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Simulation of the Laki volcanoe based upon analogs of winds

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We used daily surface pressure measurements from 1783 over Europe to reconstruct a year of 3D wind fields based upon the closest analog found in the 6-hourly fields from the ECMWF ERAI re-analysis from 1979 to 2013.
These fields are then used to nudge the LMDZORINCA global model with a full chemical scheme and a horizontal resolution of 1.29°x0.94° with 39 vertical layers to simulate the emissions of SO_2 from the volcano emitting over several months from June to August 1783. Fields of SO_2 and H2SO4 were analyzed over the whole year of 1783. We inject 81 Tg (S) over the period.
In France, the Royal society of medicine (Société royale de médecine) had developed for the first time a network of persons that observed both climatic variables and morbidity. The network is composed of 150 contributors over France, and has a more scattered coverage for Italy, Austria, Germany the United States and Madagascar. The measurements reported three times a day include: temperature, air pressure, air humidity wind direction and a description of the sky. Within the CHEDAR (Climate and Health Data Rescue and Modelling) project an archive of daily observations of fogs over French meteorological stations was created and registers of deaths in main cities were compiled.
These data indicate that increased mortality occurred from June to September 1783 immediately following the Laki eruption when compared to the average mortality over the period from 1774 to 1789. We quantified this increase over 23 cities in France.
We provide a comparison of SO_2 surface concentrations and draw the following conclusions:
- The days when the first manifestations of the volcano are reported over Western and Northern Europe are extremely well captured by the construction of analogs of winds for 1783.
- The sharp increase and the days of heavy fogs are correlated with decreases in visibility due to the advection of sulfur from the volcanic cloud
- Increased mortality in the 4 months that followed the eruption coincides with large concentration increases in SO_2 and H2SO4.