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Reconstruction of the Tambora forcing with global aerosol models : Challenges and limitations

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It is now generally recognised that volcanic eruptions have an important effect on climate variability from inter-annual to decadal timescales. For the largest tropical volcanic eruptions of the last millennium, simulated volcanic surface cooling derived from climate models often disagrees with the cooling seen in tree-ring-based proxies. Furthermore, cooling estimates from simulations show large uncertainties. Such disagreement can be related to several sources, including inconsistency of the currently available volcanic forcing datasets, unrealistic modelled volcanic forcing, insufficient representation of relevant climate processes, and different background climate states simulated at the time of the eruption. In particular, for eruptions that occurred before the observational period forcing characteristics related to the eruption magnitude and stratospheric aerosol properties are deduced from indirect evidences. So, while climatically relevant forcing properties for recent volcanic eruptions are relatively well constrained by direct observations, large uncertainties remain regarding processes of aerosol formation and evolution in the stratosphere after large tropical eruptions of the remote past.
Several coordinated modelling assessments have been defined to frame future modeling activities and constrain the above-mentioned uncertainties. Among these, the sixth phase of the Coupled Model Intercomparison Project (CMIP6) has endorsed a multi-model assessment focused on the climatic response to strong volcanic eruptions (VolMIP). VolMIP defines a protocol for idealized volcanic-perturbation experiments to improve comparability among climate model results. Identification of a consensual volcanic forcing dataset for the 1815 Tambora eruption is a key step of VolMIP, as it is the largest-magnitude volcanic eruption of the past five centuries and reference for the VolMIP core experiments. Therefore, as a first key step, five current/state-of-the-art global aerosol climate models had been subject to a common experimental protocol for the 1815 Tambora eruption in order to assess the uncertainties in the derived volcanic forcing. Results indicate substantial differences among model regarding key aerosols optical properties for the Tambora eruption. In this contribution we will discuss current uncertainties regarding relevant microphysical processes possibly underlining these large differences and challenges for current global stratospheric aerosol models to derive consensual forcing for large tropical volcanic eruptions.