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Equatorward dispersion of the Sarychev volcanic plume and the relation to the Asian summer monsoon

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Sulfur dioxide emissions and subsequent sulfate aerosols from strong volcanic eruptions have large impact on global climate. Although most of previous studies attribute the global influence to volcanic eruptions in the tropics, high-latitude volcanic eruptions are also an important cause for global climate variations. In fact, the potential climate impact of volcanic also largely depends on the season when eruptions occur, the erupted plume height and the surrounding meteorological conditions.

This work focuses on the eruption of a high-latitude volcano Sarychev, and the role of Asian summer monsoon (ASM) during the transport and dispersion of the erupted plumes. First, the sulfur dioxide emission rate and height of emission of the Sarychev eruption in June 2009 are modelled using a Lagrangian particle dispersion model named Massive-Parallel Trajectory Calculations (MPTRAC), together with sulfur dioxide observations of the Atmospheric Infrared Sounder (AIRS/Aqua) and a backward trajectory approach. Then, the transport and dispersion of the plumes are modelled with MPTRAC and validated with sulfur dioxide observations from AIRS and aerosol observations from the Michelson Interferometer for Passive Atmospheric Sounding (MIPAS). The modelled trajectories and the MIPAS data both show the plumes are transported towards the tropics from the southeast edge of the ASM (in the vertical range of 340-400K) controlled by the clockwise winds of ASM, and from above the ASM (above 400K) in form of in-mixing process. Especially, in the vertical range around 340-400K, a transport barrier based on potential vorticity (PV) gradients separates the 'aerosol hole' inside of the ASM circulation and the aerosol-rich surrounding area, which shows the PV gradients based barrier may be more practical than the barrier based on the geopotential height.

With help of ASM circulation, the aerosol transported to the tropics and stayed in the tropical lower stratosphere for about eight months, which were the main aerosol sources during that time. This enables the Sarychev eruption to have potential impact on global radiative budget similar to a tropical volcanic eruption.