Interactive Impacts of Warming and Drought on CH_4 Cycling in the S1 Bog

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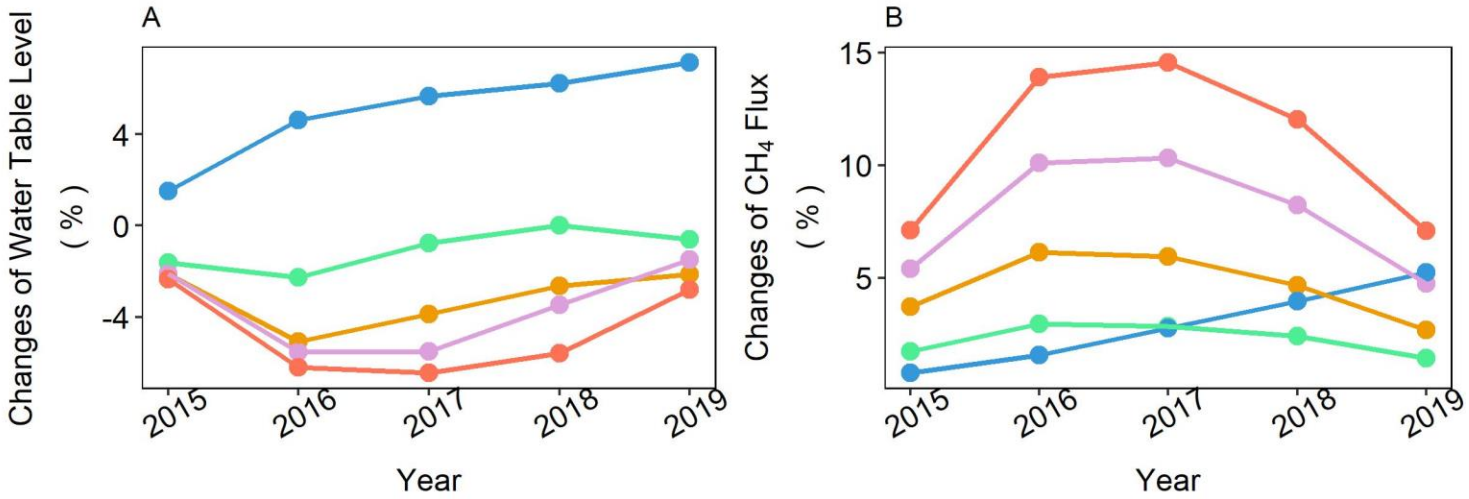
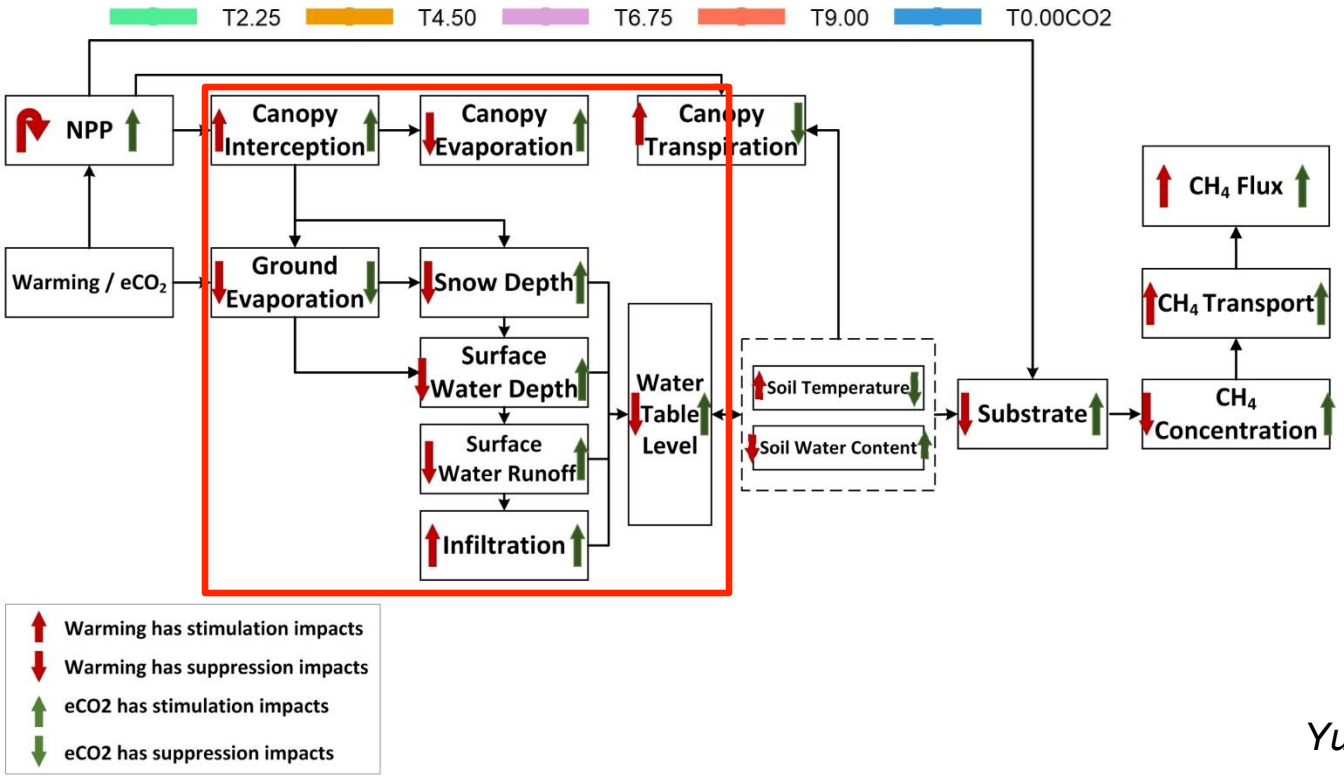
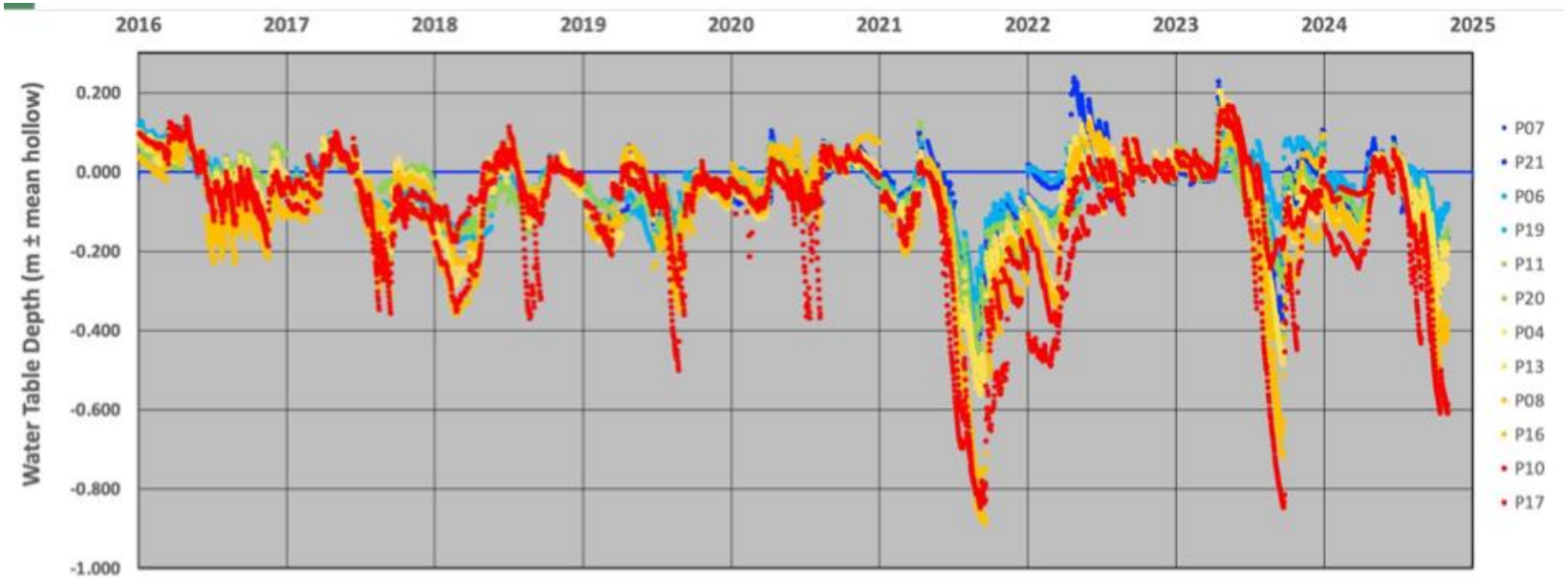
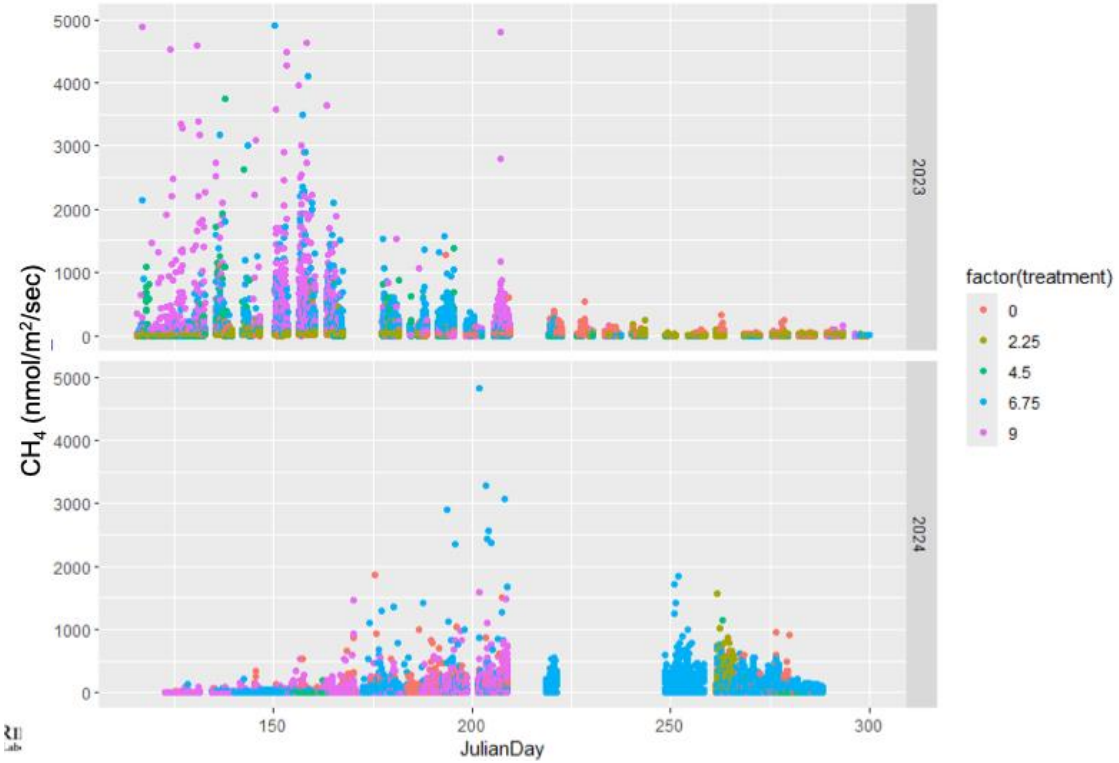
Hydrological feedbacks on CH_4 processes





Yuan et al., 2021





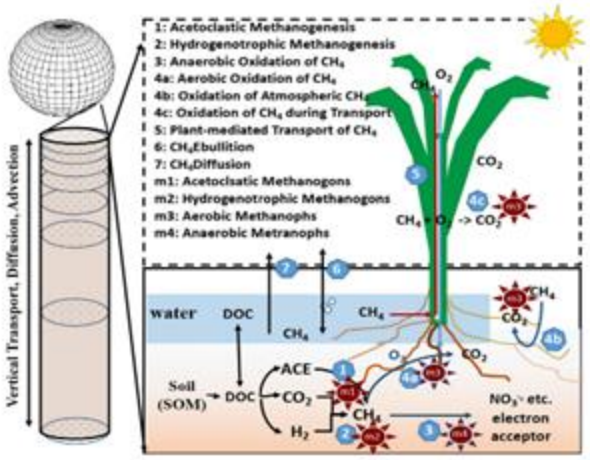
A severe drought in 2021 & a moderate drought in 2023

Conclusions based on observational data

- Warming impacts
- Drought impacts (high emissions in early season)

Hanson & Stelling et al., SPRUCE talk

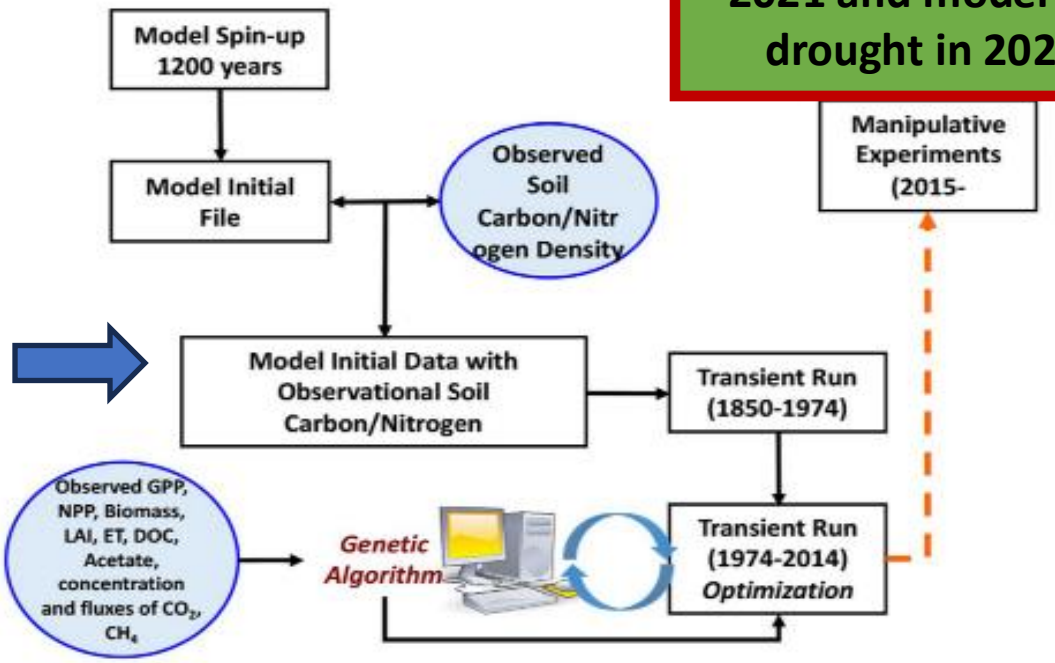
ELM-SPRUCE Methane Module



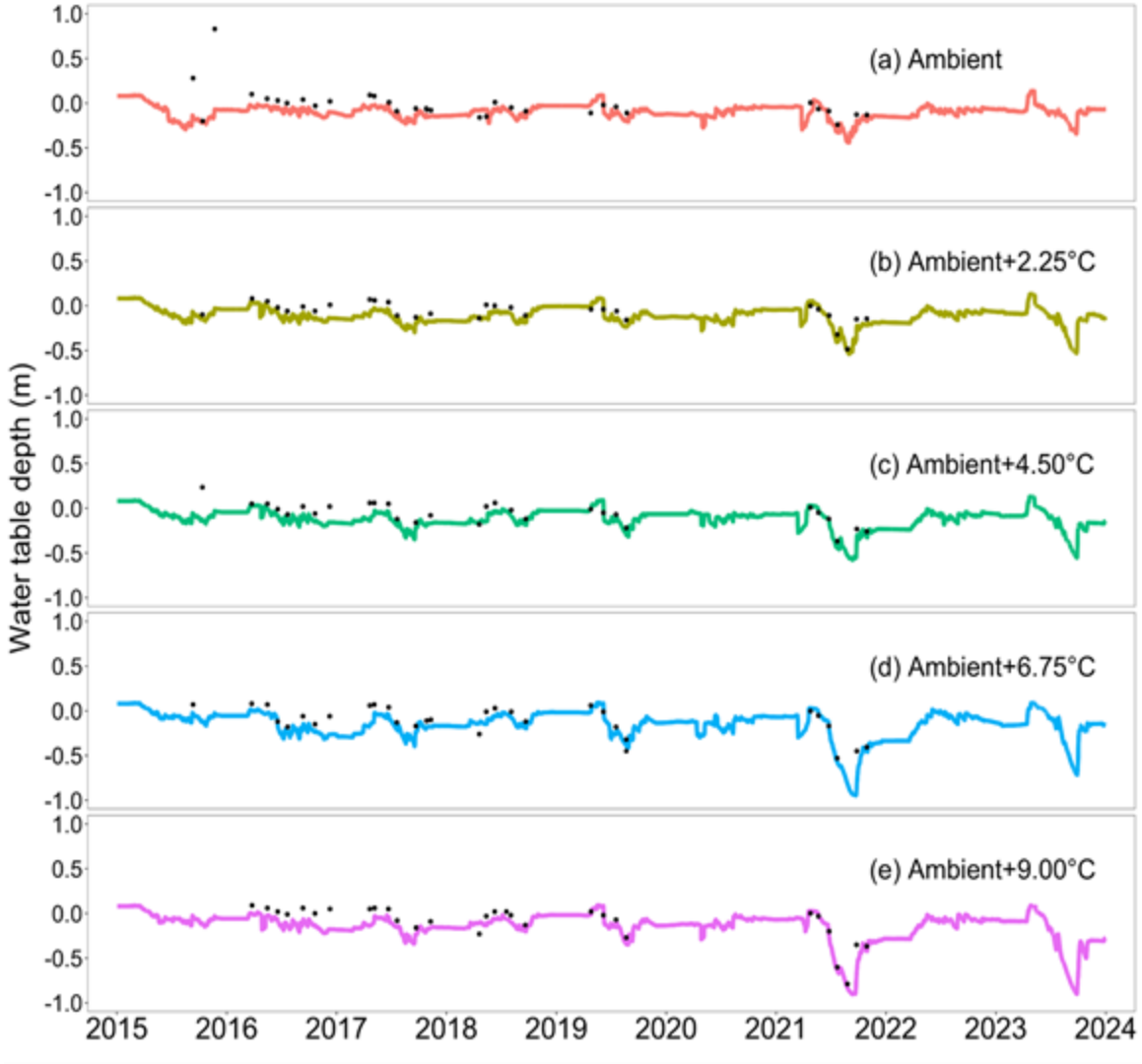
- Warming gradient (0-9)
- Drought gradient
  - Severe drought in 2021
  - Moderate drought in 2023
  - Regular year 2018

Transient runs for severe drought in 2021 and moderate drought in 2023

Water table and other driving forces

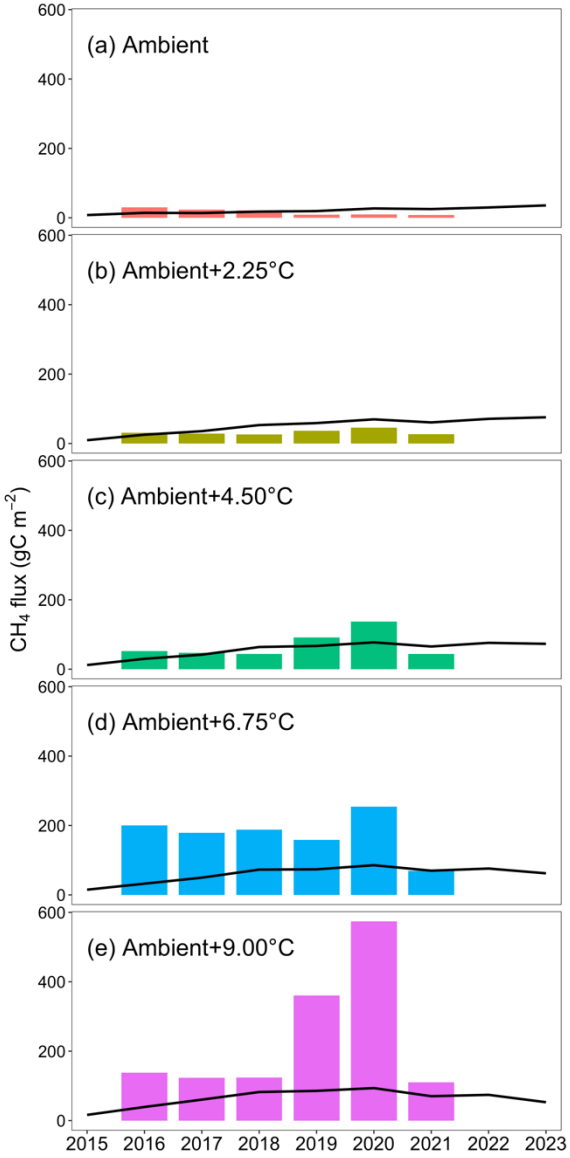


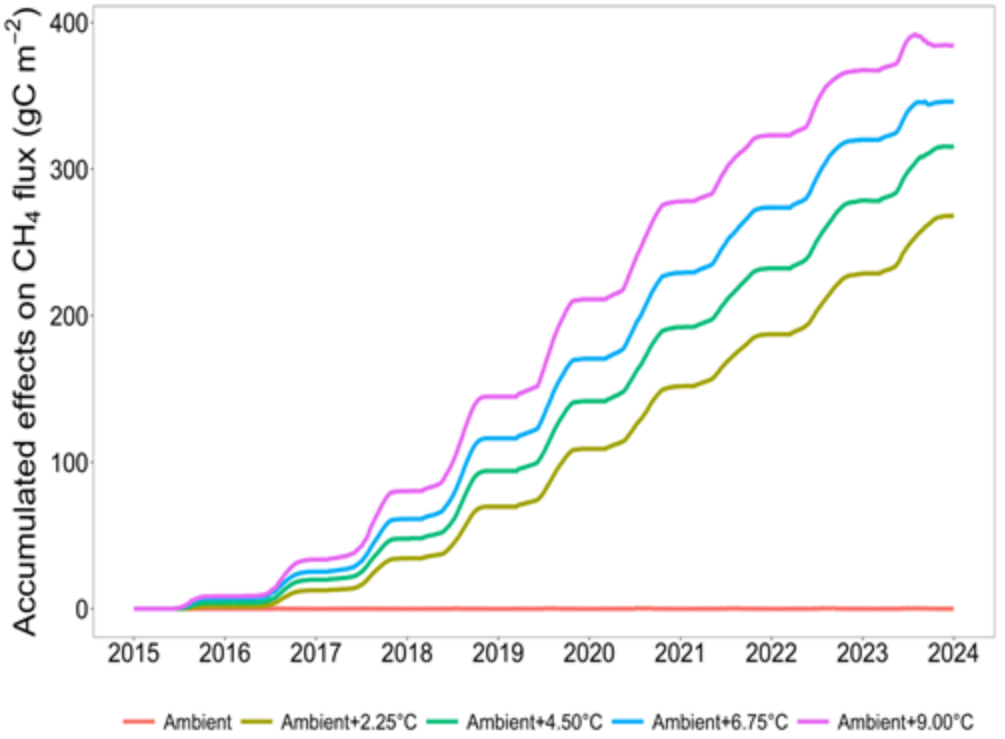
A severe drought in 2021 & a moderate drought in 2023



Water table drawdown is exacerbated along the warming gradient

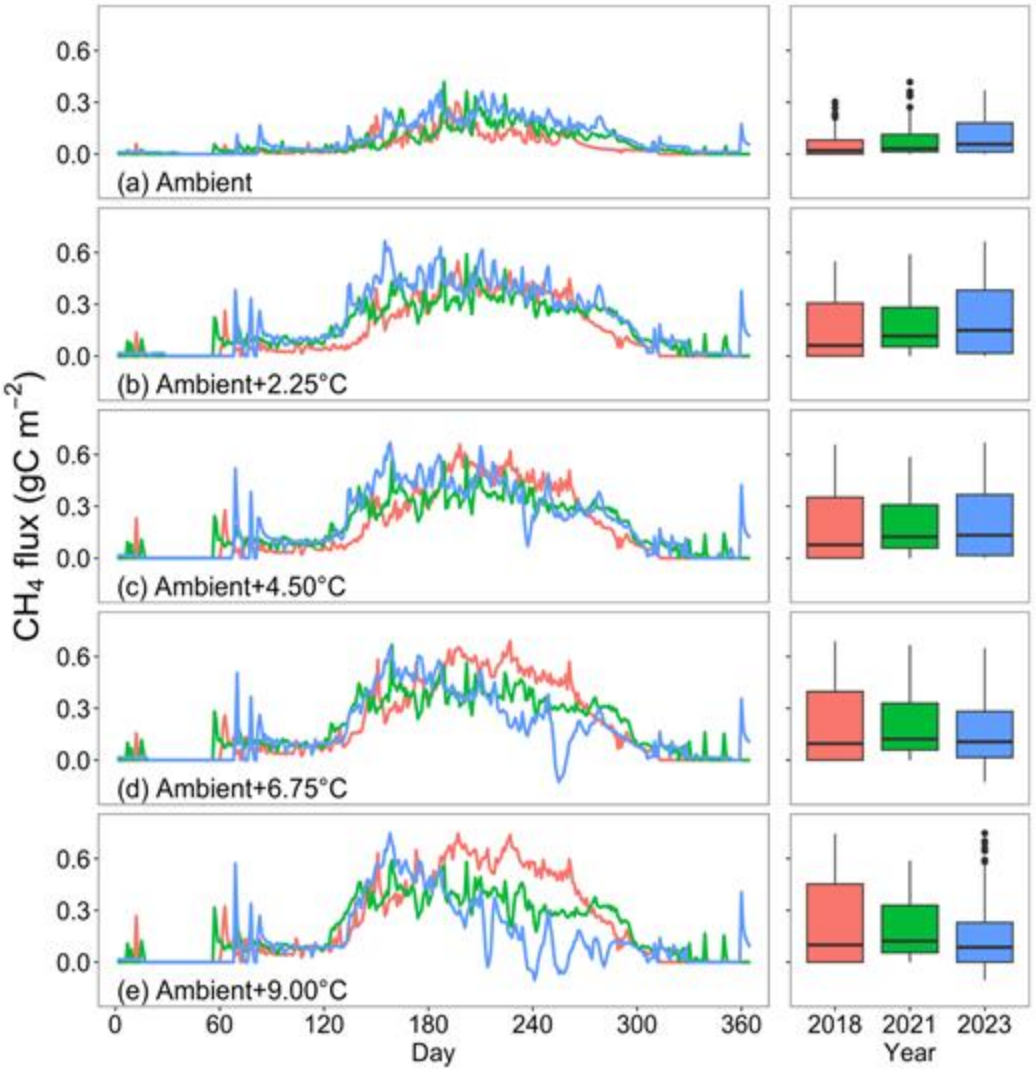
Warming impacts on CH_4 emission





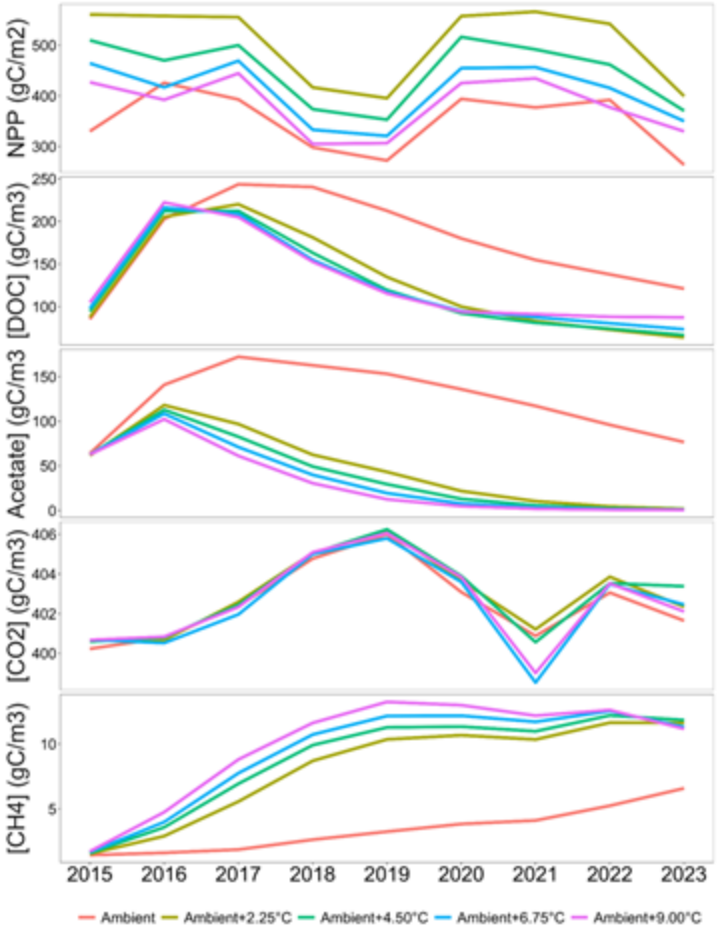
CH_4 flux increases with warmer temperatures

Warming and drought Impact on CH_4 flux



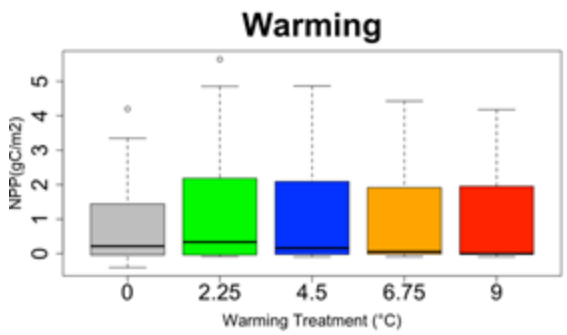
- Warming enhances CH_4 emission under normal climate conditions (2018-red lines) (A, B, C, D,E)
- CH_4 flux increases under both moderate and severe droughts without warming (panel A)
- Along the warming gradient, drought's suppression on CH_4 flux get stronger and stronger

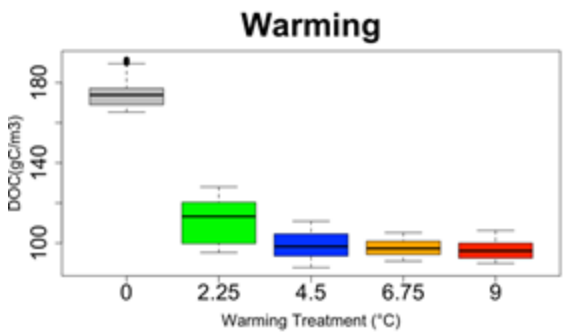
Methane substrates under warming & droughts

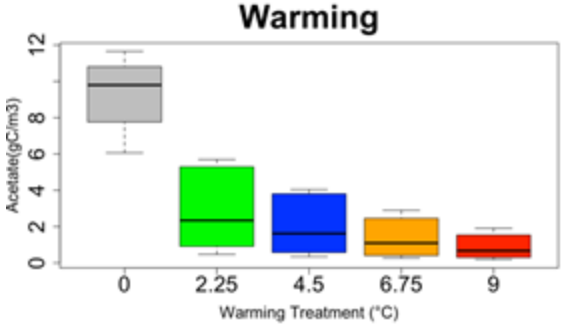


- Warming promotes NPP, but not for 9 C warming.
- DOC decreases with increasing temperature.
- Acetate decreases with increasing temperature.
- CO_2 concentration is not sensitive to temperature changes
- CH_4 concentration increases with increasing temperature.

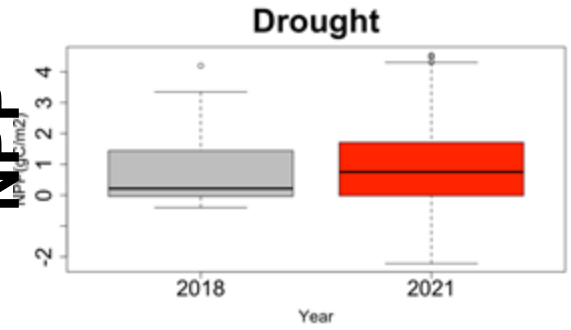
Substrate under warming and drought



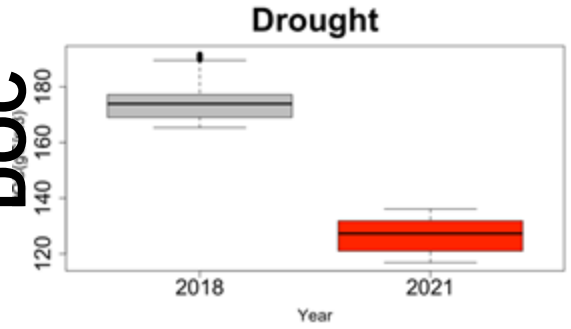




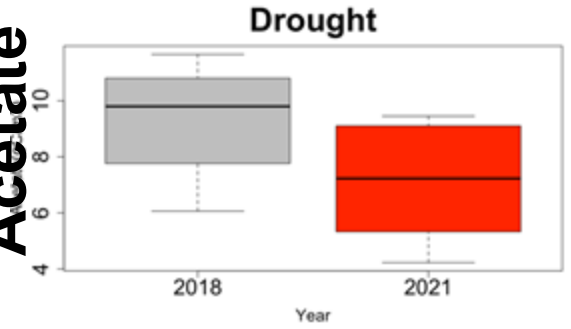
NPP

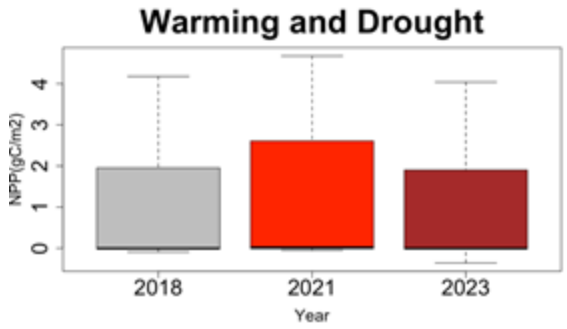


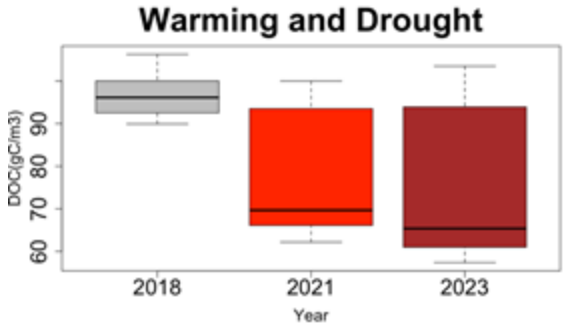
DOC

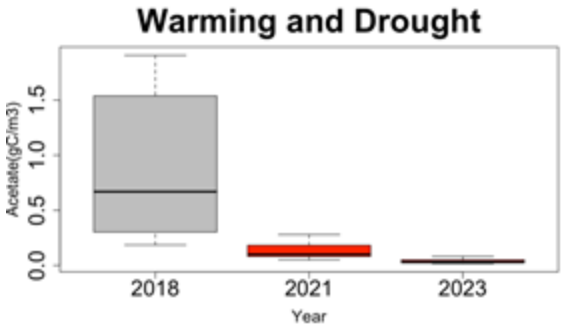


Acetate

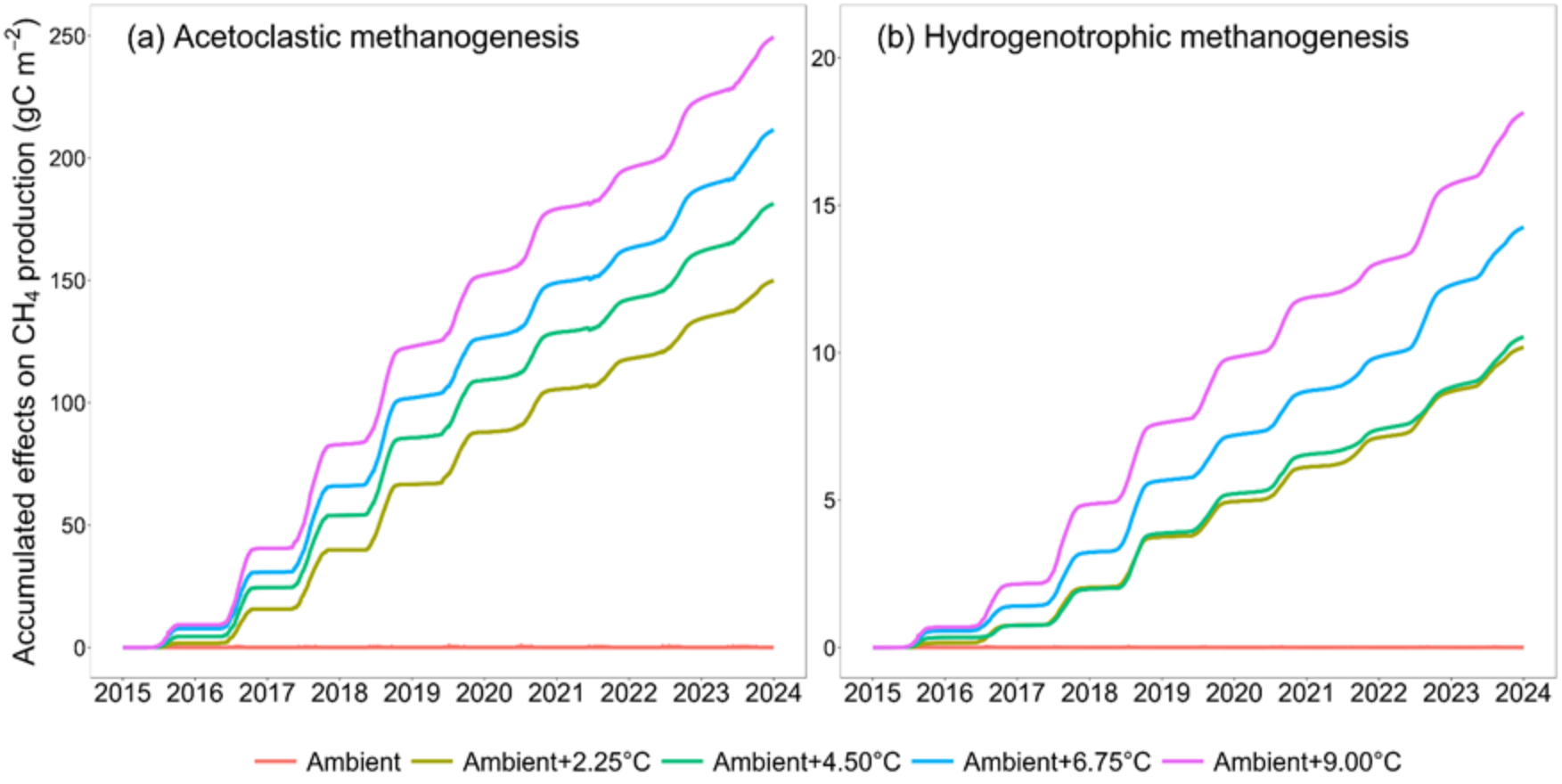






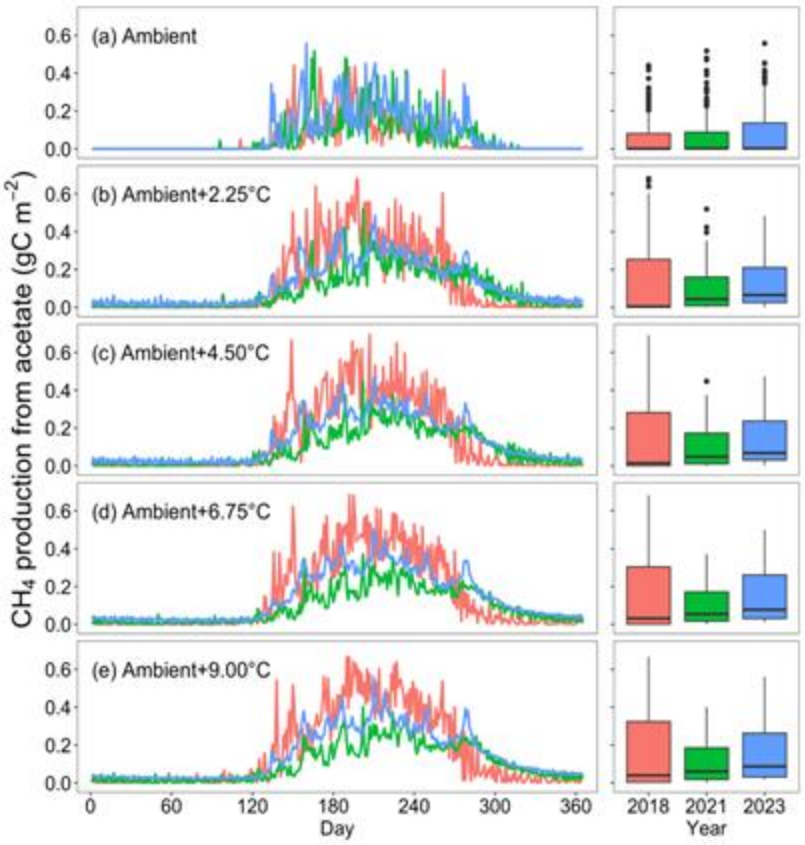


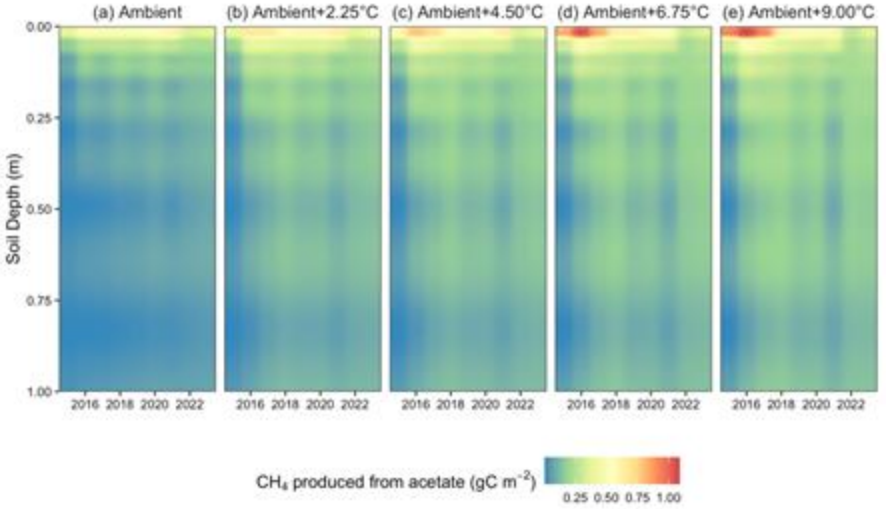
CH_4 Production Changes with Warming



CH_4 production from both pathways increases with increasing temperature

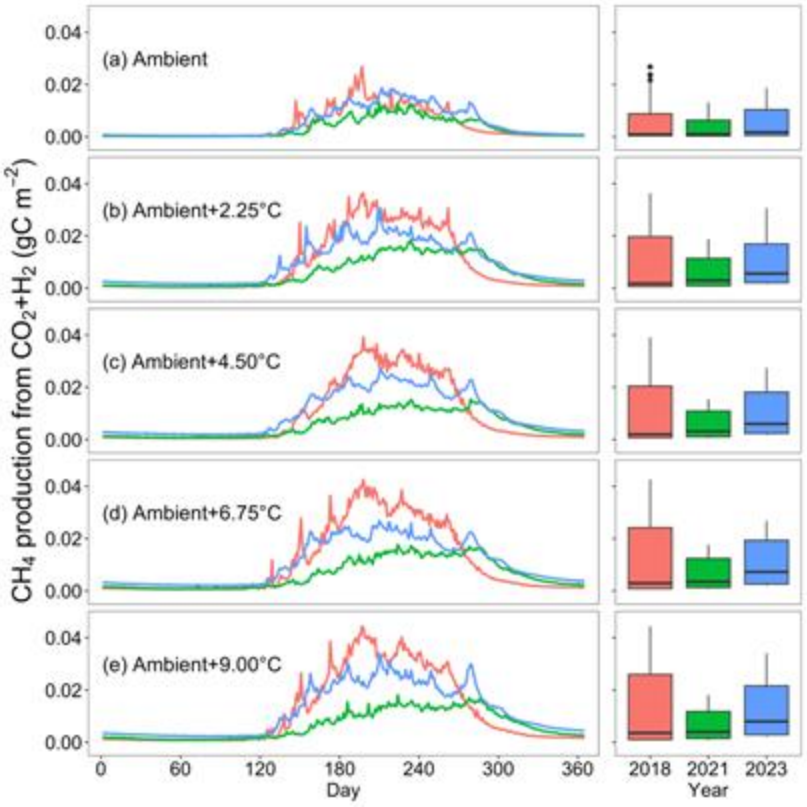
Aceclastic methanogenesis under warming and drought

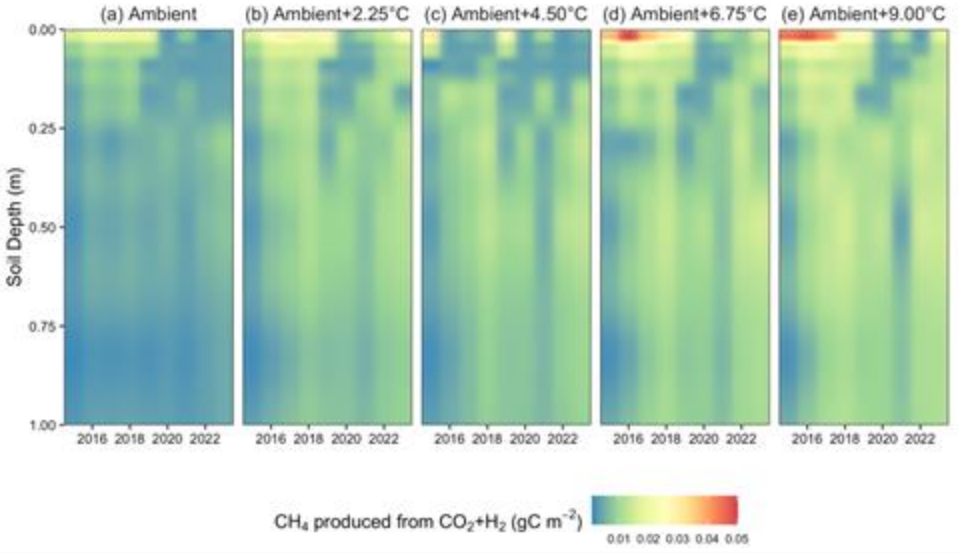




Under warming, CH_4 production decreases under moderate drought condition and decreases more under severe drought condition

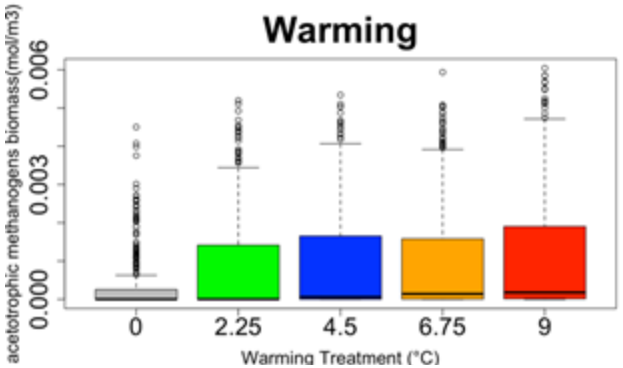
Hydrogenotrophic methanogenesis under warming and drought

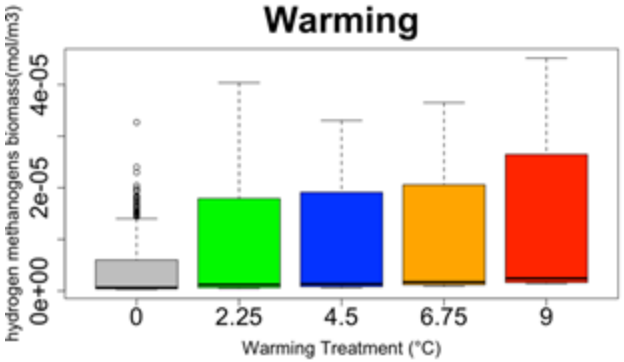


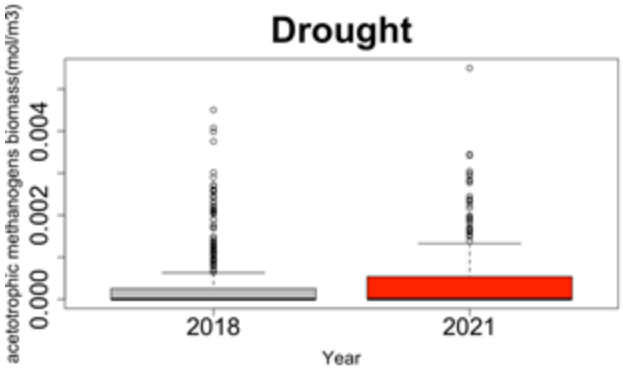


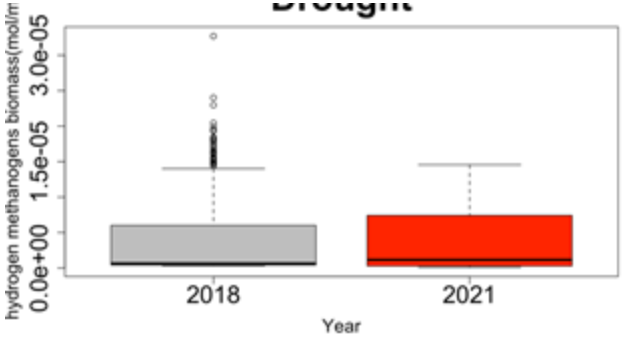
Under warming, hydrogenotrophic methanogenesis was enhanced but it was suppressed under moderate drought conditions

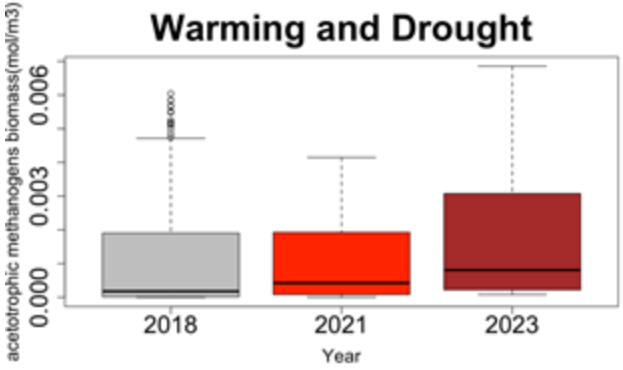
Microbes under warming and drought

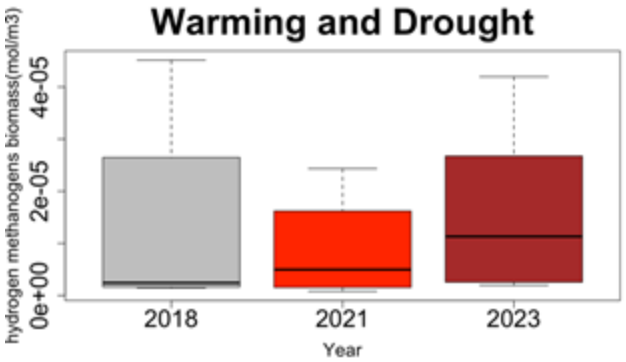




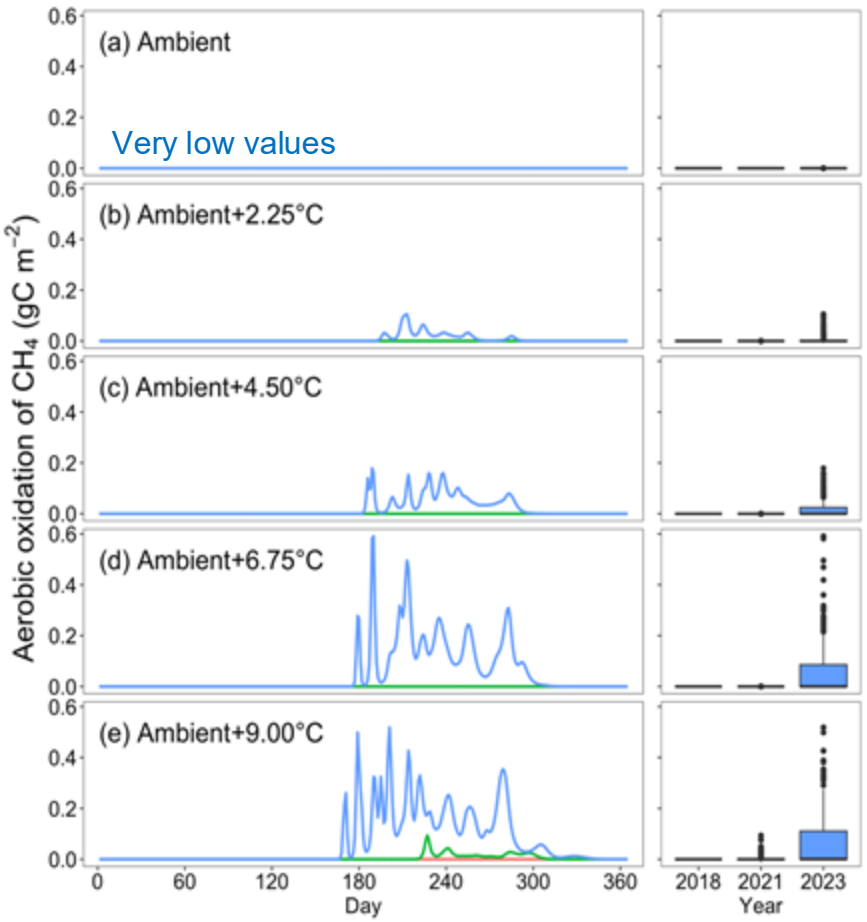


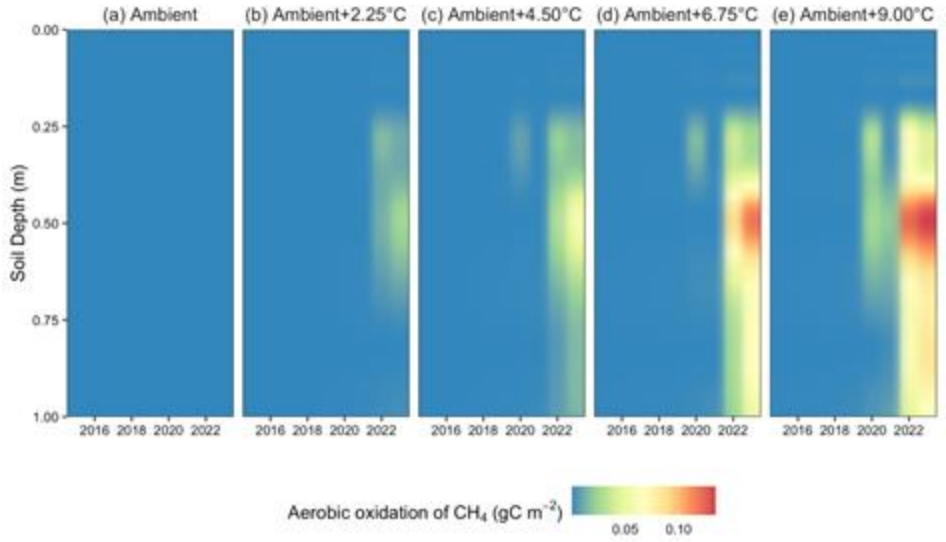






Oxidation of atmospheric CH_4 along soil column

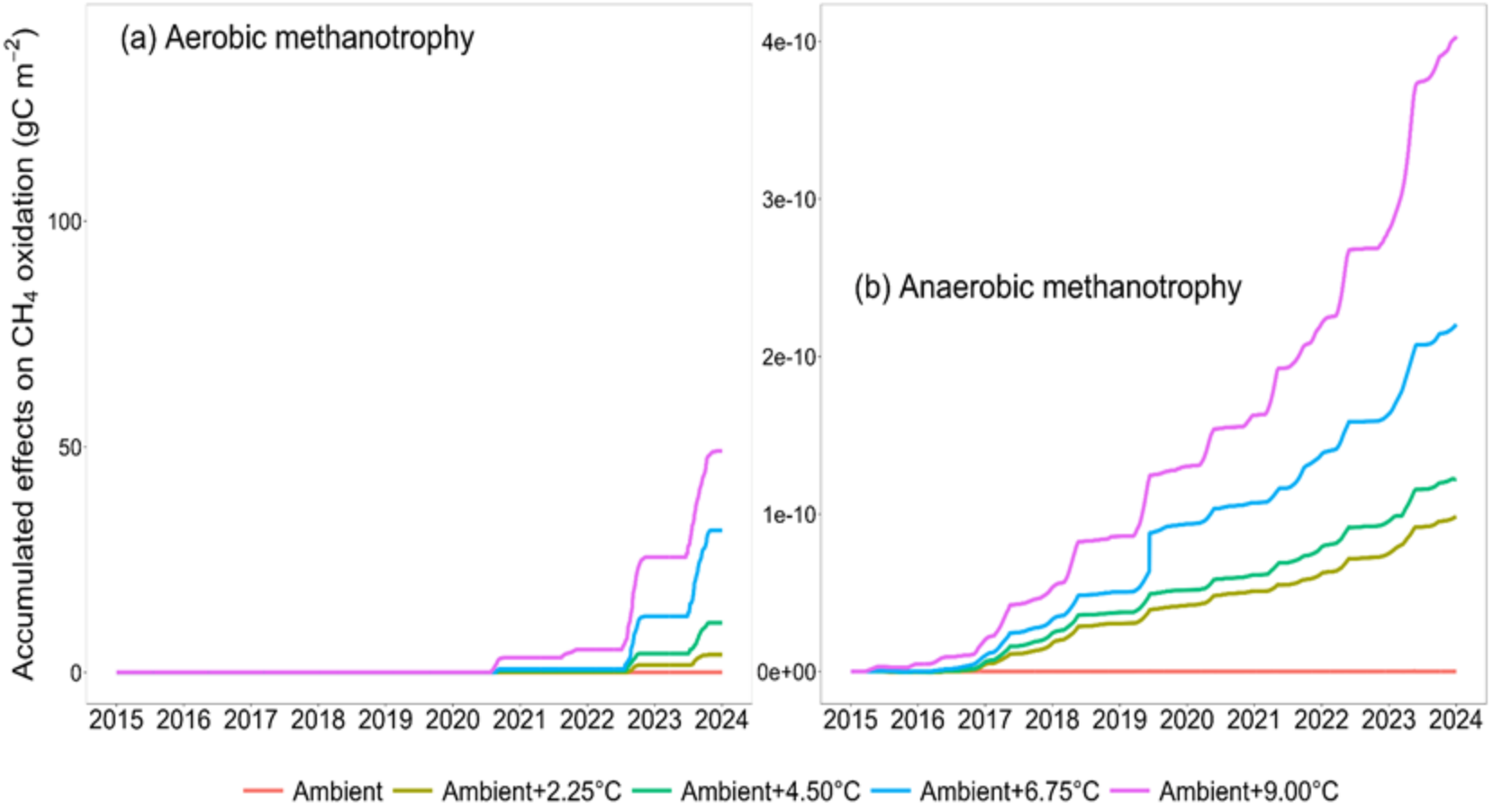




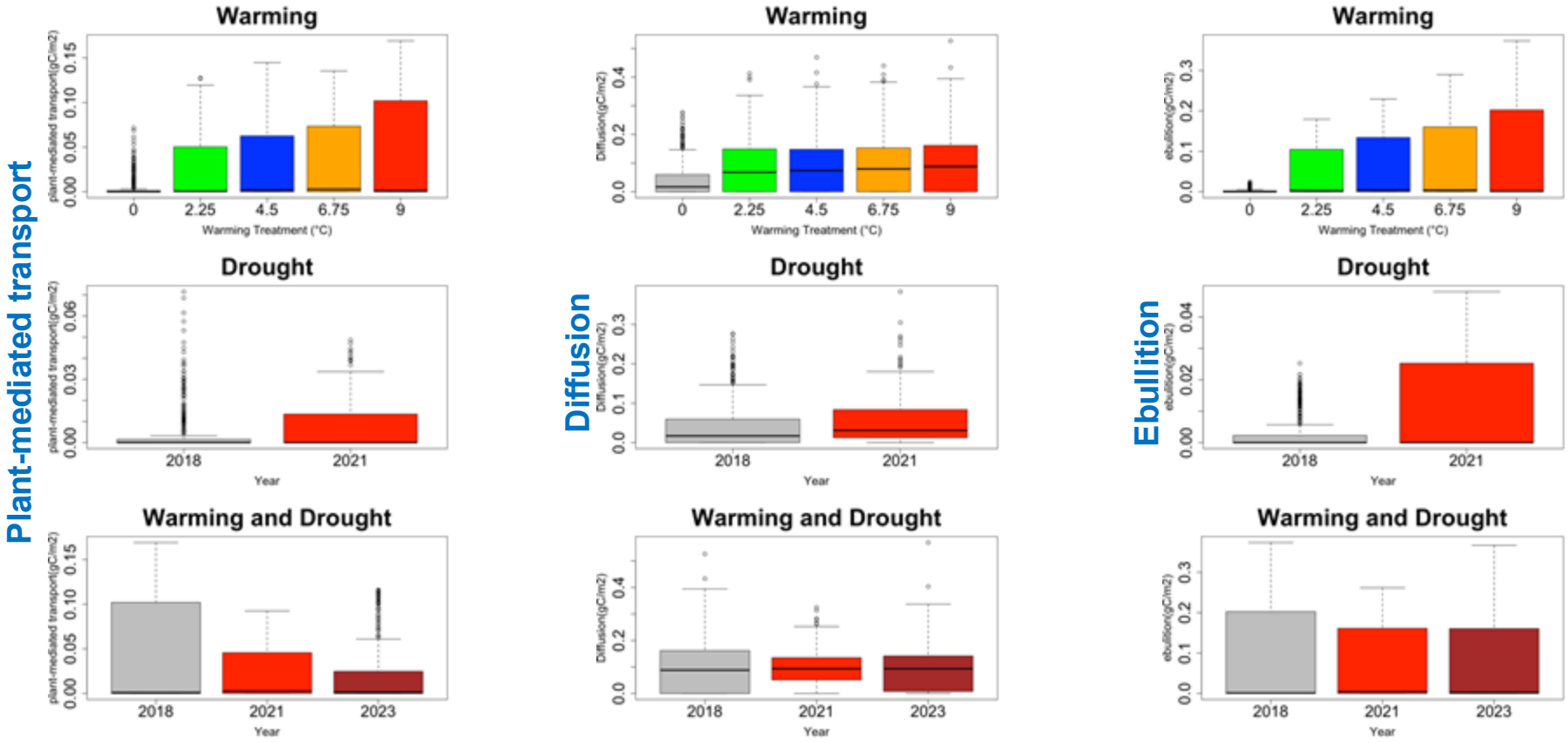
Oxidation of atmospheric CH_4 was enhanced under drought exacerbated by warming.

The increase is greater under moderate drought conditions (severe drought's legacy).

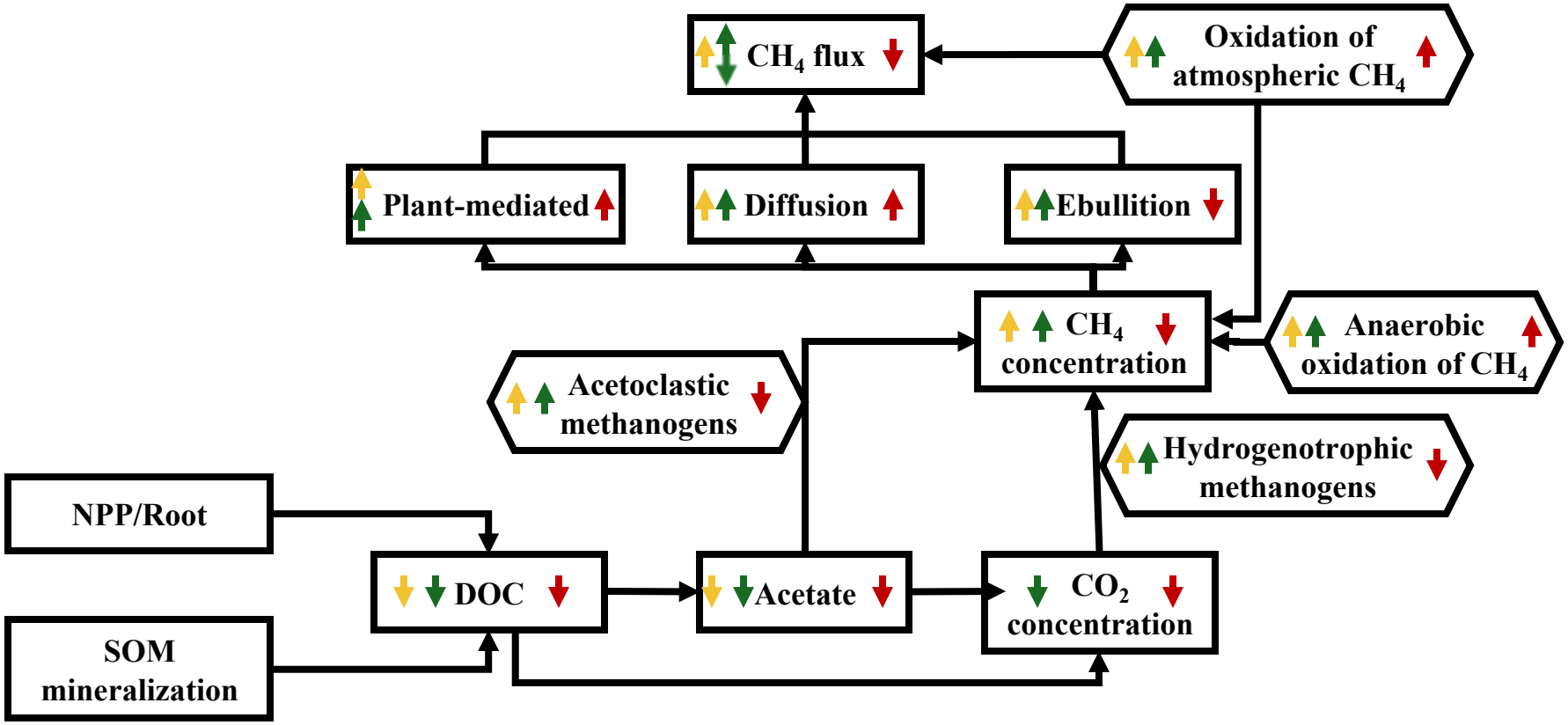
Oxidation of CH_4 produced in soil column



CH_4 transport under warming and drought



A mechanistic framework of warming and drought impacts on CH_4 flux



Warming has stimulation impacts

Warming has suppression impacts

Drought has stimulation impacts

Drought has suppression impacts

Warming & Drought has stimulation impacts

Warming & Drought has suppression impacts

Acknowledgements

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