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Responses of terrestrial ecosystem CO_2 fluxes to droughts and heat waves: insights from the ICOS network

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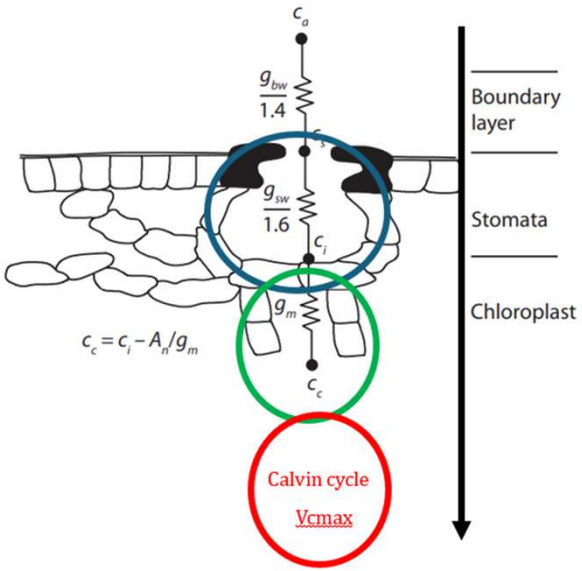
TOC

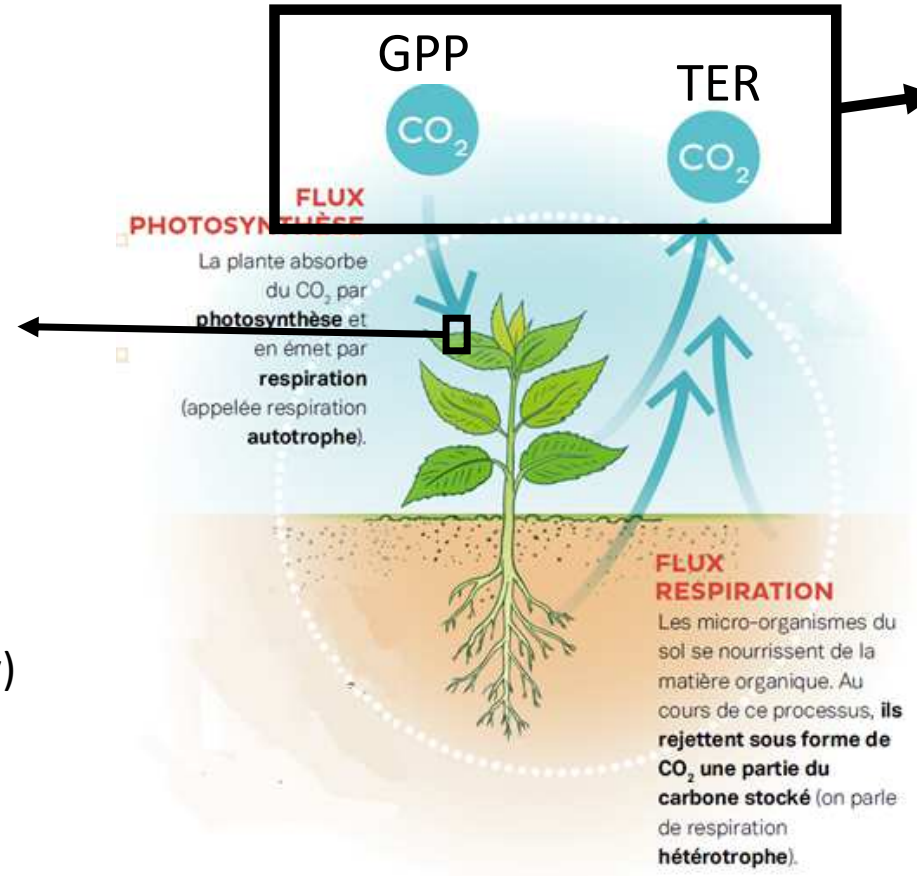
- GPP, TER and NEE + droughts/heat waves influence
- The ICOS network
- Impact on CO_2 fluxes at the continental level using the ICOS network
- Improved modeling at the leaf/plant/ecosystem level using individual ecosystem ICOS stations

GPP/TER/NEE and droughts/heat waves influence



GPP
(Gross Primary Productivity)

radiation
soil moisture
air humidity



NEE
(Net Ecosystem Exchange)

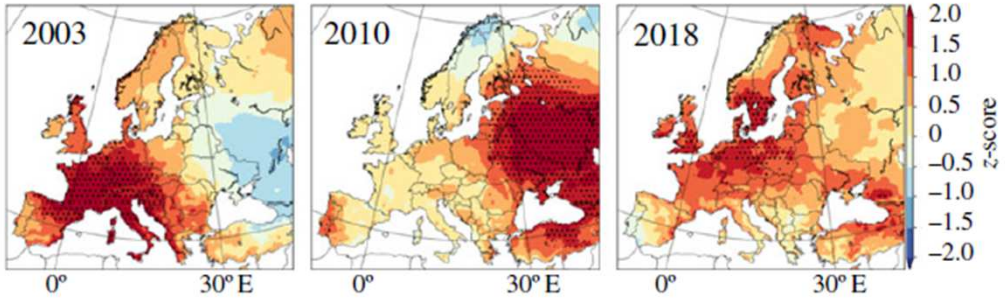
TER
(Total Ecosystem Respiration)

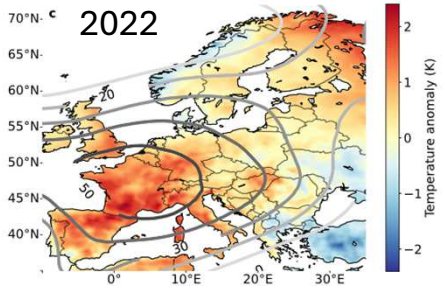
temperature
soil moisture

Droughts/heat waves in Europe

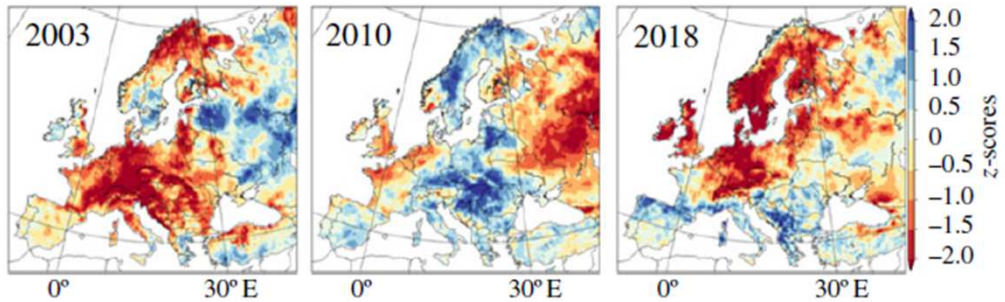
- Europe hit repeatedly but with various locations, seasonal timing and severity

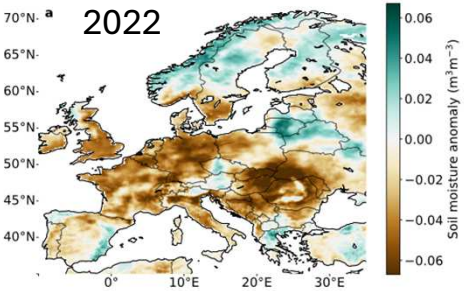
Temperature anomalies





Soil moisture anomalies



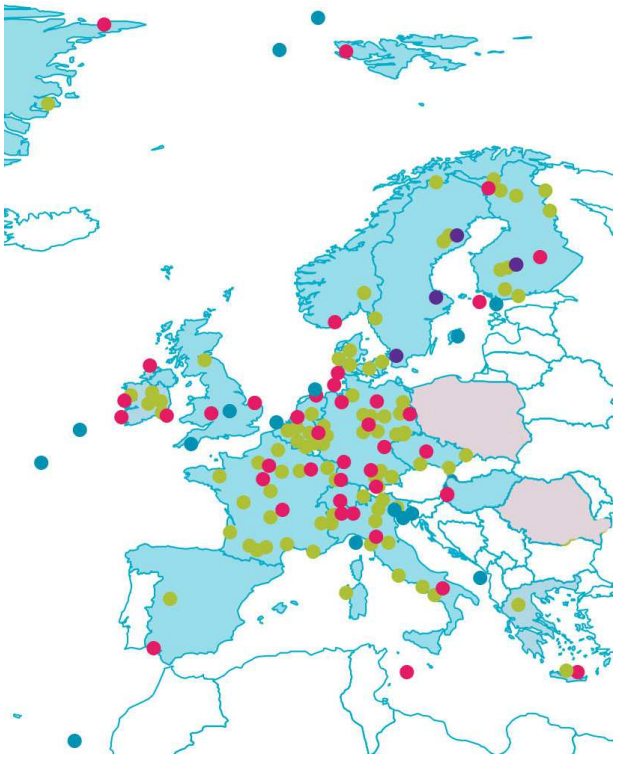


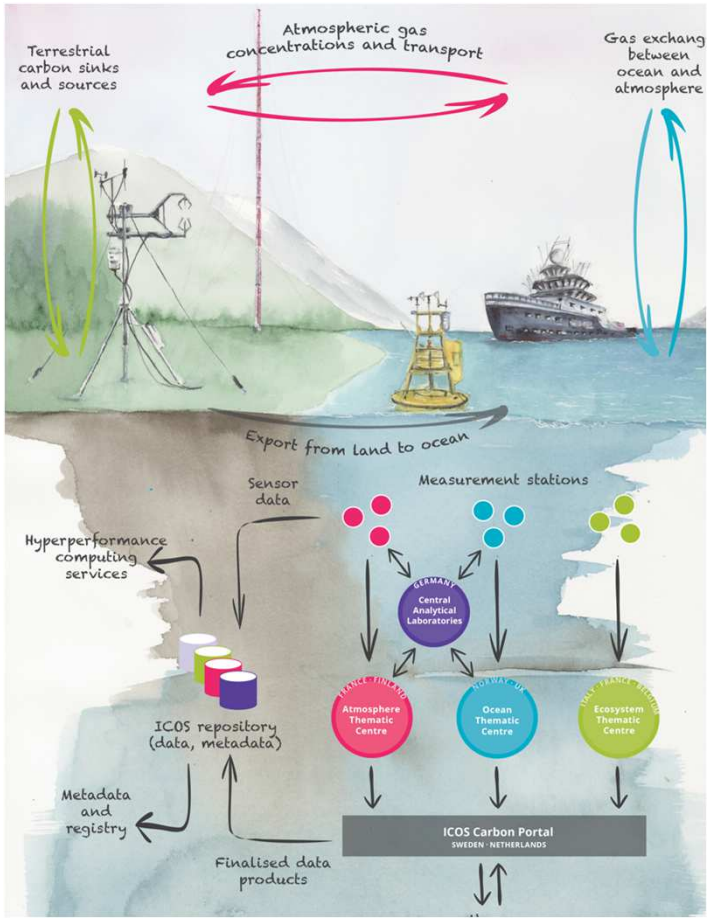
z-scores refer to the standardized anomalies for the reference period 1979–2018.

Bastos et al., 2020, PTRS

The ICOS network

The Integrated Carbon Observation System (ICOS) is a distributed European research infrastructure operating **standardized, high-precision, and long-term observations**





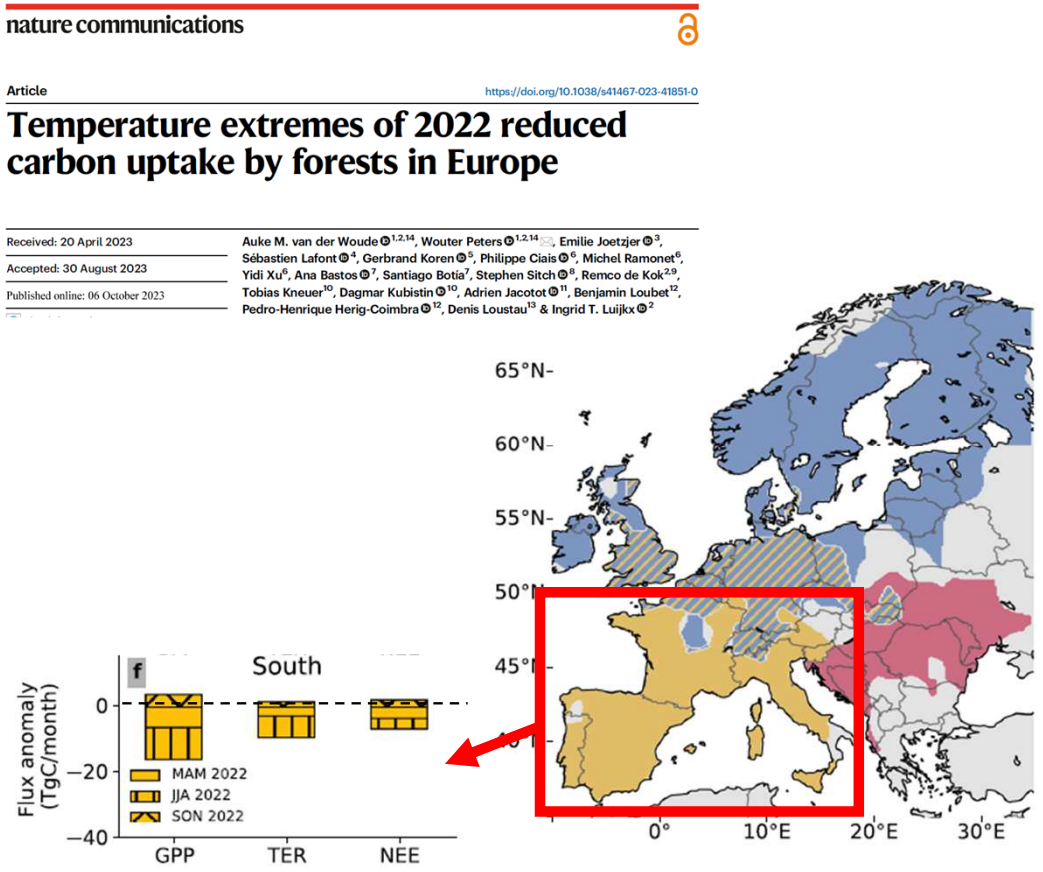
The ICOS Belgian network

The Integrated Carbon Observation System (ICOS) is a distributed research infrastructure operating **standardized, high-precision, and long-term observations**,

Funding by

Impact at the continental level using the ICOS network

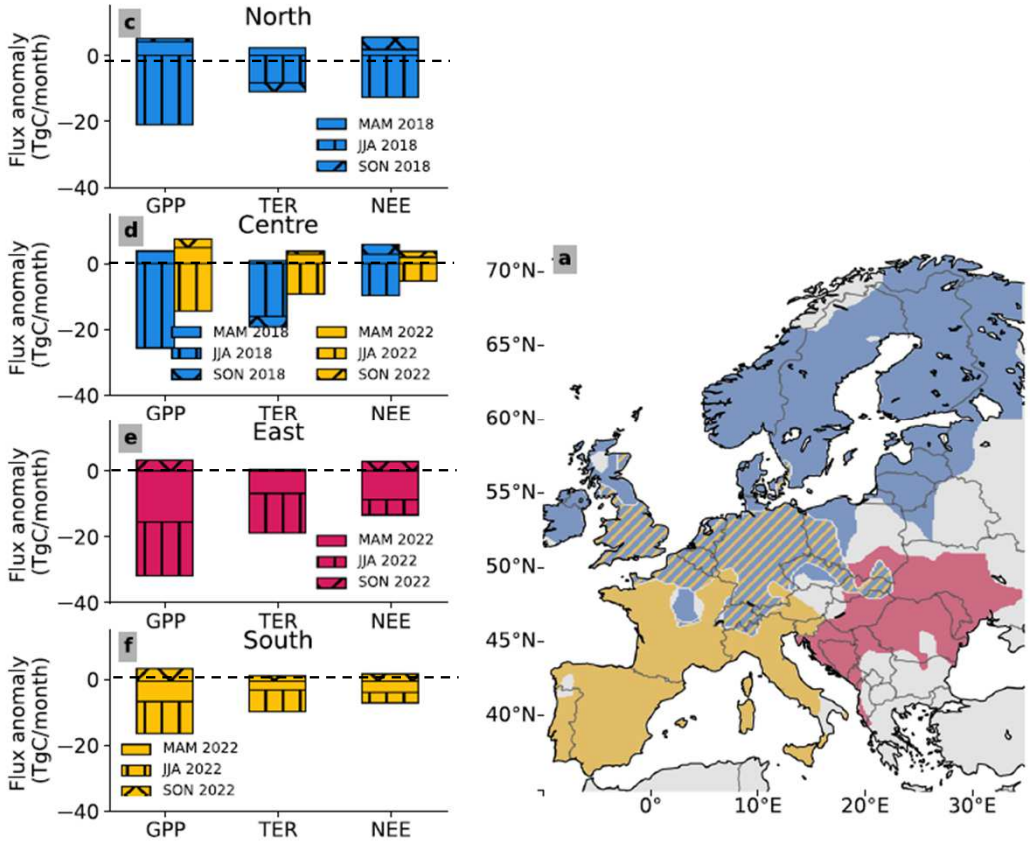
- Anomalies are relative to the last 5 normal years
- Reduced photosynthesis (GPP) in summer
- Also reduced respiration (TER) in summer
- But GPP effects are more important than TER effects, => reduced net uptake (NEE)
- Only partial recovery in autumn



Van der Woude et al., 2023, Nature Comm

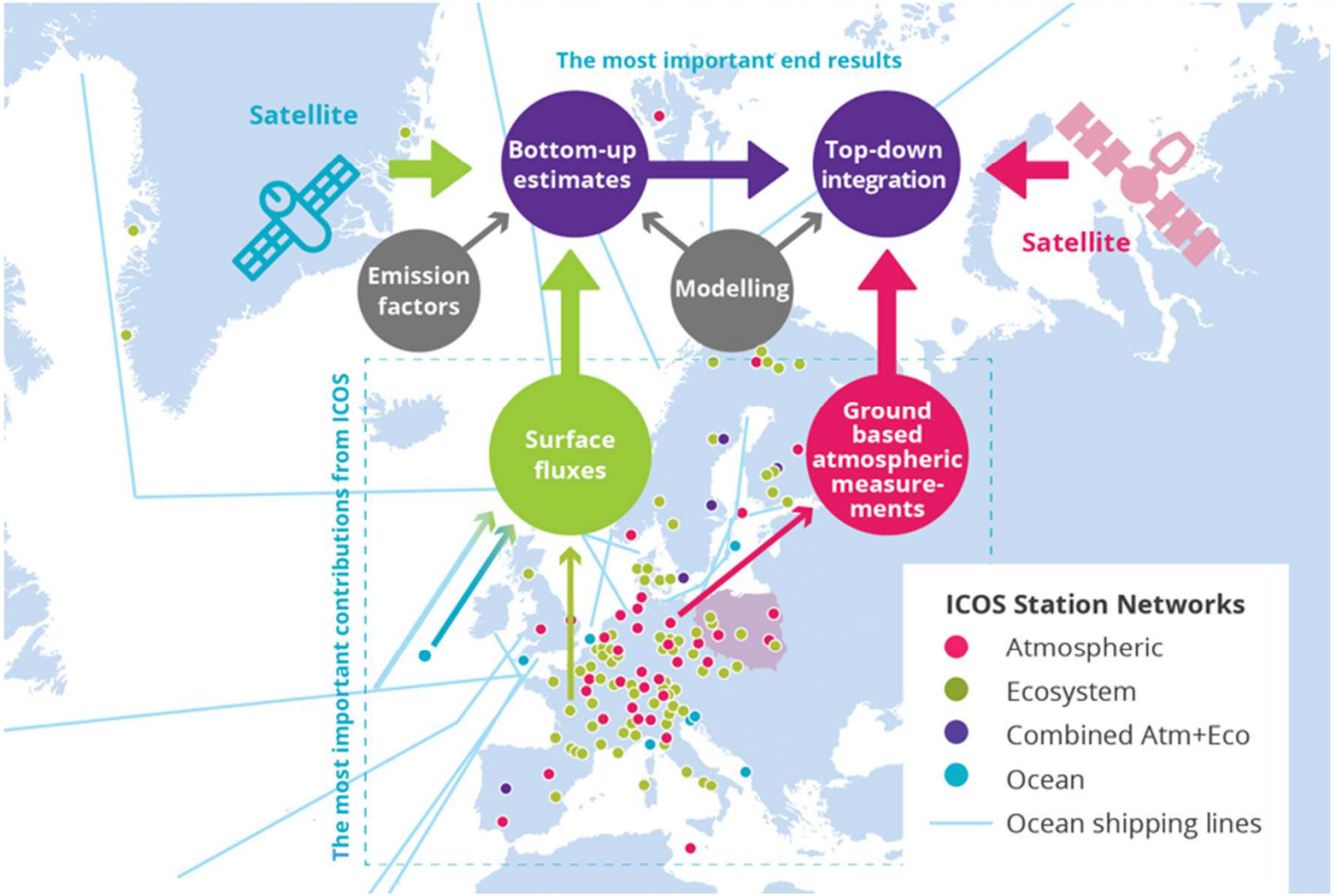
Impact at the continental level using the ICOS network

- In 2022,
  - the summer CO2 sink was reduced by 59 Tg C
  - The fall CO2 sink was enhanced by 19 Tg C
  - The annual sink was reduced by 40 Tg C
- 40 Tg C ≈ ¼ of German anthropogenic annual emmissions



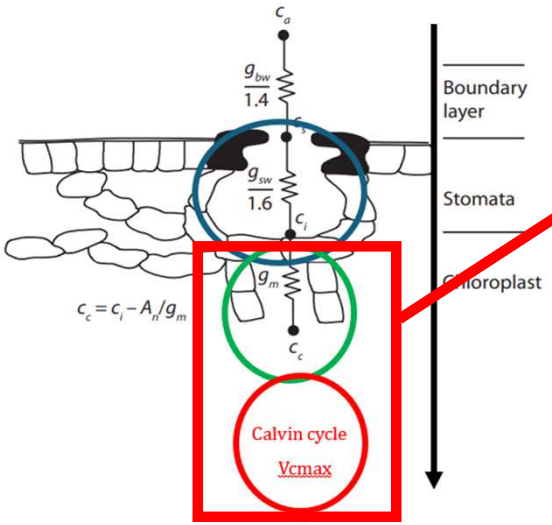
Van der Woude et al., 2023, Nature Comm.

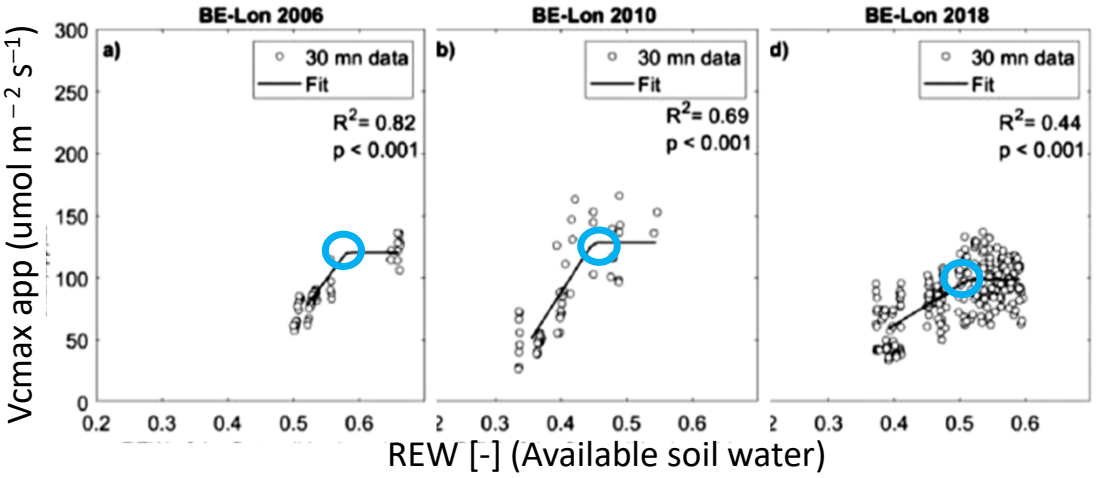
- Mechanistic modeling plays an important role
- Cal/val of those models using ecosystem flux stations



Improved modeling at the leaf/plant/ecosystem level using individual ecosystem ICOS stations

- Non-stomatal limitations are dominating the GPP sensitivity to edaphic drought
- Effect starts at a REW threshold ≈ 0.5





Beauclaire et al., 2023, AFM

Conclusions

- Drought/heat waves reduce carbon sequestration by European vegetation through reduced photosynthesis
- Monitoring networks like ICOS are critical for quantifying this effect and modeling it (also resilience of ecosystem facing repeated droughts)
- ICOS-Belgium delivers representative data for our typical ecosystems

Thank you for your attention

Improved modeling at the leaf/plant/ecosystem level using individual ecosystem ICOS stations

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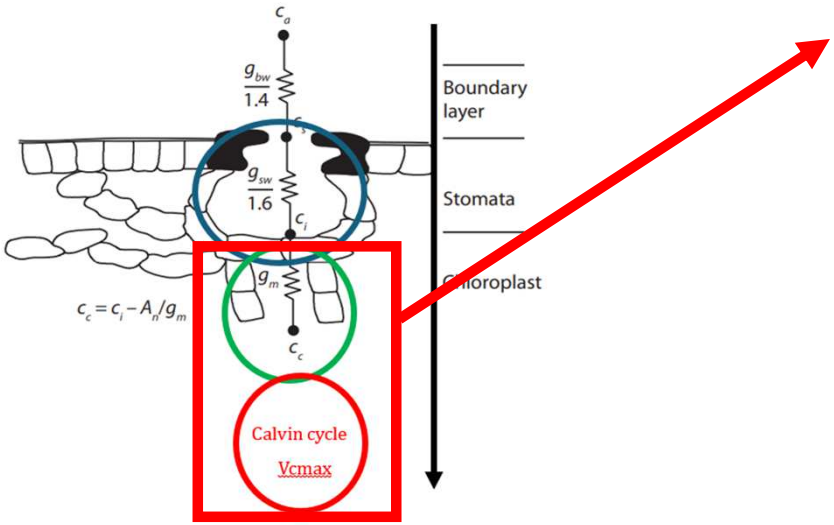

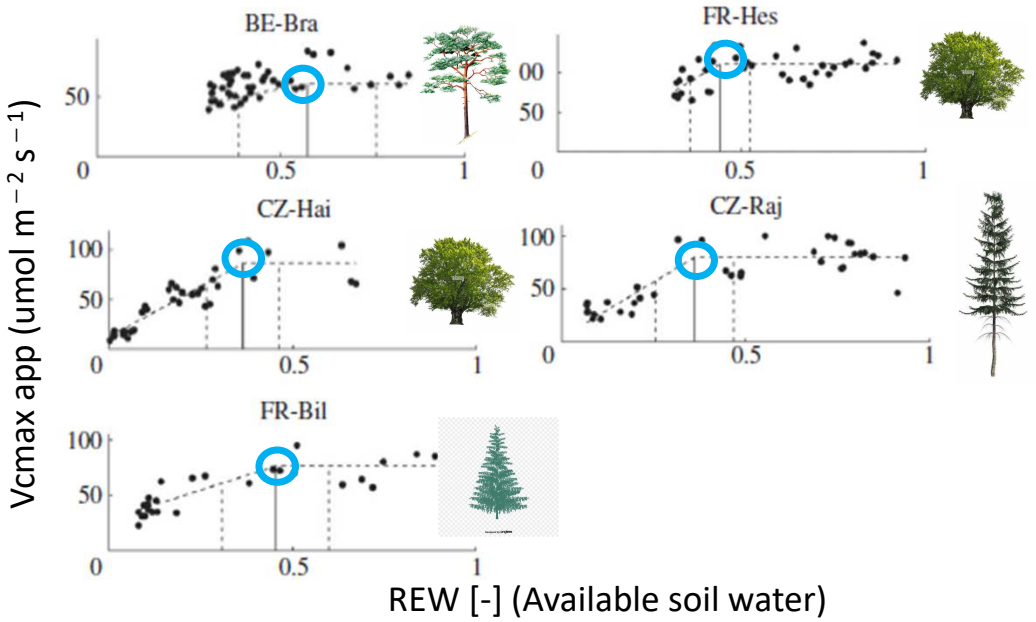

Gourlez de la Motte et al., 2020, PTRS