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Untangling climatic and autogenic signals in peat records

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Raised bogs contain potentially valuable information about Holocene climate change. However, autogenic processes may disconnect peatland hydrological behaviour from climate, and overwrite and degrade climatic signals in peat records. How can genuine climate signals be separated from autogenic changes? What level of detail of climatic information should we expect to be able to recover from peat-based reconstructions?

We used an updated version of the DigiBog model to simulate peatland development and response to reconstructed Holocene rainfall and temperature reconstructions. The model represents key processes that are influential in peatland development and climate signal preservation, and includes a network of feedbacks between peat accumulation, decomposition, hydraulic structure and hydrological processes. It also incorporates the effects of temperature upon evapotranspiration, plant (litter) productivity and peat decomposition.

Negative feedbacks in the model cause simulated water-table depths and peat humification records to exhibit homeostatic recovery from prescribed changes in rainfall, chiefly through changes in drainage. However, the simulated bogs show less resilience to changes in temperature, which cause lasting alterations to peatland structure and function and may therefore be more readily detectable in peat records. The network of feedbacks represented in DigiBog also provide both high- and low-pass filters for climatic information, meaning that the fidelity with which climate signals are preserved in simulated peatlands is determined by both the magnitude and the rate of climate change. Large-magnitude climatic events of an intermediate frequency (*i.e.*, multi-decadal to centennial) are best preserved in the simulated bogs. We found that simulated humification records are further degraded by a phenomenon known as secondary decomposition. Decomposition signals are consistently offset from the climatic events that generate them, and decomposition records of dry-wet-dry climate sequences appear to be particularly vulnerable to overwriting.

Our findings have direct implications not only for the interpretation of peat-based records of past climates, but also for understanding the likely vulnerability of peatland ecosystems and carbon stocks to future climate change.