

Field measurements of photo- and thermal degradation in an arid ecosystem

JRA1: WP13.2

The in-situ FTIR-analyzer for biosphere-atmosphere exchange measurements

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Outline

- Introduction
- Set up of field experiment
- Results of field experiment
- Laboratory experiment
- Discussion & Conclusion

Introduction

- **Decomposition in arid ecosystems is relatively unknown**
 - Underestimation of decomposition (temperature, moisture)
- **Abiotic decomposition can be relevant in arid ecosystems**
 - Photodegradation
 - Thermal degradation

Introduction

- **Photodegradation → breakdown by sunlight (CO₂, CH₄, CO)**
 - Produced by UV as by visible light;
 - Reported for different litter types;
 - Biochemical mechanisms still unknown
 - Also literature to be found not existing or not significant
- **Thermal degradation → breakdown by temperature (CO₂, CH₄, CO)**
 - Less studied, role unknown

Introduction

- **Mostly laboratory studies**
- **Measurement of abiotic decomposition is challenging:**
 - Radiation:
inhibits microbial decomposition,
microbial facilitation by fragmentation
 - Temperature: effect on biological processes
- **Field study: estimated up to be 20% of total CO₂ production in arid ecosystem**

Introduction

Aim of field measurements:

To quantify the role of photo and thermal degradation on (arid) ecosystem scale



Material and Methods: Field experiment

FTIR-spectrometer (Fourier T

- Measures CO₂, CO, CH₄, N₂
- High precision
- Mobile, measurements can be taken in the field
- Possible to connect to different sensors

Location: Viterbo, Italy

- Mediterranean climate



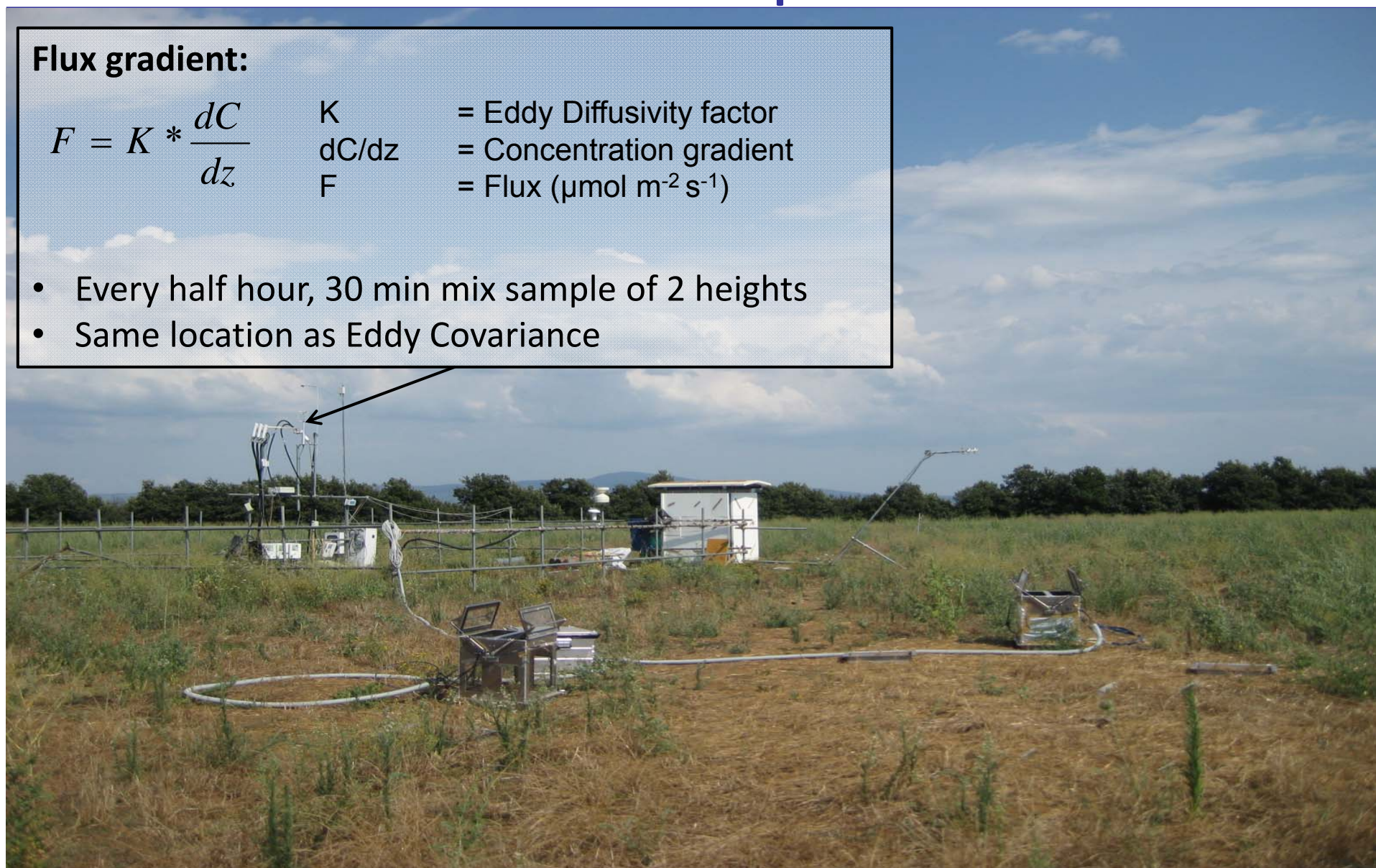
Material and Methods: Field experiment

Flux gradient:

$$F = K * \frac{dC}{dz}$$

K = Eddy Diffusivity factor
dC/dz = Concentration gradient
F = Flux ($\mu\text{mol m}^{-2} \text{s}^{-1}$)

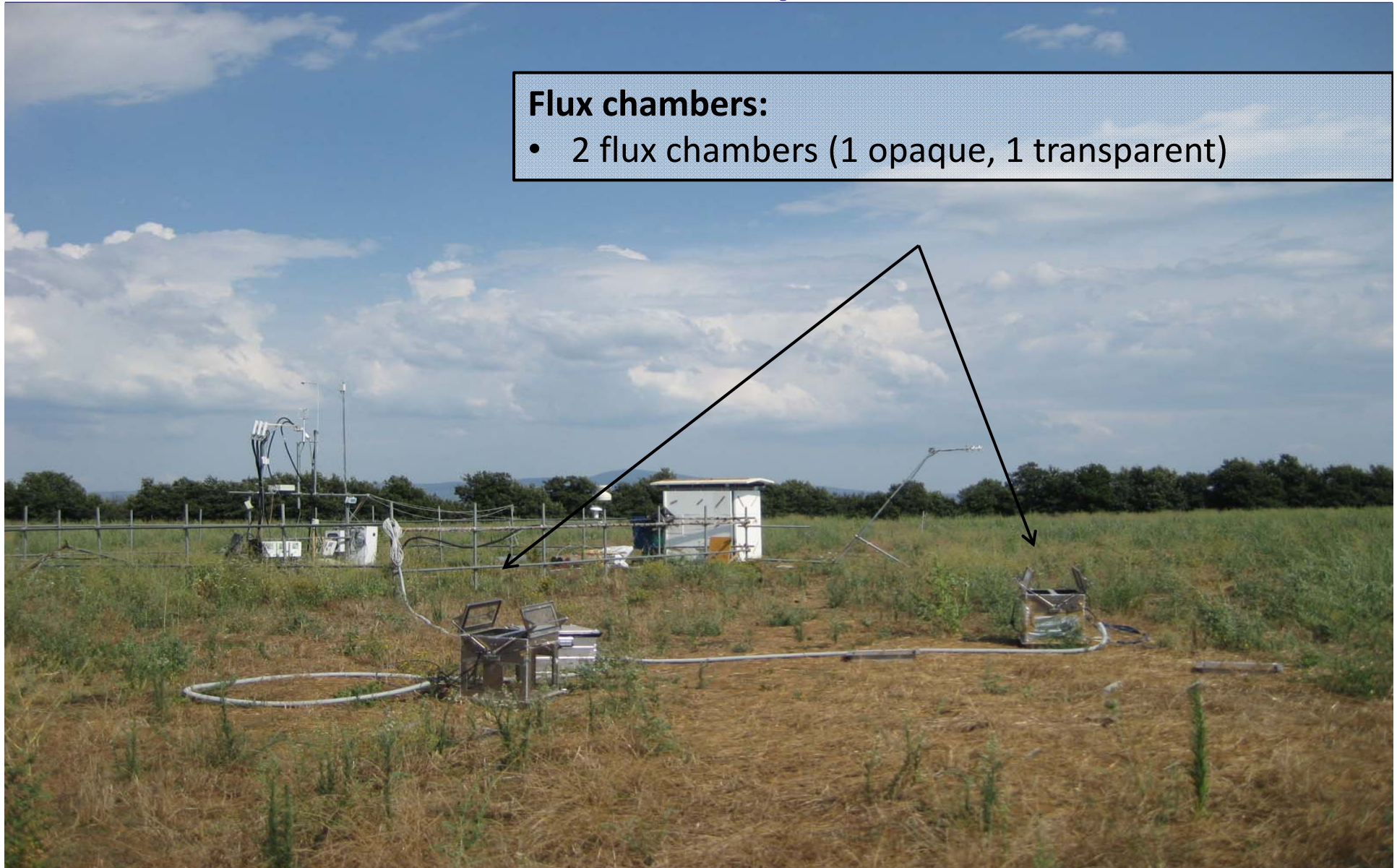
- Every half hour, 30 min mix sample of 2 heights
- Same location as Eddy Covariance



Material and Methods: Field experiment

Flux chambers:

- 2 flux chambers (1 opaque, 1 transparent)



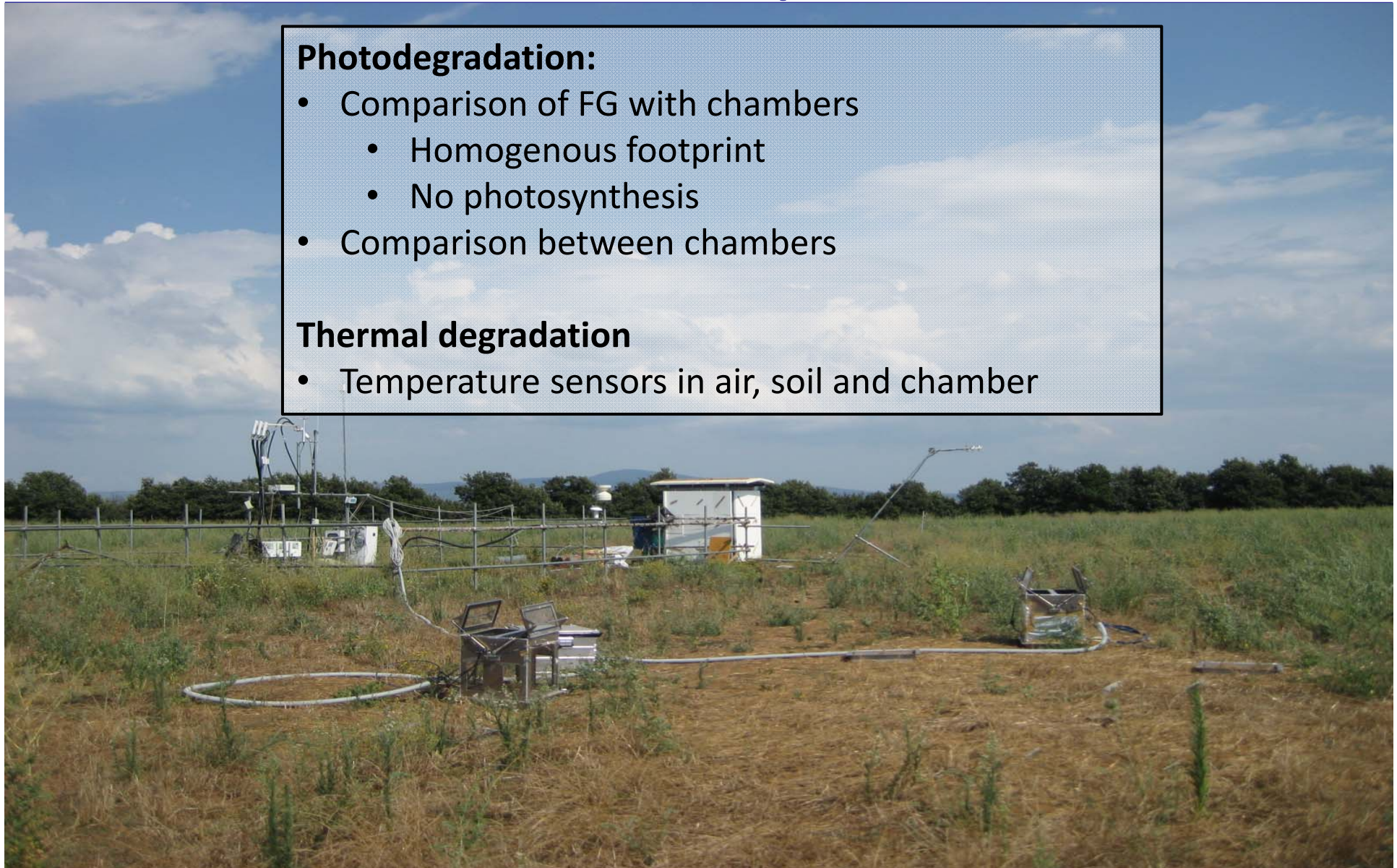
Material and Methods: Field experiment

Photodegradation:

- Comparison of FG with chambers
 - Homogenous footprint
 - No photosynthesis
- Comparison between chambers

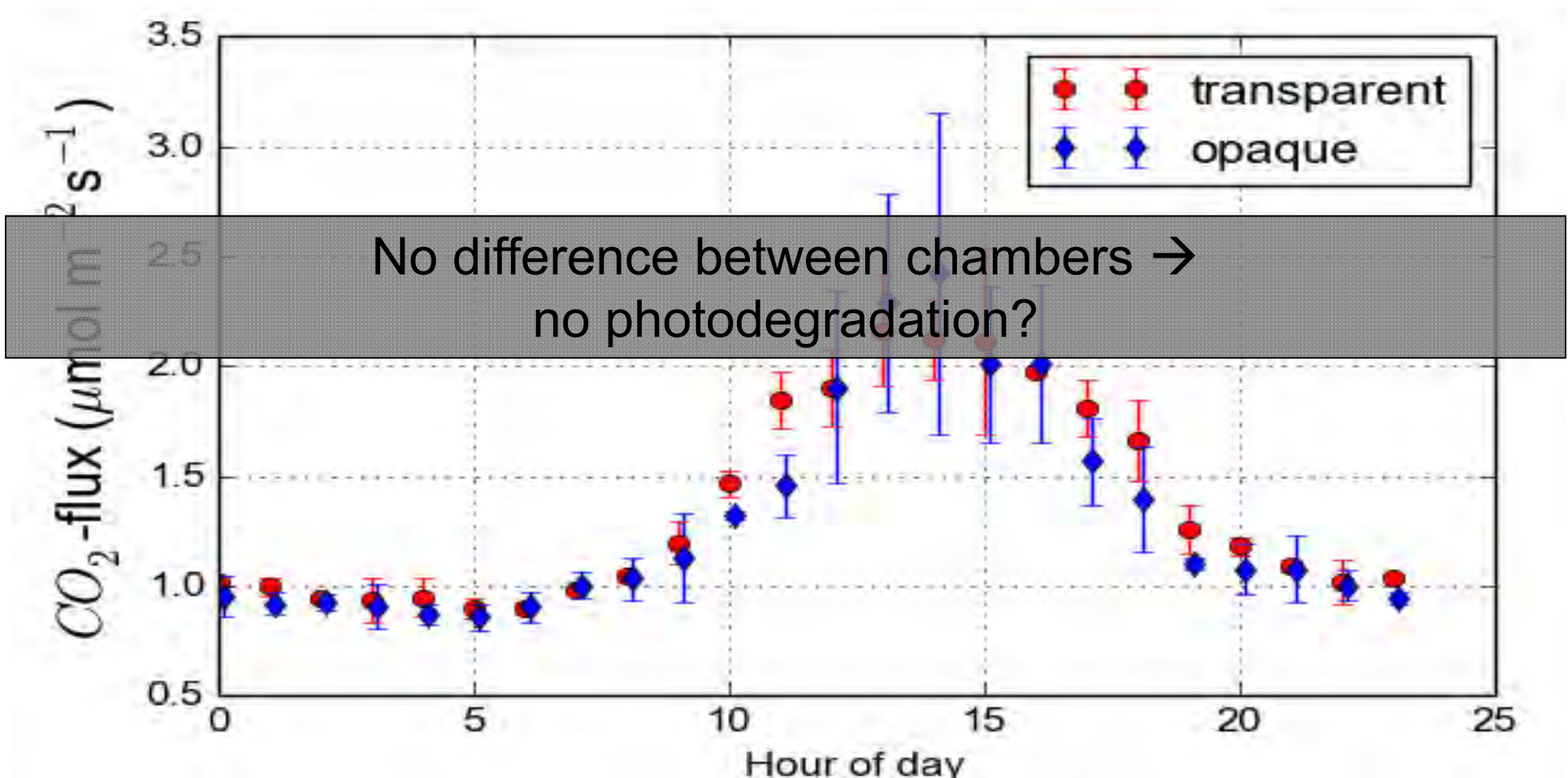
Thermal degradation

- Temperature sensors in air, soil and chamber



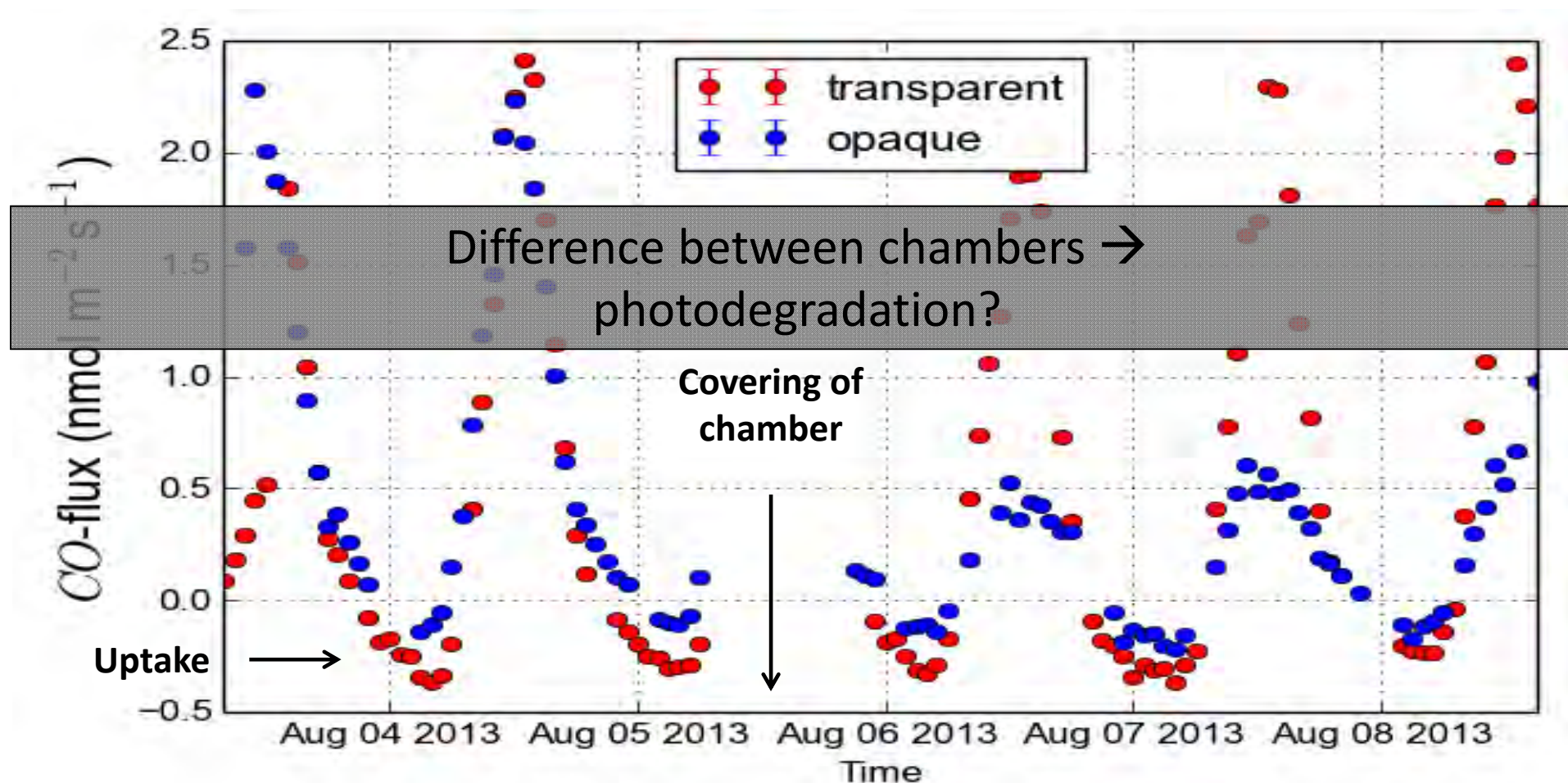
Results: Flux chamber CO₂-fluxes

- No photosynthesis



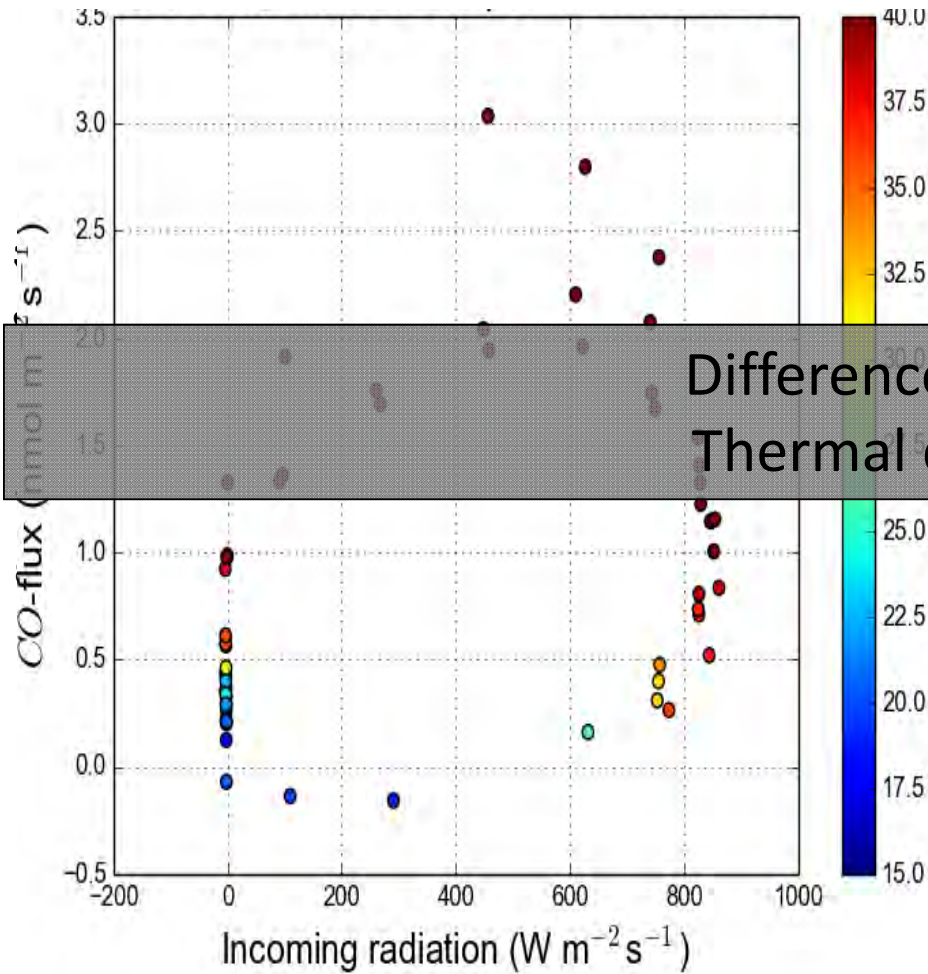
Results: Flux chamber CO-fluxes

- No biological CO-emission!
- Biological CO-uptake

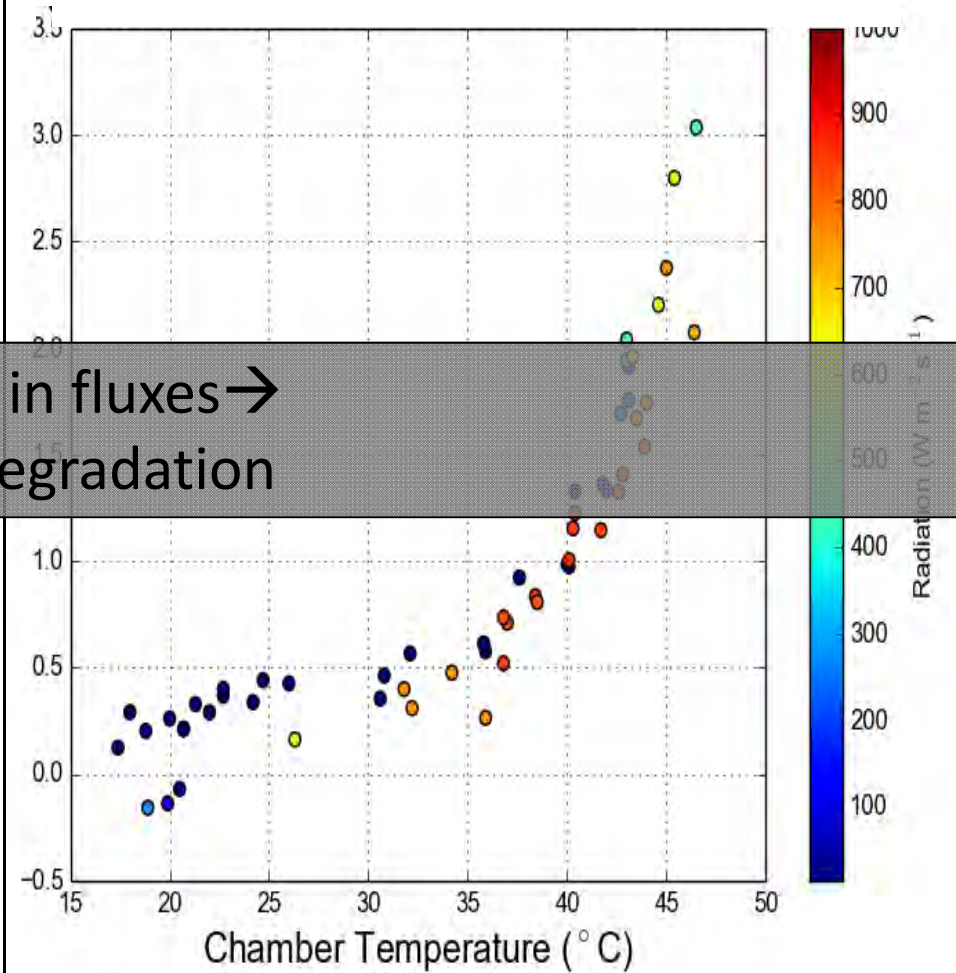


Results

CO flux vs Radiation



CO flux vs Temperature

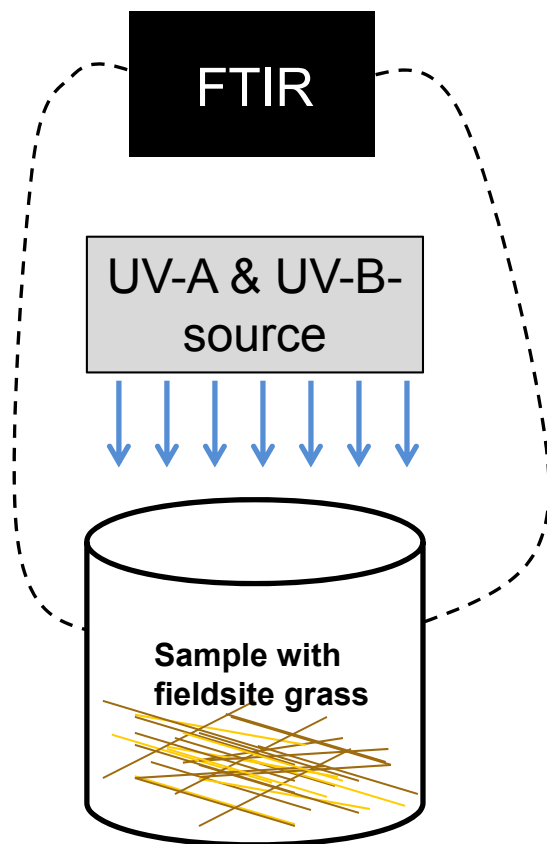


Difference in fluxes →
Thermal degradation

Laboratory experiment

Laboratory experiment

No photodegradation?



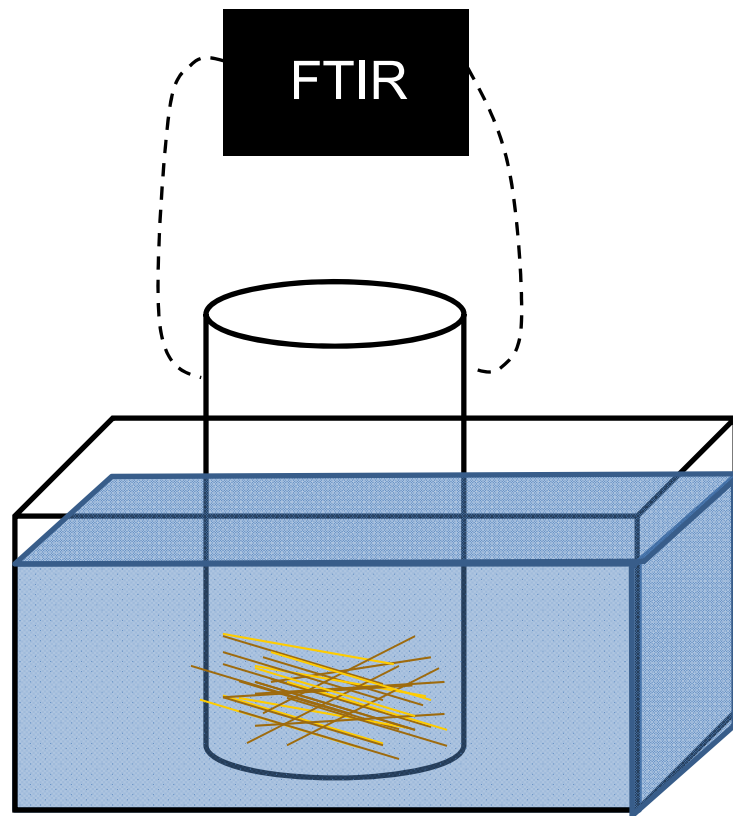
Samples:

- 2 gram fieldsite grass
- Air dried (35 °C)
- 3 treatments
 - No radiation
 - UV-A radiation
 - UV-B-radiation

No photodegradation-fluxes observed for CO₂ and CO

Laboratory experiment

Thermal degradation?

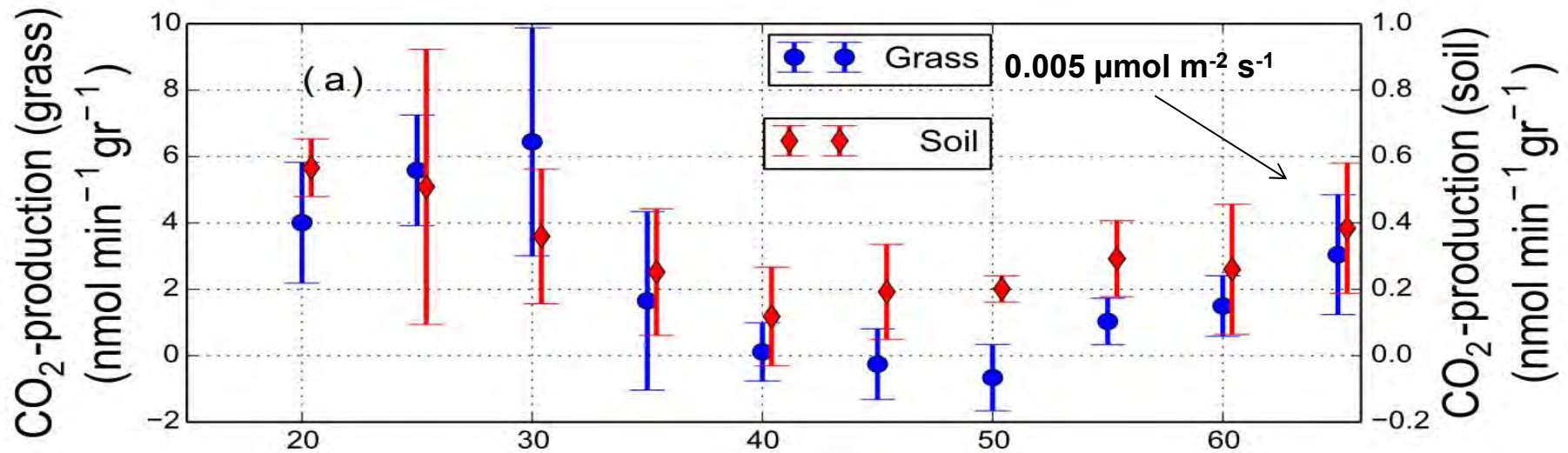


Samples:

- 2 gram fieldsite grass & soil
- Air dried (35 °C)
- 20-65 °C

← Temperature controlled waterbath

Laboratory experiment

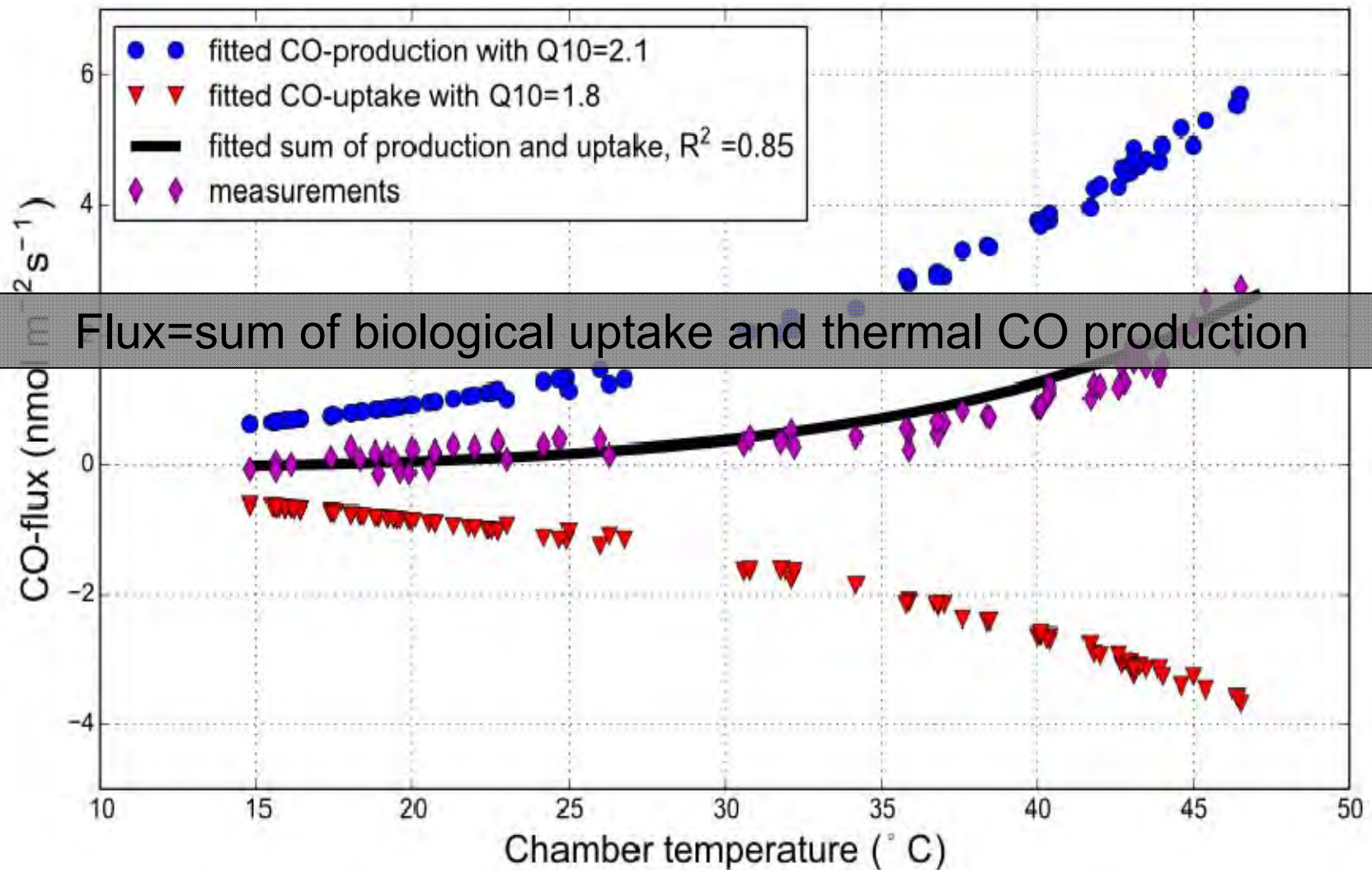


Laboratory experiment

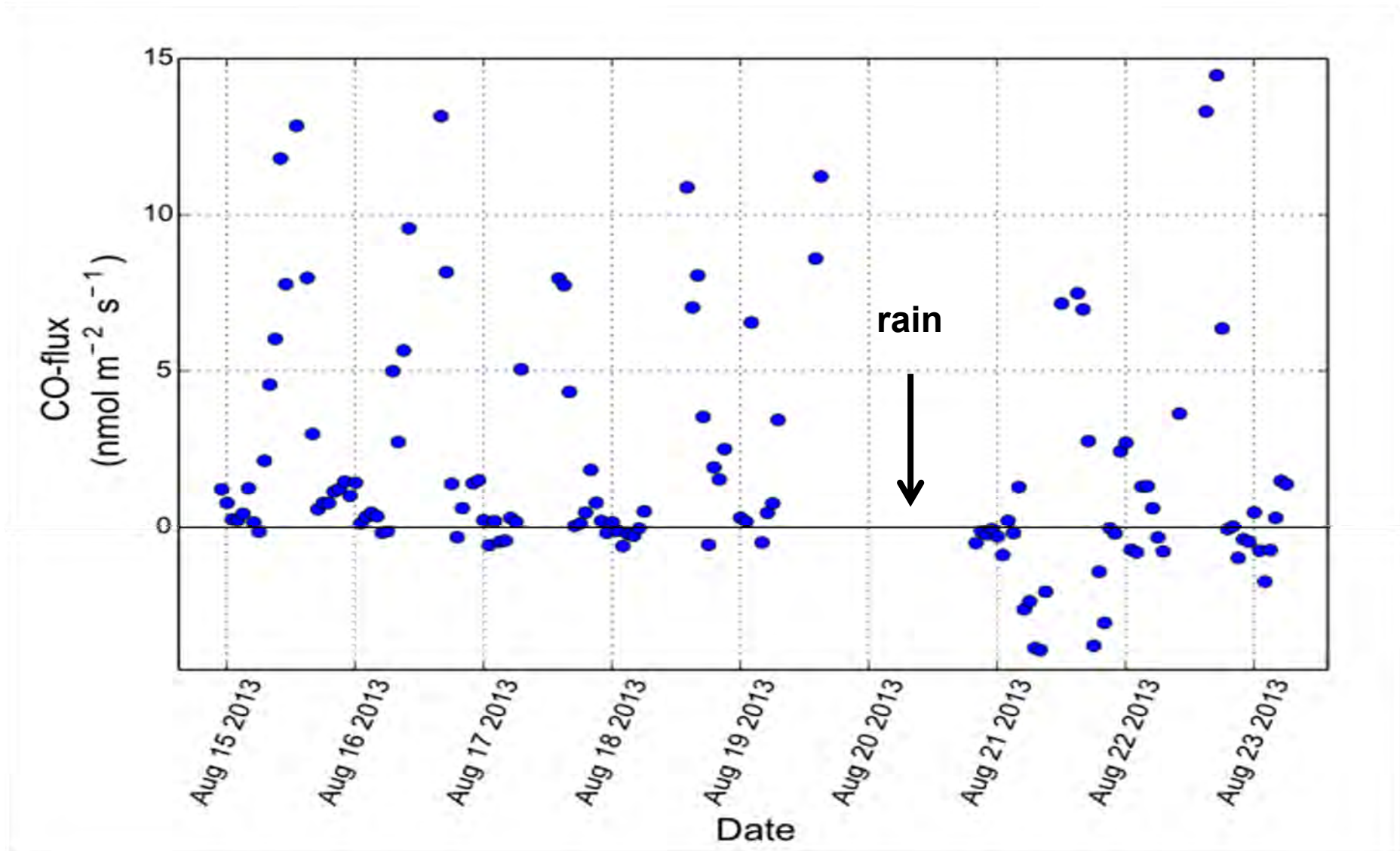
CO-fluxes in field:

Result of biological uptake and thermal CO production?

Laboratory experiment



Flux gradient CO fluxes



Discussion & Conclusion

No photodegradation observed (on ecosystem scale) in contrast to other studies

- Small fluxes (in comparison to biological) on ecosystem scale
- Different fieldsite and litter
- Thermal degradation (partly) misinterpreted as photodegradation

Discussion & Conclusion

Thermal degradation for CO₂ → Observed in laboratory

- Observed from high temperatures (>55°C)

Thermal degradation for CO → Observed in field and laboratory

- Observed at lower temperatures (20°C)
- Sum of biological uptake and abiotic degradation

Published in Biogeosciences

van Asperen, H., Warneke, T., Sabbatini, S., Nicolini, G., Papale, D., and Notholt, J.: The role of photo- and thermal degradation for CO₂ and CO fluxes in an arid ecosystem, *Biogeosciences*, 12, 4161-4174, doi:10.5194/bg-12-4161-2015, 2015.

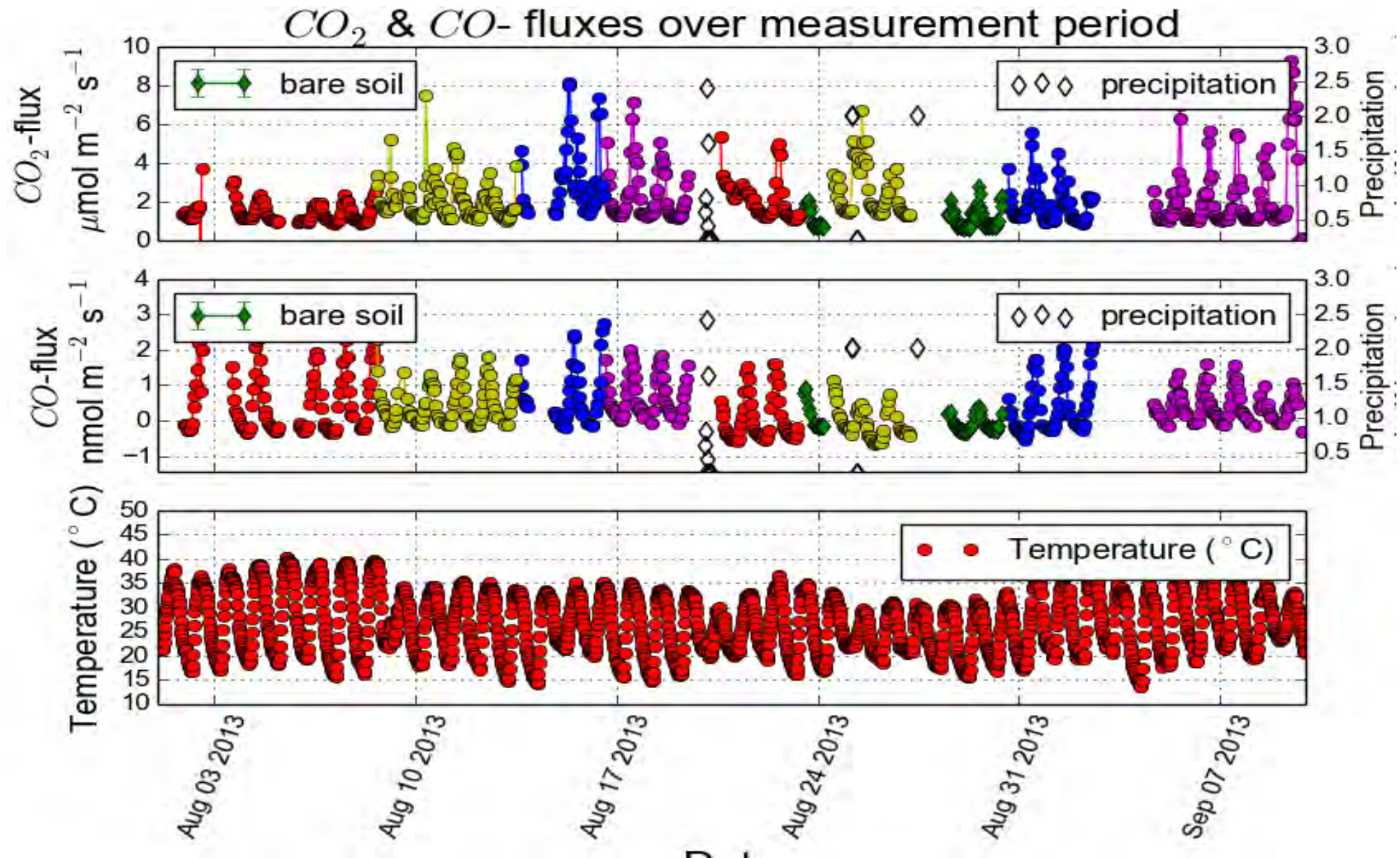
Thank you

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- TTOrch; support of exchange stay at DIBAF, Italy
- University of Tuscia; all the help in the field

- Thank you all for your attention



Results: chamber fluxes over measurement period



Results: chamber fluxes over measurement period

In field: 300-2800nm

UVA: 315-400nm

UVB: 280:315nm

Lab: UVA)(375):45 W nm

Lab: UVB)(310):30 W nm

