Quantifying the impact of moderate volcanic eruptions on the stratosphere


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Quantifying the impact of moderate volcanic eruptions on the stratosphere


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It is expected that the aerosols in the stratosphere, are predominantly derived from volcanic sources, mainly: carbonyl sulfide (OCS), sulfur dioxide (SO2). Sulphate aerosols are regarded as the main constituent of the “Junge layer” between the tropopause and about 30 km. This assumption is regularly challenged by detection of solid aerosols with aircraft and balloon measurements. The direct injection of gaseous SO2 into the stratosphere by major volcanic eruptions is likely to generate significant amounts of sulphate aerosols that can stay for several years. Recently, Vernier et al. (2011) have shown from satellite measurements that moderate eruptions modulate the aerosol content during periods not influenced by a major volcanic eruption, called “background” periods. Surprisingly, the radiative impact of the background stratospheric aerosols over the last decades, has been found to be significant with a counterbalance to global warming (Solomon et al., 2011).

Sarychev eruption (12 June 2009)

In the framework of the Stratus project, eight stratospheric balloons were launched from the Espérons base (Sweden) in summer 2009. A number of in-situ optical aerosol counters (OTAC), a UV-visible remote sounding spectrometer for the aerosol extinction (SALMONE) and a photometer (microADHIB) provided information on the nature and size distribution of the stratospheric aerosols. The observations highlighted high amounts of aerosols in the lower stratosphere. These observations have been explained by the eruption in June 2009 of the Sarychev volcano, located in the Kuril Islands which injected ash and an estimated 1 Tg of sulphur dioxide into the upper troposphere and lower stratosphere.

Kelud eruption (13 February 2014)

In January 1979 to 31 December 2010, the GES_DISC_MSVOLSO2L4_V1 Multi-Satellite Volcanic Sulfur Dioxide database has been produced. The particular project, “Multi-Decadal Sulfur Dioxide Climatology from Satellite Instruments”, is expected to produce SO2 total column (Du) over the Indian Ocean on the stratosphere. The climate effects of volcanic eruptions are well acknowledged. These effects are due to the production of a layer of sulphate aerosols that can stay for several years. For these radiative effects to accumulate, the aerosols must remain in the atmosphere for an extended period of time. The residence time of aerosol varies from a few months for moderate eruptions to more than 1 year for major eruptions (volcanic explosive index >6).

Perspectives

The climate effects of volcanic eruptions are well acknowledged. These effects are due to the production of a layer of sulphate aerosols that can stay for several years. For these radiative effects to accumulate, the aerosols must remain in the atmosphere for an extended period of time. The residence time of aerosol varies from a few months for moderate eruptions to more than 1 year for major eruptions (volcanic explosive index >6).

Several studies estimate the radiative impact of volcanoes on a global climate scale. However, it is important to note that the climatic and atmospheric impact of volcanoes is strongly dependent on the altitude of injection. The residence time of aerosol is strongly dependent on the altitude of injection. The residence time of aerosol varies from a few months for moderate eruptions to more than 1 year for major eruptions (volcanic explosive index >6).

The good agreement between the WACCM-CARMA model and the observations gives evidence that moderate stratospheric eruptions control the variability of the Junge layer. Moderate eruptions like the Sarychev eruption have the potential to increase the background aerosol loading by a factor 2 to 10.

The Kelud eruption in 2014 was performed in this way with different instruments like the backscatter sonde COBALD or the LOAC counter. These results are consistent with the WACCM-CARMA model. The Kelud eruption is symbolized by the red triangle. The black dotted lines are tropopause.