UNDERSTANDING THE ROLE OF MINERAL WETLANDS AS NATURE-BASED CLIMATE SOLUTIONS IN AGRICULTURAL REGIONS OF CANADA

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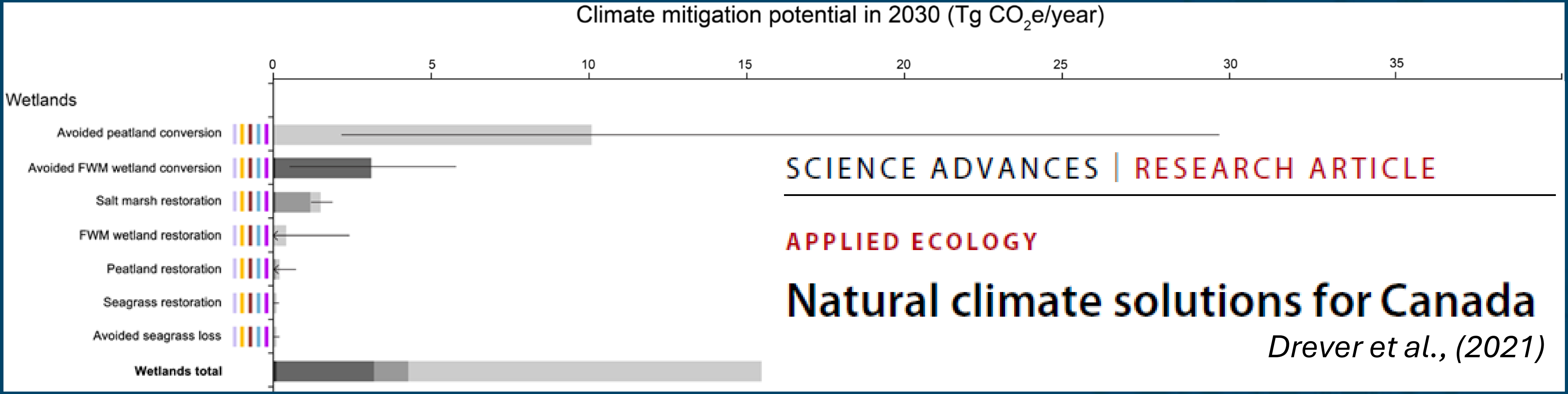
Wetlands as Nature-Based Climate Solutions



- **Wetlands can provide 15.5 (5.5 to 34.9) Tg CO_2e/year in 2030 and cumulatively 82.6 (27.0 to 195.6) Tg CO_2e between 2021 and 2030.**

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Wetlands as Nature-Based Climate-Change Solutions

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+ many students and staff!

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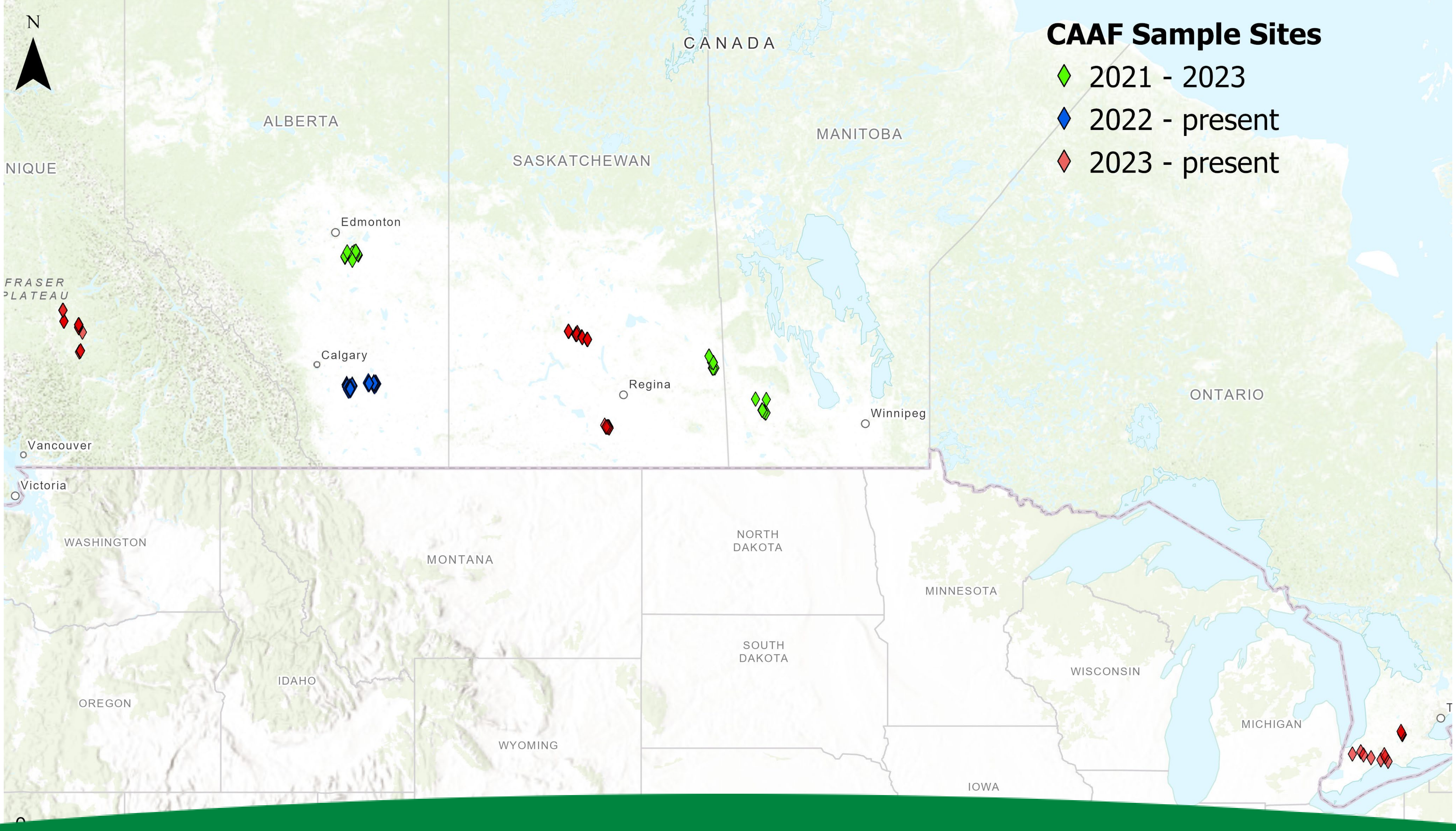

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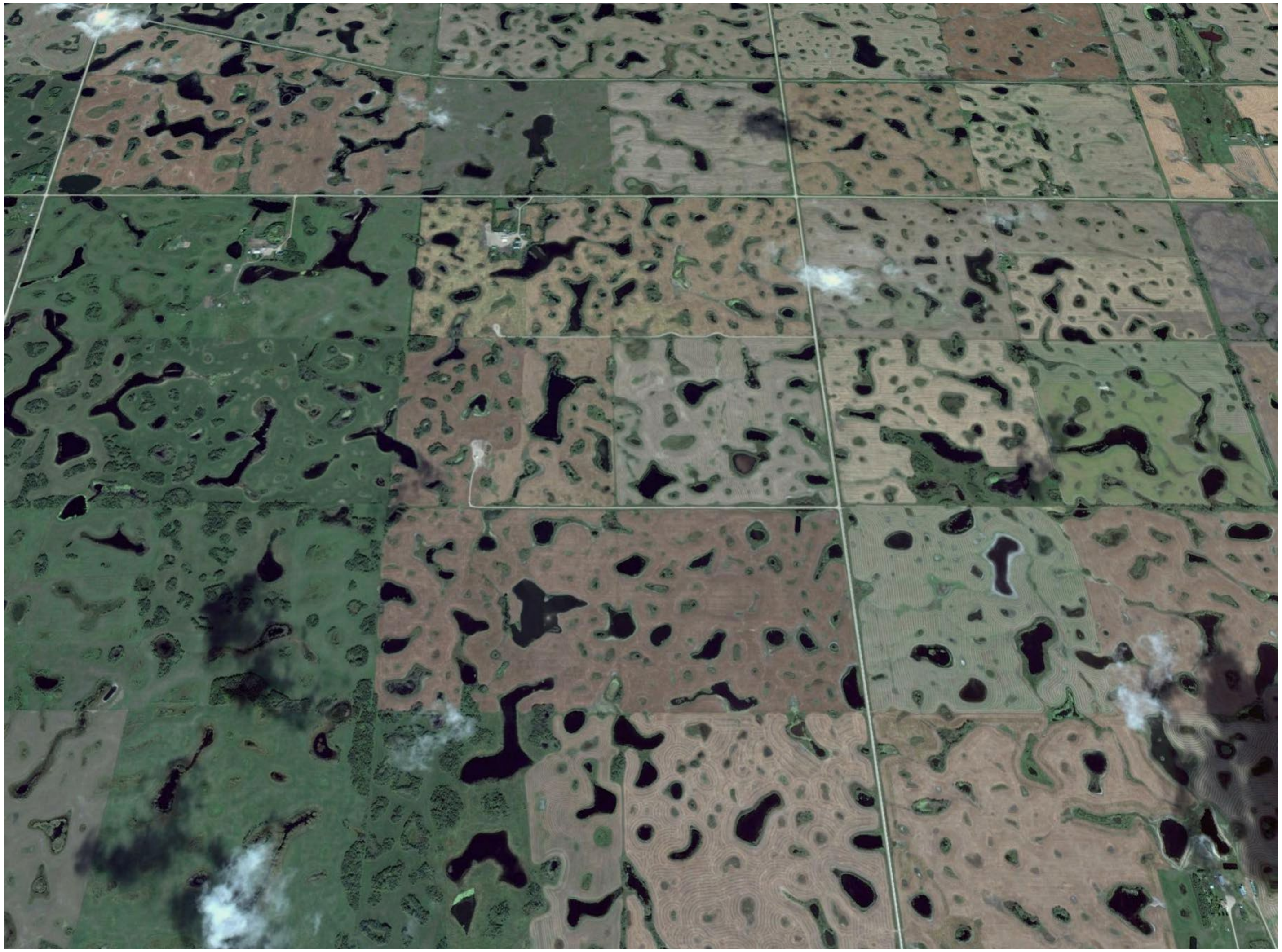
Prairie Pothole Region:

- Contains 5-8 million small wetland basins depending on moisture conditions



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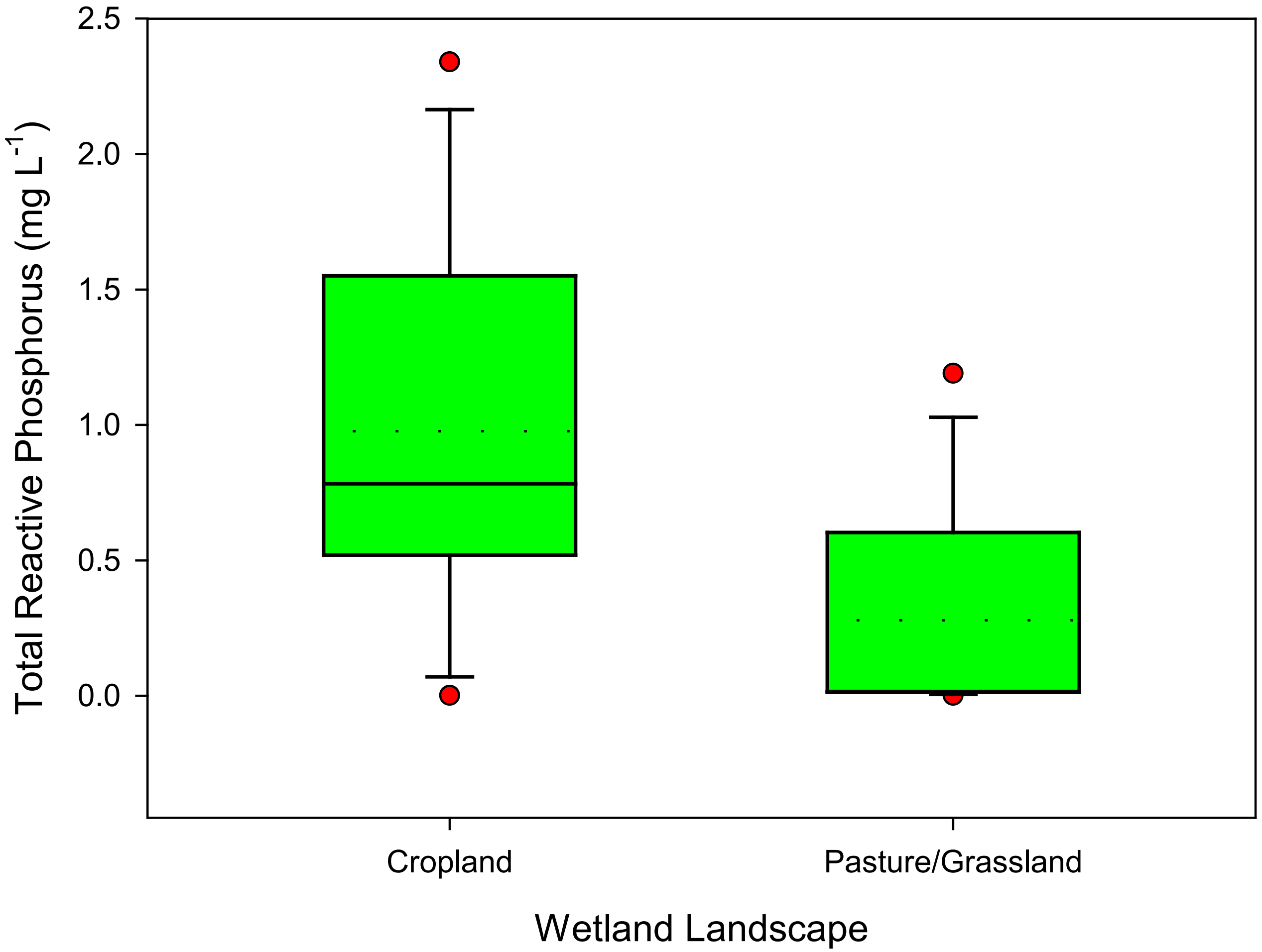
Survey of wetlands embedded in cropland vs pasture/grassland

- 31 wetlands were sampled, cropland (n=17), pasture/grassland (n=14)
- Mean [P] in cropland wetlands (0.98 mg L^{-1}) were more than 3x those in grass/pasture wetlands (0.28 mg L^{-1})
- Median [P] in cropland wetlands (0.78 mg L^{-1}) were more than 40x higher than those in grass/pasture wetlands (0.02 mg L^{-1})



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Research Design - PPR

- Monitored ~ 100 wetland sites across the three soil zones of the PPR (50% cropland, 50% perennial cover)
- Water quality / Water level
- Diffusive fluxes
- Ebullition (bubble traps)
- Sediment cores, dating Pb210/Cs137, carbon accumulation

- Deployed 3 wetland eddy covariance flux towers in Manitoba
  - Also measured diffusive fluxes, ebullition, and emissions through emergent vegetation

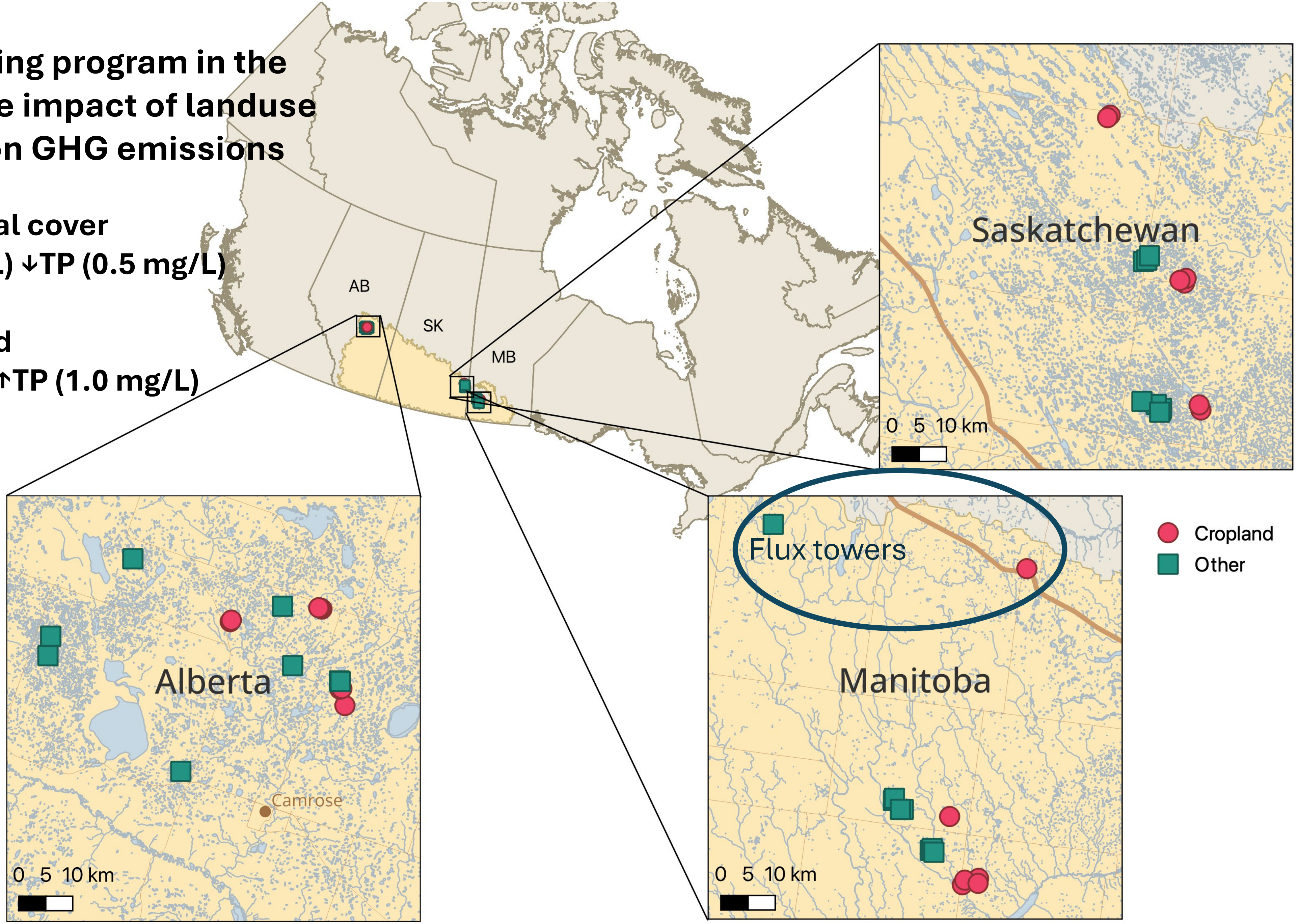
Extensive monitoring program in the PPR to examine the impact of landuse around wetlands on GHG emissions

Wetlands in perennial cover

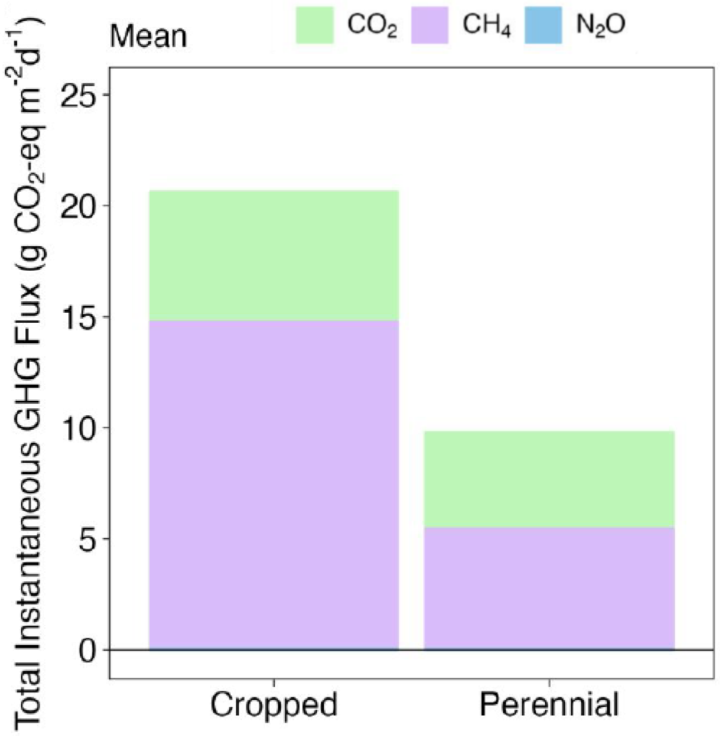
- **↑SO4 (1,041 mg/L) ↓TP (0.5 mg/L)**

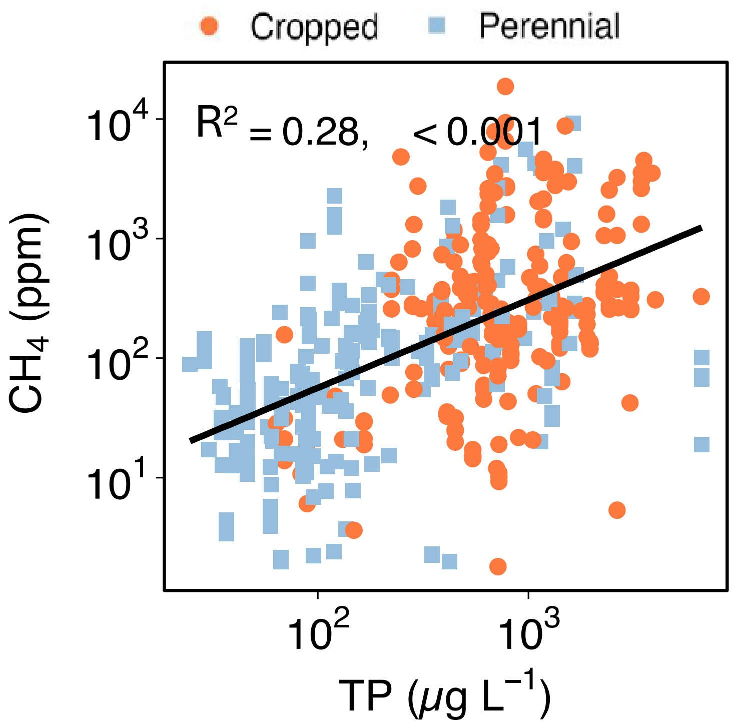
Wetlands in cropland

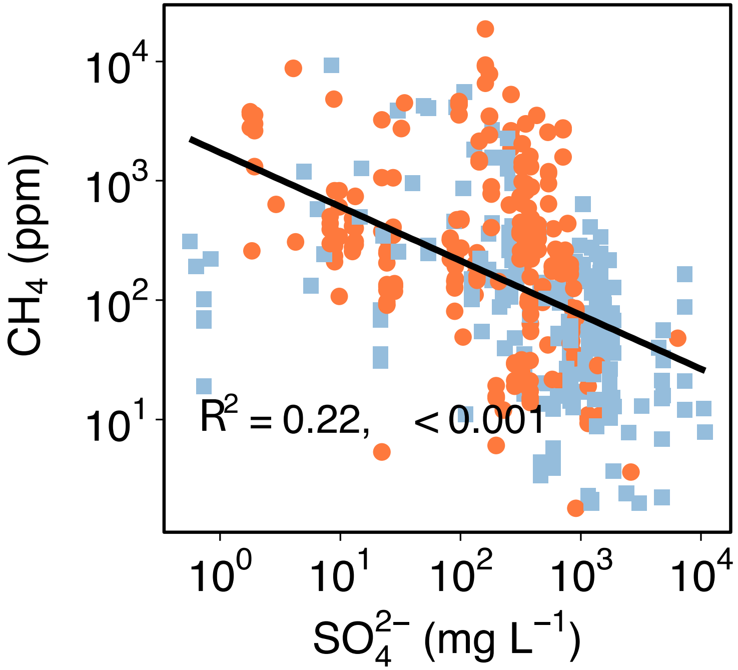
- **↓SO4 (537 mg/L) ↑TP (1.0 mg/L)**



CH_4 fluxes are higher in wetlands in cropland







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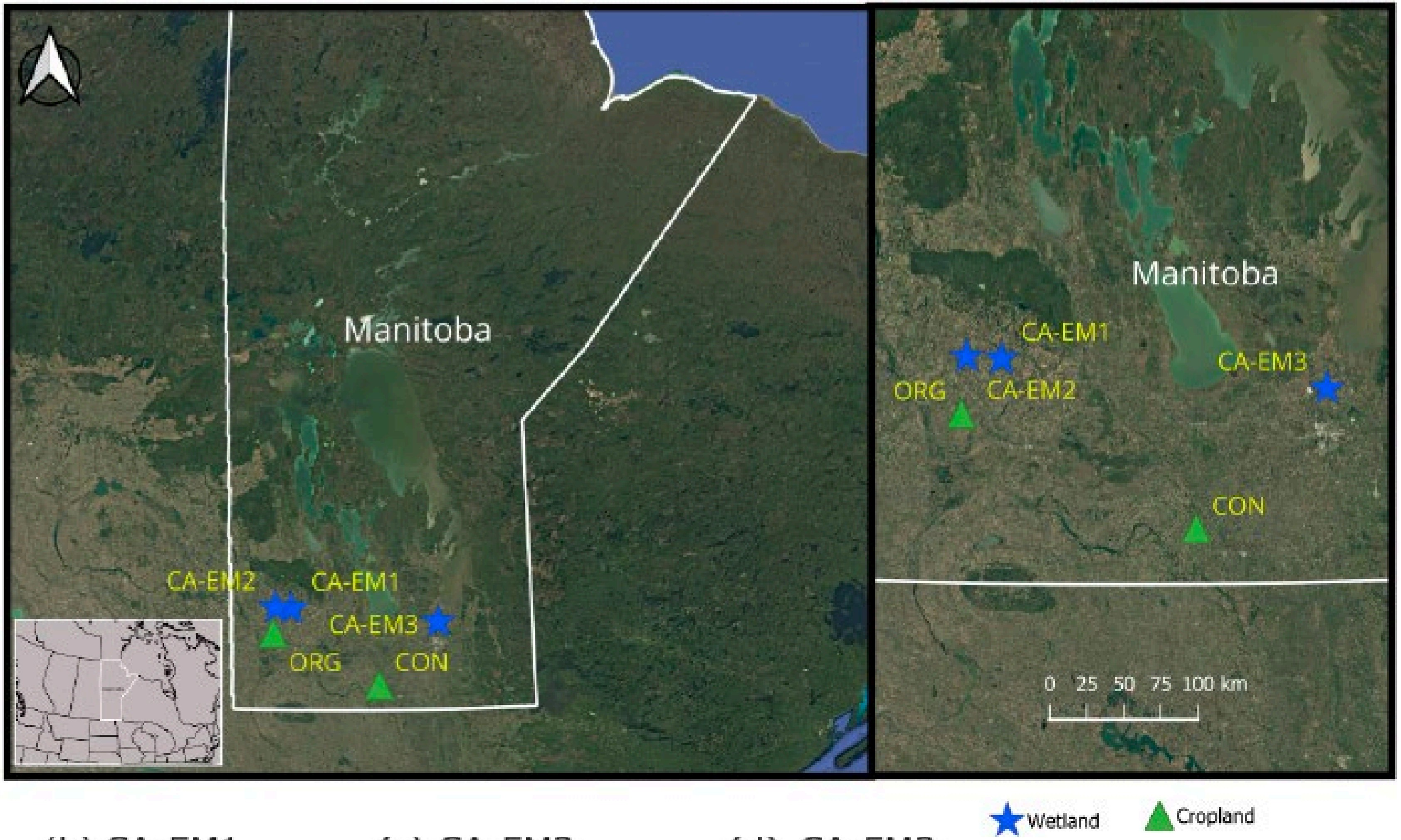
Logozzo et al., in review



(b) CA-EM1

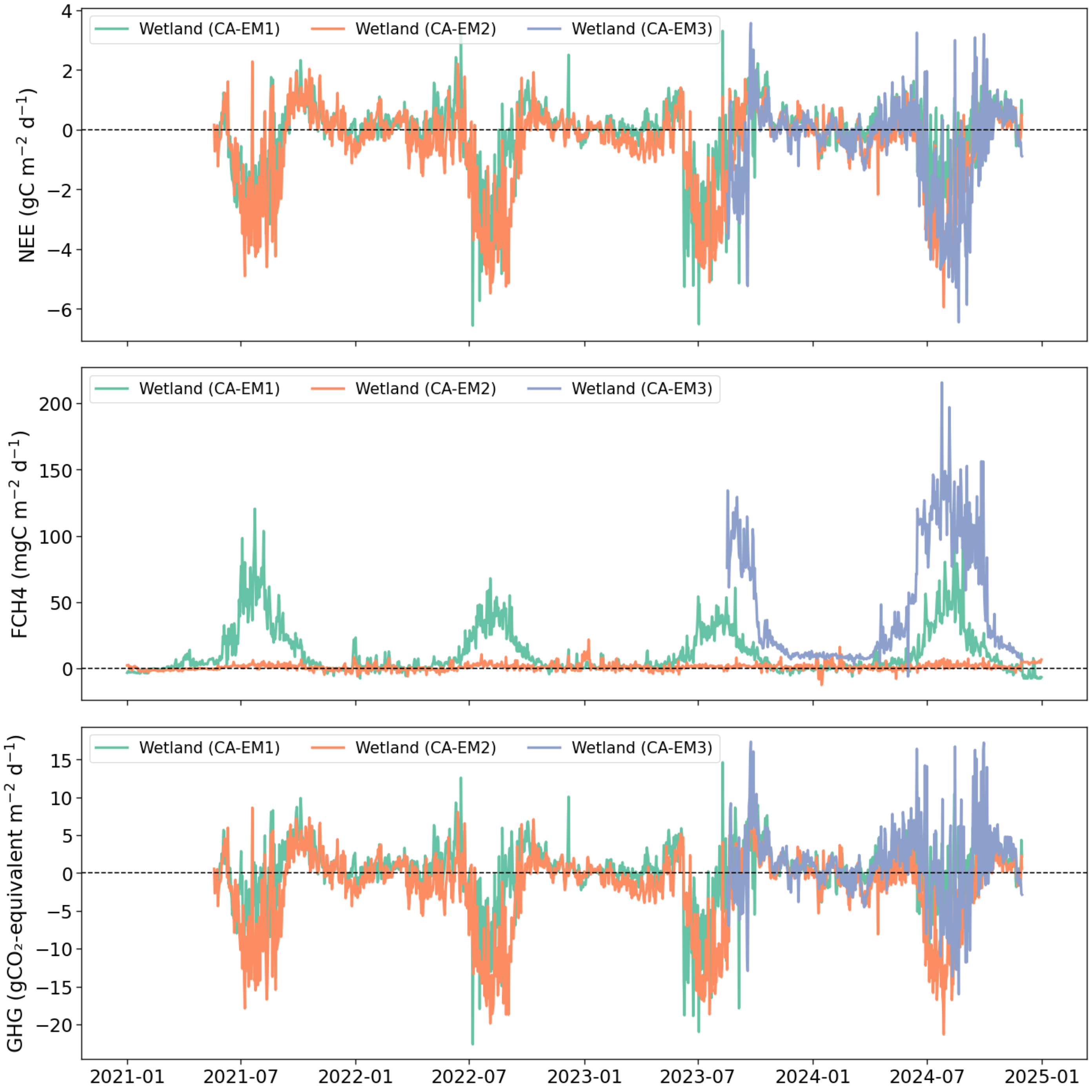
(c) CA-EM2

(d) CA-EM3

First Eddy Covariance Flux Tower deployment in Prairie Wetlands

- CA-EM1 is surrounded by croplands.
- CA-EM2 is surrounded by grassland
- CA-EM3 large restored wetland

Daily mean fluxes of NEE, FCH4 & GHGs



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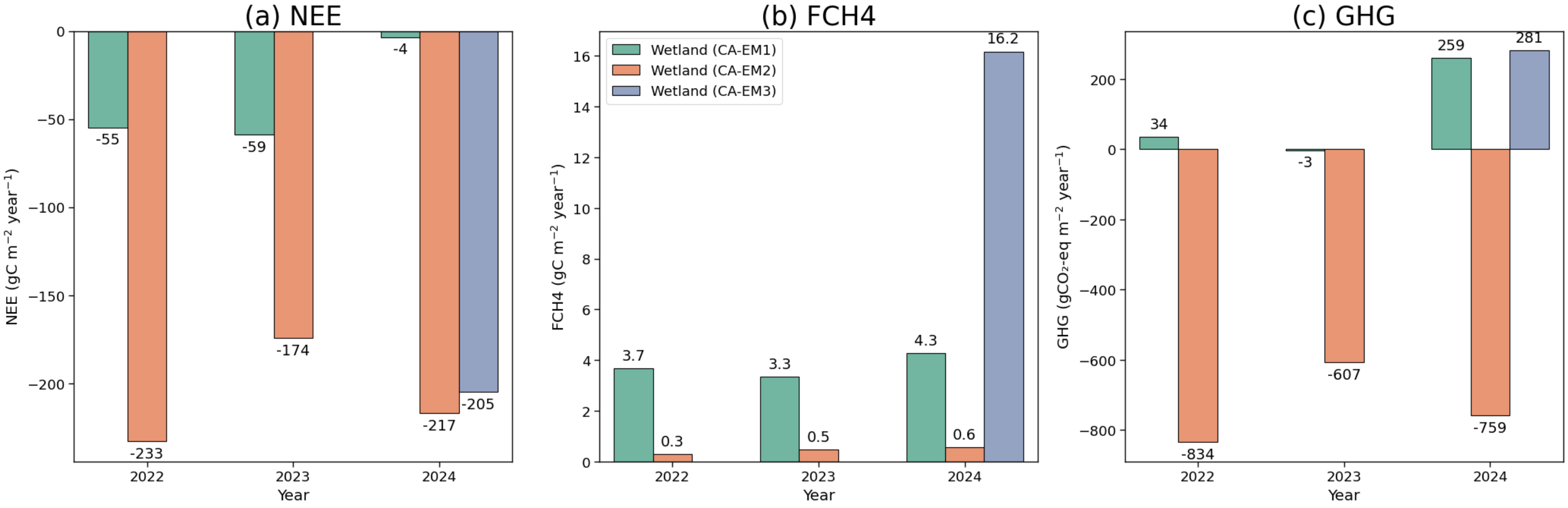
Large variability in GHG fluxes across sites



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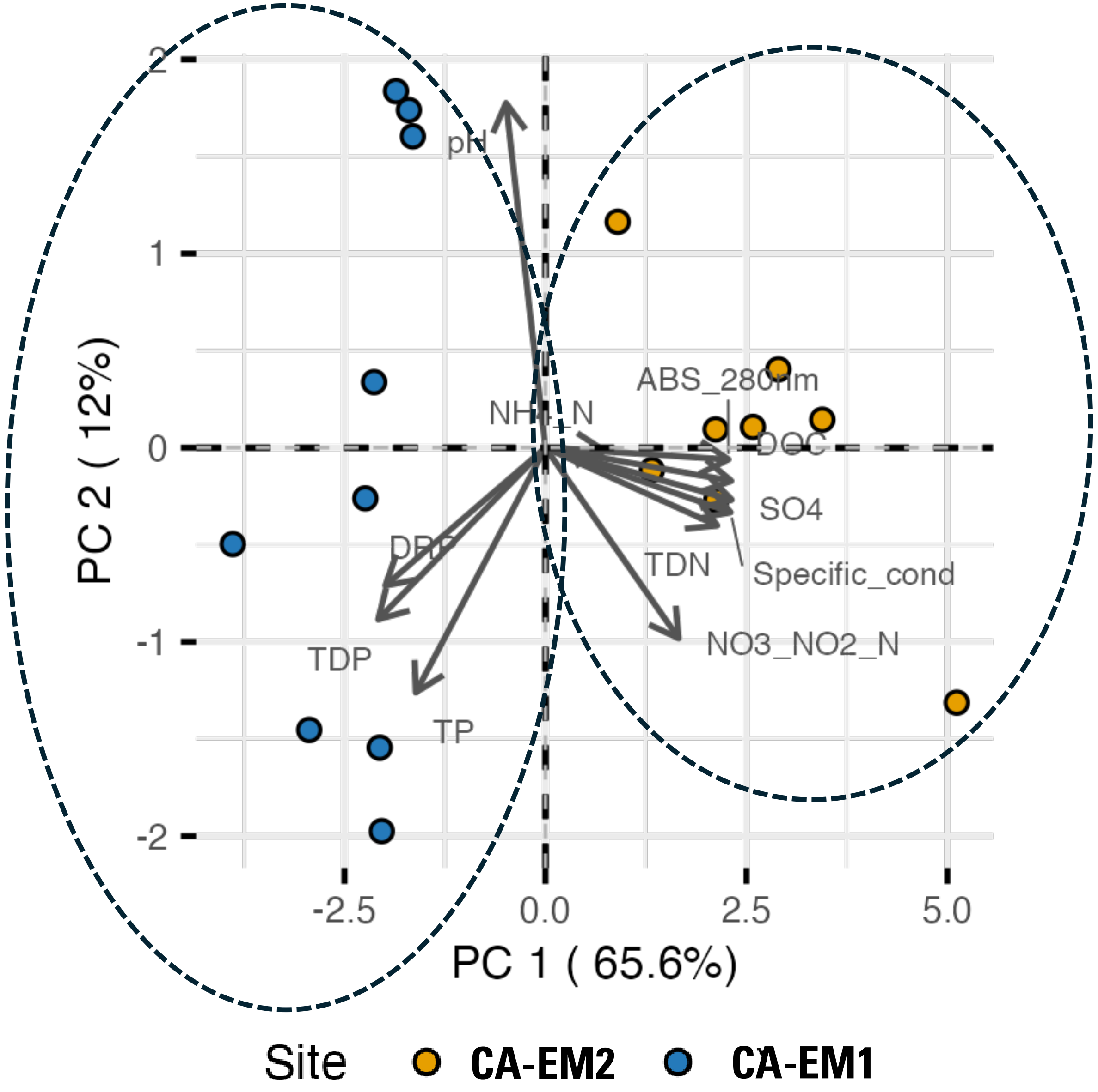
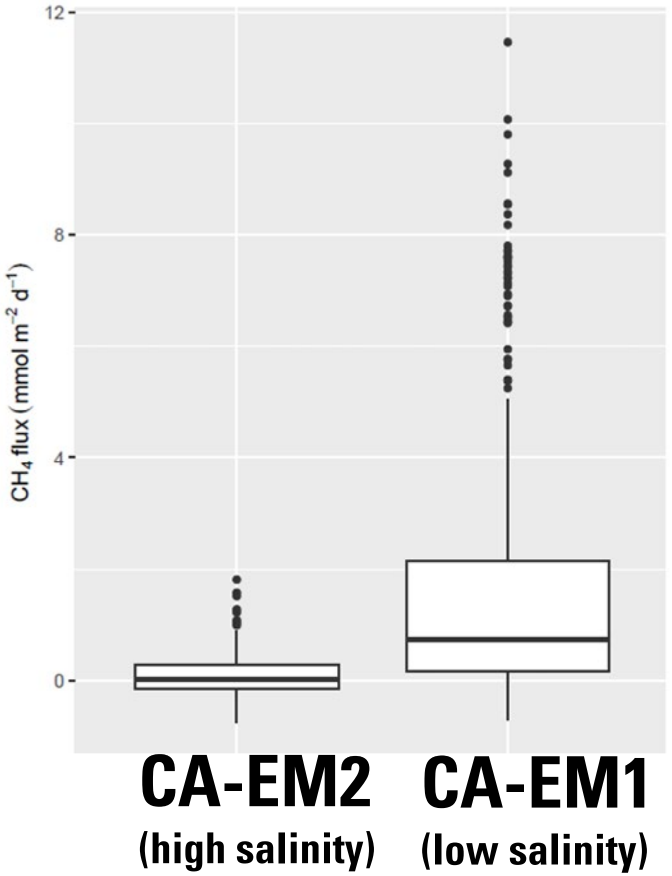
DIFFERENCES DRIVEN BY VARIATIONS IN WATER CHEMISTRY?



- **CA-EM2** – higher sulfate, conductivity, DOC, TDN
- **CA-EM1** – higher P & pH



Comparison of flux tower CH4 emissions and IPCC default emission factors

TABLE 5.4
DEFAULT EMISSION FACTORS FOR CH_4 FROM MANAGED LANDS WITH IWMS WHERE WATER TABLE LEVEL HAS BEEN RAISED

Climate Region	$EF_{CH4\text{-}IWMS}$ (kg CH_4 ha^{-1} yr^{-1})	95% Confidence Interval[A]	Number of Studies
Boreal	76	±76[B]	1[C]
Temperate	235	±108	21
Tropical	900	±456	18

Prairie Flux Tower CH4 emissions

- CA-EM1 wetland – (in cropland) 50.7 kg CH4/ha/y
- CA-EM2 wetland – (in perennial) 6.7 kg CH4/ha/y
- CA-EM3 wetland – (large restored marsh) 216 kg CH4/ha/y
- Need to consider landuse

Wetlands help buffer against the impacts of climate change

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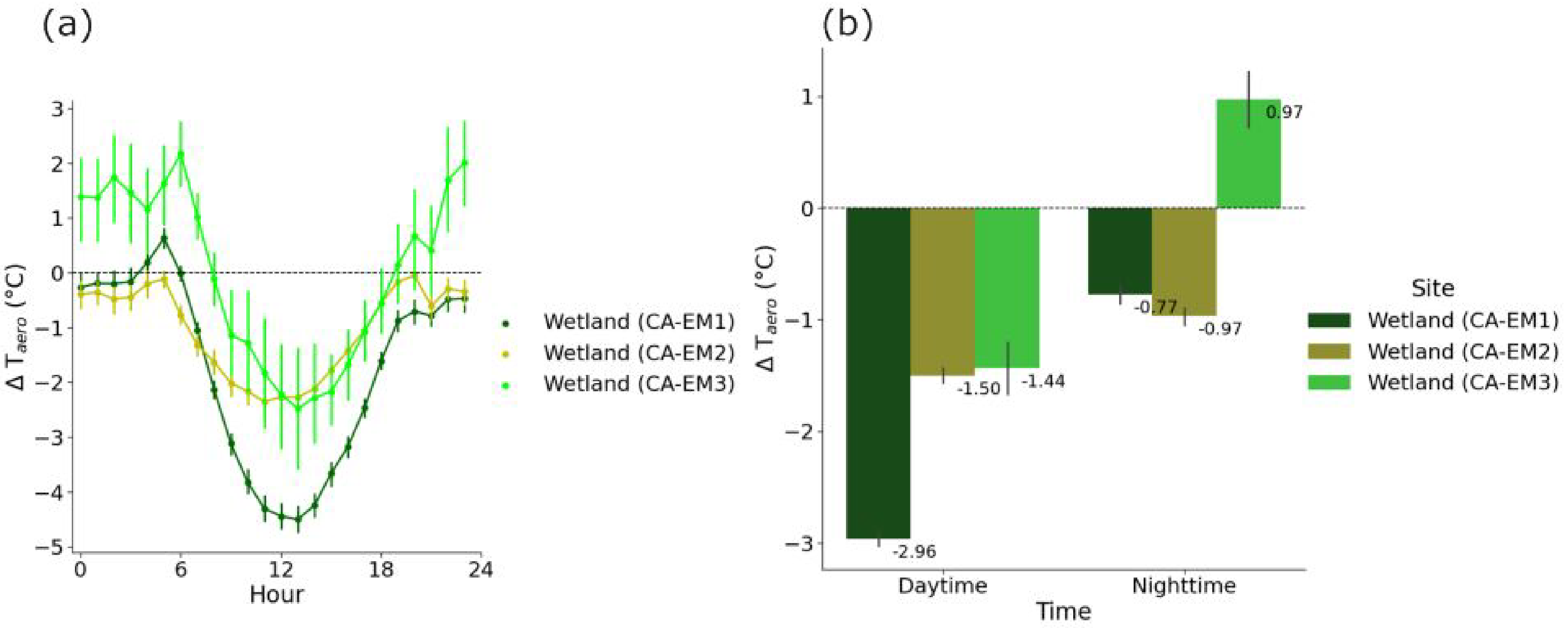
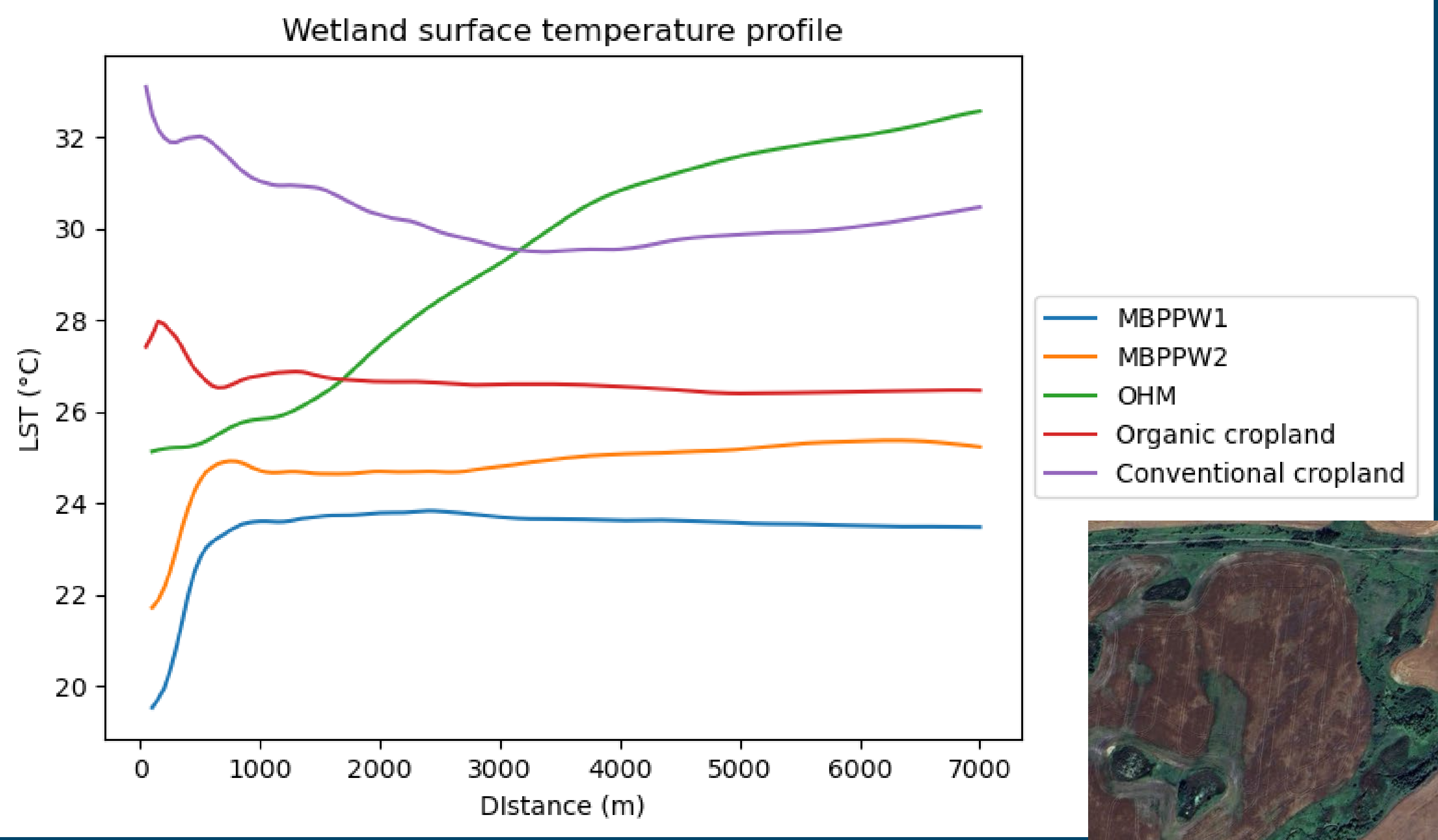
Evident cooling effects of surface wetlands to mitigate climate change - a study of the Prairie Pothole Region (Zhang et al., 2021)

- Dynamic wetland scheme was tested using the coupled WRF model, demonstrated evident cooling effect of 1~3℃ in summer where wetlands are abundant
- Simulation indicated a reduction in the number of hot days by more than 10 days over the summer period

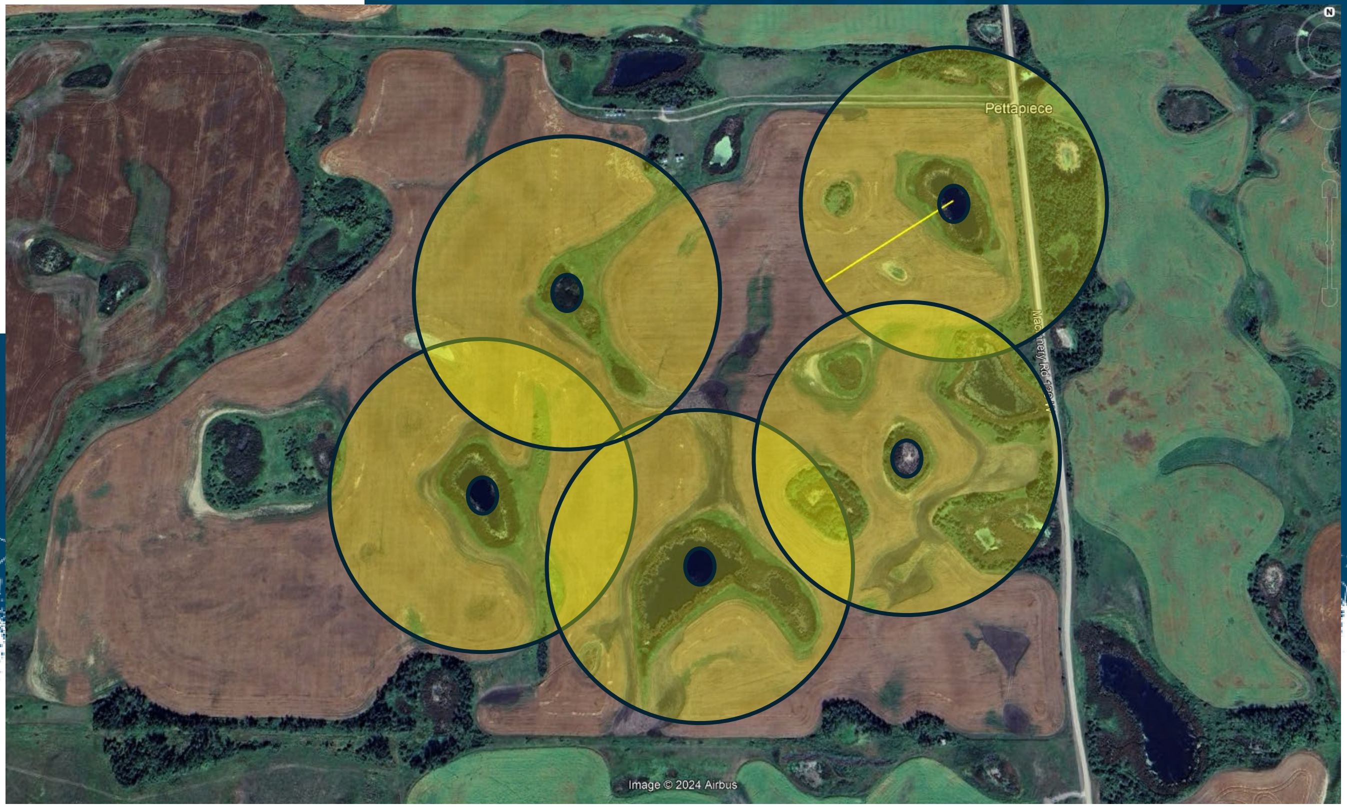
Biophysical impacts of wetlands on local and regional climate (observed at wetland tower sites)



(a) Mean diurnal aerodynamic temperature (Δ Taero) differences between the respective wetland sites and the mean of the reference cropland sites during the growing season (May– September) and (b) Mean daytime and nighttime Δ Taero for the three wetlands (from Ahongshangbam et al., 2025 in review).



Do wetlands produce a goldilocks zone where crop yield is improved, particularly in times of drought?



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Conclusions

- Landuse surrounding prairie wetlands appears to regulate CH_4 emissions by influencing water quality.
- CH_4 emissions at wetland flux towers over a 3-year period suggest that Tier 1 IPCC default emission factors significantly overestimate emissions from prairie wetlands.
- When considering the role of wetlands as nature-based solutions for mitigating impacts of climate change we also need to consider their biophysical impact at the local/regional scale.
- Next steps, examine soil amendments and/or targeting of wetland restoration to reduce methane emissions based on drivers.

Thank you

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