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Volcanoes and climate: testing the Unified Model's response to volcanic aerosol forcing.

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Winters closely following explosive volcanic eruptions tend to show warm anomalies, for example, in Europe. On average, strong eruptions over the last 500 yrs caused significant winter warming in models and reconstructions, and lead to significantly detectable model fingerprints in reconstructions. However, the mechanism involved and the ability of models to simulate this mechanism fully is still uncertain. Natural variability in climate events includes internal/chaotic variability and that driven by natural forcings such as volcanoes and solar irradiance changes. To assess changes in the likely frequency of events, good estimates of natural variability in such events are required. There is reasonable certainty that large volcanic eruptions generate a dynamic response in the global circulation, but the magnitude of the response and the mechanisms involved are uncertain. Recent studies show that current climate models generally appear to underestimate the observed magnitude of the circulation changes due to stratospheric volcanic aerosol. Studies with simplified global circulation models have shown that temperature forcings applied to the lower equatorial stratosphere are able to generate a coupled stratospheric-tropospheric response that resembles the one observed after major tropical volcanic eruptions. The role of anomalous eddy-momentum fluxes in the upper troposphere appears to be key in driving the anomalous mean meridional circulation. Seasonal hindcasts with a new version of the Unified Model HadGEM2 with improved representation of the stratosphere do not show a big impact of the lower stratospheric resolution on the simulation of the volcanic effect on global circulation. This could be due to a lack in the stratospheric dynamics or to biases in the eddy transport in the upper troposphere and related feedbacks.
The study is focused on testing and improving the response of the HadGEM2 model to the forcing induced by volcanic aerosol injected in the lower equatorial stratosphere. Both the low top (40km) and high top (84km) version of HadGEM2 will be employed, in order to verify the effect of the stratospheric dynamics in the model's response.