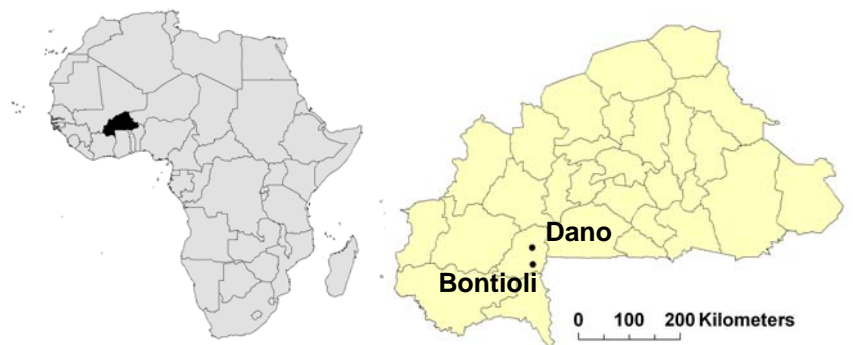
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Site description

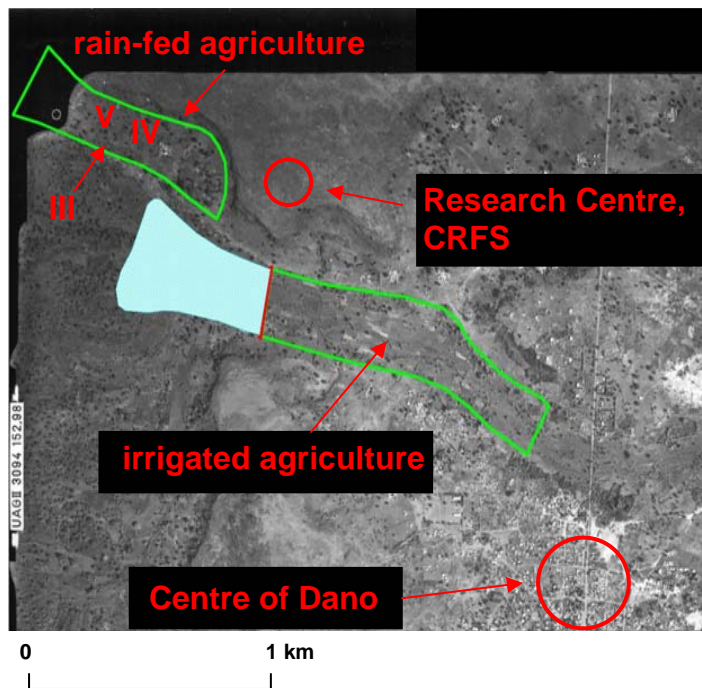
I	– Bontioli Réserve	293 m asl
II	– Bontioli Sorghum	295 m asl
III	– Dano Sorghum	318 m asl
IV	– Dano Cotton	322 m asl
V	– Dano Peanut	322 m asl



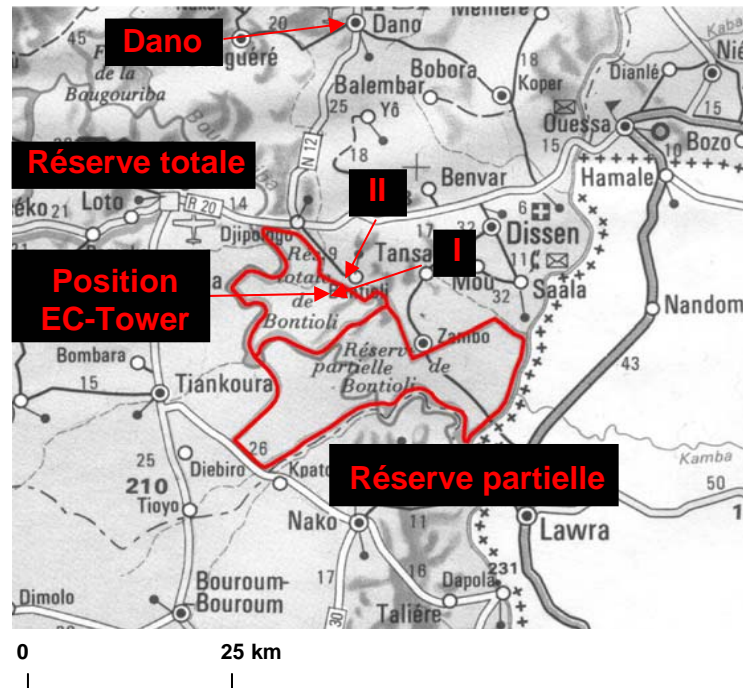
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Dano



Bontioli



Hydrologic presentation of the study area

Dano and surrounding

Instruments deployed and monitoring sites



- Discharge station from the Burkinabe hydraulic services
- Water level diver
- Gas emission monitoring sites :
 - Dano:
 - sorghum
 - cotton
 - peanut
 - Bontioli:
 - sorghum
 - natural savanna
- Weather Station :
 - temperature,
 - air pressure,
 - humidity,
 - wind speed and direction,
 - radiation short, long and PAR,
 - rain.
- Rain gauges



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Two selected catchments

Bontioli

- Natural savannah.
- Difficulty of access.

Dano

- Anthropogenic influence, agriculture.
- A reference catchment to estimate local parameters



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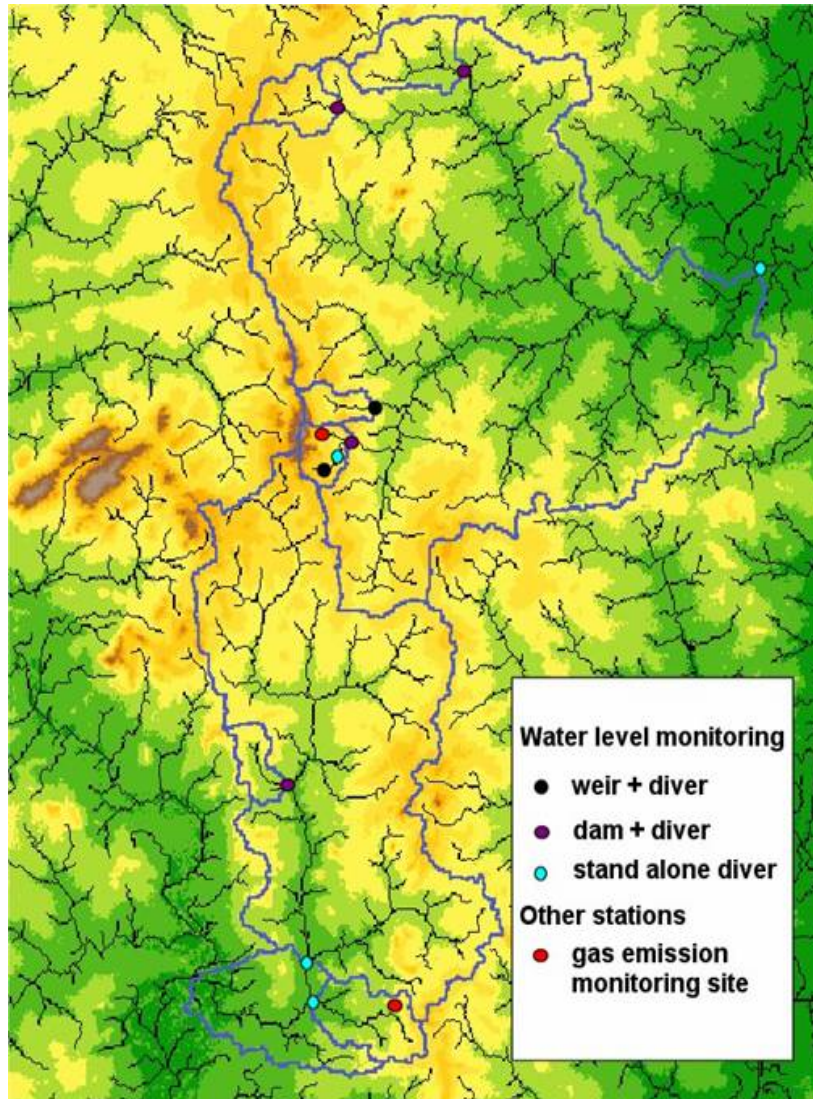
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Discharge monitoring : Localisation of the water level loggers



Installation of divers April 2005
and March 2006

0km 10km 20km



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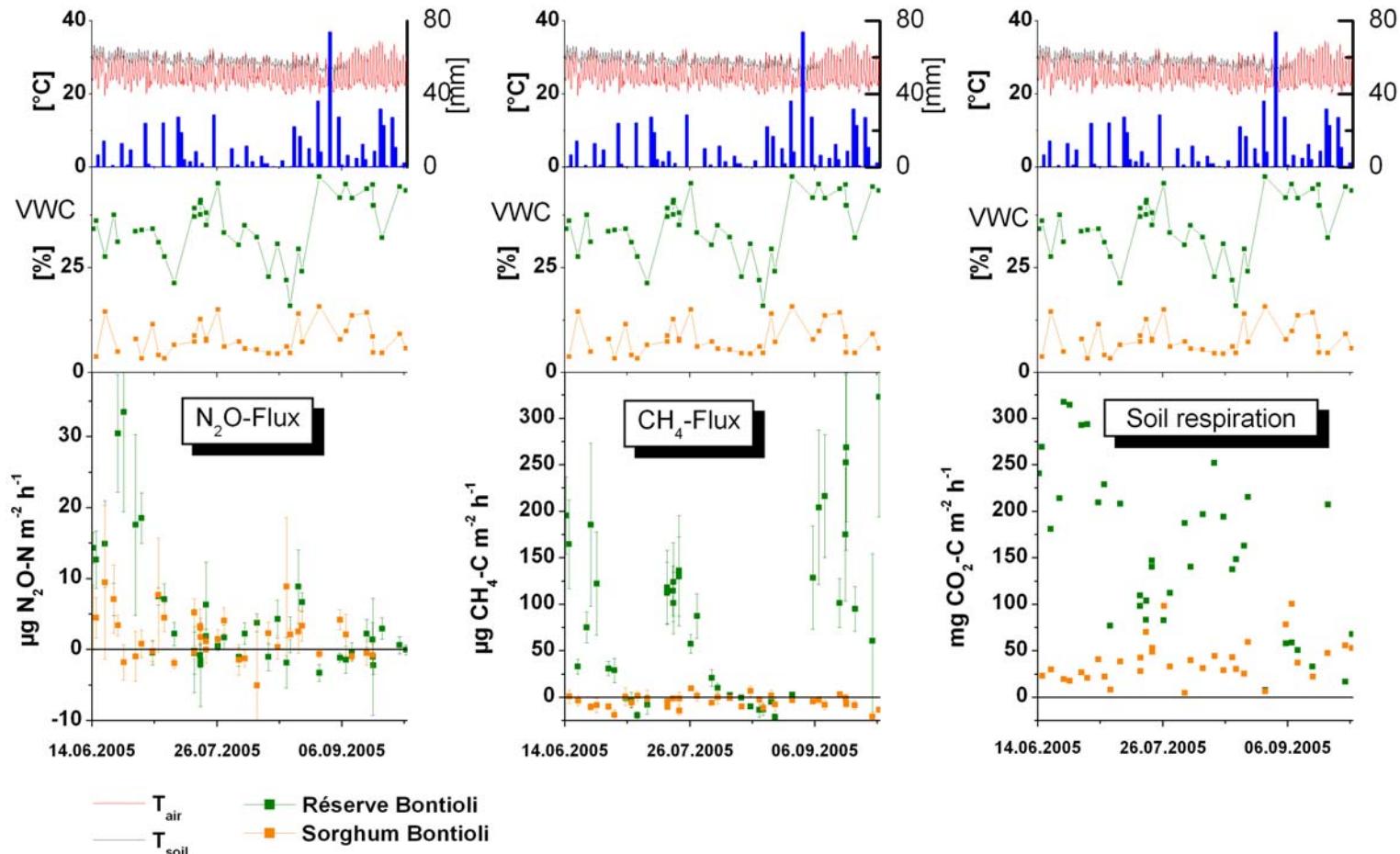
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1) Manual chamber measurements:

Seasonal patterns of N₂O-, CH₄- and CO₂-Fluxes in Bontioli (nature park and sorghum site) as well as volumetric water contents (VWC), rainfall, soil and air temperature



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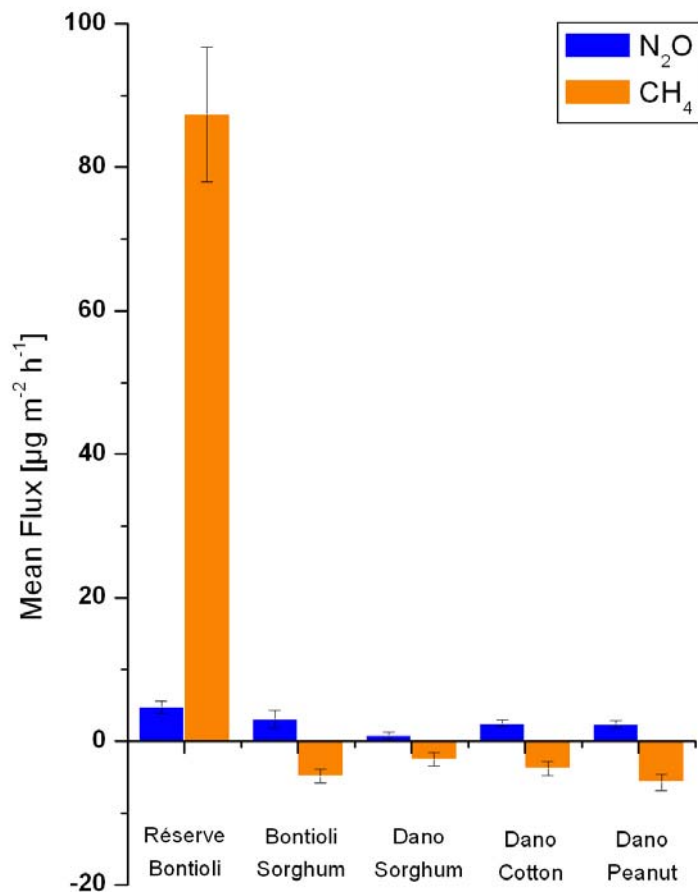
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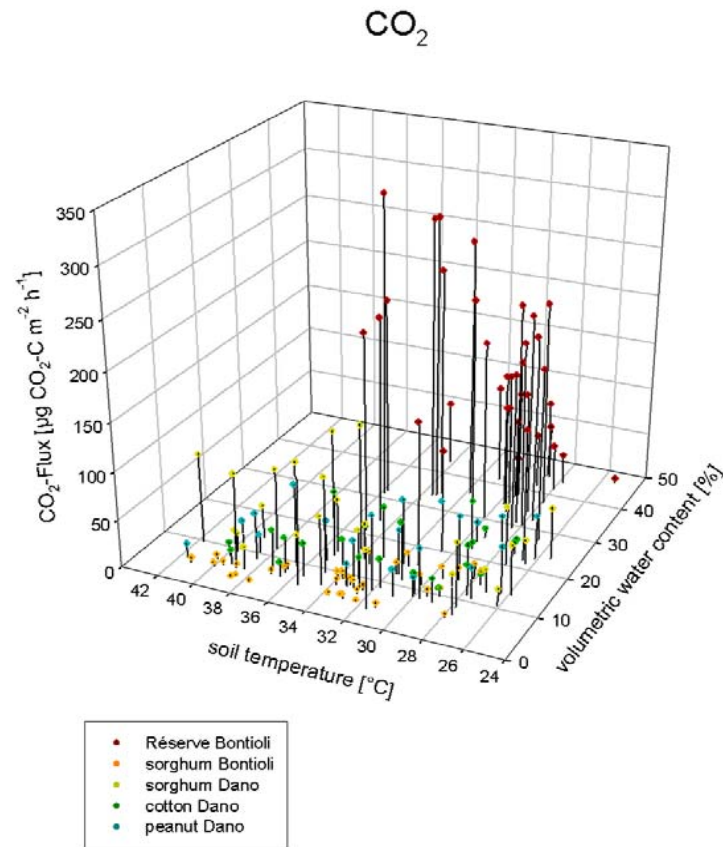
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1) Manual chamber measurements:

Mean CH₄- and N₂O-flux rates of all investigated land-use types during field campaign 2005

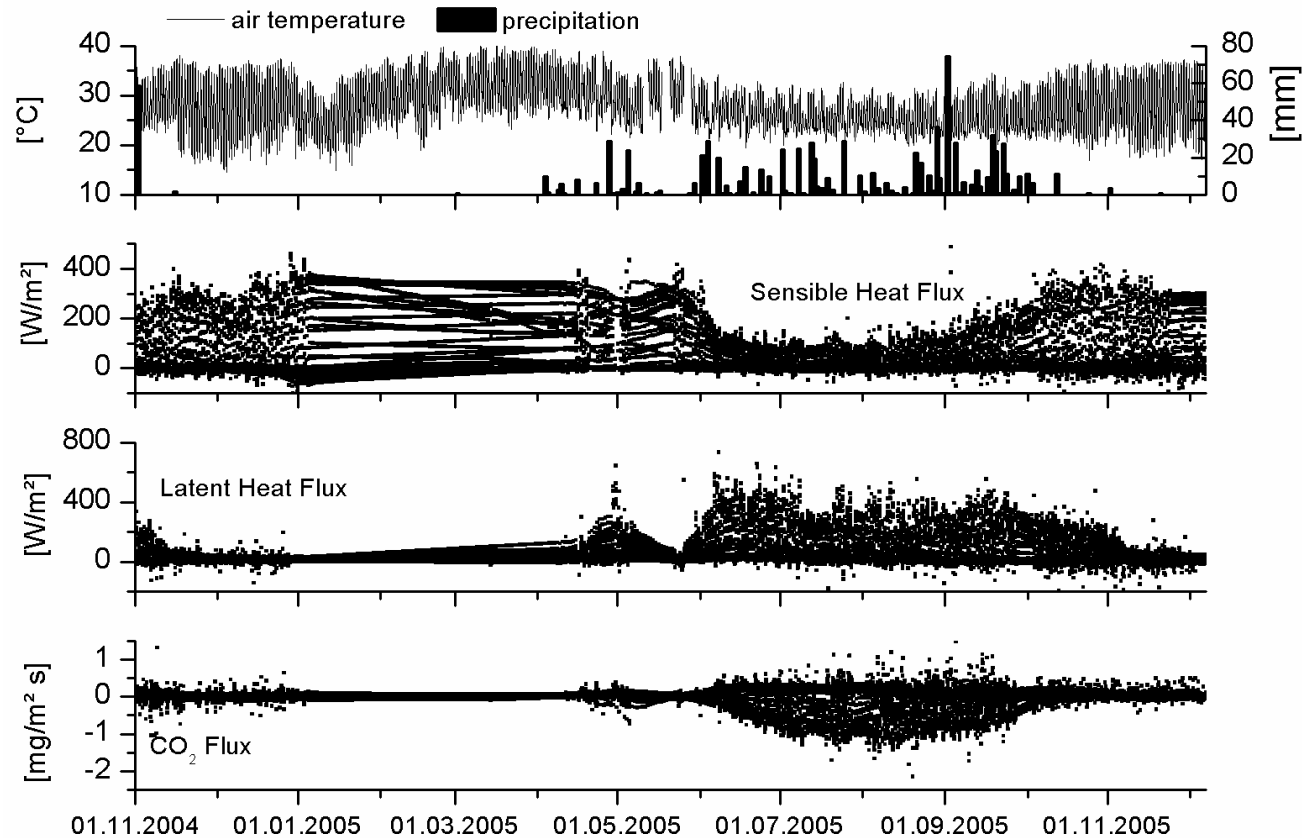


Impact of soil moisture and soil temperature on soil respiration



2) Eddy Covariance (EC) – Measurements:

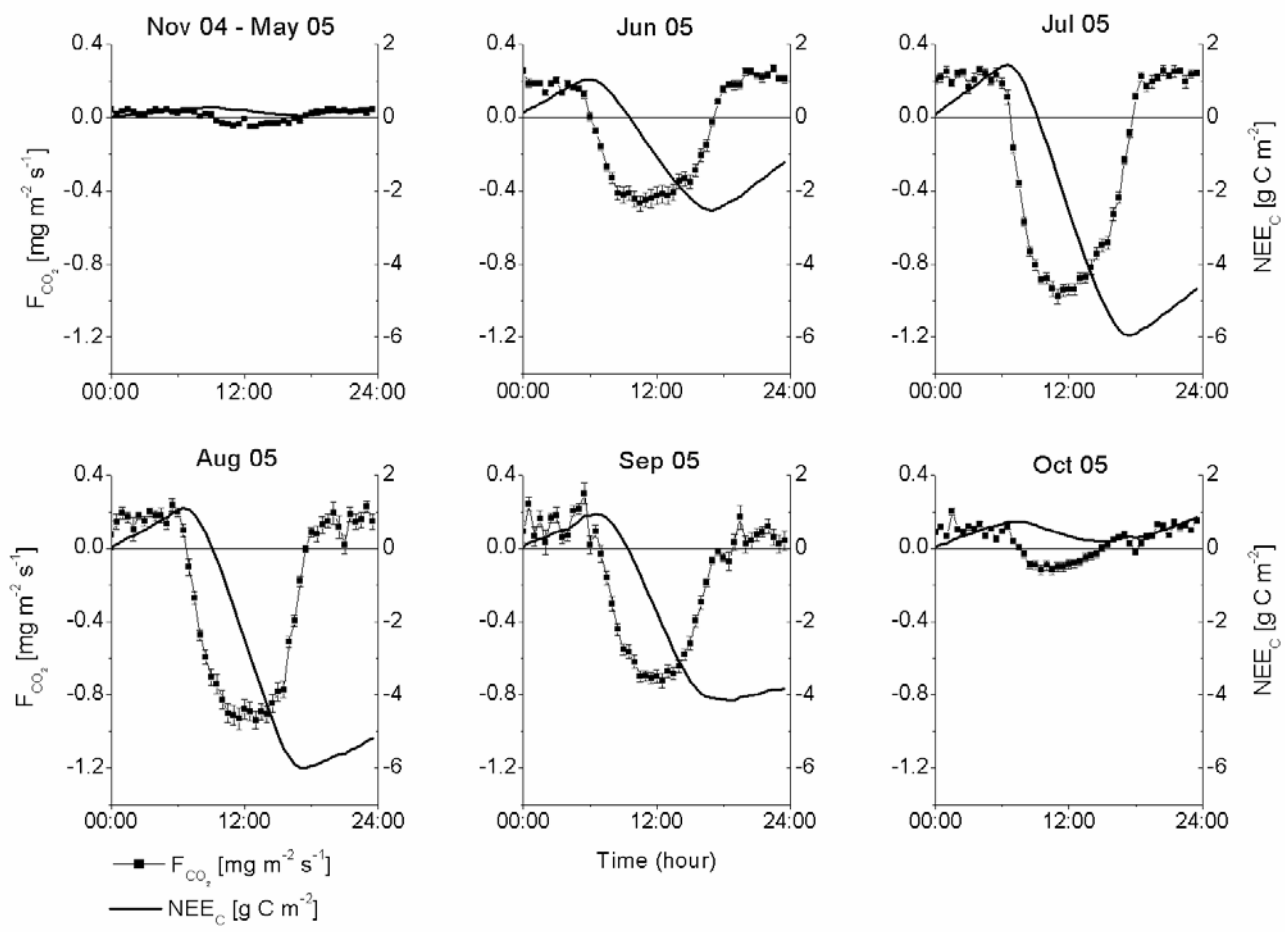
Seasonal variation of CO₂, sensible and latent heat fluxes in the Bontioli natural park, 01.11.04 – 08.12.05, data gaps filled by MDV (d=14), flux dots indicate 30 min means



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2) Eddy Covariance (EC) – Measurements:

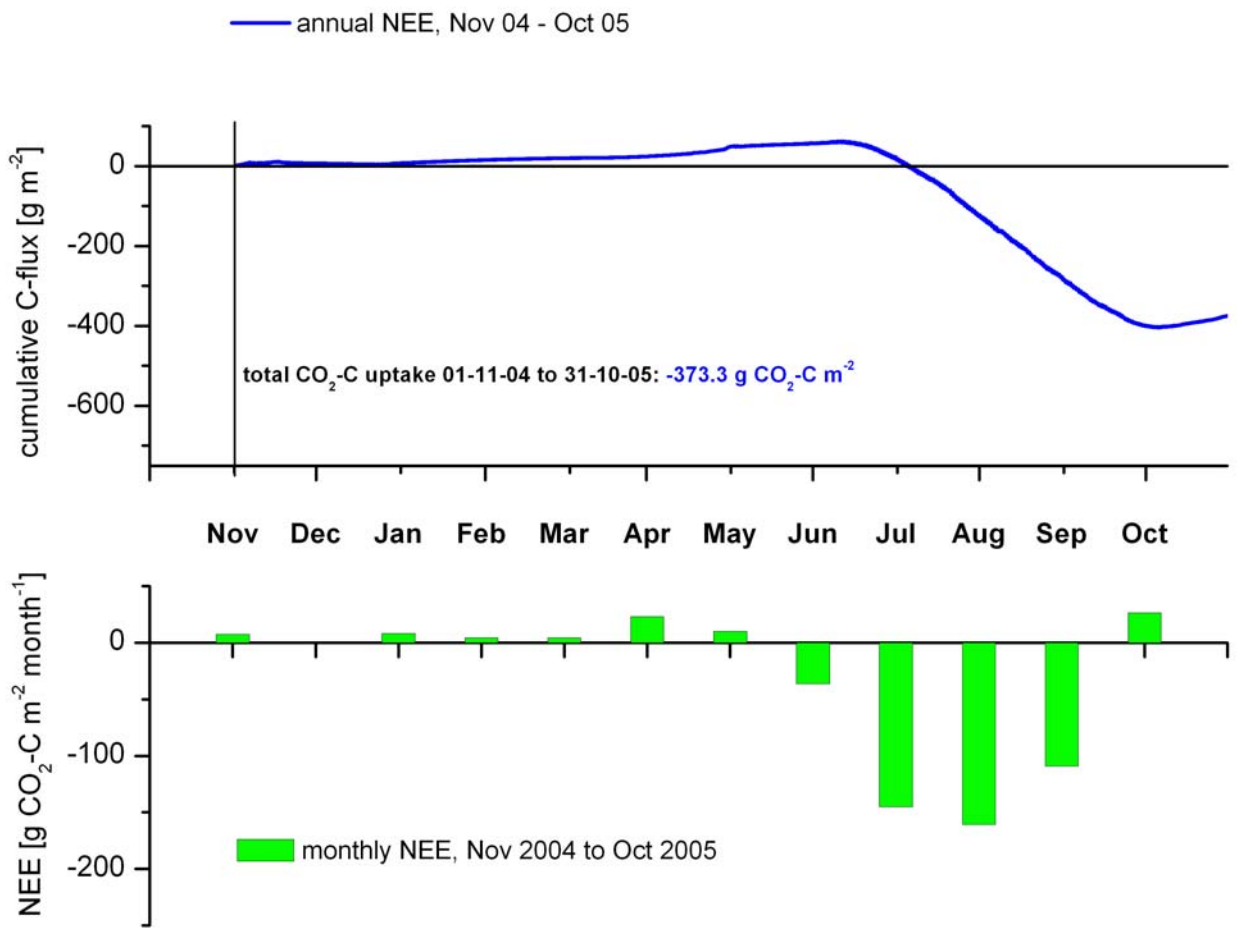
Mean diurnal in-situ and cumulative fluxes of CO₂ in the dry season (Nov 04 – May 05) and for single months in the rainy season



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2) Eddy Covariance (EC) – Measurements:

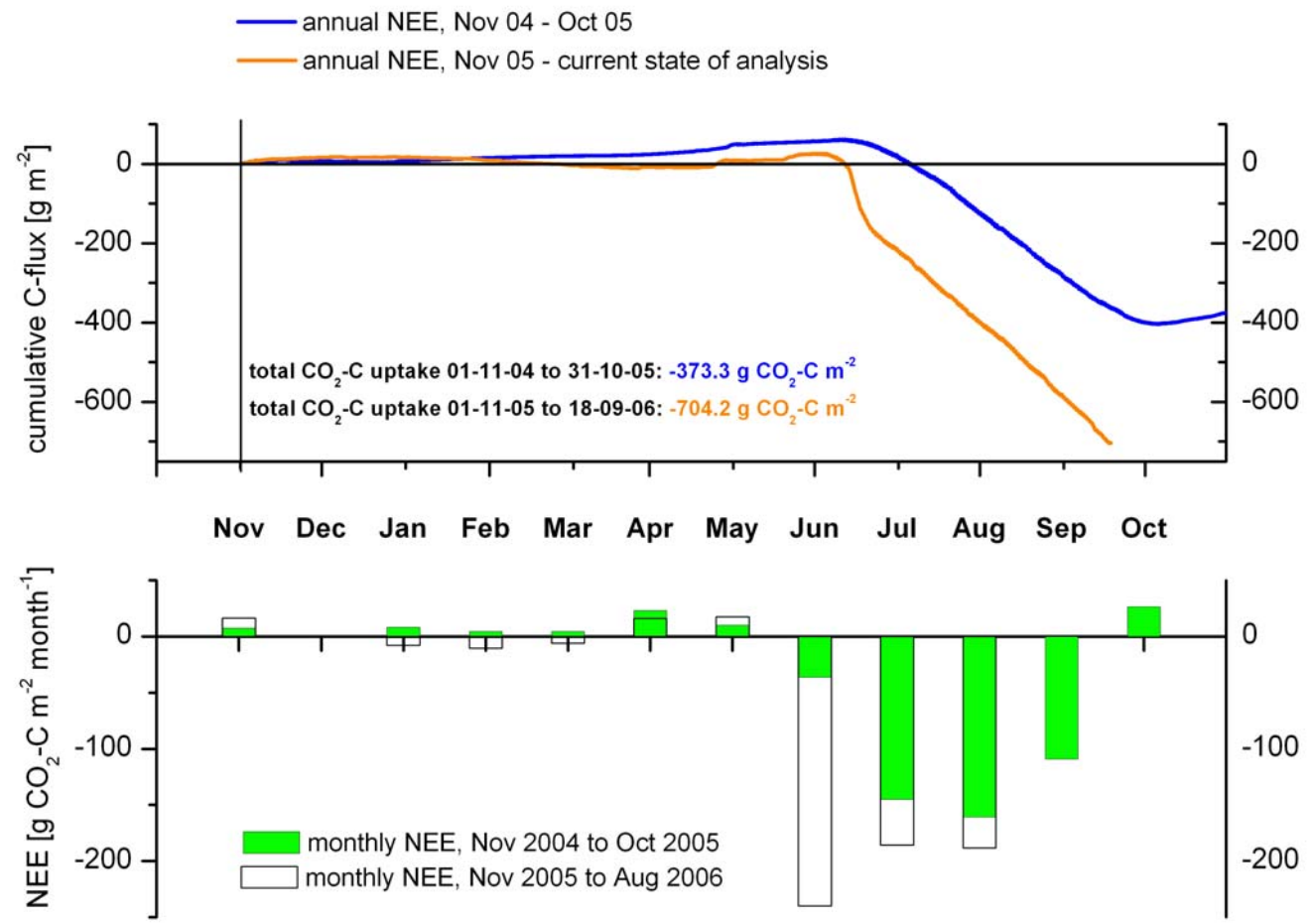
Total C-balance: Net ecosystem exchange (NEE) in the first year of investigation, 01-11-04 – 31.10.05



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2) Eddy Covariance (EC) – Measurements:

Total C-balance: Inter-annual variability of NEE among the first year of investigation (01-11-04 – 31.10.05) until current state of data processing



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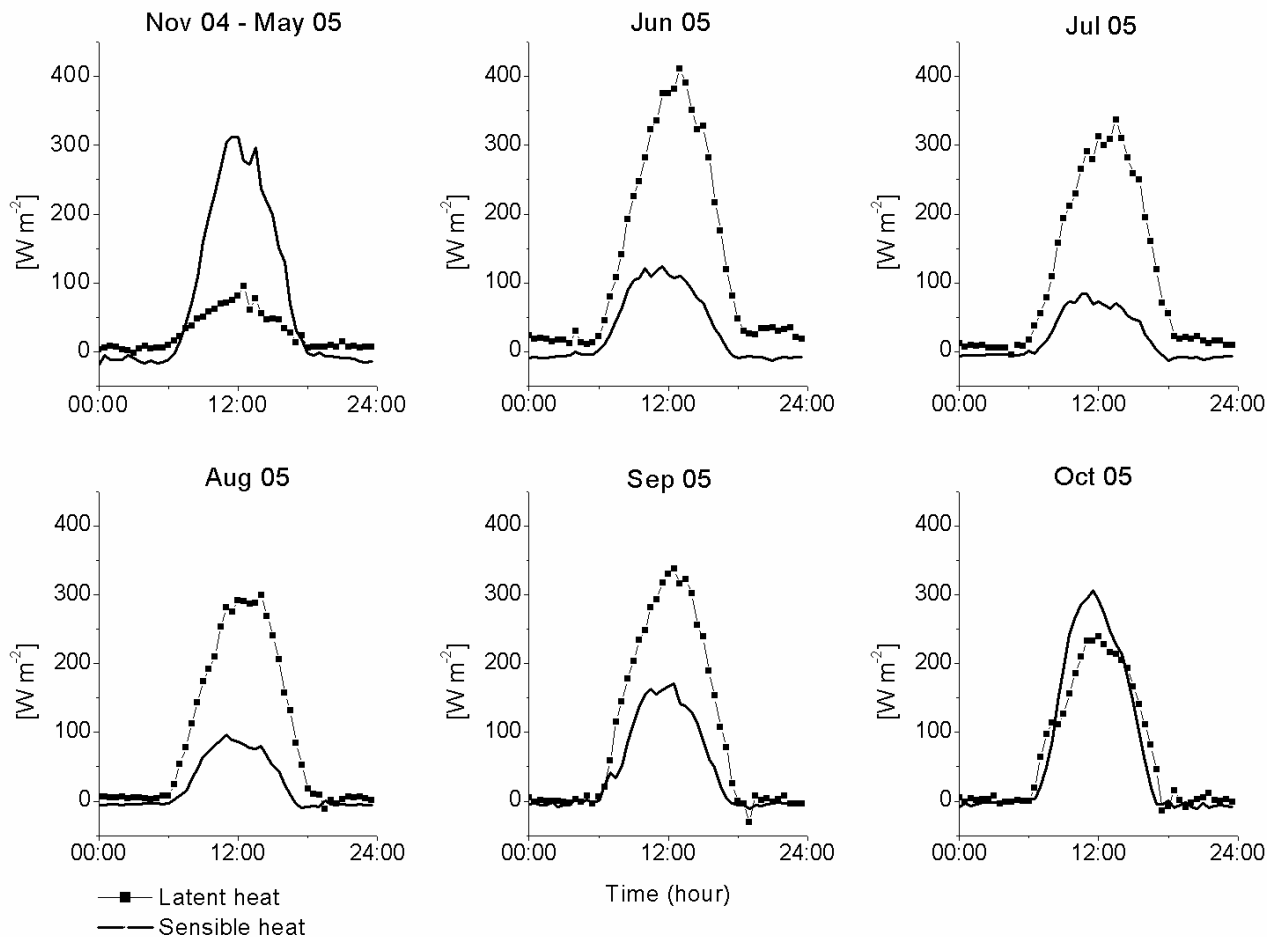
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2) Eddy Covariance (EC) – Measurements:

Mean diurnal fluxes of sensible (H) and latent (LE) heat in the dry season (averaged for Nov 04 – May 05) and for single month in the rainy season



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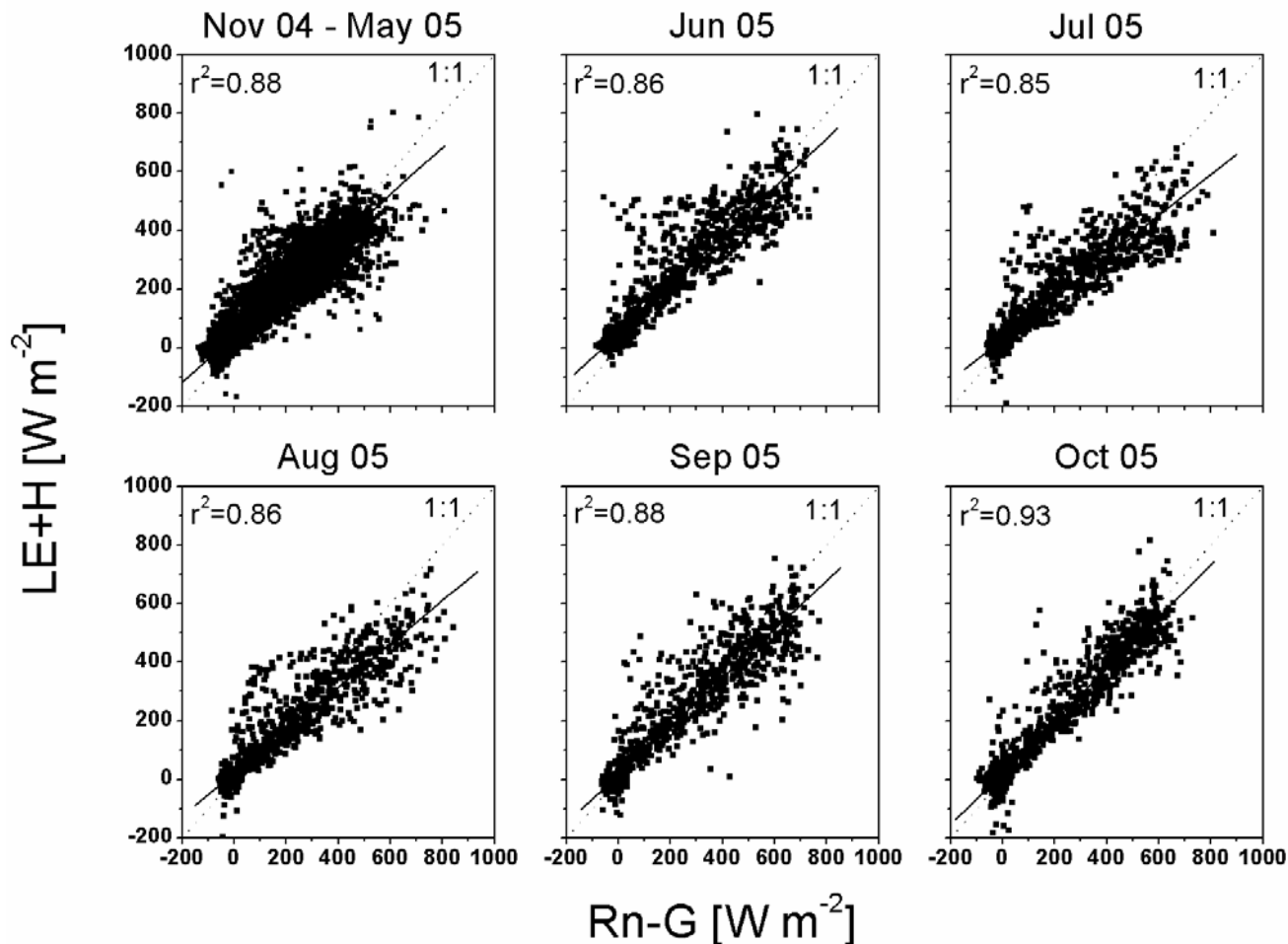
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2) Eddy Covariance (EC) – Measurements:

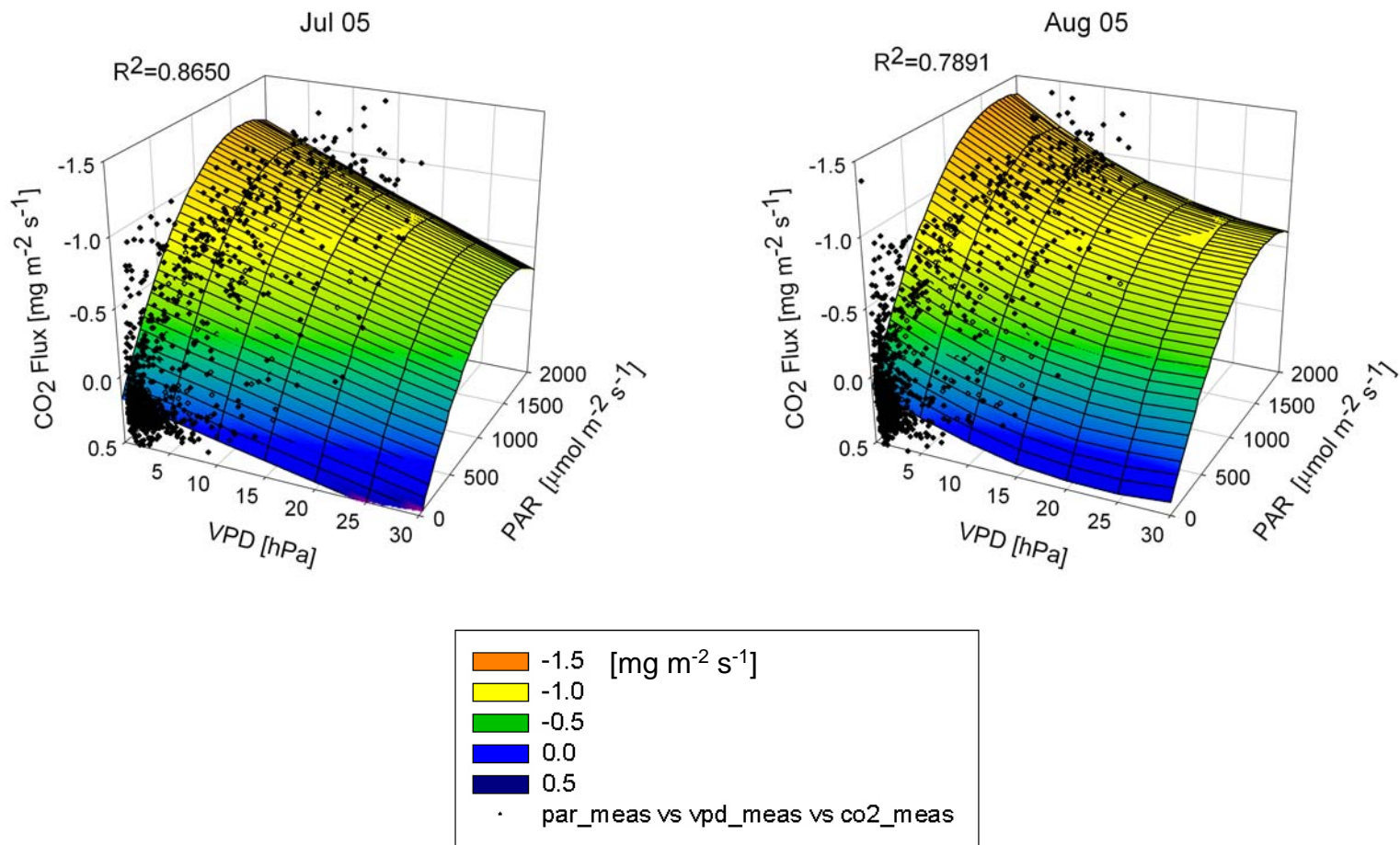
Energy budget closures as measured by 30-min means of net radiation (R_n), soil heat flux (G), sensible (H) and latent heat (LE) in the dry season (averaged for Nov 04 – May 05) and for selected months in the rainy season



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2) EC – Measurements:

Effect of photosynthetically active radiation (PAR) and vapour pressure deficit (VPD) on mean carbon dioxide fluxes exemplified for July and August 2005



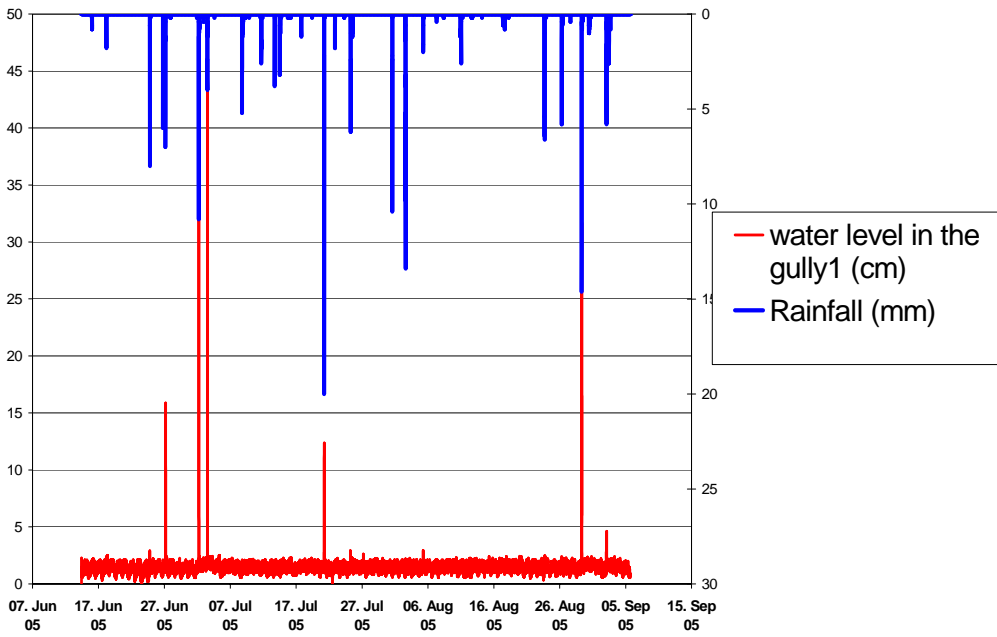
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3) River Discharge– Measurements : the divers

First divers installed during the dry season 2005 without prior knowledge of the flow conditions in the area.

Some selection appeared through the rainy season to be inappropriate cause the very low flow conditions.

For example, this diver is sensitive only to extreme rain events :



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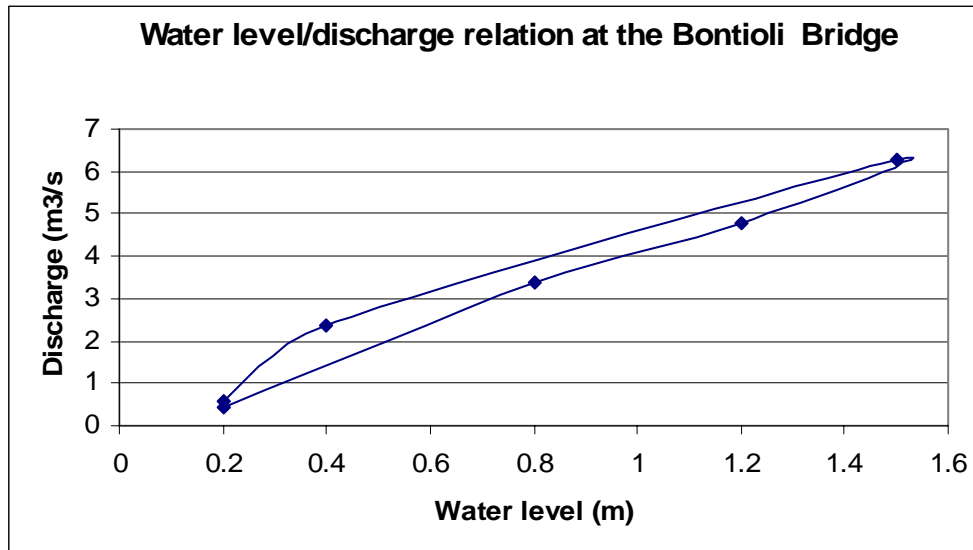
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3) River Discharge– Measurements: the current meter

Monitoring with current meter in 3 different locations during the year 2005 and 2006 (around 8 value pro site till now).

Divers installed in these locations in April 2006 (data not yet available)



3) River Discharge– Measurements : the weirs

Photo 1: Weir, 07.06.2006, 15h

→ 3h later →

Photo 2: 07.06.2006, 18h



Lost of the water level logger

More during the rain season 2006, floods cut roads and prevented from reaching the monitoring point on a regular basis

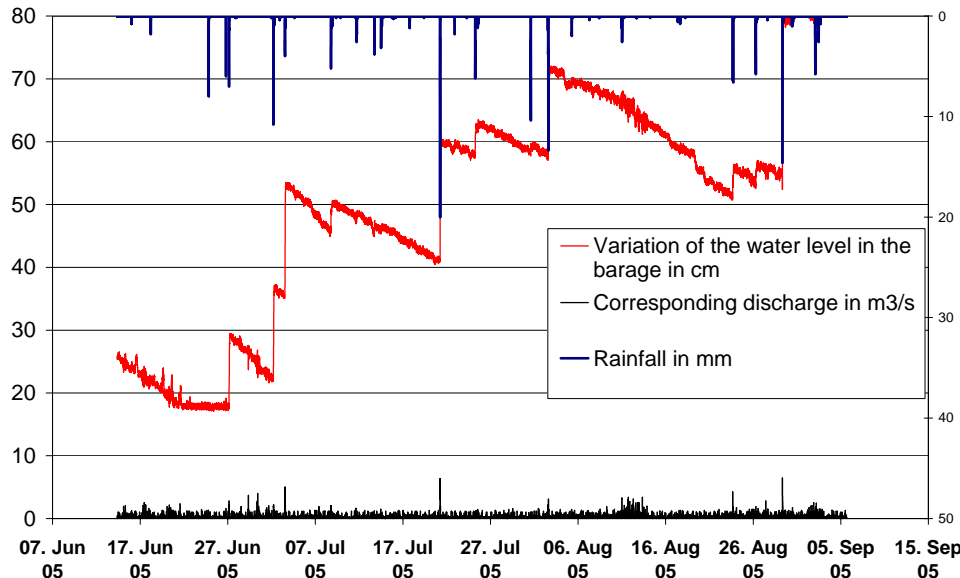
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3) River Discharge– Measurements : the dams

From the variation of the water level in the reservoir to an estimation of the discharge at the outlet of the catchment upstream of the dam.



Summary:

Agriculturally used fields:

- no significant differences among agricultural land-use types
- in general very low exchange rates of N_2O and CH_4
 - CH_4 :
 - high soil moisture → release
 - low soil moisture → uptake
- soil respiration depends mainly on soil moisture
 - dry conditions → low rates
 - wet conditions → higher rates

Réserve Bontoli:

- extremely high CH_4 emissions after heavy rainfalls
- termite clusters have an enormous potential as CH_4 sources
- high soil respiration rates, but values decrease at a certain soil moisture threshold
- NEE:
 - dry season → C release
 - wet season → C uptake
- balance for the first 12 months of investigation: $-373.3 \text{ g C m}^{-2}$

Further measurements (not shown):

- N-fertilizer experiment with an automatic chamber system
- CH_4 and N_2O measurements on termite nests in Bontoli nature park
- Soil analysis: Determination of Ammonification, Nitrification and Denitrification rates



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