EGU23-12992, updated on 26 Apr 2024
https://doi.org/10.5194/egusphere-egu23-12992
EGU General Assembly 2023

The Hunga Tonga-Hunga Ha'apai stratospheric eruption of 15th January 2022: a global warming volcanic plume?

Pasquale Sellitto[1,2], Bernard Legras[3], Clair Duchamp[3], Redha Belhadji[1], Elisa Carboni[4], Richard Siddans[4], and Corinna Kloss[5]

[1]Univ. Paris Est Créteil and Université de Paris, CNRS, Laboratoire Interuniversitaire des Systèmes Atmosphériques, Institut Pierre Simon Laplace, Créteil, France

[2]Istituto Nazionale di Geofisica e Vulcanologia, Osservatorio Etneo, Catania, Italy

[3]Laboratoire de Météorologie Dynamique, UMR CNRS 8539, École Normale Supérieure, PSL Research University, École Polytechnique, Sorbonne Universités, École des Ponts PARISTECH, Institut Pierre Simon Laplace, Paris, France

[4]UK Research and Innovation, Science and Technology Facilities Council, Rutherford Appleton Laboratory, Chilton, UK

[5]Laboratoire de Physique de l'Environnement et de l'Espace, CNRS UMR 7328, Université d'Orléans, Orléans, France

The underwater Hunga Tonga-Hunga Ha'apai volcano erupted in the early hours of 15th January 2022 and injected volcanic gases and aerosols to over 50 km altitude. In this talk, we synthesise satellite, ground-based, in situ and radiosonde observations of the eruption to investigate the emissions, the horizontal and vertical dispersion, and the strength of the stratospheric aerosol and water vapour perturbations in the initial six months after the eruption. The aerosol plume was initially formed of two clouds at 30 and 28 km, mostly composed of submicron-sized sulfate particles, without ash, which is washed out within the first day following the eruption. The large amount of injected water vapour led to a fast conversion of SO2 to sulphate aerosols. We find that the Hunga Tonga-Hunga Ha'apai eruption produced the largest global perturbation of stratospheric aerosols since the Pinatubo eruption in 1991 and the largest perturbation of stratospheric water vapour observed in the satellite era. Then, using offline radiative transfer calculations driven by aerosol and water vapour observations, we quantify the net radiative impact across the two species. Immediately after the eruption, water vapour radiative cooling dominated the local stratospheric heating/cooling rates, producing a spectacular radiatively-driven plume descent of several kilometres. At the top-of-the-atmosphere and surface, volcanic aerosol cooling dominated the radiative forcing during this first dispersion phase. However, after two weeks, due to dilution, water vapour heating started to dominate the top-of-the-atmosphere radiative forcing, leading to a net warming of the climate system. On a longer timescale, sulphate particles, undergoing hygroscopic growth and coagulation, sediment and gradually separate from the moisture anomaly entrained in the ascending branch Brewer–Dobson circulation. This is the first time a warming effect on the climate system has been linked to volcanic eruptions, which usually produce a transient cooling.