Variations in Stratospheric Aerosol Layer and Aerosol Microphysical Processes Following the 2021 La Soufrière Eruption: Insights from *in situ* and Satellite Observations

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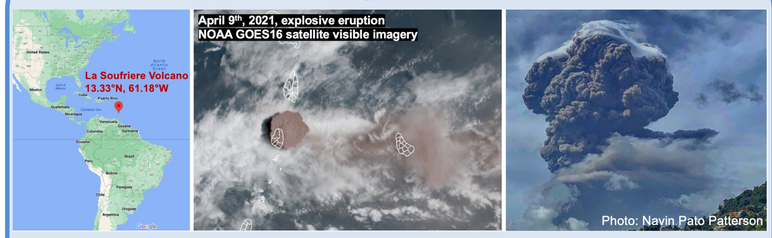
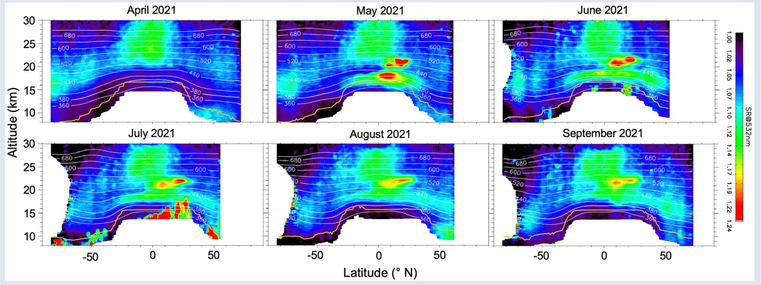
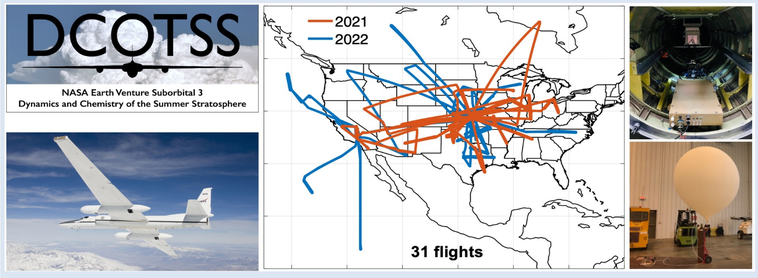
2021 La Soufrière eruptions and observations



- La Soufrière (13˚N, 61 ˚W) **erupted >20 times** between April 9-11th, 2021. The eruptions injected **~0.4 Tg of SO_2** into the UTLS (based on the TROPOMI analysis). Plumes reached up to 23 km (*Horváth et al., 2022*)



- Evolution of La Soufrière volcanic plumes observed by CALIOP/CALIPSO: Two distinct plumes were identified in the tropical lower stratosphere, one between **17-19 km** and another between **20-22 km** (*Li et al., 2023*)



- Dynamics and Chemistry of the Summer Stratosphere (DCOTSS) is a NASA EVS-3 project with ER-2 aircraft flying over North America in summer 2021 and 2022 (**up to 21.5 km**). The DPOPS instrument onboard the ER-2 measured number density and size distribution of particles between 140-2,500 nm diameter. Balloon-borne measurements in DCOTSS 2021 also measured number density and size distribution of particles larger than 300 nm diameter.

Data and Acknowledgements

- All DCOTSS data presented here are publicly available at: https://asdc.larc.nasa.gov/project/DCOTSS. This work was supported by NASA grant 80NSSC19K0326.

References

Horváth et al., *Atmospheric Chemistry and Physics*, 2022
Li et al., *Atmospheric Chemistry and Physics*, 2023
Wrana et al., *Atmospheric Chemistry and Physics*, 2023

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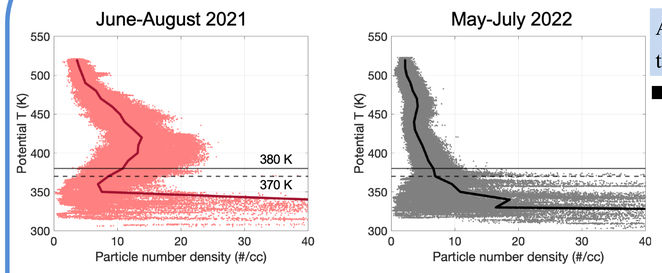
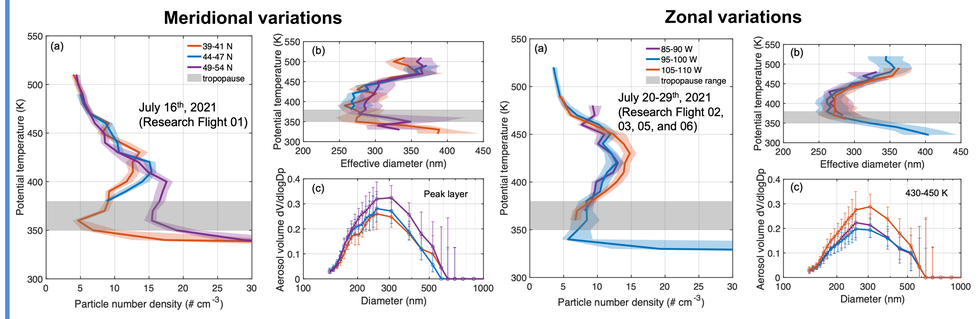
Variations and characteristics of the lower volcanic plume

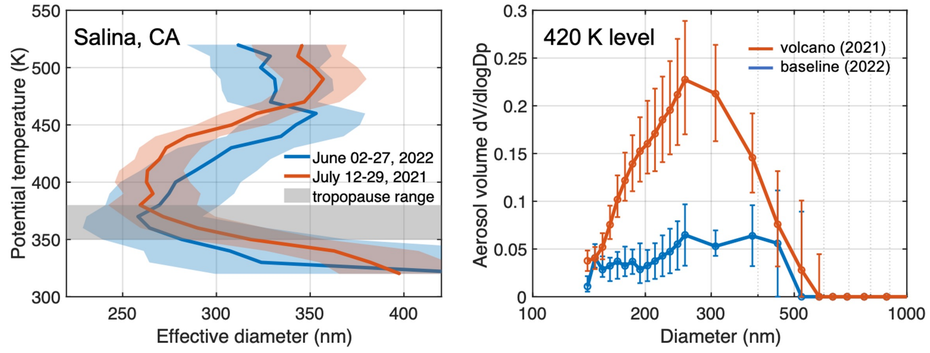


Airborne DPOPS measurements of the lower plume at mid-latitudes

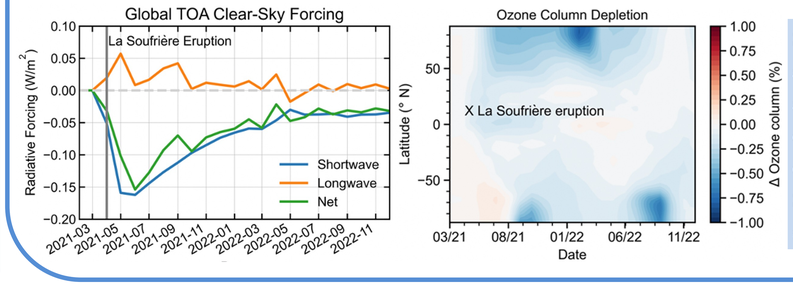
- Aerosol number (and surface area) density in the lower stratosphere was **2-4 times higher** in summer 2021 than in the minimally perturbed summer of 2022



- Meridional variations in number concentration profiles: poleward isentropic transport + downwelling Brewer-Dobson circulation at mid-latitudes; minimal variations in aerosol size profiles
- Zonal variations in number concentration profiles: synoptic variations; minimal variations in size

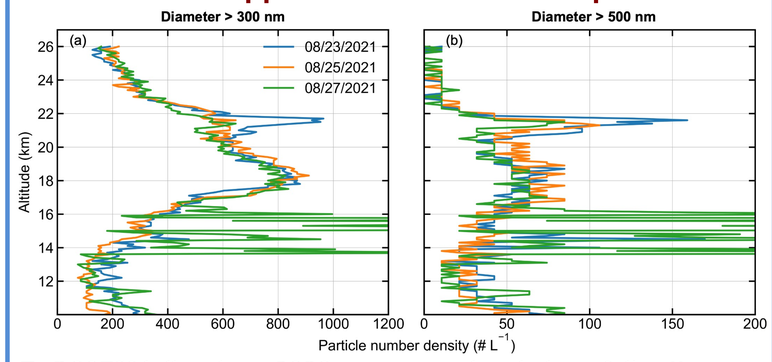


- The eruptions resulted in a **smaller aerosol effective diameter** in the midlatitude lower stratosphere.
- Volcanic eruptions are generally thought to lead to an increase in aerosol size. However, the 2021 La Soufrière eruption led to an increase in the number concentration of small particles (**< 400 nm**).

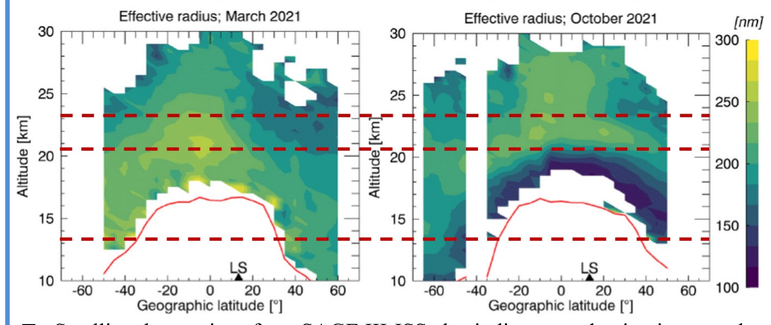


Small radiative and ozone impacts as indicated by observationally-constrained SOCOL_AERv2 simulations

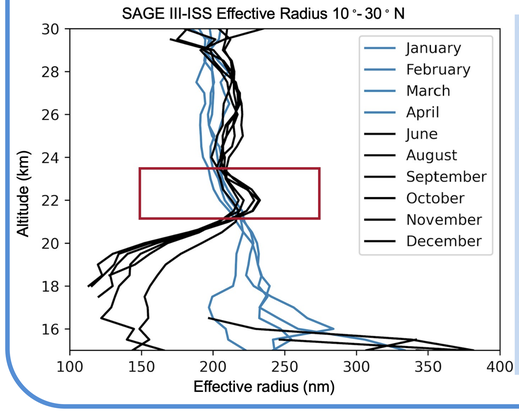
Contrasting aerosol microphysical processes within the upper and lower volcanic plumes



- DCOTSS balloon-borne POPC measurements launched over Salina, Kansas (39° N, 98° W) detected a thin layer of aerosol enhancement for particles larger than 300 nm at ~21.5 km (a transient filament excursion of the upper plume)
- The upper plume likely consists of **larger particles** due to an extended process time within the tropical reservoir, likely involving condensation growth.



- Satellite observations from SAGE III-ISS also indicate a reduction in aerosol size within the lower stratosphere, as affected by the lower volcanic plume (*Wrana et al., 2023*)
- Additionally, SAGE III-ISS has observed an increase in aerosol size within the upper volcanic plume (~21-23 km), predominantly contained within 30 ° N.



The variance in volcanic aerosol microphysical processes between the tropical reservoir (upper plume) and the midlatitude lower stratosphere (lower plume), along with their consequence on changes in aerosol size, warrants further exploration.

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