éclaire

Effects of temperature and moisture variability on soil CO_2 emissions in European land ecosystems

University of Natural Resources and Life Sciences Vienna
Department of Forest and Soil Sciences

Christine Gritsch, Michael Zimmermann and Sophie Zechmeister-Boltenstern

University of Natural Resources and Life Sciences
Institute of Soil Research

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Introduction

- Climate change -> varying temperature & increase of frequency and intensity of precipitation
  - Soil redox reactions -> control production and emission of greenhouse gases
  - Climate change research -> temperature and moisture

- Soils influence climate by releasing CO_2
  - by-product of decomposition of organic matter
  - Soil microbial processes that emit and consume greenhouse gases
  - Heterotrophic soil respiration (excluding autotrophic)

- Temperature and moisture effects – generally speaking
  - Chemical and microbial processes increase with temperature
  - Moisture content influences gas diffusivity and is important for substrate supply

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Research questions

- **At which temperature and moisture, respectively, do we see maximum CO_2 efflux?**

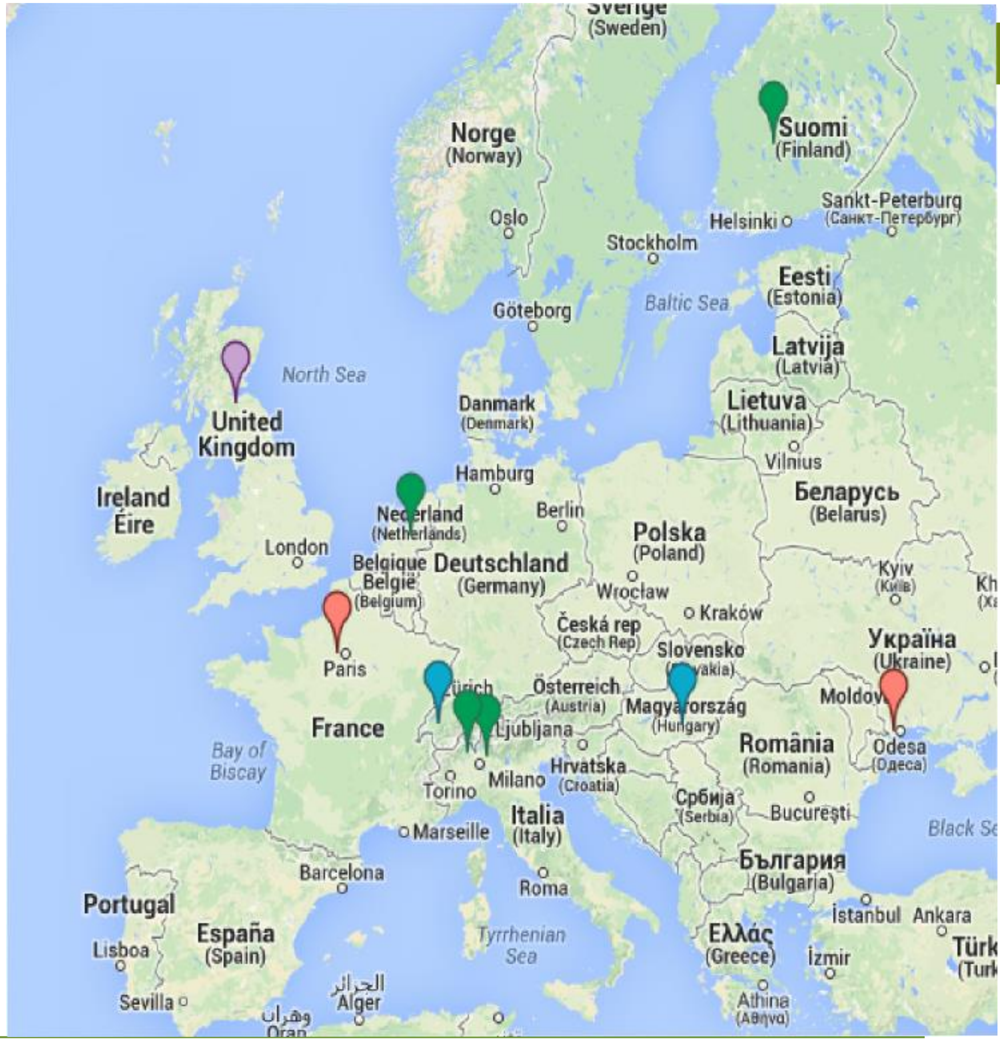
- **How to calculate temperature and moisture sensitivities of CO_2 efflux?**

- **What is the influence of moisture and land-use on <u>temperature sensitivity</u> of CO_2 efflux?**

- **What is the influence of temperature and land-use on <u>moisture sensitivity</u> of CO_2 efflux?**

How did we do it?

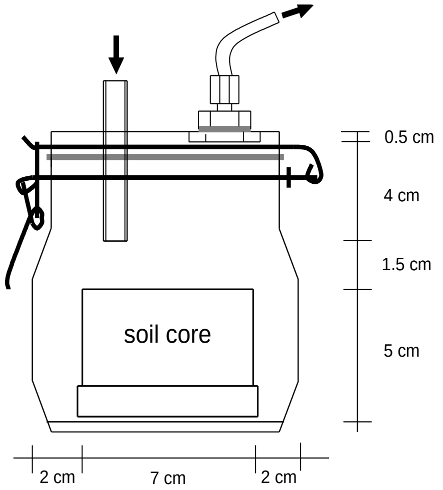
- 4 landuses
  - Forest (deciduous & coniferous), arable lands, grasslands, peat land
- Two-factorial design
  - 5 temperatures
    - 5, 10, 15, 20, 25 °C
  - 5 moisture contents
    - 5, 20, 40, 60, 80 (100) % WFPS



How did we do it?

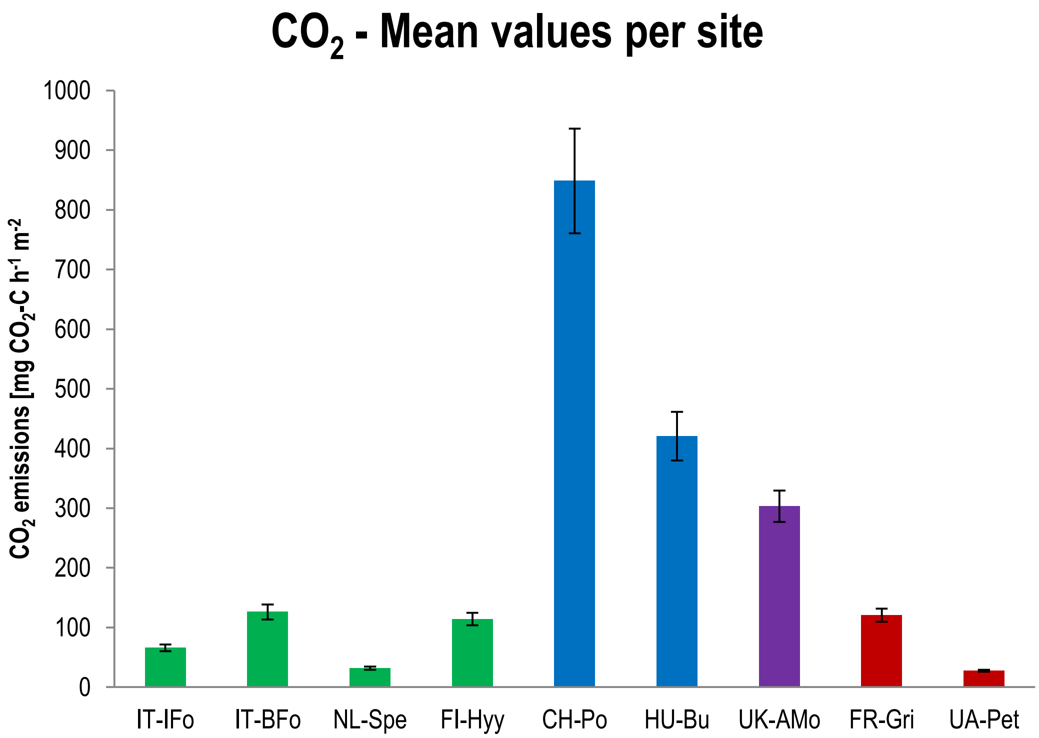
Automated laboratory incubation measurement system

- 22 h continuous measurement
  - PP SYSTEMS WMA-2 infrared CO_2
- OpenChamber in incubator
  - Automated measurement system

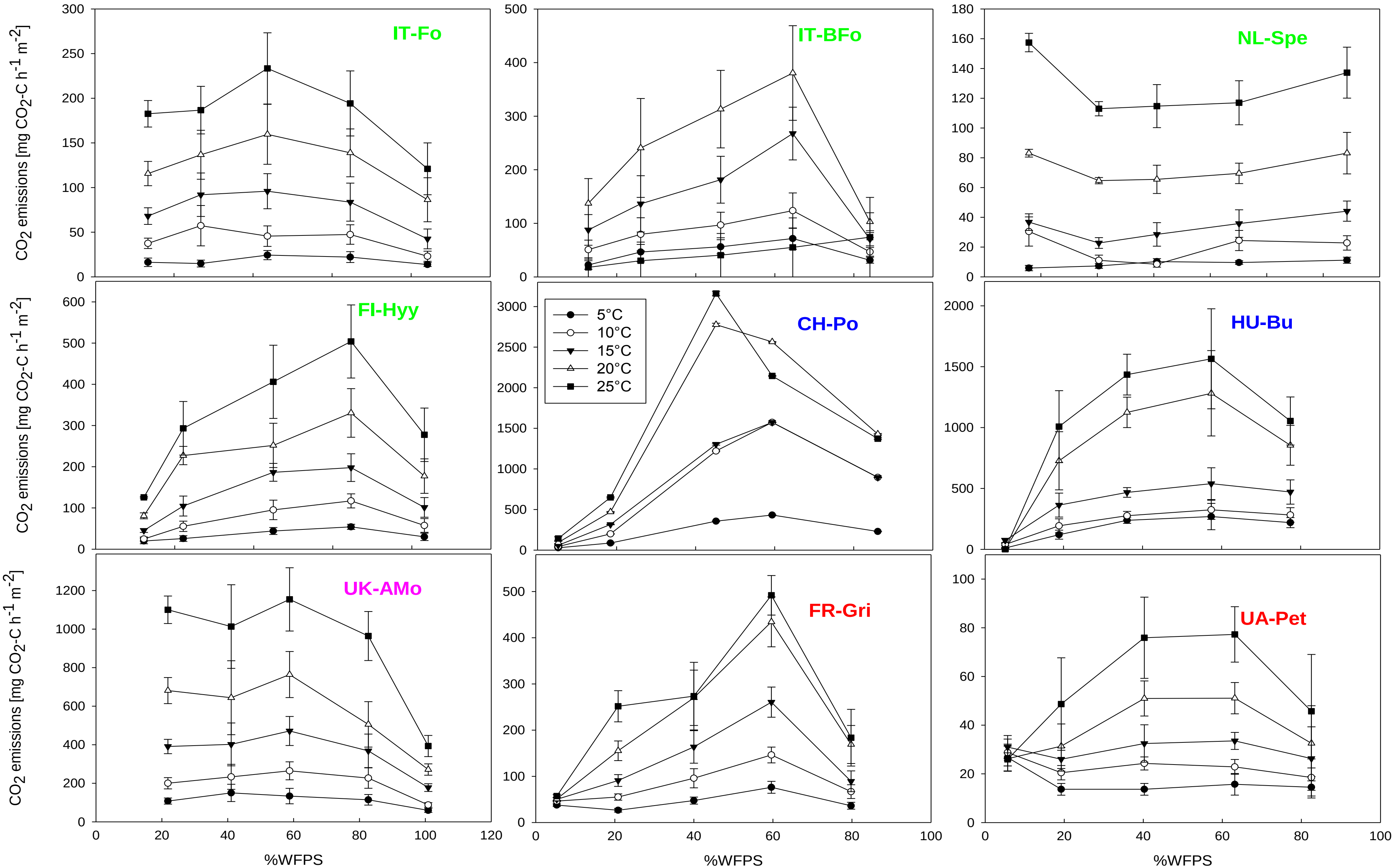


Findings

- Land-use generally had a substantial influence on carbon dioxide fluxes
  - grassland > peatland > forest = arable land

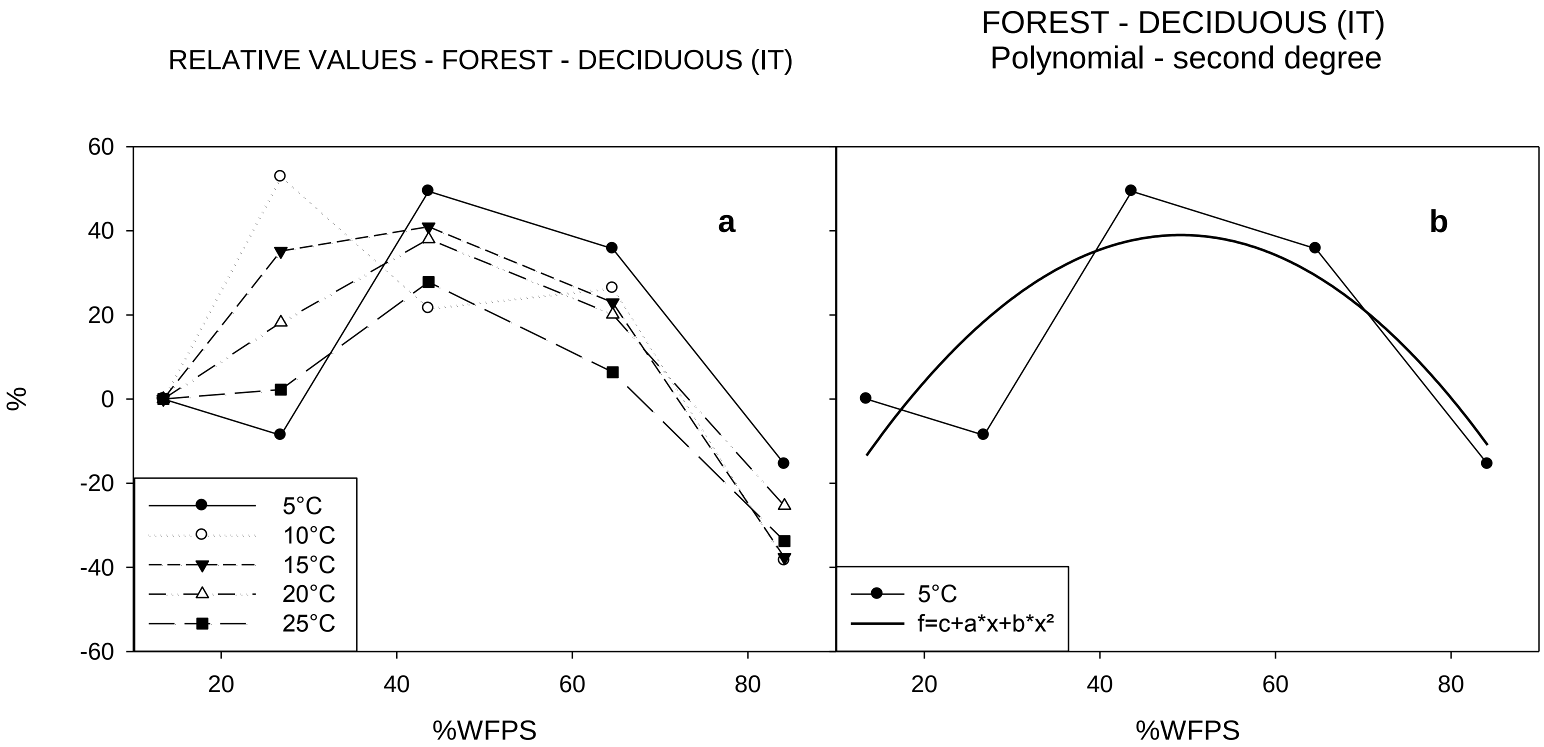


Findings



IT-Fo
IT-BFo
NL-Spe
FI-Hyy
CH-Po
HU-Bu
UK-AMo
FR-Gri
UA-Pet
5°C
10°C
15°C
20°C
25°C
CO2 emissions [mg CO2-C h-1 m-2]
%WFPS

Moisture sensitivity – Slope of quadratic function



Relative CO_2 emission rates were used to exclude temperature contribution

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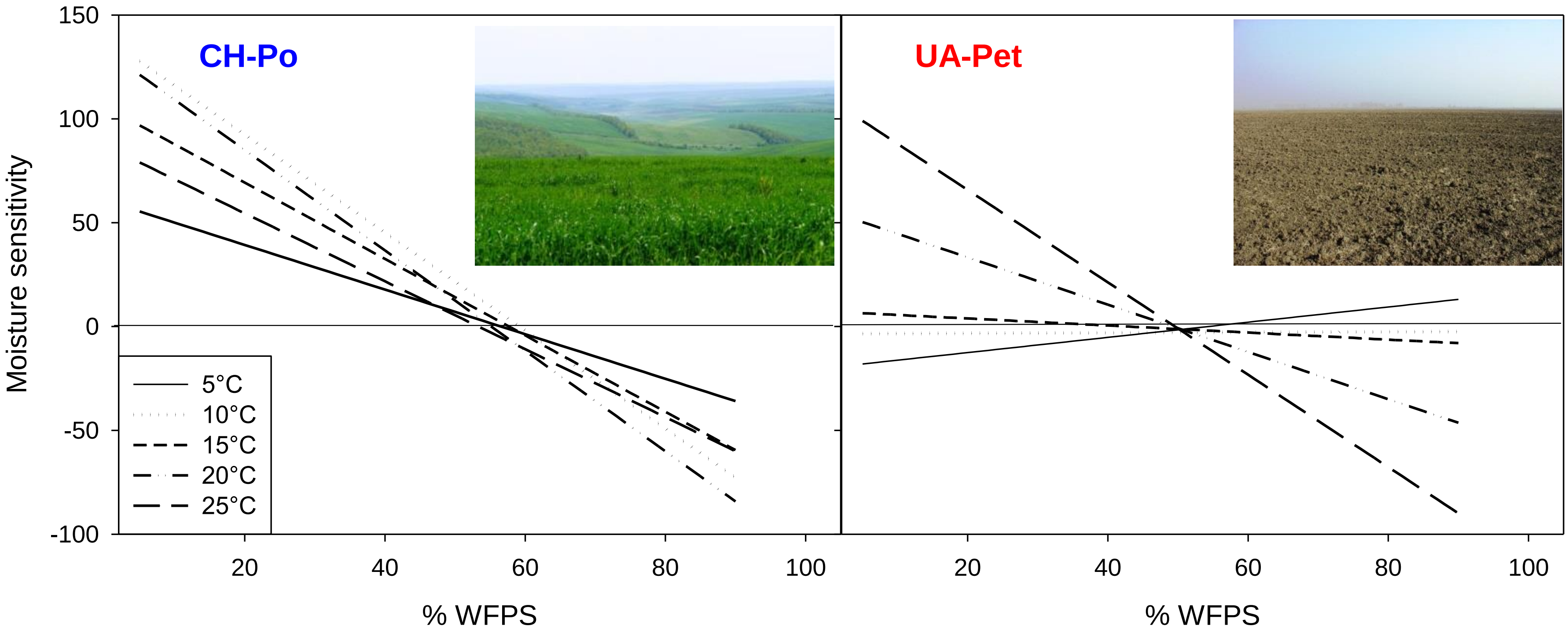
http://galerie.chip.de/k/wettbewerb/fotowettbewerb-landschaftsfotografie/laubwald_in_den_ardennen/548807/

Moisture sensitivity

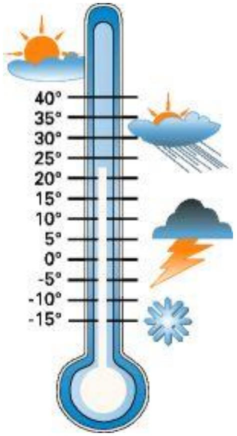


Moisture sensitivities of arable soils increased with temperature

http://de.dreamstime.com/stockfoto-transparente-wassertropfen-image4211860; http://www.moldawien.de/tourismus.html
http://www.immobilien-kleinanzeigen.com/kleinanzeige-Ackerland-in-Westungarn-zu-verpachten-312-ha-261711.html

Temperature – Gaussian model

$$R(T) = R_4\, e^{a_4 T + b_4 T^2}, \quad Q_{10} = F_{T_1} / F_{T_1 - 10}$$



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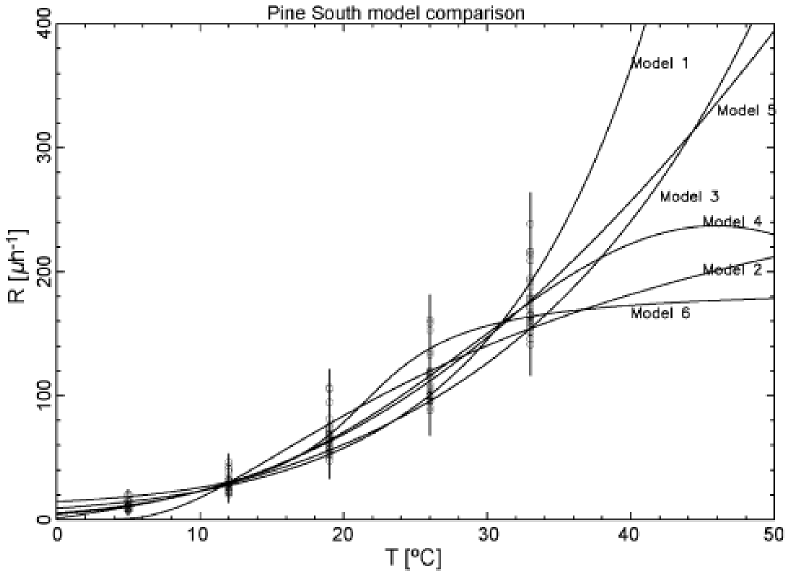
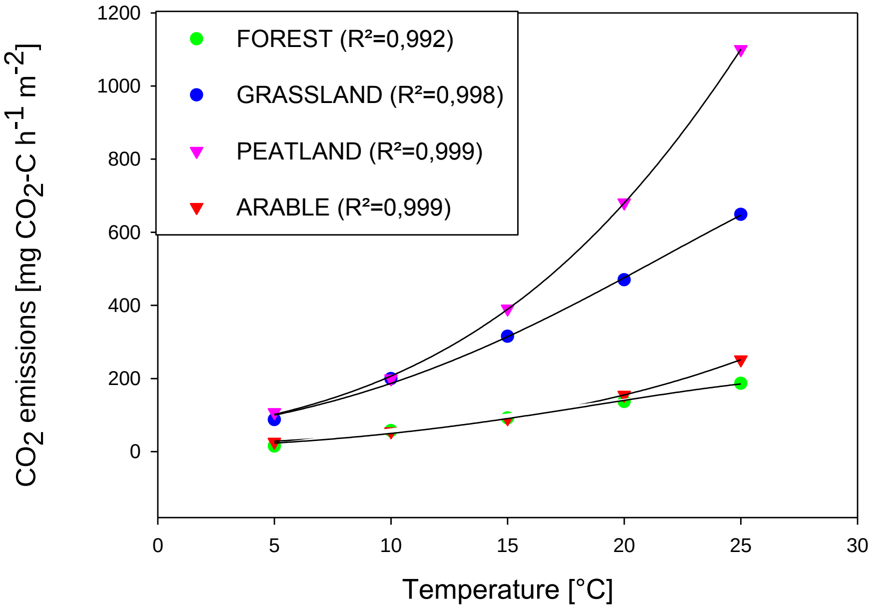
Temperature fit - Gaussian Model
~ 20 % WFPS
R^2= 0,87 - 1

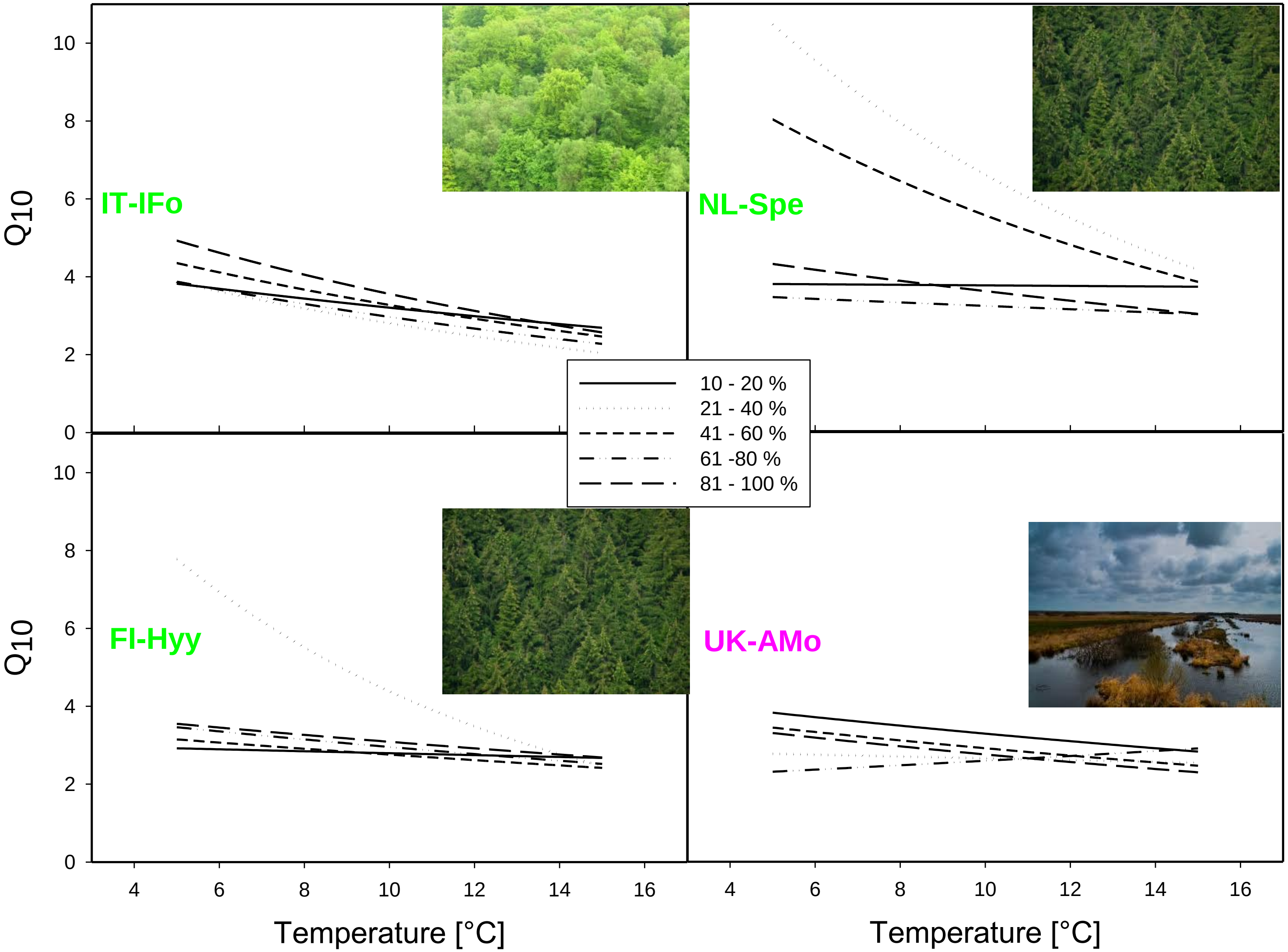




http://www.das-kaffeekontor.de/kaffee-geschichte/beeinflussende-faktoren-beim-anbau-von-kaffee/

Tuomi et al 2008

Temperature sensitivity – Q_{10}



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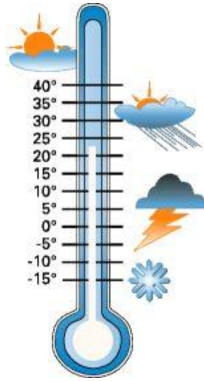
- Temperature sensitivity is highest under cold temperatures
- In coniferous forest sites temperature sensitivity is highest between 20-40 % WFPS
- at cold temperatures variability between Q_{10} higher



http://de.worldmapz.com/admin2/3040919_zh.htm; http://galerie.chip.de/k/landschaft-natur/auf-dem-land/moorlandschaft/669145/
http://galerie.chip.de/k/wettbewerb/fotowettbewerb-landschaftsfotografie/laubwald_in_den_ardennen/548807/

Summary

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- Land-use, temperature and moisture content had a substantial influence on carbon dioxide fluxes
  - Land-use - grassland > peatland > forest / arable land
  - Moisture – maximum at intermediate moisture content; decline at dry and wet conditions
  - Temperature - increase

- Temperature sensitivity and its relations to
  - Temperature – cold temperatures
  - Moisture – no positive or negative relationship; at cold temperatures variability between Q_{10} higher
  - Coniferous forests - Moisture range between 20 – 40 % WFPS highest temperature sensitivity

- Moisture sensitivity and its relations to
  - Moisture – dry and wet conditions
  - Positive relation with temperature in arable lands

Conclusions

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- Temperature sensitivity and its relations to
  - Temperature – cold temperatures

    In cold areas (Mountains, Northern latitudes) warming will have a larger influence on CO_2 emissions.
  - Moisture – no positive or negative relationship; at cold temperatures variability between Q_{10} higher

    In cold areas (Mountains, Northern latitudes) rain events will influence temperature sensitivity.

- Moisture sensitivity and its relation to
  - Moisture – dry conditions and wet conditions

    Increased moisture in dry areas will promote CO_2 emissions more than in moist areas.
  - Positive relation with temperature in arable lands

    Irrigation of arable lands will have a higher impact on CO_2 emissions in warmer regions in the south of Europe than in the north.

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Photo from http://www.xurian.com/de/taxonomy/term/285