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Chemical Processing and Ozone Loss in the Southern Hemisphere Stratosphere Following the Eruption of the Hunga Volcano

The 2022 eruption of the submarine Hunga volcano injected an unprecedented amount of water vapor directly into the stratosphere. In this talk, we use measurements of gas-phase constituents from the Aura Microwave Limb Sounder (MLS) and the Atmospheric Chemistry Experiment-Fourier Transform Spectrometer (ACE-FTS), aerosol from the Suomi-NPP Ozone Mapping and Profiler Suite Limb Profiler (OMPS-LP), and polar stratospheric clouds (PSCs) from the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) on Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations (CALIPSO) together with MERRA-2 meteorological reanalyses to investigate how the extraordinary hydration from Hunga affected chemical processing and ozone loss in the Southern Hemisphere polar and extrapolar lower and middle stratosphere. We review results showing widespread stratospheric chlorine and nitrogen repartitioning in the southern mid- and low-latitude stratosphere in the months following the eruption. Observed composition changes are consistent with heterogeneous processing on volcanic sulfate aerosol, in particular the hydrolysis of N_2O_5. However, the moderate enhancements in reactive chlorine did not cause appreciable chemical ozone loss, and extrapolar ozone abundances remained largely controlled by dynamics. At higher latitudes, the Hunga hydration was effectively excluded from the winter polar vortices in the first post-eruption winters in both hemispheres. While excess moisture from Hunga inside the 2023 Antarctic vortex led to unusually early and vertically extensive PSC formation and chlorine activation and intensified dehydration, by mid-winter chemical processing had essentially run to completion, as is typical in the Antarctic, preventing an exceptionally severe springtime ozone hole. The Antarctic vortex was relatively warm and dynamically disturbed through much of the 2024 season, and lower stratospheric chemical processing and ozone loss mostly followed typical patterns. The Arctic vortex in the 2023/2024 winter/spring was also unusually humid, but dynamically disturbed conditions were unfavorable for chlorine-catalyzed ozone loss. Finally, we will also report on the 2024/2025 Arctic winter, which will have recently concluded.

Topic

Atmospheric composition (Earth and planets), chemistry and transport

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