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Simulation of ash clouds after a Laacher See-type eruption

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The large explosive eruption of the Laacher See volcano c. 12,900 yrs BP marked the end of explosive volcanism in the East Eifel volcanic zone (Germany). We have reviewed the current evidence for the impact of the Laacher See Eruption (LSE) on the immediate and wider environment as recorded in a range of proxies with a series of interactive stratospheric aerosol model experiments. Recent studies about the climate impact of NH extratropical eruptions and new insights about the dating of the LSE warrant a return to this cataclysmic eruption and its potential influence on Northern Hemisphere climate. Rather detailed reconstructions of its eruption dynamics have been proposed. The eruption might have lasted several weeks or even months, most likely with an initial (~10h) intense early phase resulting in deposits over north-east Germany and the Baltic Sea, and a slightly later and weaker phase leaving deposits south of the volcano towards the Alps.

Our interactive stratospheric aerosol model experiments are based on a reference LSE experiment with emission estimates of 20 Tg of sulfur dioxide (SO_2) and 200 Tg of fine-ash, across two eruptive phases in May and June. Additional sensitivity experiments reflect the estimated range of uncertainty of the injection rate and altitude and, assess how the solar-absorptive heating from the 150 Tg of sub-micron ash emitted in the first eruptive phase changed the LSE cloud's dispersion. Our simulations reveal that the heating of the ash likely played an important role in the transport of ash and sulfate. Depending on the altitude of the injection, our simulated volcanic cloud begins to rotate shortly after the eruption. This meso-cyclone, as well as the additional radiative heating of the fine ash then changes the dispersion of the cloud to be more southerly compared to dispersal estimated without fine-ash heating. Sulfate transport is similarly impacted by the heating of the ash, resulting in a stronger transport to low-latitudes, later arrival of the volcanic cloud in the Arctic regions and a longer lifetime compared to cases without injection of fine ash.