

Opportunity Title: Volcanic gas emissions before, during, and after eruptions.

Opportunity Reference Code: 0083-NPP-NOV23-ARC-EarthSci

Organization National Aeronautics and Space Administration (NASA)

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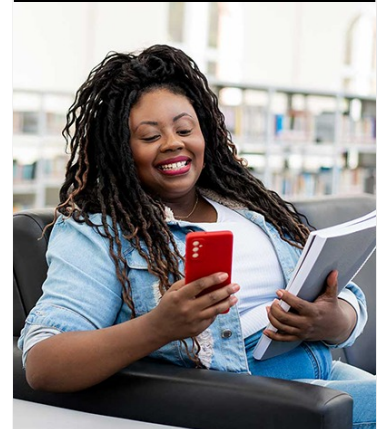
Application Deadline 11/1/2023 6:00:59 PM Eastern Time Zone

Description Over 500 historically active volcanoes on Earth exhibit >40 eruptions a week, some ongoing, with profound effects on the human and natural environment. How do volcanoes move from quiescence to unrest, and from unrest possibly to an eruption? How do local hydrology, vegetation, and their climate change induced instabilities affect eruption runup phases and outcome?

Changes in volcanic gas emissions herald eruptions, indicate eruption progress change, and help us understand the cessation and waning of activity after eruptions. Continuous subtle CO₂ emissions wax and wane with underground magmatic and tectonic activity, silently emanating as cold gas seeps from the often vegetated flanks of volcanoes into overlying forests which may react and adapt to these unique conditions - offering earliest precursors and indicators of long-term change. SO₂ emissions from crater vent areas indicate magma either close to the surface or erupting, creating a "hot phase" short-term tracker of eruption onset and progress. Water vapor emissions track changing hydrology like ingress, hydrothermal dry-out, and eruption progress.

Earth observing satellites enable detection, tracking and quantification of the atmospheric signatures of, and vegetation response to these gas emissions. Uncrewed Aerial Systems (UAS) enable remote and in-situ surveying of large areas of potential emissions and tracking of known gas seeps and their dispersion pattern. Ground-based measurements help validate these observations and provide important prior data for forward dispersion models. Inverse plume modeling provides quantification of fluxes from airborne and spaceborne observations.

This project seeks to use spaceborne datasets including SWIR data from OCO-2, OCO-3, GOSAT, GOSAT-2 for CO₂, TIR data possibly from sensors like ASTER, ECOSTRESS for SO₂, optionally GOSAT data for HDO/H₂O ratios, imaging spectroscopy data for ecosystem health, and available airborne UAS data, to track eruption runup and progress for select case study volcanoes. Inverse modeling and/or forward dispersion modeling will play an essential role to quantify fluxes and better understand how these gases may affect the local human and natural environment. We seek candidates with a background in environmental or earth science and expertise in remote sensing data analysis, data fusion, and experience in inverse and/or forward modeling of gas dispersion. We encourage research proposals to explore questions about how volcanic gas emissions constrain and characterize unrest or eruption process changes and progress, and how these may measurably interact with hydrology and forest ecosystems.



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The Earth Science Division at NASA Ames Research Center in Silicon Valley spans science expertise in atmospheric composition and dynamics, biospheric science (carbon cycle science, coastal and oceans ecosystems research, ecology), volcanic emissions, the NASA Earth Exchange (NEX), the Airborne Science Program with its UAS fleet and the Airborne Sensors Facility, and is associated with related local capabilities in intelligent systems, supercomputing, and aeronautics. The Ames sister divisions of Space Science & Astrobiology, and Space Biosciences include additional capabilities in volcanology and ecology. USGS Moffett Field and its California Volcano Observatory are co-located at NASA Ames and cross-project engagements thrive.

<https://www.nasa.gov/centers/ames/earthscience>

References:

- Schwandner, F.M., et al., 2017. Spaceborne detection of localized carbon dioxide sources. *Science*, 358(6360).
- Johnson, M.S., Schwandner, F.M., et al., 2020. Carbon dioxide emissions during the 2018 Kilauea volcano eruption estimated using OCO² satellite retrievals. *Geophysical Research Letters*, p.e2020GL090507.
- Bogue, R.R., Schwandner, F.M., Fisher, J.B., Pavlick, R., Magney, T.S., Famiglietti, C.A., Cawse-Nicholson, K., Yadav, V., Linick, J.P., North, G.B. and Duarte, E., 2019. Plant responses to volcanically elevated CO₂ in two Costa Rican forests. *Biogeosciences*, 16(6), pp.1343-1360.
- Cawse-Nicholson, K., Fisher, J.B., Famiglietti, C.A., Braverman, A., Schwandner, F.M., Lewicki, J.L., Townsend, P.A., Schimel, D.S., Pavlick, R., Bormann, K.J. and Ferraz, A., 2018. Ecosystem responses to elevated CO₂ using airborne remote sensing at Mammoth Mountain, California. *Biogeosciences*, 15(24), pp.7403-7418.
- Realmuto, V.J. and Berk, A., 2016. Plume Tracker: Interactive mapping of volcanic sulfur dioxide emissions with high-performance radiative transfer modeling. *Journal of Volcanology and Geothermal Research*, 327, pp.55-69.
- Nassar, R., et al., 2017. Quantifying CO₂ emissions from individual power plants from space. *Geophysical Research Letters*, 44(19), pp.10-045.

Location:

Ames Research Center
Moffet Field, California

Field of Science:Earth Science

Advisors:

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Applications with citizens from Designated Countries will not be accepted at this time, unless they are Legal Permanent Residents of the United States. A complete list of Designated Countries can be found at: <https://www.nasa.gov/oior/export-control>.

Eligibility is currently open to:

- U.S. Citizens;
- U.S. Lawful Permanent Residents (LPR);
- Foreign Nationals eligible for an Exchange Visitor J-1 visa status; and,
- Applicants for LPR, asylees, or refugees in the U.S. at the time of application with 1) a valid EAD card and 2) I-485 or I-589 forms in pending status

**Eligibility
Requirements**

- **Degree:** Doctoral Degree.