EGU22-10953
https://doi.org/10.5194/egusphere-egu22-10953
EGU General Assembly 2022

Peatbogs to the rescue! Opportunities and challenges in using ombrotrophic peat cores for a reconstruction of paleo-storms during the Holocene in eastern Canada

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Tropical cyclones and winter storms are pervasive dangers to coastal communities in eastern Canada and, under future climate change regimes, these extreme weather events are projected to increase. However, it remains challenging to establish the relationship between external forcing mechanisms, such as the North-Atlantic Oscillation (NAO) and the Atlantic Multidecadal Oscillation (AMO), and temporal variability of past storms on short timescales in this region. This is due to the scarce availability of and difficulty of producing high-resolution paleo-storm records. Here, we contribute to Northeast Atlantic paleo-storm research by showing how to leverage the advantages of using ombrotrophic peatlands in building a high-resolution paleo-storm reconstruction. Ombrotrophic peatlands receive water and minerals exclusively from atmospheric deposition and often accumulate sediments rapidly, making them excellent repositories of past storms.

Our reconstruction is based on a multi-proxy analysis of two peat sequences of 3.25 m (TAC – Tourbière-de-l'Anse-à-la-Cabane) and 7.00 m (TLM – Tourbière-du-lac-Maucôque) that were recovered from two ombrotrophic peat bogs on Île du Havre-Aubert, the southernmost island of the Magdalen Islands archipelago, in eastern Canada. The samples cover the entire peat sequence, with the base of the cores ending in sediments of glacial or marine origin. The cores were dated by ^{14}C and ^{210}Pb.The bottommost peat sediments date to ~8500 BP for TLM and ~4200 BP for TAC, with mean accumulation rates of 10 years/cm and 20 years/cm, respectively. We used a combination of X-ray microfluorescence (μ-XRF) measurements, computerized-tomography density, and Aeolian Sand Influx (ASI) measurements to identify allochthonous material from the ocean and surrounding beaches and sandstone cliffs in the peat cores. Analyses show high frequency variability in bromine and chlorine, which we hypothesize to be associated to sea-spray, and in terrigenous elements (potassium, titanium, manganese, iron), which we hypothesize to be associated to surrounding beaches and cliff sediments. ASI variations in the core closely match variations in terrigenous elements. It is hypothesized that mineral particles were deposited in the peat bogs during extreme weather events; this is suported by short-term peaks in chemical elements and aeolian sand from the topmost portion of the core that are correlated to known extreme events from modern instrumental data. High frequency (decadal) variability seen in the elemental and aeolian sand data throughout the core could possibly result from variation in storminess.

By applying a multi-proxy approach that combines μ-XRF geochemistry, density measurements, aeolian sand influx, and modern instrumental data on the full peat sequence, we were able to identify storm-derived materials with confidence while building a high-resolution paleo-storm reconstruction. With this data, we can establish the relationship between external forcing mechanisms and past storms.