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Climate, vegetation, and society impacts in Scandinavia following the 536/540 CE volcanic double event

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The mid-6th century is an outstanding period in climate history featuring one of the coldest decades in the past 2000 years. It was triggered by the 536/540 CE volcanic double event, creating the strongest decadal volcanic forcing in the last two millennia. The centuries of the first millennium are characterized by great societal changes, including the ending of antiquity and the beginning of early medieval state formations, a process believed to have been reinforced by the LALIA and the Justinian Plague. However, less is known about causal relationships between global cooling, regional climate, and local societal changes in Scandinavia after this volcanic double event. Here we aim to improve this understanding by combining global climate and local growing-degree-day (GDD) modeling for southern Norway.

We use the PMIP4 past2k and the 6th-7th century (520-680 CE) MPI-ESM ensemble simulations, to analyze the atmospheric circulation and surface climate changes as a response to the 536/540 CE volcanic double event, focusing on Scandinavia. The ensemble mean reveals significant surface cooling up to 2K, accompanied by reduced precipitation up to 25% over Scandinavia during the growing season. However, single MPI-ESM model realizations show slight warming and increased precipitation reflecting different atmospheric circulation patterns over the years following the eruptions. Three sites are selected for the GDD model as a case study, representing different weather regimes in Southern Norway, which are then driven with the MPI-ESM ensemble data as input. The high-resolution data are compared to archaeological- and high-resolution pollen records, to shed more light on the climate, vegetation, and society impacts for southern Norway. We discuss the likely volcanic climate response over Scandinavia based on the model spread, atmospheric circulation change patterns, and the local archaeological and pollen records.