**Forschungszentrum Karlsruhe**
in der Helmholtz-Gemeinschaft

Institut für Meteorologie und Klimaforschung
Atmosphärische Umweltforschung (IMK-IFU), Garmisch-Partenkirchen

# Soil-atmosphere $N_2O$ exchange in natural savannah, non-fertilized and fertilized agricultural land in Burkina Faso (W. Africa)

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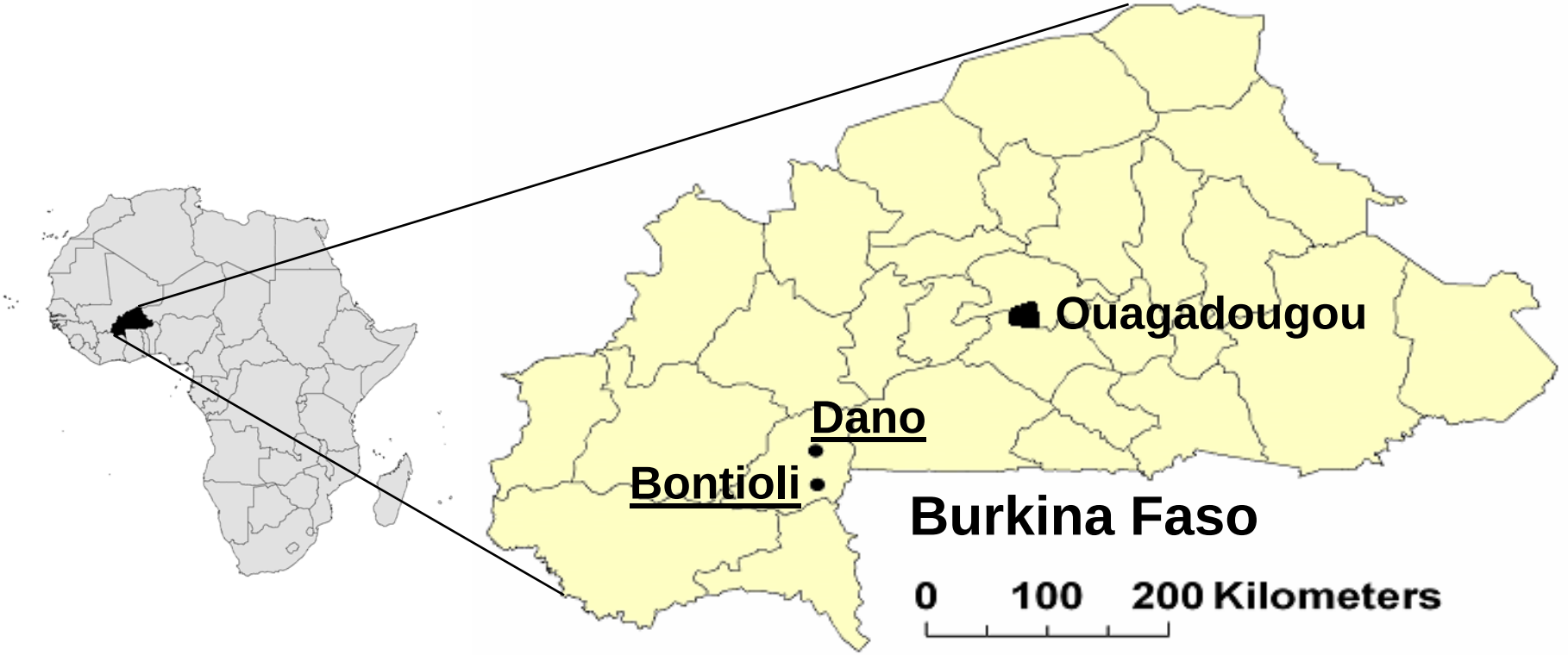
# Location of study area




**Climate**

| | |
|---|---|
| **Mean annual air temperature:** | **29.5 °C** |
| **Mean annual precipitation:** | **926 mm** |
| **Rainy season:** | **May to October** |

# Field sites

## Bontioli




*Bontioli Reserve*
nature park, no farming, no tillage, no livestock

used for agriculture since 15 years

## Dano




used for agriculture since several decades



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# Site characteristcs

| | I<br>Bontioli Reserve | II<br>Sorghum Bontioli | III<br>Sorghum Dano | IV<br>Cotton Dano | V<br>Peanut Dano |
|---|---|---|---|---|---|
| Location | 10° 51' 55.8" N<br>3° 04' 21.5" W | 10° 52' 18.1" N<br>3° 03' 59.0" W | 11° 09' 52.9" N<br>3° 05' 03.0" W | 11° 09' 53.2" N<br>3° 05' 01.4" W | 11° 09' 53.6" N<br>3° 05' 02.7" W |
| Altitude [m a.s.l.] | 293 | 295 | 318 | 322 | 322 |
| Slope [°] | <1 | <1 | 1.5 | 1 | 1 |
| Management | Natural reserve, no farming, no tillage | Agriculture since 15 years | Agriculture since several decades | Agriculture since several decades | Agriculture since several decades |
| Sampling Frequency | 1-3 week$^{-1}$ | 1-3 week$^{-1}$ | 1-3 week$^{-1}$ / 10 d$^{-1}$ | 1-3 week$^{-1}$ | 1-3 week$^{-1}$ |
| Bulk density [g cm$^{-3}$] | 1.43 ± 0.01 | 1.44 ± 0.01 | 1.58 ± 0.02 | 1.47 ± 0.03 | 1.59 ± 0.04 |
| pH | 4.9 ± 0.2 | 6.0 ± 0.1 | 5.9 ± 0.1 | 5.9 ± 0.1 | 5.9 ± 0.1 |
| C:N ratio | 11.08 ± 0.15 | 11.08 ± 0.18 | 11.80 ± 0.30 | 11.09 ± 0.33 | 11.78 ± 0.24 |
| $C_{org}$ [%] | 0.56 ± 0.06 | 0.66 ± 0.04 | 0.86 ± 0.12 | 0.85 ± 0.09 | 0.89 ± 0.11 |
| $N_{total}$ [%] | 0.05 ± 0.01 | 0.06 ± 0.01 | 0.07 ± 0.01 | 0.07 ± 0.01 | 0.07 ± 0.01 |
| Soil texture | sandy loam | loamy sand | loam | loam | loam |
| sand [%] | 65.1 | 80.6 | 42.3 | 47.0 | 32.6 |
| silt [%] | 27.2 | 13.4 | 35.4 | 30.5 | 46.3 |
| clay [%] | 7.7 | 6.0 | 22.3 | 22.5 | 21.1 |
| Stone fraction [%] | 35.3 | 37.8 | 75.2 | 54.2 | 75.0 |

## Agricultural practice

**Seeds sown in May, no fertilizer application (except fertilizer experiment), topsoil aerated with hoes every 2 to 4 weeks after sowing, harvest in October.**

# Experiments

**Experiment A**

**$N_2O$ fluxes from natural savannah and sorghum in Bontioli, and from sorghum, cotton & peanut in Dano using manual chamber sampling 1-3 times per week in 2005 and 2006**

**Experiment B**

**Effect of NPK-fertilizer addition to 3 plots of a sorghum field in Dano (plot A: 140 kg N $ha^{-1}$; plot B: 52.5 kg N $ha^{-1}$; plot C: control) on $N_2O$ fluxes using automated chamber sampling over several weeks in 2006**

**Experiment C**

**Laboratory study on potential $N_2O$ efflux from soils of the Bontioli natural savannah and Bontioli sorghum under different soil moisture conditions**

# Manual and automated chamber measurements

Sampling with syringes in the field

Manual:
4 chambers at each site, measured 1-3 times per week

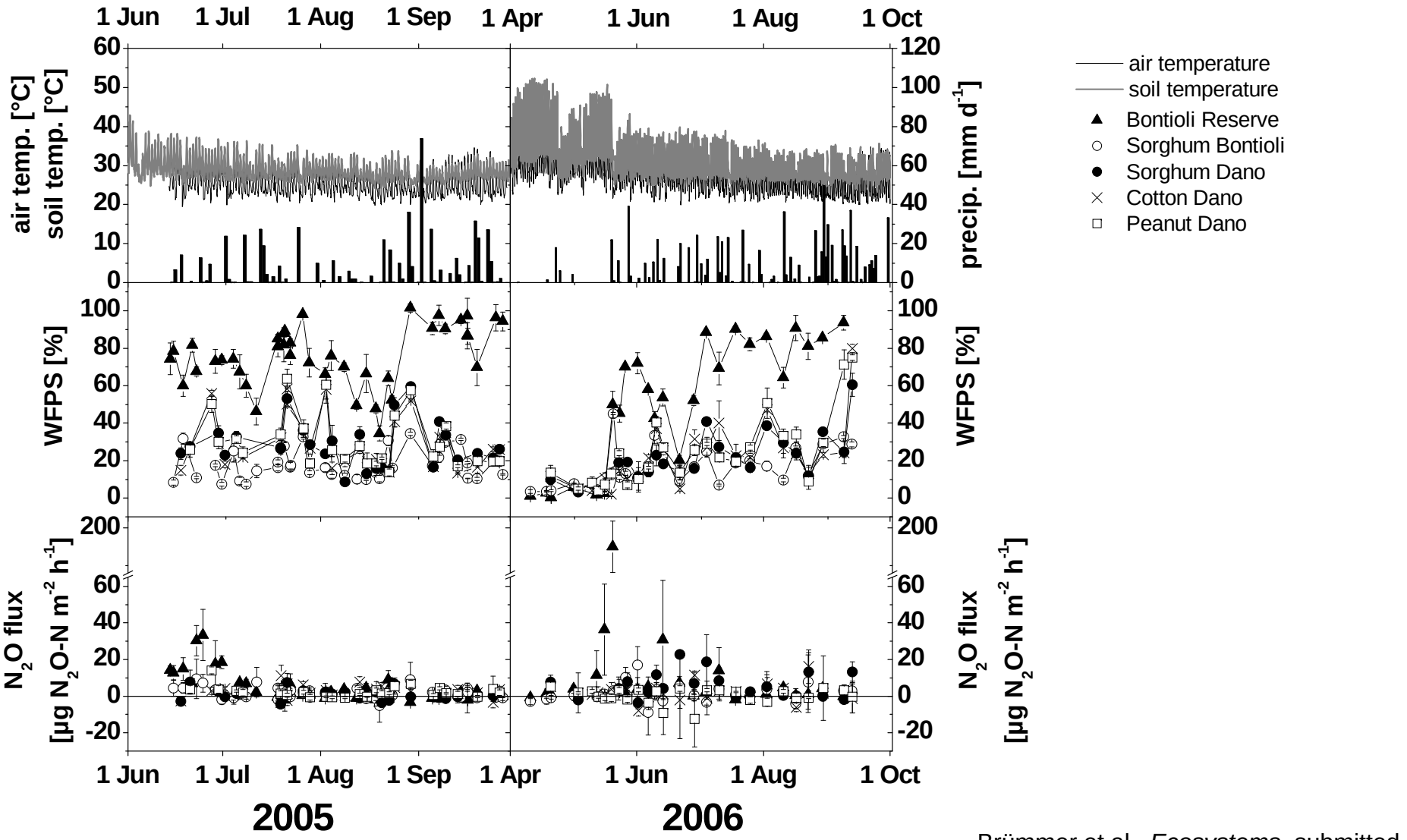
GC analysis at the same day

Pneumatically operated chambers

Automated:
3 chambers at each plot, measured continuously (10 values per day)

On-line GC analysis in the field

# No fertilization, manual measurements




Brümmer et al., *Ecosystems*, submitted



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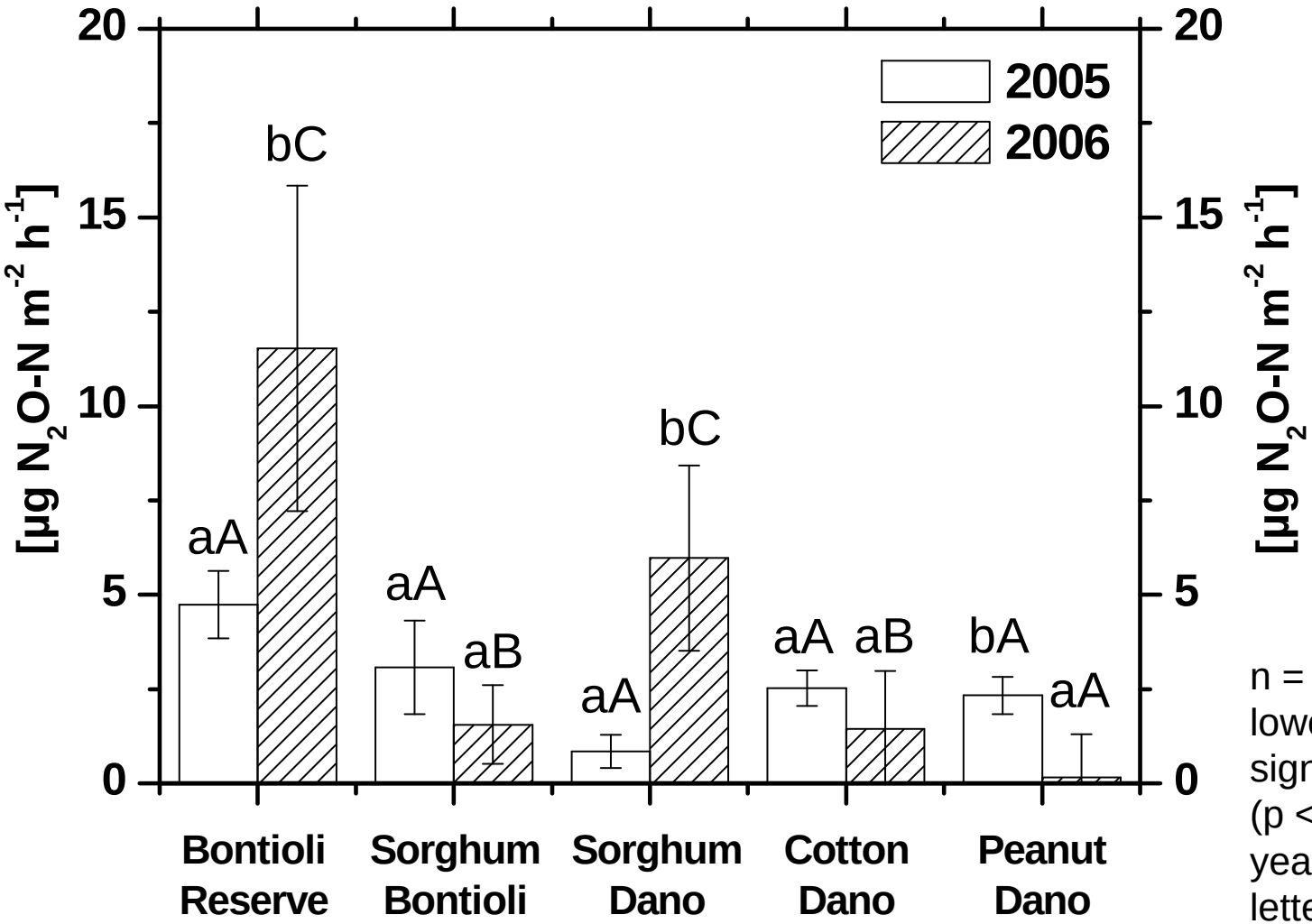
# No fertilization, manual measurements – mean fluxes




n = 79-162, ± SE; lowercase letters = significant differences ($p < 0.05$) between years; uppercase letters = between sites

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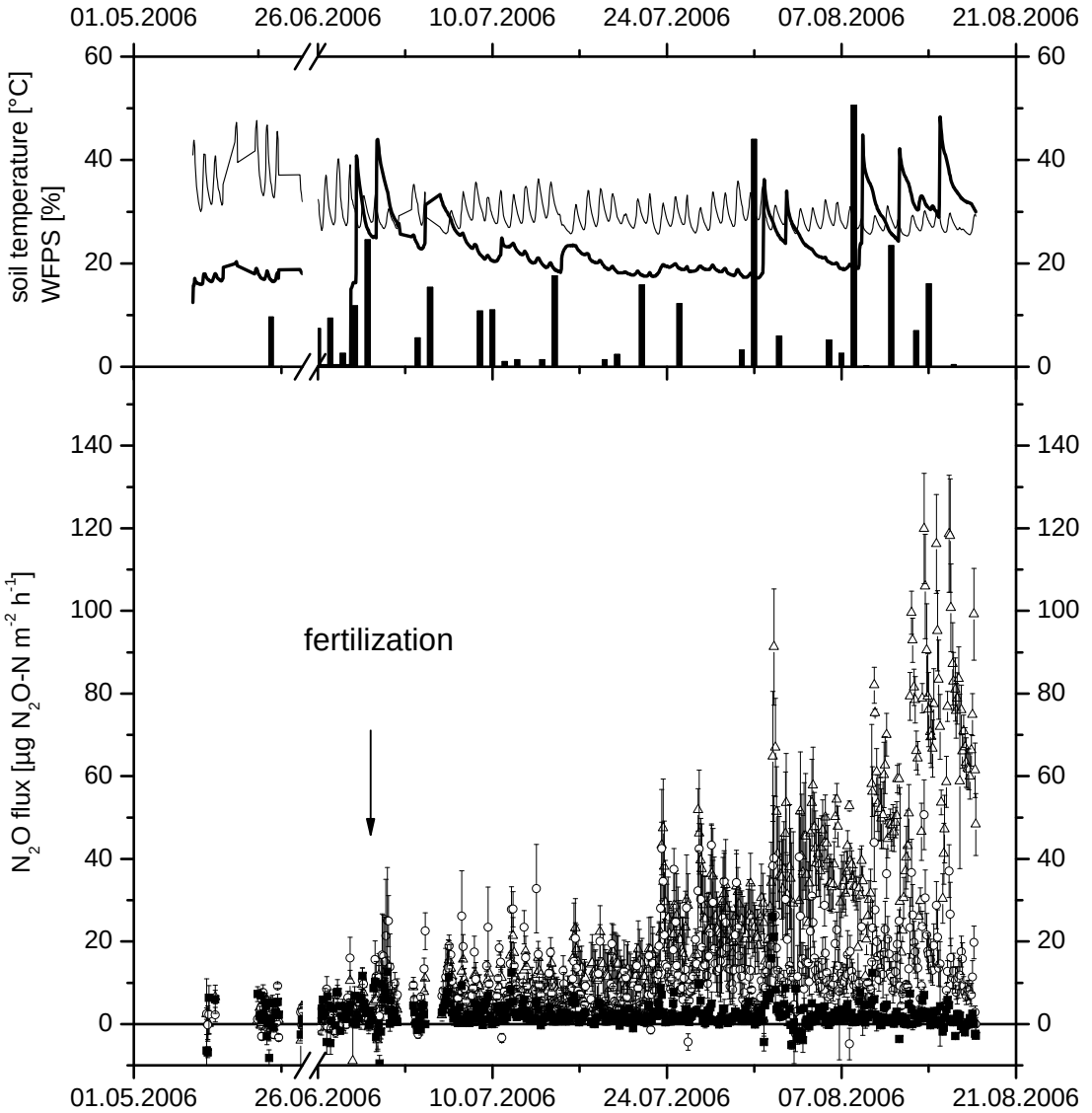
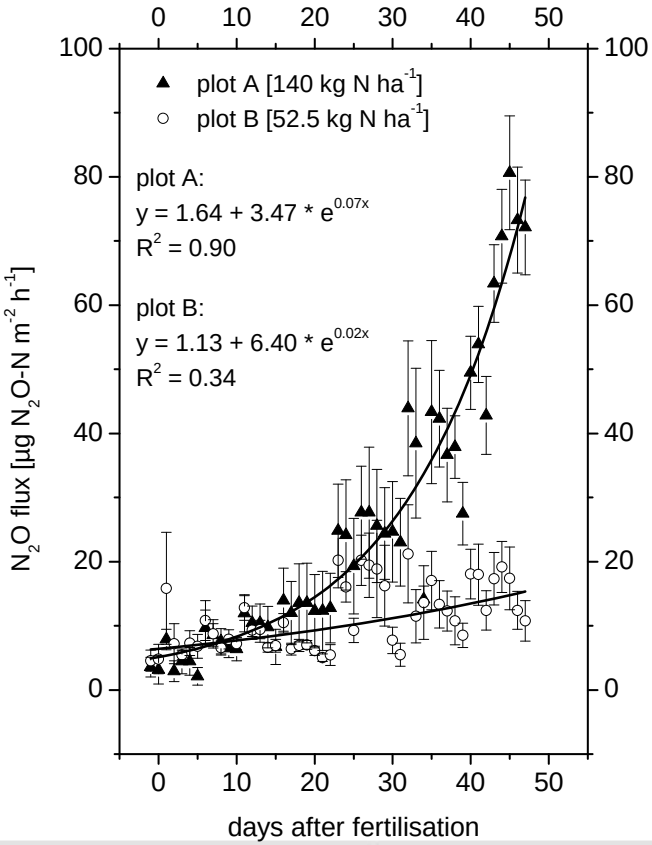
# Fertilization, automated measurements

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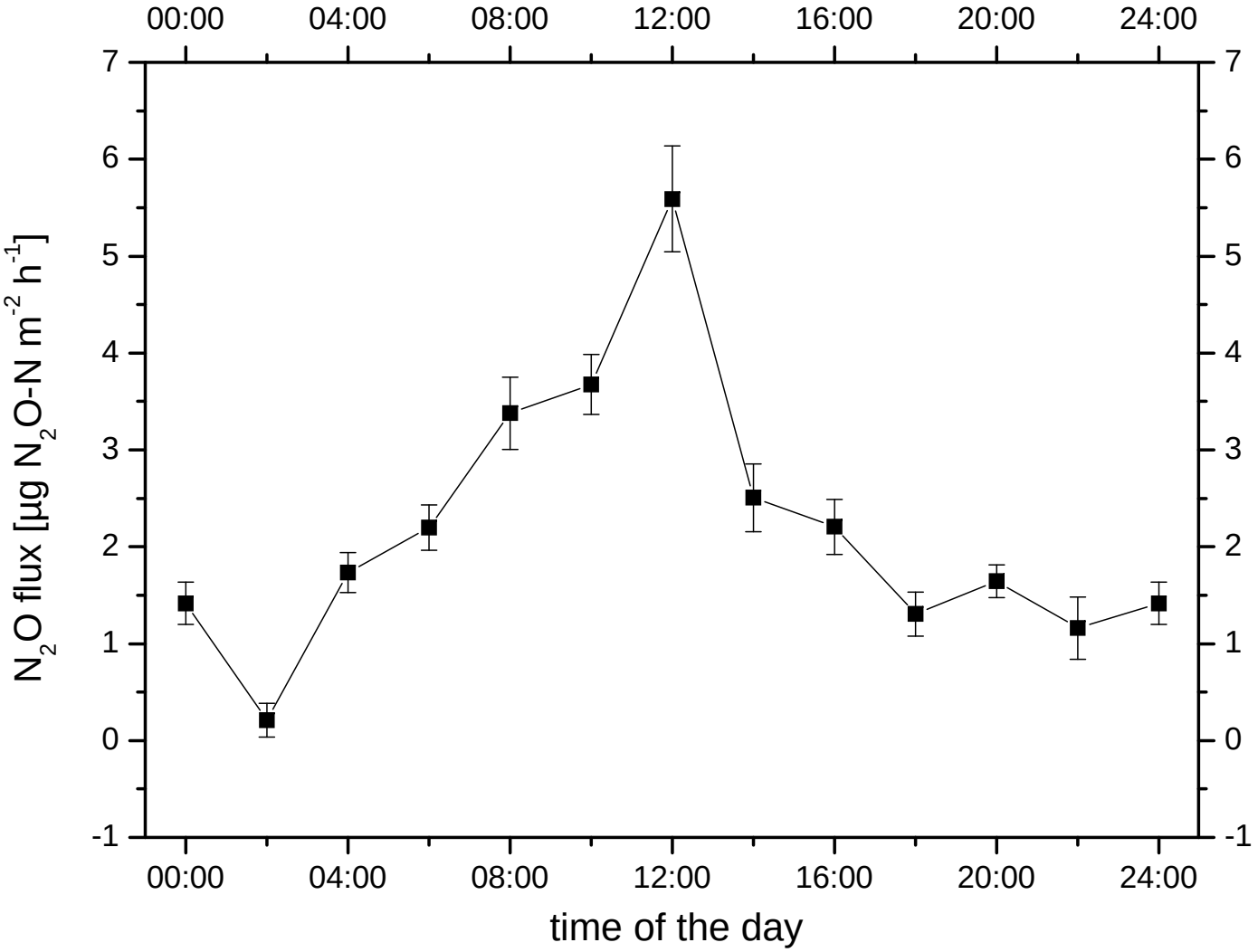
# No fertilization, diurnal cycles of $N_2O$ fluxes

Mean diurnal $N_2O$ fluxes at the unfertilized Sorghum field in Dano from June 26 to August 17, 2006 (n = 42, ± SE).

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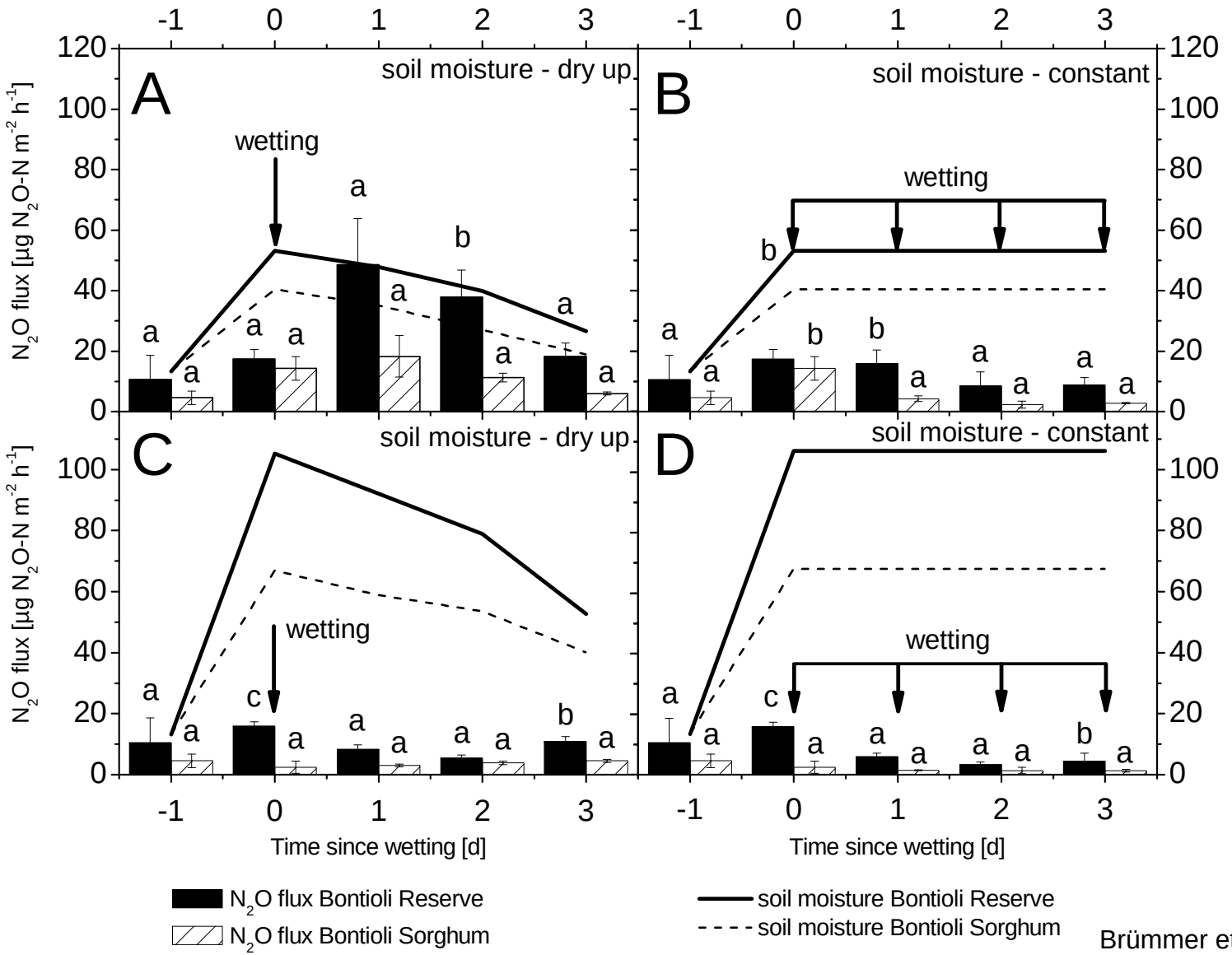
# Effect of single and repeated watering on $N_2O$ fluxes




**Medium water content**

**High water content**

(n = 3, ± SE)

Brümmer et al., *Ecosystems*, subm.



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# Conclusions

- Very low $N_2O$ emission rates from rain-fed and non-fertilized agricultural fields during both wet and dry season
- No significant differences in $N_2O$ exchange between the most typical crops of Burkina Faso, i.e. sorghum, cotton, and peanut in 2005, however in 2006
- $N_2O$ emissions from a natural savannah site in 2005 slightly, but not significantly higher than from the agricultural fields, in 2006 significantly higher
- No significant difference of time of conversion of savannah to agriculture on $N_2O$ emissions
- Application of N fertilizer led to a gradual, but significant increase of $N_2O$ emissions
- $N_2O$ emissions were highest at medium soil water content, especially after single wetting events with subsequent dry up



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Thank you,

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