No persistent North Atlantic Cooling during the Little Ice Age in Paleoclimate Modelling Intercomparison Project 3 Last Millennium Simulations

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Geological evidence collected from Baffin Island in the Eastern Canadian Arctic and Iceland shows sudden and persistent cooling during the descent into the Little Ice Age (LIA), which caused ice caps to grow and remain in their expanded states until the past century. The ice cap expansions are coincident with periods of major volcanic perturbations over the past millennium, begging the question of whether successive volcanic eruptions could have triggered the descent into the LIA. Some specific modeling experiments have shown that it is possible to induce long term cooling given sea ice feedbacks, although the results are sensitive to ocean conditions at the time of eruptions.

Here we analyze the most recent suite of Last Millennium simulations (850-1850 C.E.) from the Paleoclimate Modelling Intercomparison Project 3 (PMIP3) and the Coupled Model Intercomparison Project 5 (CMIP5) to determine if the current state-of-the-art models capture the sudden onset and persistence of the LIA cold period inferred from geological records in the North Atlantic region. We find that snow cover over Baffin Island does not show the sudden expansion as seen in the proxy records. This is likely a result of the models' inability to capture the critical plateau elevations that hold the ice caps. Sea ice expansion is seen in some PMIP3/CMIP5 models after single large eruptions, however none of these models produce significant centennial-scale effects. This is likely caused by biases in the mean climate; average hemispheric temperatures range by more than 3 K between models, while NH sea ice extent is consistently lower in the models than in reconstructions over the past millennium. This has critical consequences on ice and snow persistence in regions such as the Arctic where temperatures are near the freezing point and small temperature changes can induce feedbacks, such as ice-albedo, which could cause dramatic climate changes.