HIGH LATITUDE VOLCANIC ERUPTIONS AND CLIMATE: FILLING THE GAPS

Lecture Series

Thursday, Nov. 6 Arrhenius building, MISU, C609

Bolin Centre for Climate Research

Stockholm University

Beginning on Wednesday, until Friday morning, we will be hosting six special guests who are active in volcano's volcano's impact on climate and/or climate dynamics research. On Wednesday and Thursday morning there will be a series of lectures and in the afternoon we will have round-tables to on current and proposed volcano research Our invited guests will present the following lectures, everyone is welcome.

Thursday, Nov. 6

09:30-10:00 Modeling volcanic eruptions from global aerosol models to earth system models

Claudia Timmreck

Max-Planck-Institute for Meteorology, Hamburg

Large volcanic eruptions are an important driving factor of natural climate variability. A sound assessment of the role of volcanoes in the climate system in comparison to other forcing factors is therefore a prerequisite for understanding future and past climate variability. New advances in understanding volcanic climate effects have been achieved by using on one hand sophisticated global aerosol models and on the other hand comprehensive climate and Earth system models. An important achievement is thereby the improved understanding of the volcanic imprint on decadal to multi-decadal time scales. New insights have also been gained about the relation between the initial climate state at the time of the eruption, the latitude of eruption and the volcanic climatic impact.

In my talk, I will highlight recent developments in the simulation of the climate effect of volcanic eruptions with different kind of global models and discuss open questions and research needs. Furthermore, I will outline future planned model intercomparison studies and cross validations of model simulations with observations which are essential to better constrain the radiative forcing of large volcanic eruptions and their climate impact.

10:00-10.30 Simulating the climate responses induced by super volcanic eruptions using a global aerosol model.

Myriam Khodri

LOCEAN-IPSL, Paris

It is now generally recognised that volcanic eruptions have an important effect on climate variability from inter-annual to decadal timescales. Several outstanding questions remain and concern the behaviour of huge SO_2 cloud injected into the stratosphere after super eruptions such as those that did occur during the last centuries.To contribute to the on-going effort to reduce the large uncertainties regarding the climatic responses to large volcanic eruptions we performed idealized process-oriented sensitivity experiments using the state-of-the-art IPSL global climate model forced with a well-established global aerosol process model containing a fully explicit size-resolving aerosol microphysical module. We developed experiments aiming at exploring the range of climate sensitivity to the magnitude (amount of SO_2 and altitude of the volcanic plume), latitude and season of eruptions. The effects of these eruptions factors were systematically evaluated. Climate simulations reveal that there is no canonical linear relationship between the global cooling and the magnitude of the eruptions, due notably to self-limiting microphysical aerosol processes. These processes explain the relatively weak global cooling that never exceeds 2.5°C in our model for the very large eruptions.

10:30-11:00 -- Coffee break --

11:00-11:30 Volcanic eruptions as an analog for stratospheric geoengineering

Alan Robock

Rutgers University, Department of Environmental Sciences, New Brunswick, NJ

In response to the global warming problem, there has been a recent renewed interest in geoengineering "solutions" involving "solar radiation management" by injecting particles into the stratosphere, brightening clouds or the surface, or blocking sunlight with satellites between the Sun and Earth. No systems to conduct geoengineering now exist, but a comparison of different proposed stratospheric injection schemes, using airplanes, balloons, and artillery, shows that using airplanes to put sulfur gases into the stratosphere would not be expensive. Nevertheless, it would be very difficult to create stratospheric sulfate particles with a desirable size distribution. While volcanic eruptions have been suggested as innocuous examples of stratospheric aerosols cooling the planet, the volcano analog also argues against geoengineering because of ozone depletion, regional hydrologic responses, and other negative consequences. Volcanic eruptions are an imperfect analog, since solar radiation management proposals involve the production of a permanent stratospheric aerosol layer, while volcanic layers are episodic. Nonetheless, we can learn much from the volcanic example about the microphysics of stratospheric sulfate aerosol particles; changes in atmospheric circulation, producing regional climate responses, such as changes to the summer monsoon; atmospheric chemistry; changes of the partitioning of direct and diffuse insolation; effects on satellite remote sensing and terrestrial-based astronomy; and impacts on the carbon cycle. There are 26 reasons why geoengineering may be a bad idea, and five reasons why it might be a good idea. Some of these can be evaluated with climate modeling, and some using the volcanic analog. Observations of the next large volcanic eruption will help to understand the evolution in stratospheric sulfate aerosol size distribution over the first few months after the eruption. Much more research is needed before we can quantify each of these, so that policymakers in the future can make informed decisions about whether to ever implement stratospheric geoengineering. Given what we know today, global efforts to reduce anthropogenic emissions and to adapt to climate change are a much better way to address anthropogenic global warming.

11:30-12:00 Geoengineering by sulfate aerosols to stabilize climate in the face of increasing CO_2: the impact on the Southern Hemisphere atmosphere and ocean circulation and on the ice shelves in western Antarctica

David Battisti

University of Washington, Department of Atmospheric Sciences, Seattle, WA

When sulfate aerosols are used to ameliorate the global average warming due to increasing CO_2, the result is a residual warming in the high latitude northern hemisphere and a residual cooling in the tropics. In the high latitudes of the southern hemisphere, geoengineering by sulfate aerosols exacerbates the atmospheric circulation changes associated with increasing CO_2, and may increase the probability that grounded ice sheets in Antarctic would be destabilized, leading to rapid changes in global sea level. Each of these residual effects is due to the different spatial and temporal distribution of the forcing associated with increasing sulfate aerosols and increasing CO_2.

13:15-17:00 Open Discussion --

Contact: Francesco S.R. Pausata: francesco.pausata@misu.su.se for further information or to attend the workshop on Wednesday and Thursday afternoon.