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Outstanding Student & PhD candidate Presentation contest

High summer precipitation reduces soil methane sink capacity and alters decomposition processes in a mature temperate forest

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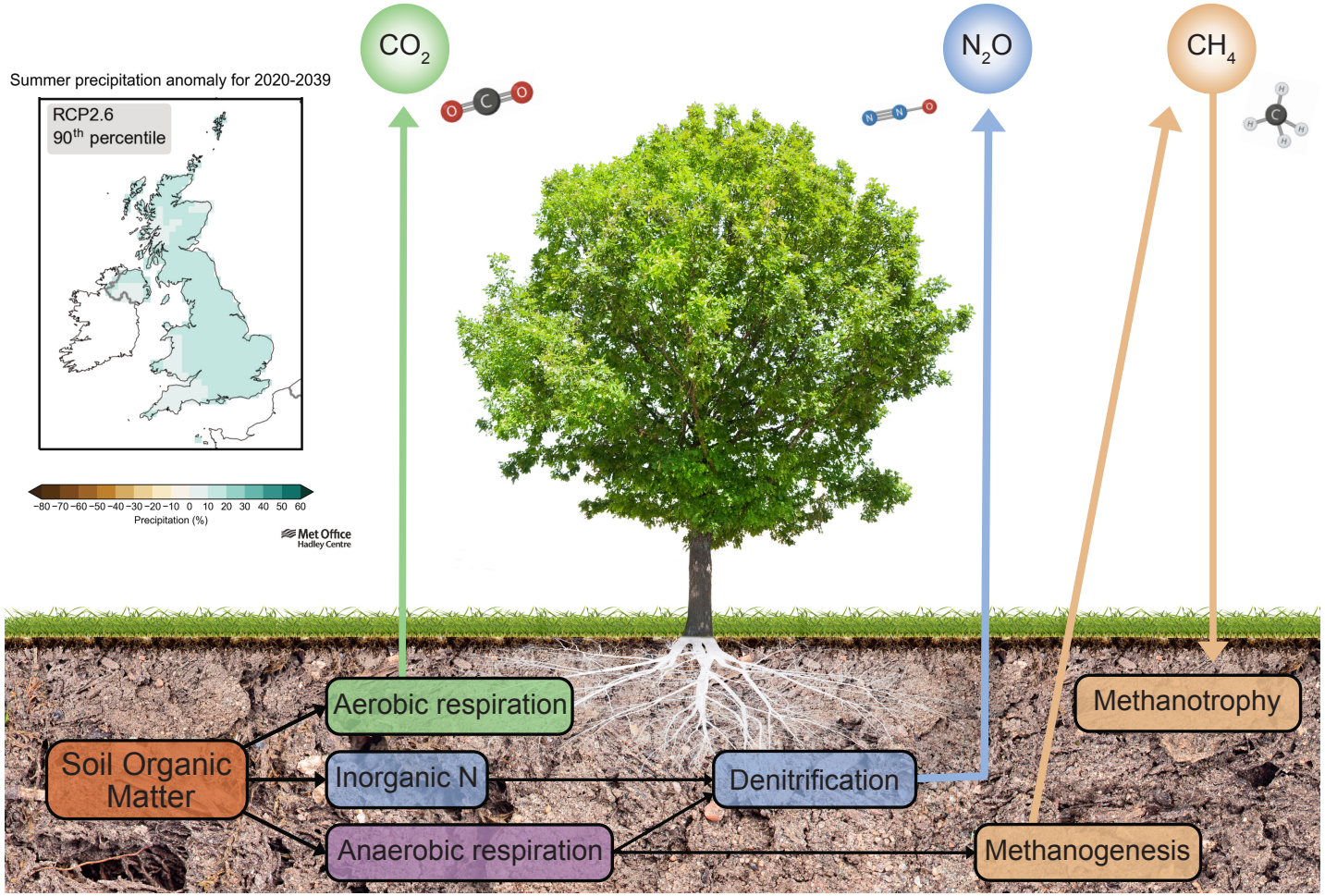
Background



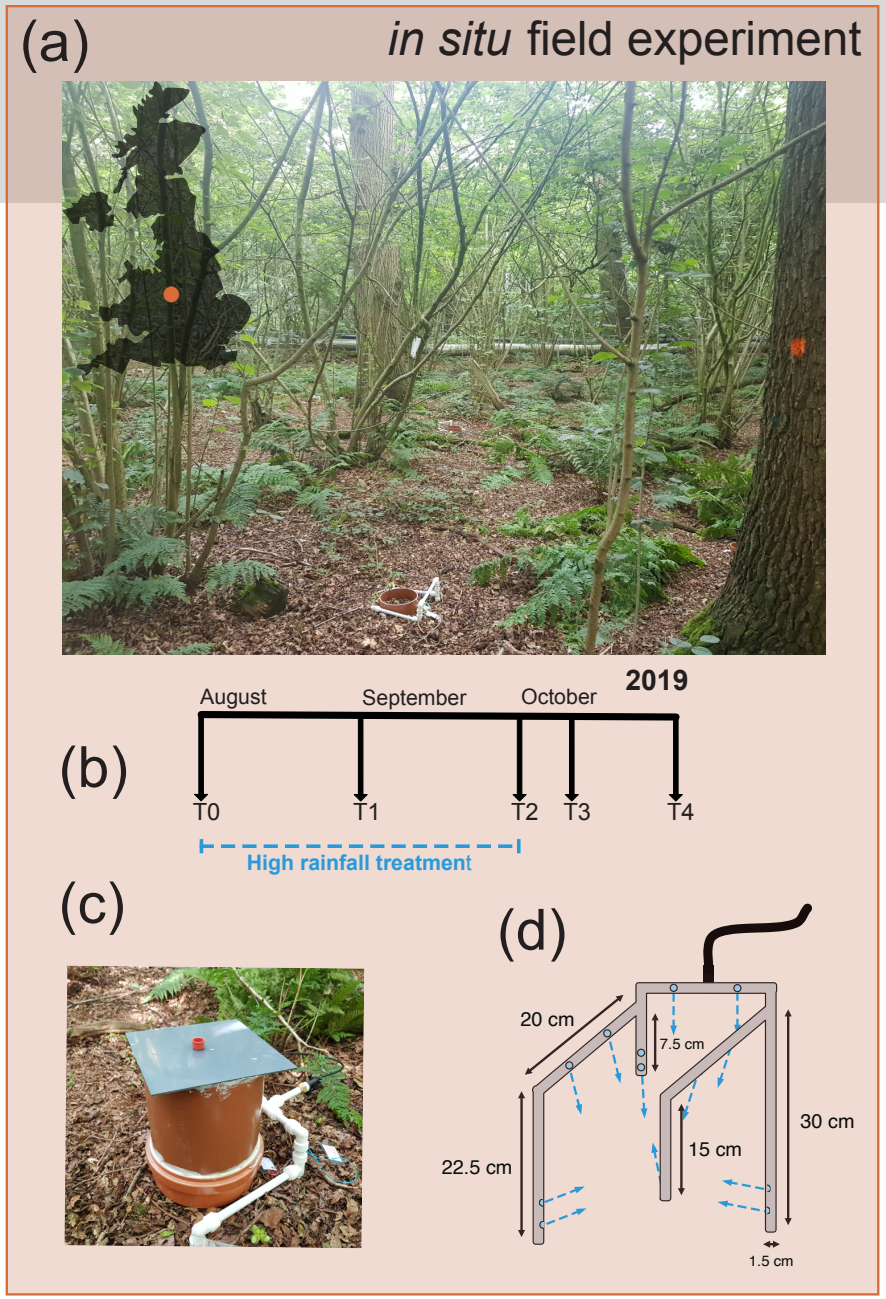
- **Temperate** forests store ~ **120 Pg carbon** *(Pan et al.,, 2011)*
- Act as **sinks** or **sources** for **major greenhouse gases** including CO_2, CH_4 and N_2O thus play an important role in **global carbon** and **nitrogen budgets** *(Friedlingstein et al., 2021; Saunois et al., 2020; Tian et al., 2020)*
- **Shifting precipitation patterns** and increased **frequency, duration** and **magnitude** of **high rainfall events** *(Hajek and Knapp, 2022)*
- Soil **moisture** is a key driver of microbial processes *(Lui et al., 2009)*

Methodology

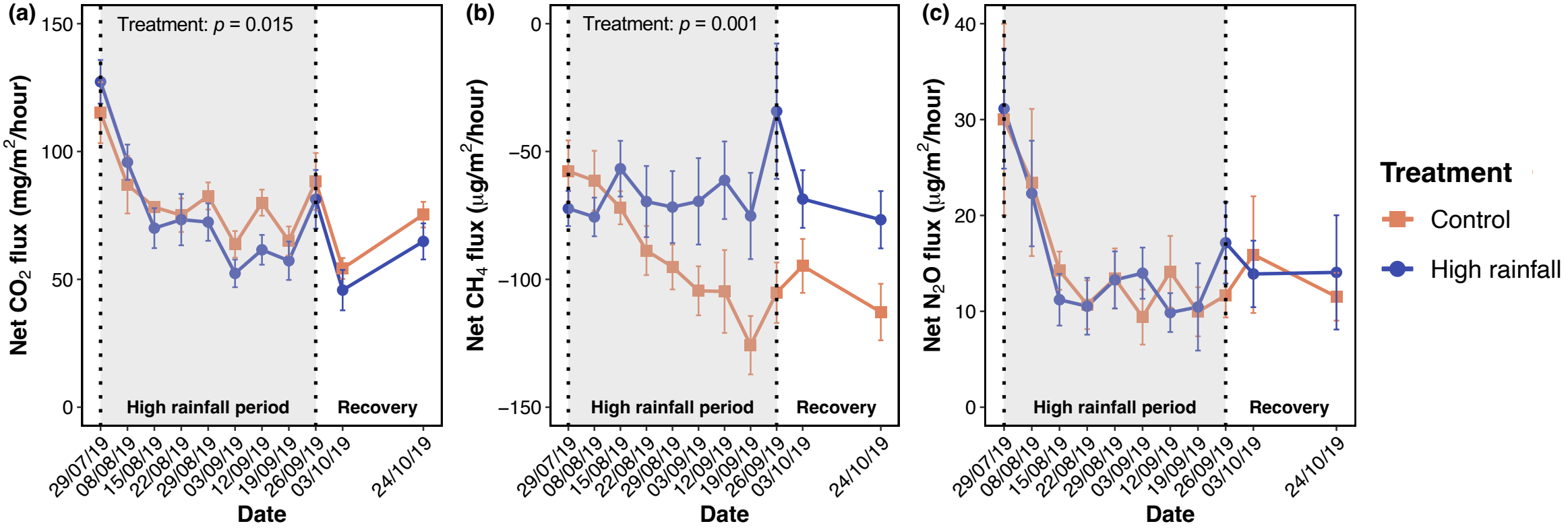
Research Objectives:

1. Determine the resilience of forest soil **microbial structure** and **function** to **altered rainfall**
2. Determine the **direct** and **indirect** contributions of **soil** and **microbial properties** on soil CO_2, CH_4 and N_2O fluxes

- **Oak** (*Quercus robur*) dominated **mature temperate forest** in Staffordshire, UK
- **30% increase** in volumetric soil moisture content for 8-week period
- **Molecular** and **functional** analyses



How will high rainfall events impact forest soil microbial function?

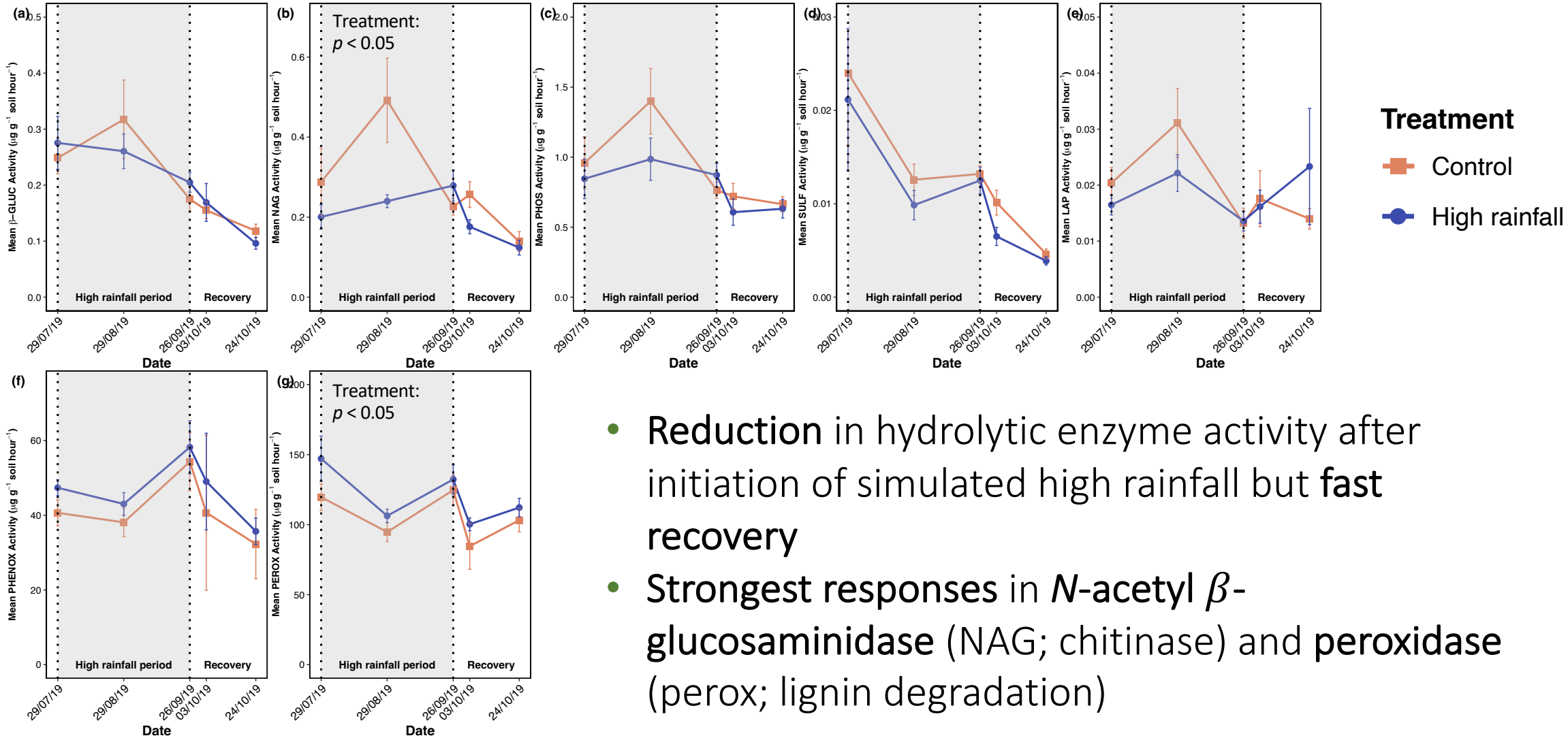


- Significant **reduction** in **methane** sink capacity (21 – 67%) during the **high rainfall** treatment period with **limited recovery** 1- and 4-weeks post-treatment
- Significant **reduction** in soil **respiration** (2 - 23%) during the high rainfall period with **no recovery** 1- and 4-weeks post-treatment

How will high rainfall events impact forest soil microbial function?

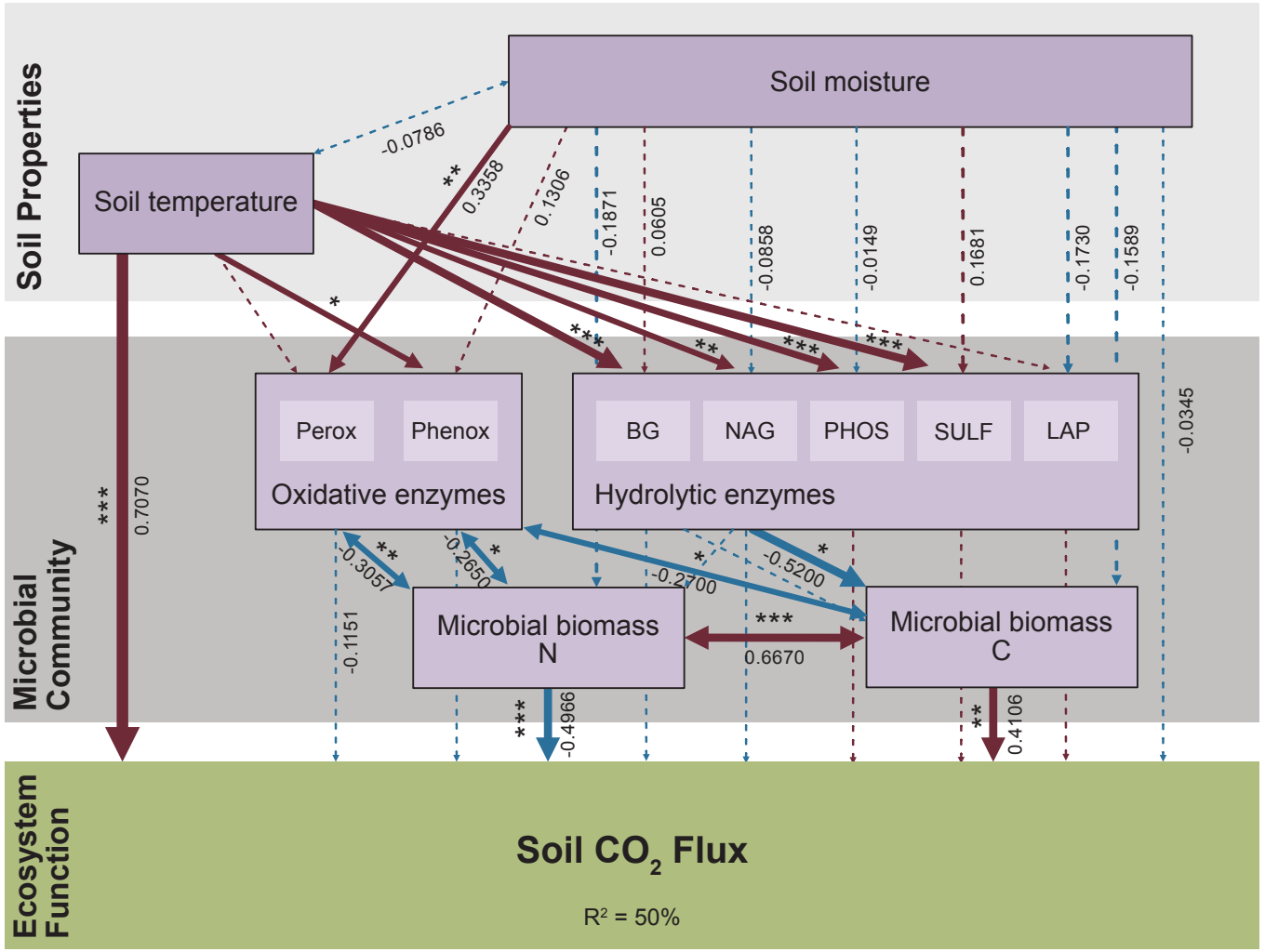
Hydrolytic

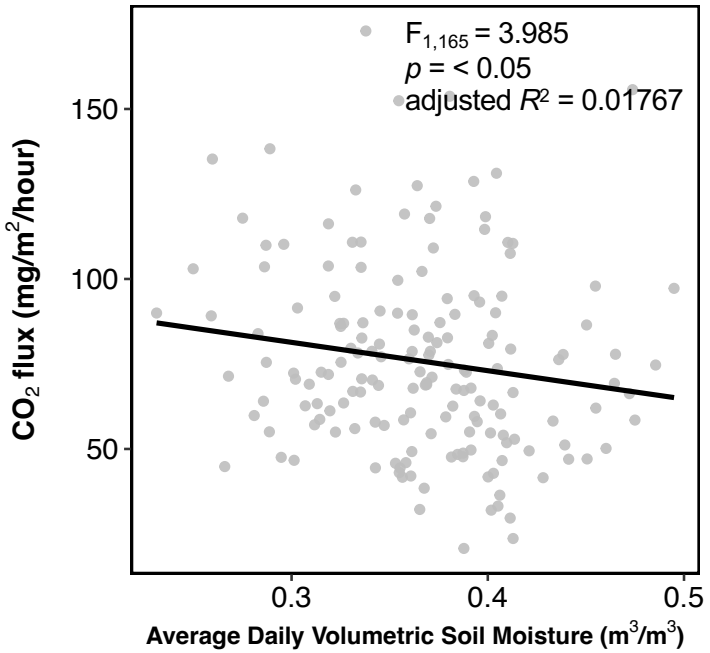
Oxidative



- **Reduction** in hydrolytic enzyme activity after initiation of simulated high rainfall but **fast recovery**
- **Strongest responses** in ***N*-acetyl *β*-glucosaminidase** (NAG; chitinase) and **peroxidase** (perox; lignin degradation)

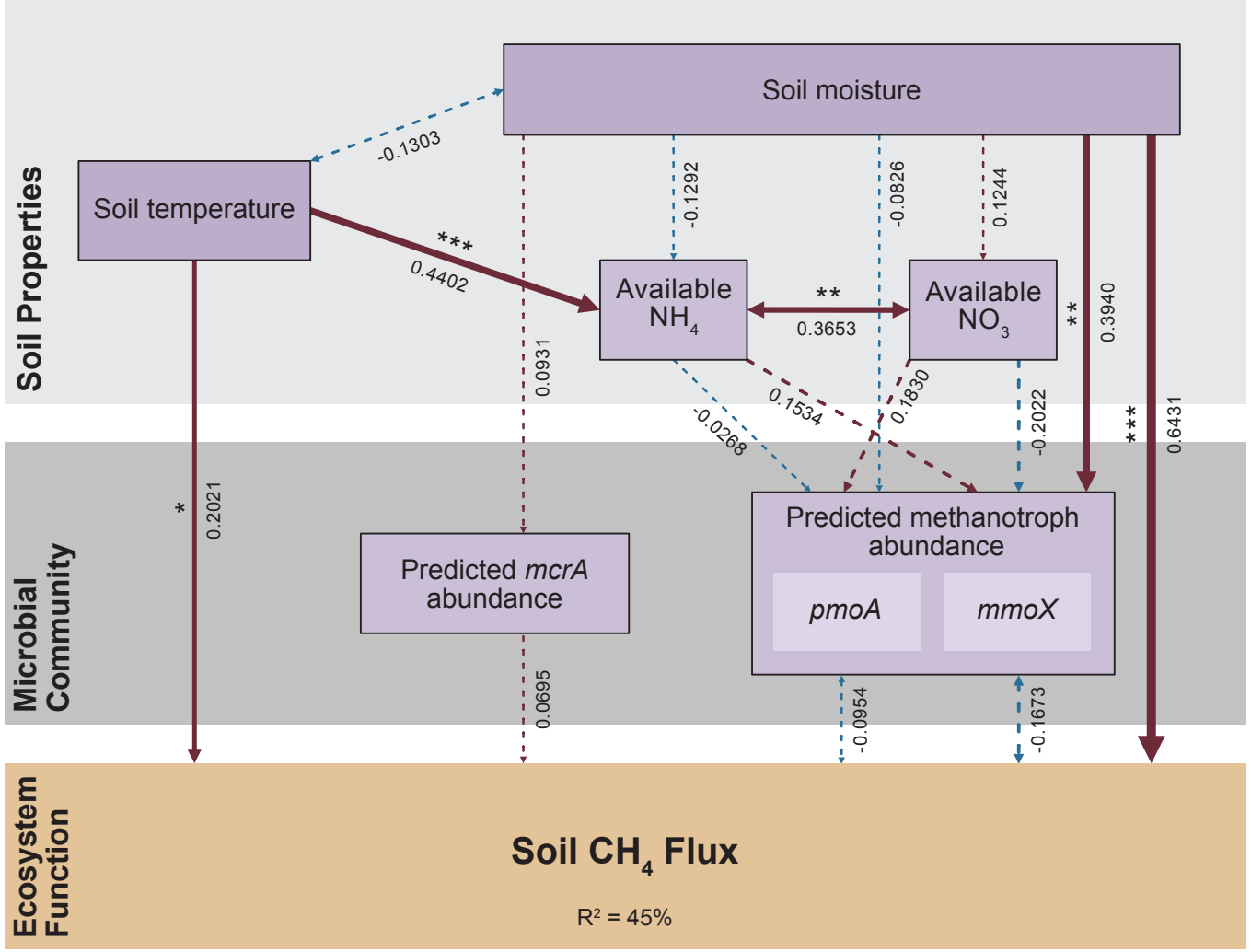
How does soil moisture drive forest soil CO_2 flux?

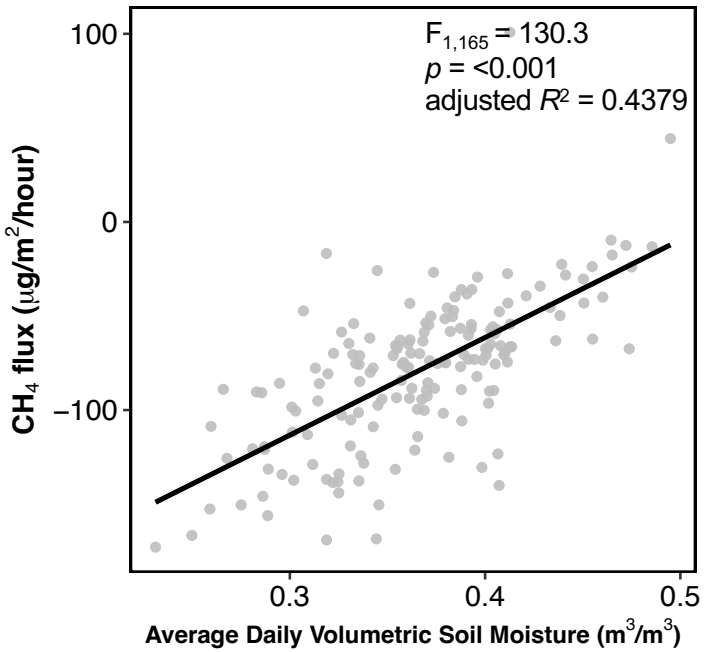




- Soil **moisture** indirectly alters the soil CO_2 flux via **increased peroxidase activity** and **reduced microbial biomass N**
- Significant **reduction** in CO_2 flux with increased soil moisture during experiment

How does soil moisture drive forest soil CH_4 flux?





- Soil **moisture** both **directly** and **indirectly** affects the soil CH_4 flux via methanotroph abundance
- Significant **increase** in CH_4 flux with increased soil moisture during experiment

Summary and acknowledgments

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- **CO_2** and **CH_4** fluxes significantly altered from simulated high rainfall period and do not recover after 4-weeks
- **Soil moisture** primary driver of **CH_4** flux which is **highly responsive** to high rainfall treatment but methanogenic and methanotrophic community abundance are poor predicters of net CH_4 flux
- **Soil moisture** indirectly reduces **CO_2** flux via altered soil enzyme activities and microbial biomass

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