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Reconstruction of the atmospheric column from surface pressure: application to regional climate modelling of the volcano eruptions of Laki (1783)

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Our work aims at modelling regional climate conditions that prevailed during the volcano eruptions of Laki (Iceland) in 1783, with a regional climate model (WRF). Several types of data are available to describe coarsely large-scale atmospheric conditions that accompanied the Laki period and its impacts on health. These data are observations from meteorological stations, sanitary records available in the archives of public health institutions. We used a gridded sea-surface pressure data reconstruction obtained by Kington (1988)from a set of meteorological stations.
However, those data sets are not sufficient to constrain the boundary and initial conditions of a regional climate model. In this work, we discuss a method to overcome this problem by obtaining a three dimensional atmospheric field from surface observations. This method consists in the reconstruction of time continuous vertical atmospheric conditions based on sea-surface pressure. It is based on an analogue method between historical surface pressure (from Kington (1988)) and present surface pressure from NCEP reanalysis.
The method is evaluated on a reconstruction of the atmospheric column around the North Atlantic for the year 2010, from reanalysis data. We then provide a reconstruction for 1783 of the atmospheric column. Finally, we propose a WRF simulation over the European domain, forced on its boundaries by observed and reconstructed atmospheric fields, for the year 1783. This simulation will be used in a chemistry transport model to estimate the trajectory of the volcanic clouds that were emitted by the Laki eruption.