Methane emission from pan-Arctic natural wetlands estimated using a process-based model, 1901–2016

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The vast pan-Arctic wetlands appear to be a large source of methane (CH_4), a potent greenhouse gas. Here, I simulated CH_4 emission from pan-Arctic wetlands (above 60°N) over the period 1901–2016 using a process-based biogeochemical model (VISIT), including two different schemes of wetland CH_4 production, that was forced by historical atmospheric composition, climate, and land-use conditions. The two schemes simulated mean wetland CH_4 emission rates of 10.9 and 11.4 Tg CH_4 yr^{-1} in the 2000s with slightly different spatial source distributions (Fig. 1). Both simulations showed clear seasonal cycles of CH_4 emission, but the two schemes had different amplitudes and peak months. The schemes differed markedly in their simulated long-term patterns (i.e., a stationary trend and an increasing decadal trend), making it difficult to relate them to global atmospheric trends in a consistent manner. Linear regression analysis clarified the agreements and differences in environmental sensitivity and biological control of CH_4 production simulated by the schemes. The time-series of CH_4 emission in northern North America, northern Europe, and Siberia showed different patterns of correlation with two major meteorological teleconnection indices. This model-based study implied that the high-latitude CH_4 emission accounts for 5–7% of global wetland emission and would play increasingly important roles (e.g., positive feedback) under changing climate. To reduce estimation uncertainties, as demonstrated by the comparison of two schemes, we need further studies for improving biogeochemical models in collaboration with field studies.

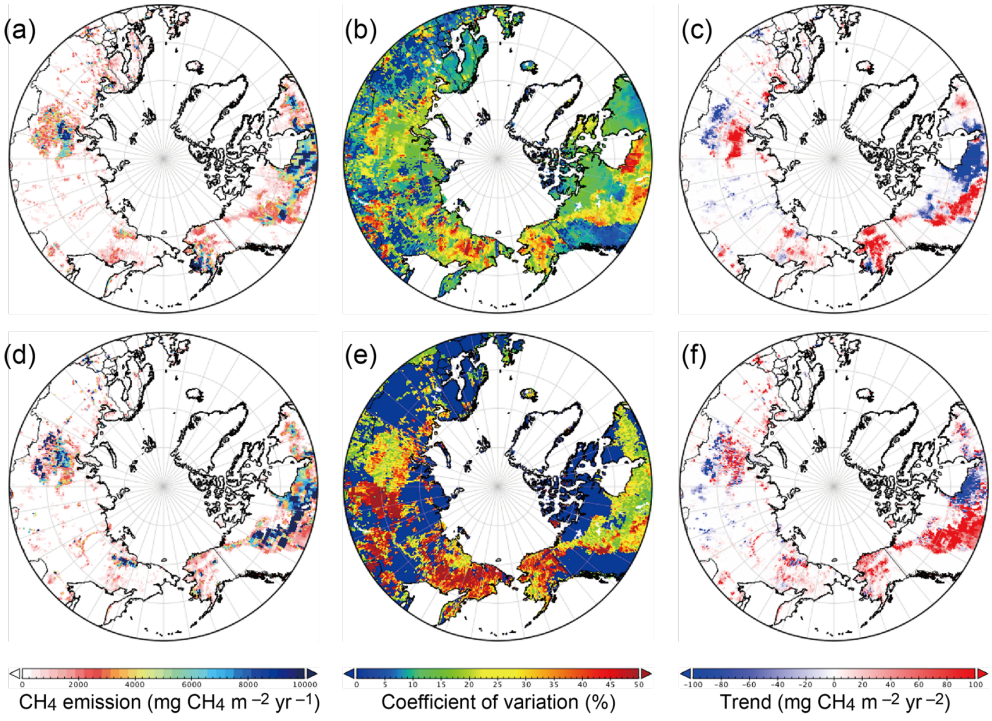

Figure 1. Properties of annual CH_4 emission simulated by (a, b, c) the Cao scheme and (d, e, f) the Walter–Heimann scheme implemented in the VISIT model in 2001–2010. (a, d) Mean, (b, e) coefficient of variation of interannual variability, and (c, f) linear trend.

References

Ito A. Methane emission from pan-Arctic natural wetlands estimated using a process-based model, 1901–2016. Polar Science in press.