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Understanding the Climate Signal of the 1258 Eruption

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Solar and volcanic forcing variations are assumed to be the major drives of climate change over the last millennium. Large volcanic eruptions constitute extremely strong forcing to the Earth System by scattering incoming radiation back to space and absorbing outgoing longwave radiation. This leads to considerable negative temperature anomalies at the surface and significant warming of the aerosol containing layers altering atmospheric and oceanic circulation and composition substantially. The largest signal of volcanic activity in the last 10,000 years recorded in ice core data of both hemispheres is the 1258 eruption with unknown location. However, paleo temperature reconstructions show that the temperature response after this eruption was not as big as one would expect, given the size of the sulphate signal in the ice core. One cause might be the shift of the aerosol size distribution to larger particles. Larger particles scatter less visible light and absorb more efficiently in the near- and far-infrared. Simulations of the 1258 eruption are performed with a fully coupled atmosphere-ocean circulation model (ECHAM5/MPIOM) including information about both, the optical thickness and the effective particle radius. We analyse the effect of this large volcanic forcing on the atmosphere, surface exchange processes and oceanic circulation. Model simulations, in particular as a function of time dependent size distributions of volcanic aerosols, are compared with available temperature proxy data for the period following the historic eruption.