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Critical transitions in peatland development in South Florida

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Terrestrial organic sediments cores from Southern Florida and the Everglades show two distinct episodes of initiation of peatland development between 4.5-6.5 ka and 2.0-3.5 ka and a mysterious interrupt separating these peat development phases. As peat development is highly sensitive to changes in groundwater, precipitation and evaporation, the reconstructed pattern of Southern Florida peatland development may provide novel insight in the response of Florida ecosystems to Holocene climate change. In this paper we propose and substantiate three hypotheses to explain these two distinct episodes of peat initiation: (1) a gradual increase in precipitation throughout the Holocene derived from proxies and climate models, (2) decreased drainage due to Holocene sea level rise depending on local topography and, (3) increased climatic variability from mid- to late-Holocene. The three hypotheses were tested in a model of peat accumulation and decomposition by means of specific forcings based upon climatic regional proxy data sets. The model results suggest that long-term average precipitation was sufficient for peat development throughout the Holocene, thereby not explaining the onset of peatland development at 6.5 ka. Although sea level rise and the local topography could explain this first period of peatland initiation, it could not account for the decline in peatland initiation after 4.5 ka. Instead, this period of reduced peatland initiation between 3.5-4.5 ka may be explained by an increase of multidecadal variability in precipitation. Multidecadal droughts decreased simulated hydroperiods and made peatlands vulnerable to erosion and fires. As peatland development is highly non-linear we show that peat heights may suddenly decrease from a dry to a wet low equilibrium by increased precipitation variability. The results further suggest that multidecadal climate variability after 4 ka can explain the second episode of peatland initiation. We conclude that the role of multidecadal climate variability is crucial to understand past and future peatland development in Southern Florida