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The hysteretic response of peatland methane fluxes: an improved approch to identify the factors controlling methane flux.

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Methane fluxes from wetlands have been shown to be dominated by various environmental conditions, most notably soil temperature, which influences rate of methane production and consumption by microbial soil communities, and water table, which influences the relative size of oxic and anoxic zones which these communities occupy. Despite the importance of understanding the controls on biogenic sources of methane, direct measurements over extended periods of time often have relationships with concurrent factors that are multifarious, weak, or are even entirely contradictory to a priori expectations.

Using differing approaches of direct measurements in a European peatland and the manipulation of extracted mesocosms from the same site we show that, due to a hysteretic response by methane fluxes to changing conditions, fluxes may be better explained by comparison with environmental conditions prior to the time of measurement. In situ hysteresis of methane fluxes was observed at a seasonal scale, with a pronounced autumnal shoulder of activity, and was also revealed by the improvement of regression analysis when environmental conditions prior to the date of flux measurement were used as independent variables. Mesocosms extracted from the same study site showed pronounced hysteresis of methane fluxes after the experimental manipulation of water table in highly controlled, replicated conditions.

Our results and subsequent model development indicate that the use of concurrent environmental conditions may hamper the identification of factors which control methane flux, in addition to resulting in entirely unexpected relationships. In contrast, environmental conditions prior to the time of methane flux are more effective when explaining any differences between expected and observed temporal patterns in methane flux.