

Geophysical Research Letters

RESEARCH LETTER

10.1029/2020GL088875

Key Points:

- A newly developed long-term data set of methane (CH₄) flux measurements at a northern peatland is analyzed
- Seasonal water availability is shown to control the sensitivity of CH₄ emissions to increase in soil temperature
- Shifting water availability from winter to summer may result in higher annual CH₄ emissions, even if soil temperatures remain the same

Supporting Information:

- Supporting Information S1

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Citation:

Feng, X., Deventer, M. J., Lonchar, R., Ng, G. H. C., Sebestyen, S. D., Roman, D. T., et al. (2020). Climate sensitivity of peatland methane emissions mediated by seasonal hydrologic dynamics. *Geophysical Research Letters*, 47, e2020GL088875. <https://doi.org/10.1029/2020GL088875>

Received 18 MAY 2020

Accepted 12 AUG 2020

Accepted article online 21 AUG 2020

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Climate Sensitivity of Peatland Methane Emissions Mediated by Seasonal Hydrologic Dynamics

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Abstract Peatlands are among the largest natural sources of atmospheric methane (CH₄) worldwide. Peatland emissions are projected to increase under climate change, as rising temperatures and shifting precipitation accelerate microbial metabolic pathways favorable for CH₄ production. However, how these changing environmental factors will impact peatland emissions over the long term remains unknown. Here, we investigate a novel data set spanning an exceptionally long 11 years to analyze the influence of soil temperature and water table elevation on peatland CH₄ emissions. We show that higher water tables dampen the springtime increases in CH₄ emissions as well as their subsequent decreases during late summer to fall. These results imply that any hydroclimatological changes in northern peatlands that shift seasonal water availability from winter to summer will increase annual CH₄ emissions, even if temperature remains unchanged. Therefore, advancing hydrological understanding in peatland watersheds will be crucial for improving predictions of CH₄ emissions.

Plain Language Summary Methane (CH₄) emissions from wetlands are the largest natural source of atmospheric CH₄ worldwide and are expected to increase under global warming. Because of a scarcity of field observations, we do not yet know how wetland CH₄ emissions will be affected by future climates and under what conditions. In this study, we use a newly developed long-term data set of CH₄ flux measurements at a northern peatland to demonstrate the importance of seasonal water availability in controlling the sensitivity of CH₄ emission increase to soil temperature. Our results suggest that a shift in water availability from winter to summer may result in higher annual CH₄ emissions, even if soil temperatures remain the same.

1. Introduction

Peatlands store disproportionate amounts of global soil carbon: Although they cover only ~3% of the land surface, they store one third of all soil carbon (Bridgman et al., 2006). The stability of peatland carbon pools is threatened by climate and land use change (Dise, 2009; Petrescu et al., 2015). Increasing soil temperature and changing precipitation patterns—with likely increase in middle to high latitudes of the Northern Hemisphere (Pachauri et al., 2014)—may preferentially accelerate certain microbial pathways (Bridgman et al., 2013), alter water chemistry profiles (Siegel et al., 1995), and mobilize deeper carbon pools (Glaser et al., 2016) within peatlands. This will likely contribute to the projected increase in emissions of methane (CH₄) (Stocker et al., 2013), a greenhouse gas with 28–36 times the global warming potential of carbon dioxide (CO₂) (Myhre et al., 2013) that currently accounts for 20% of the anthropogenic greenhouse effect (Ciais et al., 2014; Lelieveld et al., 1998). Global inventories suggest that anaerobic microbial CH₄ production in wetlands is the largest biogenic source of CH₄ worldwide and larger than that from the global extraction, refinement, and use of fossil fuels (Kirschke et al., 2013; Saunio et al., 2016). Nevertheless, there remains considerable uncertainty in the magnitude of wetland CH₄ emissions, their interannual variability, and their dependence on coupled environmental drivers such as soil temperature and precipitation (Poulter et al., 2017).

In contrast to the direct influence of soil temperature on microbial processes and CH₄ emissions (Dise et al., 2011; Yvon-Durocher et al., 2014), water table variations can temporally decouple CH₄-related metabolic processes belowground from net CH₄ fluxes on the surface, thus complicating the relationship between CH₄ emission and wetness. While higher soil temperature is known to increase the rates of peat organic matter degradation (which produces substrate for CH₄ production), CH₄ production, and CH₄ oxidation (Segers, 1998), the timing and duration of these processes are regulated by water table variations across the peat column (Bridgman et al., 2013). Because oxygen diffusion is reduced 100-fold in water compared to in air, the position of the water table controls the oxic-anoxic boundary that differentiates aerobic from anaerobic metabolic pathways (Ingram, 1983). Therefore, some portion of CH₄ produced in deeper peat under anoxic conditions can be later degraded within the oxic zone before being released at the surface, and the net surface emissions at any given time will depend on the history of inundation. The nonlinear and lagged effects of water table variation on CH₄ have been documented in numerous past studies (e.g., Blodau & Moore, 2003; Moore & Roulet, 1993). On the one hand, these studies suggest that the correlation between peatland CH₄ emissions and water table positions over short (e.g., daily) timescales may be confounded by interactions among CH₄ production, oxidation, and transport that play out over longer (e.g., monthly) timescales, resulting in lagged responses (Blodau & Moore, 2003; Dise et al., 2011; Kettunen et al., 1996), nonmonotonicity (Brown et al., 2014; Rinne et al., 2018), and hysteresis (Moore & Dalva, 1993; Moore & Roulet, 1993). On the other hand, the episodic and pulsing nature of CH₄ emissions in response to water table variations (Dinsmore et al., 2009) suggest that predicting the variability of CH₄ emission based solely on time-averaged long-term conditions may overlook the disproportionate contributions of short-term, high-emission periods (Romanowicz et al., 1993), including during ebullition (Glaser et al., 2004). Thus, to better understand the effects of water table variations on peatland CH₄ emissions, we must account for water table dynamics across all relevant timescales, so that both short-term and legacy effects can be properly considered.

Quantifying the effects of key environmental drivers on long-term CH₄ variability has been hindered by the lack of high-resolution data sets that are long enough to span contrasting periods of soil temperature and water availability, with most previous analyses done over just 2 or 3 years of measurements (Knox et al., 2019). To overcome this limitation, we use here a novel 11-year (2009–2019) data set of CH₄ flux measurements at a northern peatland site, with simultaneous observations of water table elevations (WTEs) and soil temperature at multiple depths up to 2 m (Deventer et al., 2019). Using this data set, we demonstrate that water table dynamics at seasonal timescales play a pivotal role in controlling the sensitivity of CH₄ emissions to temperature. Specifically, we show that (i) seasonal rather than annual metrics of soil temperature and wetness are better predictors of annual CH₄ fluxes and (ii) seasonal water table variations modulate the CH₄ flux response to changing soil temperature. Our results suggest that shifting seasonal water availability from winter to summer will increase annual CH₄ emissions, even with the same soil temperature trajectories. The hydrological dynamics and connectivity governing water table variations within peatland watersheds are currently understudied (Soulsby et al., 2015; Tunaley et al., 2016) and poorly resolved in Earth system models (Bechtold et al., 2019; Shi et al., 2015). Advancing this understanding will be crucial for improving prediction of peatland CH₄ emissions.

2. Methods

2.1. Descriptions of Study Site and CH₄ Fluxes Data Set

The net ecosystem CH₄ exchange was measured using the eddy covariance method (e.g., Foken et al., 2012) that derives the CH₄ flux from the covariance between vertical wind and CH₄ measurements obtained 2.4 m above the peatland study site, located in Bog Lake Peatland at the USDA Forest Service's Marcell Experimental Forest (47.505°N, 93.489°W; Kolka et al., 2011) near Grand Rapids, Minnesota, USA. The peatland is a poor fen dominated by ericaceous shrub and peat mosses (*Sphagnum* spp.). The climate is cold continental with warm summers, characterized by mean annual precipitation and temperature (1961–2009 reference period) of 780 mm and 3.4°C, respectively. The snow-covered period usually starts in November and typically lasts for ~120 days. After comprehensive quality control including tests for instrumental failure and for turbulence and scalar time series statistics, annual fluxes were estimated using an artificial neural network gap-filling approach as described in detail by Deventer et al. (2019). Soil temperature and WTE

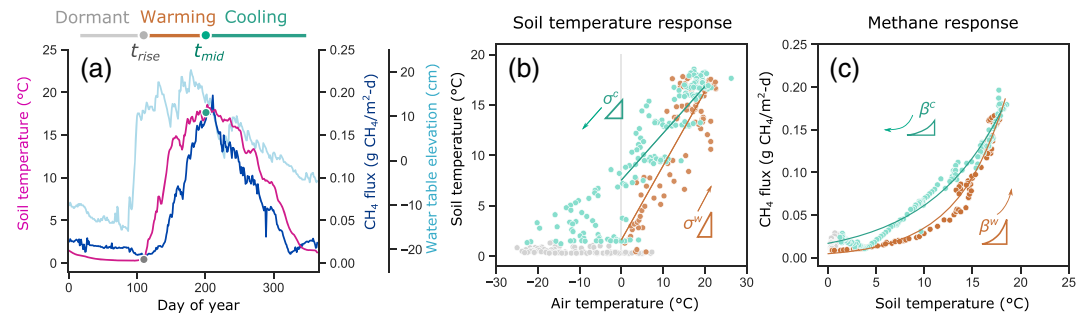


Figure 1. Seasonal peatland responses. (a) Measured soil temperature, CH₄ fluxes, and water table elevations are shown for the example year of 2014. The year is divided into dormant (light gray bar), warming (orange bar), and cooling phases (green bar) based on the timing of t_{rise} and t_{mid} (section 2). (b) Measured (dots) and fitted (line) seasonal soil temperature response to air temperature (with slope σ) and (c) CH₄ response to soil temperature (with exponent β) exhibit hysteresis, with varying rates of increase and decrease during the warming (orange) and cooling (green) phases, respectively.

data are colocated within Bog Lake Peatland; precipitation data are collected from a weather station approximately 2,000 m away. More details on the site and CH₄ fluxes measurements can be found in supporting information Texts S1 and S2.

2.2. Multivariate Linear Regression for Relating Annual CH₄ Emissions to Annual and Seasonal Environmental Drivers

Multivariate linear regression is used to relate annual CH₄ emissions to annual and seasonal metrics of soil temperature and water availability. For annual metrics, we used the mean annual soil temperature at 10 cm depth (T_s), total annual precipitation (P), and mean annual WTE (W). For seasonal metrics, we used maximum summer daily soil temperature in Celsius at 10 cm depth ($T_{s,max}$), total precipitation when soil temperature is above 15°C (P_{seas}), and mean WTE when soil temperature is above 15°C (W_{seas}) (our analysis in Figure S2 shows that subsequent results are relatively insensitive to the choice of the soil temperature threshold). The 14 models used in the analysis (also summarized in Table S2) include either one or two of these metrics as predictors: (1) T_s , (2) P , (3) W , (4) $T_{s,max}$, (5) P_{seas} , (6) W_{seas} , (7) T_s and P , (8) T_s and W , (9) T_s and P_{seas} , (10) T_s and W_{seas} , (11) $T_{s,max}$ and P , (12) $T_{s,max}$ and W , (13) $T_{s,max}$ and P_{seas} , and (14) $T_{s,max}$ and W_{seas} . Each model was fitted to seven (out of 11) randomly selected years of annual CH₄ fluxes and then tested using the remaining four out-of-sample years. The random selection was repeated 1,000 times, and the median root mean squared deviation (RMSD) was then used to identify the best performing models. All statistical analyses for this study have been conducted using the *sklearn* and *scipy* packages in Python 3.7.

2.3. Annual CH₄ to Soil Temperature Sensitivity

To investigate how the influence of soil temperature on CH₄ fluxes varies across years, we assume an exponential relationship between daily soil temperature and CH₄ fluxes within each year, that is, $\frac{dF}{dT_s} = \beta F$, where F is the daily CH₄ flux, T_s is the daily soil temperature 10 cm below peat surface, and β is a sensitivity constant that varies between years. The solution for F is $F(T_s) = C_0 e^{\beta T_s}$, where C_0 is a fitting parameter representing CH₄ flux during the dormant phase (i.e., when $T_s = 0^\circ\text{C}$). The annual CH₄ to soil temperature sensitivity metric Δ is defined as the rate of soil temperature-dependent CH₄ changes at $T_s = 10^\circ\text{C}$, that is, $\Delta = \left. \frac{dF}{dT_s} \right|_{T_s=10} = C_0 \beta e^{10\beta}$.

2.4. Seasonal CH₄ to Soil Temperature Sensitivity and Hysteresis

To investigate the seasonal variations in the CH₄ to soil temperature relationship, we delineate each year into “dormant”, “warming”, and “cooling” phases based on distinct periods of peatland conditions (Figure 1a). These phases are separated by two critical timepoints, t_{rise} and t_{mid} , defined, respectively, by the day in early spring when T_s sharply rises (i.e., at the inflection point where the second derivative becomes positive) and the day in midsummer when T_s is maximized (after smoothing T_s using a 30 day window). The

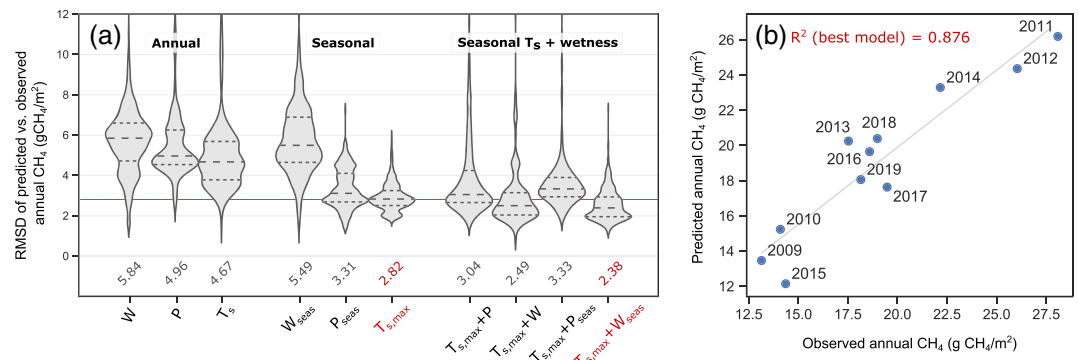


Figure 2. Evaluating annual and seasonal environmental metrics for predicting annual CH₄ fluxes. (a) Root mean squared deviation (RMSD) of predicted versus observed annual CH₄ fluxes from 10 models across 1,000 iterations shown as violin plots. Median RMSDs are shown below each plot. The best performing model using a single metric (maximum summer soil temperature $T_{s,max}$) and two metrics ($T_{s,max}$ and seasonal WTE W_{seas}) are highlighted in red, with the red line marking the median RMSD of the $T_{s,max}$ model for comparison. (b) The best performing model using $T_{s,max}$ and W_{seas} as predictors yields R^2 between predicted and observed annual CH₄ fluxes of 0.876 and RMSD of $1.59 \text{ gCH}_4 \text{ m}^{-2}$.

responses of CH₄ fluxes to soil temperature ($F_{CH_4} : T_s$) are analyzed during the warming and cooling phases separately to quantify their associated sensitivities and hysteresis effects. Specifically, ϵ quantifies the sensitivity of the $F_{CH_4} : T_s$ response during the warming phase, while η quantifies the hysteresis of the $F_{CH_4} : T_s$ response during the cooling phase. Finally, these sensitivity and hysteresis metrics are correlated against WTE averaged over a window of size w and phase shifted around the two critical timepoints to deduce the effects of water table variations at different times of year.

The warming phase sensitivity of CH₄ fluxes to soil temperature, ϵ , is defined using the exponent β of the best fit exponential curve between daily CH₄ fluxes and T_s during the warming phase, that is, $\epsilon = \beta^w$ (Figure 1c). A more positive warming phase sensitivity would indicate that CH₄ fluxes increase more quickly with changing soil temperature. The cooling phase hysteresis, η , is defined by the difference between the warming and cooling phase exponents, normalized by the annual exponent β , that is, $\eta = \frac{\beta^w - \beta^c}{\beta}$. The hysteresis η will be positive if CH₄ fluxes decrease *more slowly* in response to cooling soil temperatures during the cooling phase than the rate it increases during the warming phase. We observe this to be the case, with majority of the years exhibiting positive η (Figure 1c). A more positive η in the cooling phase corresponds to greater deviations from the same response during the warming phase.

3. Results

3.1. Seasonal Versus Annual Drivers of Peatland CH₄ Emissions

To identify the dominant environmental drivers and their relevant timescales of flux variability at our northern peatland site, we first hypothesize that seasonal metrics of soil temperature and water availability can explain interannual CH₄ flux variability better than can annual metrics. This is motivated by previous studies that have shown poor correlations between annual CH₄ fluxes and WTEs (Rinne et al., 2018). Our previous analysis have revealed a 2.4-fold flux difference between low and high emitting years at this site ($13.1 \text{ gCH}_4 \text{ m}^{-2}$ in 2009 vs. $28.1 \text{ gCH}_4 \text{ m}^{-2}$ in 2011; Deventer, Roman, et al., 2019; Olson et al., 2013). During this time, annual precipitation ranged from 693 mm in 2009 to 1,105 mm in 2015, and maximum mean daily air temperature ranged from 23.3°C in 2009 to 26.5°C in 2013 (Table S1). We test our first hypothesis using multivariate linear regression relating 11 years of annual CH₄ fluxes to 14 models consisting of annual and seasonal metrics of soil temperature and water availability (which can be represented by either precipitation or WTEs). The seasonal metrics are expected to better capture summer conditions when CH₄ emission is especially high. The median R^2 and RMSE values for each model are reported in Table S2.

Results in Figure 2 and Table S2 confirm that, compared to annual metrics, seasonal metrics of soil temperature (at 10 cm depth) and water availability can vastly improve predictions of annual CH₄ fluxes, reducing

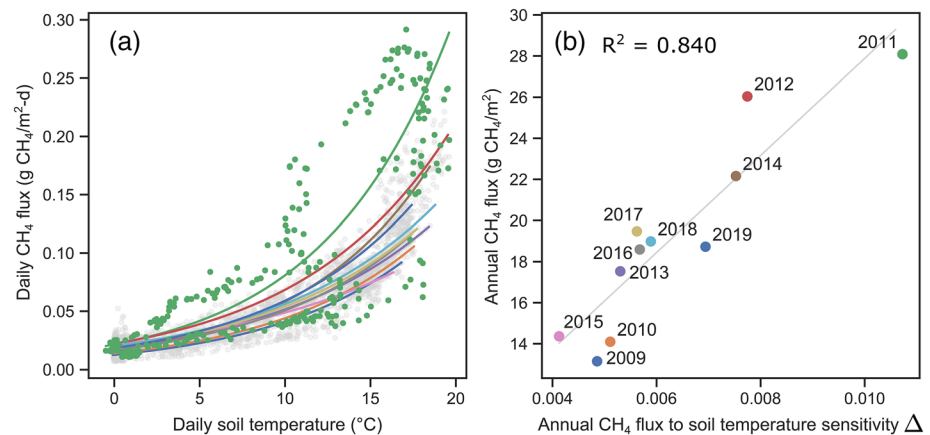


Figure 3. Annual sensitivity of CH_4 fluxes to soil temperature. (a) Response of daily CH_4 fluxes to daily soil temperature across 11 years, shown in dots for individual days (green for 2011 and light gray for all other years) and with a best fit exponential curve for each year in a different color. (b) Annual CH_4 fluxes correspond strongly to the temperature sensitivity for each year.

the median RMSD by 39.6%, 33.3%, and 6.0% for soil temperature, precipitation, and WTEs, respectively. Additionally, while maximum summer soil temperature is found to be the best individual seasonal predictor for annual CH_4 fluxes, WTEs can be added to measurably improve model performance. Of the eight models using a combination of two metrics, the best performing model combined maximum summer soil temperature ($T_{s,max}$) with seasonal WTEs (W_{seas})—both seasonal metrics. Together, $T_{s,max}$ and W_{seas} explained 87.6% of interannual variability in annual CH_4 fluxes across 11 years, with RMSD of $1.59 \text{ gCH}_4 \text{ m}^{-2}$ (which is within the random error of annual eddy flux estimates; Deventer, Griffis, et al., 2019; Table S2). Furthermore, using these seasonal metrics together improved model performance compared to using them separately, with R^2 of 0.67 and RMSD of $2.60 \text{ gCH}_4 \text{ m}^{-2} \text{ day}^{-1}$ when seasonal WTE is used alone and R^2 of 0.76 and RMSD of $2.23 \text{ gCH}_4 \text{ m}^{-2} \text{ day}^{-1}$ when maximum summer soil temperature is used alone (Table S2). These results point generally to the importance of seasonal metrics and specifically to both seasonal soil temperature and seasonal WTEs as strong and independent predictors of annual CH_4 fluxes.

3.2. Seasonal Water Table Mediates Peatland Response to Temperature

Our second hypothesis is that seasonal water table variations can control the response of CH_4 emission to changing soil temperature. We first find that annual CH_4 emissions are strongly correlated with the observed soil temperature sensitivities for the daily-scale fluxes (Figure 3). Furthermore, most years exhibit seasonal hysteresis in the air-to-soil-temperature and emission-to-soil-temperature relationships (Figures 1 and S1), wherein the relationships are not fixed but rather are path dependent on warming and cooling trajectories. Hysteresis can be associated with memory, storage, inertia, and lagged effects in a complex dynamical system (Rietkerk et al., 2004). We hypothesize that seasonal water table variations will help to explain how the variability in temperature sensitivities arises year-to-year, as well as how hysteresis emerges *within* each year. Such knowledge is needed to improve our predictions of within-year and interannual CH_4 variability in the future (Zhang et al., 2017), especially as precipitation patterns change across much of the northern latitudes (Bintanja & Andry, 2017).

By separating each year into “dormant”, “warming”, and “cooling” phases and quantifying the sensitivity and hysteresis of the $F_{\text{CH}_4}:T_s$ responses during the warming and cooling phases, our analysis indicates that higher WTE slows the increase in CH_4 fluxes during the warming phase. Figure 4a shows that a strong relationship between WTE and the $F_{\text{CH}_4}:T_s$ sensitivity (ϵ) is obtained by averaging WTE around $t_{\text{rise}} - 45$ days (over a $w = 30$ day window). The negative regression slope in this relationship (with $R^2 = 0.32$ across all years; Figure 4b) suggest that higher averaged WTEs prior to the warming phase decrease the sensitivity of CH_4 fluxes to rising soil temperature.

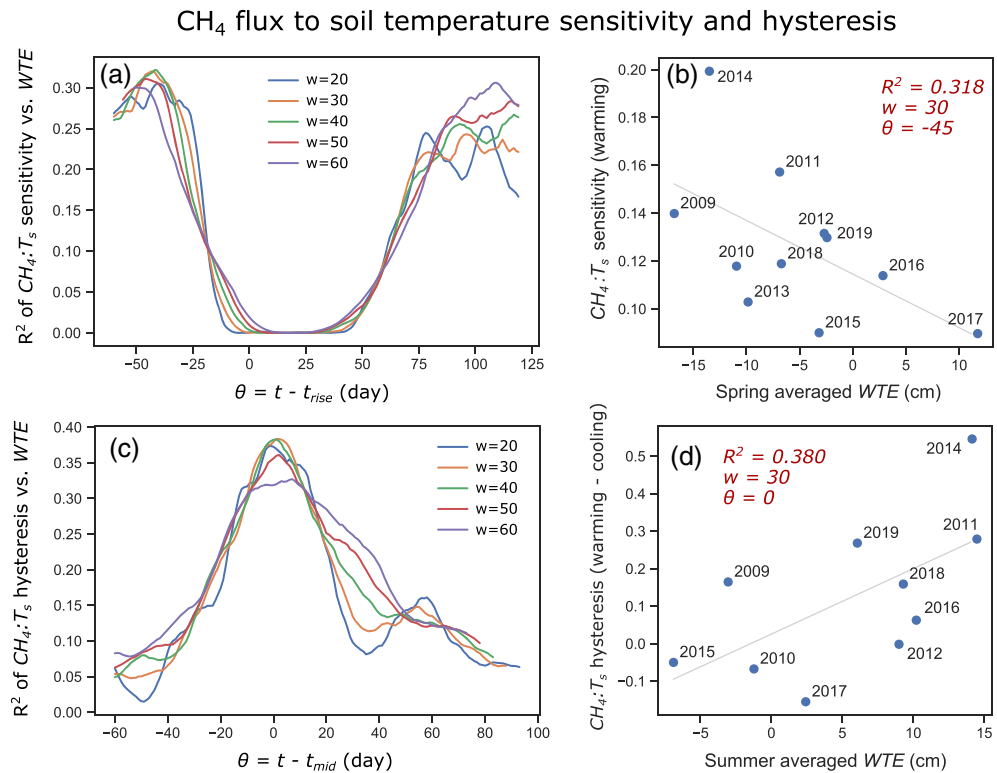


Figure 4. Warming phase sensitivity ε and cooling phase hysteresis η of CH₄ fluxes to soil temperature. The R^2 values of the ε versus WTE and η versus WTE regressions are plotted in (a) and (c). The WTE is averaged over window sizes w of 20 to 60 days (colored lines) and centered around reference times θ from 60 days before to 60 days after t_{rise} (in a) and t_{mid} (in c). The relationships between ε and averaged WTE and between η and averaged WTE are shown for the combination of w and θ that yields the best R^2 in (b) and (d).

A similar analysis during the cooling phase reveals that elevated WTE instead slows the decrease in CH₄ fluxes during late summer and fall. Figure 4c shows that a strong relationship between WTE and the F_{CH_4} : T_s hysteresis (η) is obtained when WTE is averaged around t_{mid} (over a $w = 30$ day window). The positive regression slope between averaged WTE and the cooling phase hysteresis metric (providing a measure of inertia from the warming period) with $R^2 = 0.38$ (Figures 4d and section 2) suggests that higher averaged WTE prior to and at the start of the cooling phase (i.e., near the peak of soil temperature) will extend the preceding warming phase effects and actually decrease the rates of decline for CH₄ fluxes in the cooling phase relative to their rates of increase during the warming phase. This means that CH₄ fluxes will remain higher during the cooling phase compared to their values at the same soil temperatures during the warming phase.

4. Discussion and Conclusions

Our analysis of seasonal WTEs has an important implication: Independent of soil temperature, any seasonal hydroclimatic dynamic that increases water availability from earlier to later in the year is likely to increase annual CH₄ emissions. This hydroclimatic shift can be induced by, for example, the snow to rainfall transition predicted to occur in northern high latitudes (Bintanja & Andry, 2017). The effect on CH₄ emissions results from the fact that higher WTEs dampen the CH₄-flux-to-soil-temperature dependence during both the warming and cooling phases of the year. During the warming phase, CH₄ fluxes will increase more slowly under high WTE conditions, while during the cooling phase, CH₄ fluxes will decrease more slowly under high WTE conditions. These mechanisms work together to keep peatlands more “dormant” during the warming phase and more “activated” during the cooling phase.

The physical processes underlying these WTE-induced dampening effects will require further investigation. Microbial responses to water availability are likely to play a major role. Higher WTE at the start of the

cooling phase may alter microbial composition in such a way that anaerobic methanogens continue to produce CH_4 even as soil temperature start to decrease (Updegraff et al., 1998). Furthermore, high WTE during the warming phase may be a proxy for greater snow cover during the previous winter, which reduces the extent and depth of peat freeze (Granberg et al., 1999). Under such conditions, more methanotrophs may remain active during the winter (Einola et al., 2007; Trotsenko & Khmelenina, 2005) and consume a portion of the CH_4 produced during spring, thus reducing overall CH_4 emissions at the surface. These WTE-mediated microbial effects may be further compounded by the effects of heat propagation into and out of the peat during the warming and cooling phases. Due to the high latent heat of fusion and the larger heat capacity of water compared to air, as well as the insulating effects of peat, soil temperature will increase more slowly in the spring with higher WTE (Figure S3), further dampening the increase of CH_4 emission. In the fall, although water's higher thermal conductivity will allow soil temperature to decrease more quickly with higher WTE (Figure S3), observations across all WTEs show soil cooling still occurring at a slower rate compared to warming rate in spring, contributing to slower declines in CH_4 emissions.

These findings underscore the importance of assessing the effects of environmental drivers—such as soil temperature and water table—not just for isolated snapshots in time but also considering their interactions over midrange (e.g., seasonal) timescales. When integrated over time, the synchronization between soil temperature and water availability may produce other complex legacy effects similar to the ones we have previously identified (Stockdale et al., 2014). Global-scale CH_4 emissions are currently estimated through a variety of approaches, including (i) statistically relating local CH_4 fluxes to concurrent environmental drivers (Peltola et al., 2019), (ii) relating CH_4 emissions to variations in surface inundation area (Zhang et al., 2017), and (iii) using process-based models incorporating dynamic controls by carbon and nutrient pools, microbial populations, and plant community composition and productivity (Xu et al., 2016). The statistical and inundation area-based approaches both have limited ability to account for subsurface controls that persist over time. Instead, our findings suggest that understanding hydrological processes will be crucial for predicting the response of peatland CH_4 emissions to temperature changes—due to their roles in regulating seasonal water availability, biogeochemistry, microbial activities, and vegetation functioning. Preliminary sensitivity analyses (Figure S4) suggest that increasing WTE by just 5 cm at Bog Lake Peatland from the crucial time period in winter and early spring (as identified in Figure 4) to midsummer will increase annual CH_4 emissions, on average, by 9% to 15% per year. Poor fens, like the Bog Lake Peatland, are common features in northern latitudes. More pronounced seasonal hydrologic shifts may occur in bogs, which are ombrotrophic peatlands also common in northern latitudes, because they lack water inputs from groundwater aquifers.

Despite its significance for controlling the temperature sensitivity of peatlands, peatland hydrology remains difficult to resolve within Earth system models (Bechtold et al., 2019; Shi et al., 2015). More efforts will be needed to better represent, for example, the roles of snow accumulation and snowmelt dynamics (Aurela et al., 2004; Sebestyen et al., 2008), peatland type (bog or fen), microtopography (Cresto Aleina et al., 2015; Shi et al., 2015), and lateral flows (Soulsby et al., 2015; Sprenger et al., 2017; Verry et al., 2011). As precipitation shifts across northern latitudes with respect to phase (e.g., from snow to rainfall; Bintanja & Andry, 2017) and intensity (e.g., increasingly heavier storms; Houze et al., 2019), these hydrological processes will need to be better characterized in Earth system models to advance long-term predictions of wetland CH_4 emissions.

Conflict of Interest

The authors declare no competing interests.

Data Availability Statement

Water table elevation data used in this study can be accessed online (<https://doi.org/10.2737/RDS-2018-0002>), as well as on a HydroShare repository (“Water table elevation and precipitation at Marcell Experimental Forest, daily, 2009–2019”) (<http://www.hydroshare.org/resource/330a20a22ff9479cb8b44768b3bf10a9>). Daily precipitation and water table elevation data used for the current study can be accessed through the Environmental Data Initiative (<https://doi.org/10.6073/pasta/75646a3bd41ba3219d0e578e8374ee7> and <https://doi.org/10.6073/pasta/6e9348a1c691c10271c9373bd31da67f>). Eddy covariance data along

with air and soil temperature data from Bog Lake Peatland can be accessed at the AmeriFlux website (<https://ameriflux.lbl.gov/sites/siteinfo/US-MBP>) and are currently undergoing standardized data processing procedure from Ameriflux.

Acknowledgments

X. F., R. L., and G. C. N. acknowledge support from DOE's Terrestrial Ecosystem Science Program (Grant DE-SC0019036). The Northern Research Station (NRS) of the USDA Forest Service funded the salaries of S. D. S., D. T. R., and R. K. K. The NRS also funds the long-term research program at the Marcell Experimental Forest, including monitoring of eddy covariance, meteorological, soil temperature, and water table elevation at the Bog Lake Peatland. M. J. D., T. J. G., and D. B. M. acknowledge support from NASA's Interdisciplinary Research in Earth Science program (IDS Grant NNX17AK18G).

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