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A comparison of the climate impacts of volcanic eruptions at the Last Glacial Maximum and the Preindustrial period

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The paleoclimate record allows to establish the role of natural forcing in generating climate variability in states that are very different from today, such as at the last Glacial Maximum 21 000 years ago.

Here we present the results from an ensemble of idealized 1000-year-long simulations for the Last Glacial Maximum (n=5) and the Preindustrial (n=5), performed with the isotope-enabled version of the Hadley Center Coupled Model Version 3.

All 'forced' ensemble members were initialized separately from the spin-up, but forced with the same volcanic and solar forcing. We perform a superimposed epoch analysis to identify the short-term (1-2 year) and medium-term (3-5 year) effects of eruptions in the different states for large eruptions. We find that, globally averaged, the modeled temperature and precipitation change is similar for an eruption at the LGM, compared to an eruption in the preindustrial.

However, focusing on spatial patterns, there are significant differences. The change is more uniform across the globe, and between the years after the eruption for the LGM, whereas for the preindustrial strong signals are identified in the North Atlantic and the Southern Ocean which vary between the years after the eruption. We discuss the relative importance of sea ice feedbacks, and the Atlantic Meridional Overturning Circulation in sustaining temperature anomalies, and in creating long-term climate variability in the different climate states, and evaluate, to what extent volcanism could have contributed to a larger climate variability in the Glacial climate.