Global simulation of SO_2 and sulfate aerosol from the Hunga-Tonga eruption: Potential impacts on atmospheric chemistry and climate

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For the Tonga submarine volcano (Hunga Tonga-Hunga Ha'apai) that erupted on January 15, 2022, it was confirmed by satellite observation that the eruption reached an altitude of 30 km, and the scale of the eruption may be comparable to the 1991 eruption of Pinatubo volcano (Indonesia), where eruption was confirmed to the middle of the stratosphere. However, the total amount of sulfur dioxide (SO_2) injected into the stratosphere is estimated to be only about 0.5 Tg by satellite observation (Auro / OMI) in the Tonga submarine volcanic eruption, which is less than 1/20 of the Pinatubo volcanic eruption (~ 17 Tg). Therefore, it is tentatively expected that the long-term impacts on the ozone layer and climate will be limited for this eruption of Tonga. In this study, SO_2 injected into the stratosphere due to the eruption of the Tonga submarine volcano and its conversion to sulfate aerosol (sulfate) are reproduced and predicted using the global chemical climate model CHASER (MIROC) (for 2022-2025). We tried to predict the impact of this volcanic eruption on the climate and the ozone layer. According to the current simulation results, a relatively large negative radiative forcing (long wave / short wave total: global average) of about 0.5 to 1.0 W m^{-2} will be generated especially in 2023, and the surface temperature will also slightly drop (by about -0.2 $^{\circ}C$). It was also suggested that in the Southern Hemisphere and the Antarctic region, it may lead to a decrease in the total amount of ozone by about 6 DU. However, since such prediction results greatly depend on the experimental settings such as SO_2 injection altitude, further sensitivity experiments are required.

Keywords: volcanic eruption, SO2, climate change, chemistry climate model

