Quantifying the impact of moderate volcanic eruptions on the stratosphere


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Southern tropical
Northern tropical

Sarychev eruption (12 June 2009)

In the framework of the StrataVol project eight stratospheric balloons were launched from the Erosage base (Sweden) in spring 2009. A number of in situ optical aerosol counters (OTAC), a UV-visible remote sensing spectrometer for the aerosol extinction (SALMON) and a photometer (micronADHAD) provided information on the nature and size distribution of the stratospheric aerosol. The observations highlighted high amounts of aerosol in the lower stratosphere. These observations have been explained by the eruption in June 2009 of the Sarychev volcano(48°N, 159°E) 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)

The good agreement between the WACCM-CARMA model and the observations gives evidence that moderate stratospheric eruptions control the variability of the Jung Layer. Moderate eruptions like the Kelud eruption have the potential to increase the background aerosol loading by a factor 5 to 10.

Calbuco eruption (22 April 2015)

Perspectives

The climate effects of volcanic eruptions are well acknowledged. Two other effects are to the production of a layer of sulphuric acid in the lower atmosphere, which distributes long-term, when liquid, into the ocean layers and, owing to the action of the sun, to the atmosphere. For these climate effects, in monsoon, the aerosols must remain in the atmosphere for an extended time period. The later the eruption, the more effective the climate effect. The climate effect of major eruptions generally depends on both the size and the altitude of the eruption. A major eruption in the northern hemisphere colder than in the southern hemisphere, because the aerosols remain longer in the atmosphere and the climate effect is more similar to that of the northern tropics. For the same amount of aerosol, a major eruption in June has the greatest climate effect than in December because the aerosols remain longer in the atmosphere.

It is expected that the aerosols in the stratosphere, are predominantly sulfates resulting from natural or anthropogenic sources of precursors gases mainly: carbonyl sulfide (COS), 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 liquid 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 sulfate 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 decade, has been found to be significant with a counterbalance to global warming (Solomon et al., 2011).

Quantifying the impact of moderate volcanic eruptions on the stratosphere


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Emissions of SO2 in an unique database. This work was achieved in the framework of the AeroCom hindcast project. All the volcanic emissions of SO2 listed in the Global Volcanism Program's database provided by the Smithsonian Institution were put together. This new database contains the amount and latitudes of the SO2 emissions in an unique database. This work was achieved in the framework of the AeroCom hindcast project. All the volcanic emissions of SO2 listed in the Global Volcanism Program's database provided by the Smithsonian Institution were put together. This new database contains the amount and latitudes of the SO2 emissions in an unique database. This work was achieved in the framework of the AeroCom hindcast project. All the volcanic emissions of SO2 listed in the Global Volcanism Program's database provided by the Smithsonian Institution were put together. This new database contains the amount and latitudes of the SO2 emissions in an unique database. This work was achieved in the framework of the AeroCom hindcast project. All the volcanic emissions of SO2 listed in the Global Volcanism Program's database provided by the Smithsonian Institution were put together. This new database contains the amount and latitudes of the SO2 emissions in an unique database.