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Evidence for a spontaneous onset of Little Ice Age change in the North Atlantic Arctic

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The Little Ice Age (LIA) is one of the most dramatic phases of climate deterioration experienced in the Arctic-North Atlantic during the Holocene. Yet despite this climatological significance, both timing and causes of the LIA remain debated. An expanding body of recent work shows LIA glacier growth predates two oft-invoked triggers – solar minima and volcanic eruptions – by centuries. Regardless of forcing, the expansion of regional sea-ice coverage represents a critical positive feedback loop during the inception of the LIA. Strikingly, a series of recent climate model experiments indicate that such sea-ice-atmosphere feedbacks can arise spontaneously under Late Holocene climate boundary conditions. Moreover, this coupled response may become self-sustaining or be perpetuated by additional perturbations. Alpine glaciers around the North Atlantic rim sensitively track changes in atmospheric and surface ocean (e.g. sea ice) conditions. Geological archives that capture their past behavior therefore hold great potential to investigate the expression of the LIA in the region. As continuous recorders of change, sediment archives from glacier-fed lakes are particularly suitable for this purpose. Here, we present a lake sediment-based reconstruction of Late Holocene ($\sim$1500 years) glacier activity on southeast Greenland. Due to its strategic location at the confluence of Arctic and Atlantic waters near the seasonal sea-ice limit, our study site is highly susceptible to changes in regional atmospheric and oceanic climate. To reconstruct these shifts on human-relevant (decadal) timescales, we employ a novel suite of mineralogical, geochemical and sedimentological proxy techniques. Highly significant correlations between our reconstruction and regional surface temperature measurements and sea ice observations underscore the robustness of this approach. Contextualized in a regional paleoclimate framework, our findings are consistent with modelling evidence for a spontaneous abrupt (unforced) onset of LIA cooling, sustained and enhanced by regional sea-ice feedbacks.