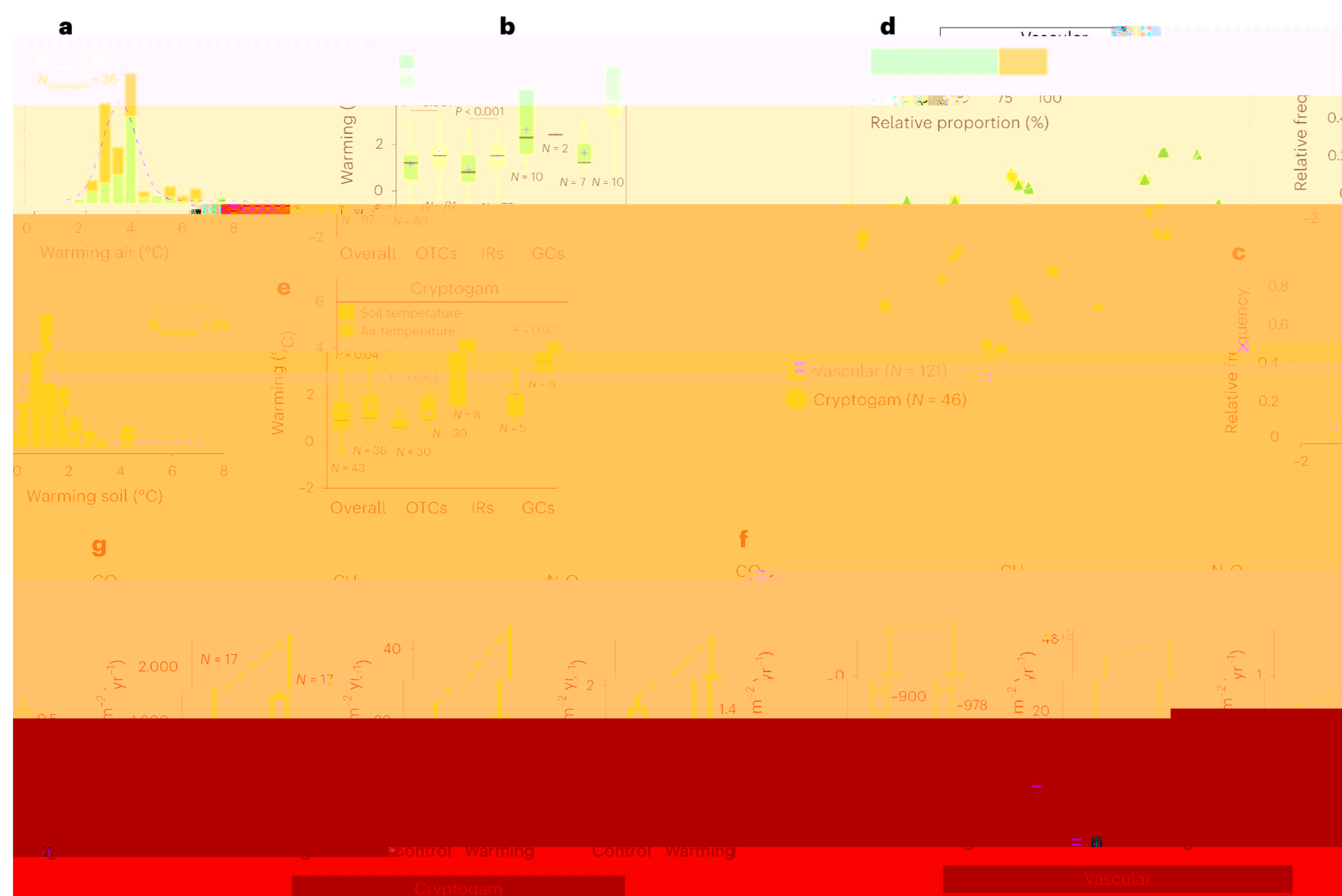


Introduction

- Wetlands store about one-third of the global soil organic carbon (SOC), which play an outsized role in regulating and stabilizing the global climate, and offer ideal locations for the production, consumption, and exchange of greenhouse gases (GHGs) due to their own active biogeochemical cycling of carbon and nitrogen.
- The considerable uncertainty in wetland GHG feedbacks to warming increases the challenge of limiting climate warming to a specific temperature threshold to meet climate change mitigation target.
- Here, we compile a database comprising observations from 167 sites with measured responses of wetland GHG emissions including CO₂, CH₄ and N₂O, to manipulated warming of 1.5-2°C.
- Our results highlight that warming undermines the mitigation potential of pristine wetlands despite achieving the Paris Agreement goal of limiting temperature to 1.5-2°C.

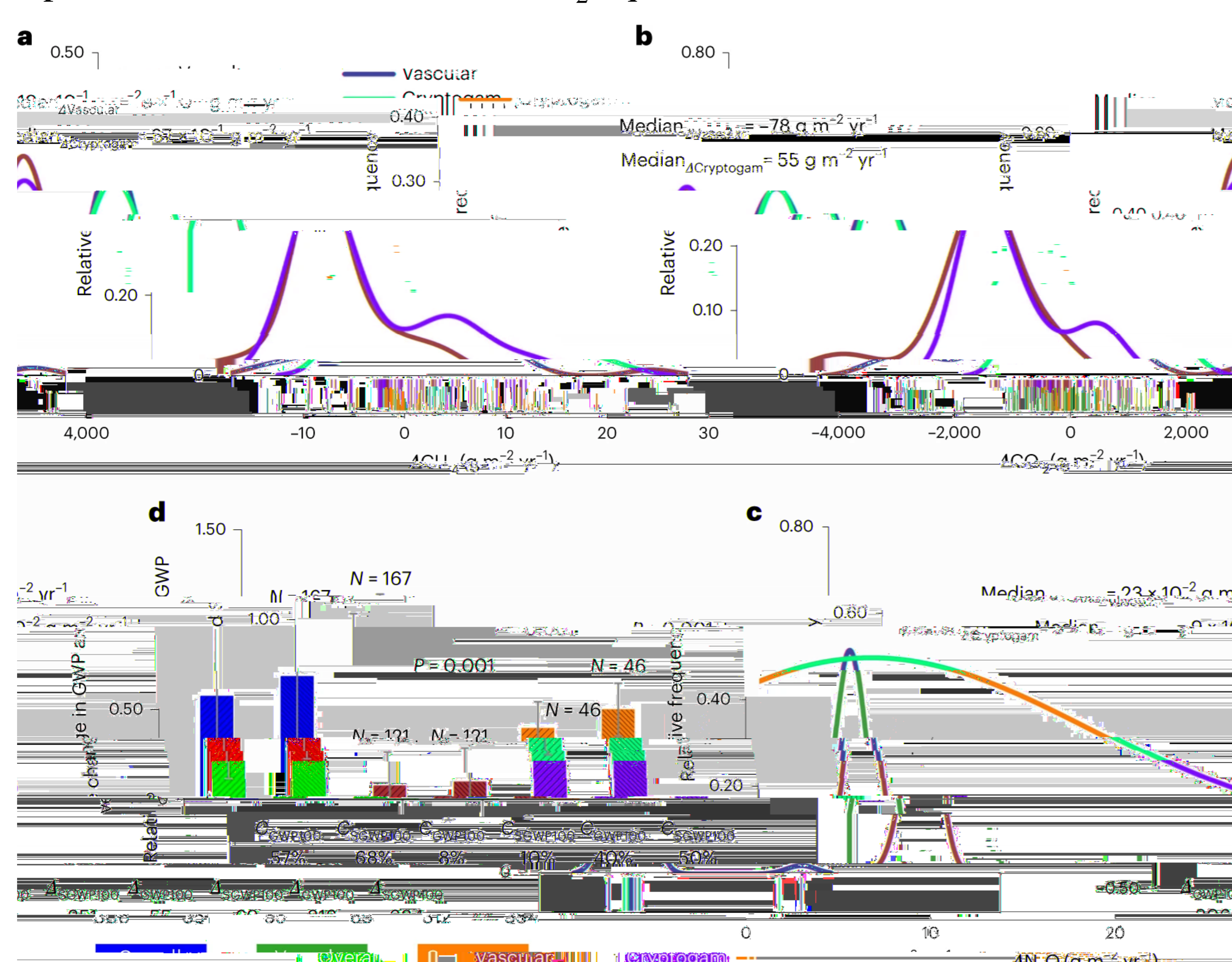
Greenhouse gas sink under warming

The wetlands are a net sink of GHGs under ambient condition before warming treatments. The sink of GHGs is weakened under warming. Wetlands dominated by vascular plants act as CO₂ sink before warming treatments, while wetlands dominated by cryptogams act as CO₂ source. Warming increases the magnitude of CO₂ sink and source at vascular plant and cryptogam sites, respectively. For CH₄ and N₂O, warming enhances their sources at both vascular plant and cryptogam sites.



Warming experiments and wetland GHG responses. **a**, Distribution of warming experiments reporting GHG emissions. **b,c**, Frequency distribution histograms of air (b) and soil (c) temperature increases at sites with vascular plants and cryptogams. **d,e**, Effects of different warming methods on the air and soil temperatures at sites with vascular plants (d) and cryptogams (e). **f,g**, GHG flux changes in response to warming treatments at vascular plant (f) and cryptogam (g) sites.

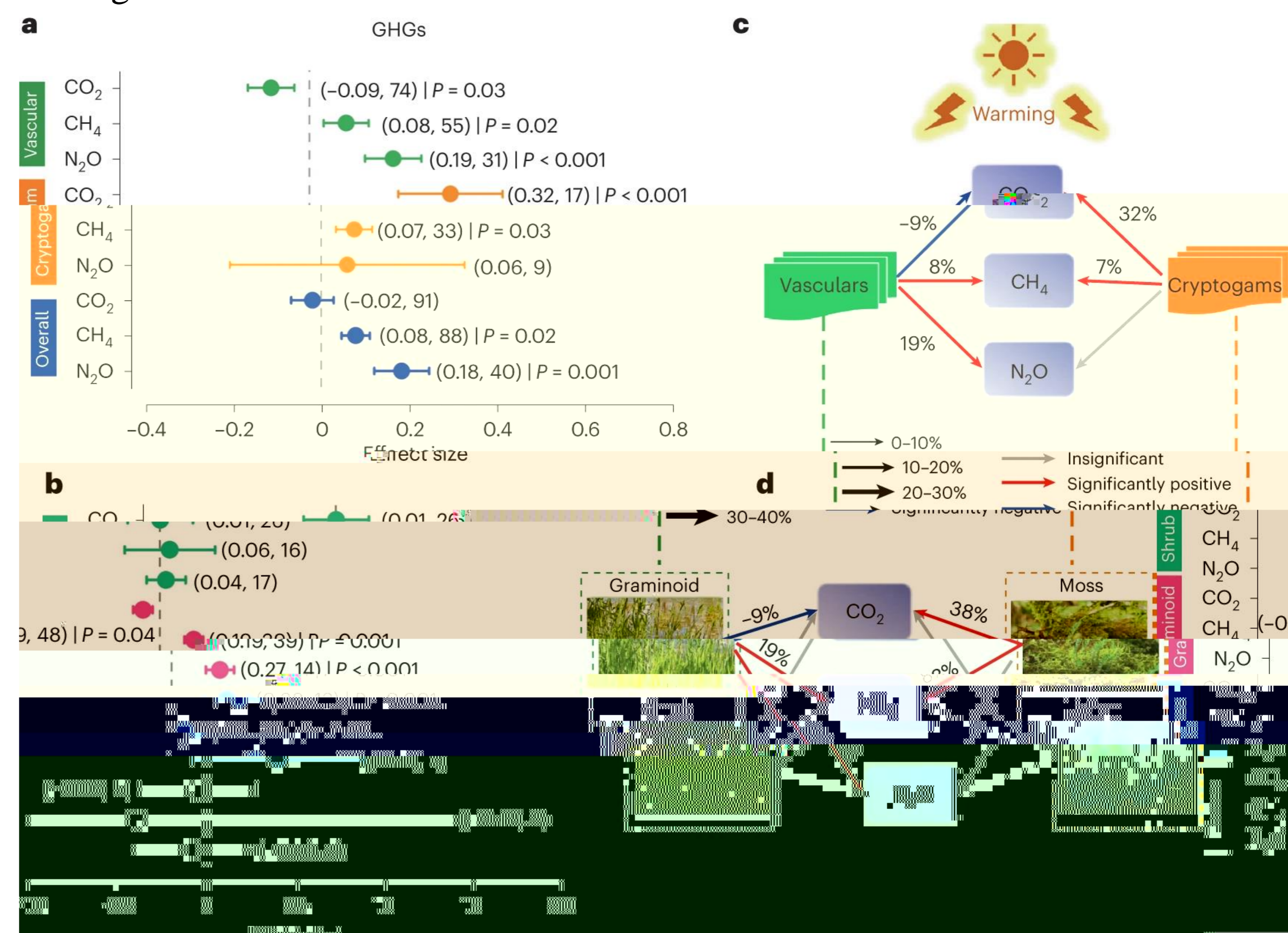
Global warming potential over 100-year time span (GWP₁₀₀) of wetland GHG emissions is increased by 57% in response to the prescribed warming, which corresponds to an increase of 305.9 t CO₂-eq ha⁻¹ in GHG emissions.



Global warming potential and sustained-flux global warming potential of wetlands. **a-c**, Frequency distribution histograms of changes (Δ) in CO₂ (a), CH₄ (b) and N₂O (c) emissions under warming treatment at sites with vascular plants and cryptogams. **d**, Changes in GWP₁₀₀ (C_{GWP100} (%)) and SGWP₁₀₀ (tCO₂e ha⁻¹) and SGWP₁₀₀ (C_{SGWP100} (%)) and Δ SGWP₁₀₀ (tCO₂e ha⁻¹) at sites with vascular plants and cryptogams as well as overall values.

Emissions and sink by plant functional type

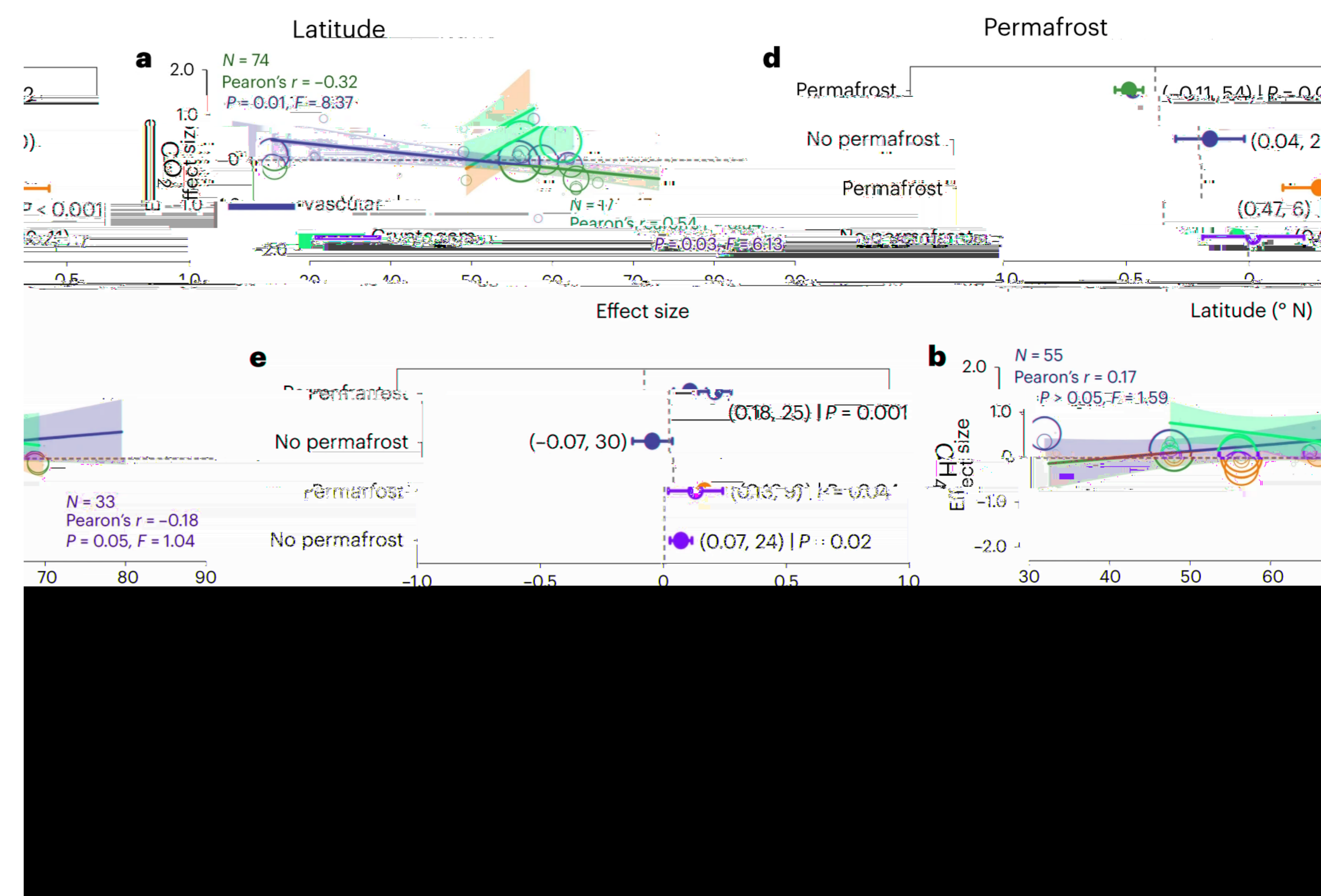
The weak response of CO₂ emissions to warming is due to a trade-off between warming-induced enhancement of CO₂ sink at vascular plant sites and CO₂ source at cryptogam sites. Warming enhances wetland CH₄ source. Response of CH₄ emissions is particularly high for graminoid and moss sites. Warming also enhances wetland N₂O source. Across all four PFTs, only N₂O emissions of graminoid sites are stimulated by warming.



Effects of warming on GHG emissions. **a,b**, The mean effect size of warming on CO₂, CH₄ and N₂O emissions at vascular plant and cryptogam sites (a), and at sites where shrub, graminoid, moss and lichen dominate (b). **c,d**, A conceptual diagram illustrating the response of wetland GHG emissions to warming (c,d).

Emissions and sink by latitude

Warming-induced increase in CO₂ sink for vascular plant sites and CO₂ source for cryptogam sites is enhanced with latitude. Warming increases CO₂ sink at vascular sites underlain by permafrost, as compared to sites where permafrost is absent. In contrast, CO₂ source at cryptogam sites with permafrost increases compared to sites without permafrost. As a net source of CH₄ and N₂O, the permafrost wetlands dominated by vascular plants positively respond to warming.



Spatial heterogeneity of wetland GHG emissions under warming. **a-c**, Latitudinal variations of the effect sizes of warming for CO₂ (a), CH₄ (b) and N₂O (c) emissions. **d-f**, Comparison of the mean effect sizes of warming for CO₂ (d), CH₄ (e) and N₂O (f) emissions in regions with and without permafrost.

References & Acknowledgments

Bao, T., Jia, G. & Xu, X*. Weakening greenhouse gas sink of pristine wetlands under warming. *Nature Climate Change* (2023). <https://doi.org/10.1038/s41558-023-01637-0>.

This study is funded by National Key R&D Program of China (2022YFF0801904 to X.X.) and Natural Science Foundation of China (#42206254 to T.B.).