Advancing our understanding of atmospheric composition and climate

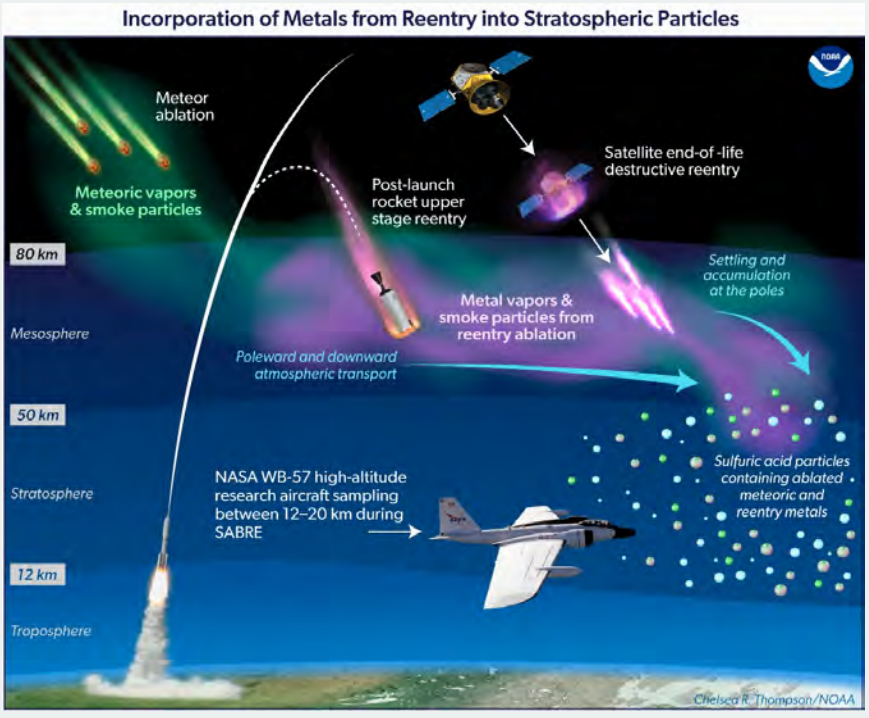
Quarterly Newsletter

Fall 2023 | Issue 6

*The **Chemical Sciences Laboratory (CSL)** is one of ten NOAA Research Laboratories located throughout the United States organized under the office of **Oceanic & Atmospheric Research (OAR)**. CSL is one of four individual OAR labs located within the David Skaggs Research Center (DSRC) in Boulder, Colorado. The research conducted at CSL aims to advance scientific understanding of the chemical and physical processes that affect Earth's atmospheric composition and climate.*

Recent News from CSL

NOAA Scientists Link Exotic Metal Particles in Upper Atmosphere to Rockets and Satellites



NOAA scientists, led by CSL' s Dan Murphy, investigating the stratosphere have found that

in addition to meteoric 'space dust,' the atmosphere more than seven miles above the surface is peppered with particles containing a variety of metals from satellites and spent rocket boosters vaporized by the intense heat of re-entry.

The discovery is one of the initial findings from analysis of data collected by a high-altitude research plane over the Arctic during a NOAA CSL mission for **Stratospheric Aerosol processes, Budget and Radiative Effects (SABRE)**. It's the agency's most ambitious and intensive effort to date to investigate aerosol particles in the stratosphere, a layer of the atmosphere that moderates Earth's climate and is home to the protective ozone layer.

Using an extraordinarily sensitive instrument custom-built at NOAA in Boulder, Colorado, and mounted in the nose of a NASA WB-57 high-altitude research aircraft, scientists found aluminum and exotic metals embedded in about 10 percent of sulfuric acid particles, which comprise the large majority of particles in the stratosphere. They were also able to match the ratio of rare elements they measured to special alloys used in rockets and satellites, confirming their source as metal vaporized from spacecraft reentering Earth's atmosphere.

The findings were published in the **Proceedings of the National Academy of Sciences** .

Read the full story >>

For Stratospheric Aerosol Injection, All Strategies are Not Created Equal

A new study finds that injecting SO_2 at higher latitudes, rather than in the tropics, could mitigate some undesirable side effects of SAI – but all options come with trade-offs.

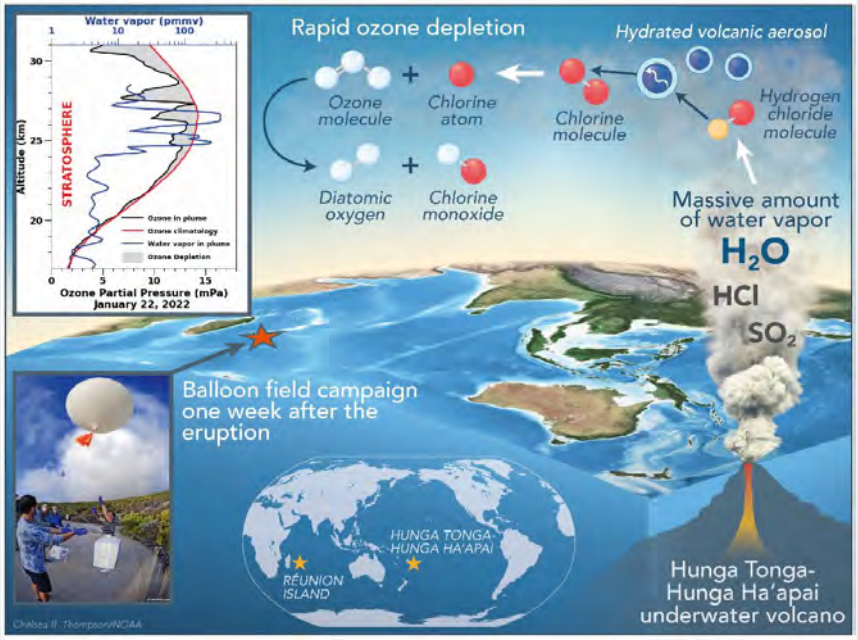
One potential method of climate intervention, known as stratospheric aerosol injection (SAI), aims to mimic the planet cooling effects of volcanic eruptions by injecting sulfur dioxide (SO_2) directly into the stratosphere where it forms sunlight-reflecting sulfate aerosols. Although the overall goal of SAI is straightforward (reflect more sunlight), when it comes to considering how such an intervention could or would be implemented, a complex patchwork of side effects and trade-offs emerges.

In a new study published in Atmospheric Chemistry and Physics, scientists from NOAA CSL and CIRES, in collaboration with Cornell and Indiana University, carefully examined a range of potential injection strategies by using a chemistry-climate model to simulate SAI while varying both the amount of SO_2 injected into the stratosphere and the latitudes where it is injected.

What they found was a complicated picture: a diverse range of outcomes beyond just decreased surface temperatures, that included impacts on the stratospheric ozone layer, large-scale circulation patterns, and regional weather and precipitation, that vary both spatially and seasonally.

Read the full story >>

Rapid Stratospheric Ozone Depletion Following the 2022 Hunga Tonga–Hunga Ha'apai Volcano Eruption



A recent study published in the journal Science found that the Hunga Tonga–Hunga Ha'apai eruption in January 2022 was so intense that it partially depleted Earth's ozone layer in the following weeks — marking the first time on record that scientists observed such a rapid and strong decrease of stratospheric ozone miles resulting from volcanic activity. The research was led by Stephanie Evan, a CNRS researcher at the Maïdo Observatory on Reunion Island, with colleagues from NOAA CSL and CIRES. The rapid mobilization of NOAA and CIRES researchers to Reunion within a week following the eruption to assist in chemical measurements of the plume, an effort dubbed TR^{2}EX, was part of NOAA's Earth's Radiation Budget research initiative.

The eruption injected huge amounts of water into the stratosphere and caused a large, rapid loss of ozone. Evan et al. collected in situ data on water, aerosols, and ozone in the volcanic plume and combined them with remote sensing observations to show that heterogeneous chlorine activation on humidified volcanic aerosols was the cause of the massive ozone loss that occurred. This loss was primarily triggered by the synergistic effects of strong humidification, radiative cooling, and added aerosol surface area, and this observation supports the suggestion that excess midlatitude stratospheric water associated with convection changes due to global warming could drive increases in lower stratospheric ozone loss.

In a second paper, published a few weeks later in PNAS, CIRES researcher Elizabeth Asher (CSL at the time of the study, now with GML) showed that the plume also exhibited rapid aerosol formation as a result of the massive amount of water vapor ejected. The large H_2O enhancements contributed as much as ~30% to ambient aerosol surface area and likely accelerated SO_2 oxidation and aerosol formation rates in the plume to approximately three times faster than under normal stratospheric conditions.

CSL's Mobile Lidar Supports October Study Investigating Oil & Gas Emissions in NW Colorado

CSL deployed their PUMAS (PickUp based Mobile Atmospheric Sounder) mobile doppler lidar to the Denver-Julesburg and Piceance oil and gas basins in NW Colorado from 15 October – 15 November to support the AMED (Airborne Measurements and analysis of Emissions over the Denver-Julesburg & Piceance) study.

The project focused on quantifying emissions of methane, ethane and selected volatile organic compounds (VOCs) from the Denver-Julesburg and Piceance basins in Colorado. It included airborne and ground based mobile measurements. The University of Maryland (UMD) Cessna 402B research aircraft made measurement of methane, ethane, carbon

dioxide, carbon monoxide, nitrogen dioxide and a suite of volatile organic compounds (VOCs). The measurements were augmented by measurements of similar suite of species from the UMD/NOAA ARL's Air Research Car (NOAAs-ARC). Total emissions from the surveyed basins will be determined from airborne measurements using the mass balance method.

The project was funded by the Colorado Department of Public Health & Environment (CDPHE).

Upcoming

CSL @ AGU

Our scientists share their research at the American Geophysical Union (AGU) Fall Meeting in San Francisco, CA and online everywhere December 11-15 – the 2023 AGU Fall Meeting is both virtual and in person this year.

CSL will give 55 total presentations in Atmospheric Sciences sessions at #AGU23. 25 posters will be presented in addition to the 30 oral presentations and invited talks.

A schedule of CSL's AGU presentations is **posted online**.

Awards & Recognition

AGU Ascent Award

Dr. Amy Hawes Butler has received the 2023 AGU Atmospheric Sciences Ascent Award for her research explaining how processes in the stratosphere link to the troposphere and can improve predictability of weather on times scales of weeks to months.

Dr. Butler studies the interaction between the stratosphere and troposphere with an eye toward using the state of the stratosphere to improve predictability of weather at the surface. She is a recognized leader in the interactions between the stratosphere and troposphere. She has led or contributed to numerous studies on the stratosphere's influence on surface weather and tropospheric composition; she has excelled in these studies.

In addition to her research accomplishments, Dr. Butler excels at communication. She is a go-to expert regularly contacted by the media to discuss the polar vortex, sudden stratospheric warmings, and associated weather/climate impacts. She has put together explanatory videos covering atmospheric dynamics topics that are clear and easily understood by a lay audience, regularly contributes to NOAA weather blogs, and has an active social media presence where she explains weather phenomena.

Read the full story >>

AGU Fellowship

Dr. Karen H. Rosenlof has been elected as a Fellow of the American Geophysical Union (AGU), in recognition of seminal contributions to the understanding of stratospheric dynamics and transport, and the processes that control stratospheric water vapor. AGU Fellows embody AGU's values by fostering equity, integrity, diversity, and open science; by mentoring; through public engagement; and in their communications.

Election to AGU Fellow is an honor reserved for less than 0.1% of AGU's membership in any given year. Karen's election to this honor is well deserved. Her research at NOAA has focused on the climate system and how it is changing. Her scientific impact is evident in both her leadership of chemistry and climate processes, and her research of stratospheric dynamics, stratosphere-troposphere interactions, and stratospheric composition including water vapor, ozone, and aerosols. Karen and the other 2023 Fellows will be recognized at the Fall Meeting of the AGU, to be held in December in San Francisco.

Silver Sherman Award

CSL's Ann Thorne receives a NOAA Silver Sherman Award. This award was initiated during Dr. Kathy Sullivan's tenure as NOAA Administrator, to recognize individuals who excel in their work, achieve a milestone that contributes significantly or critically towards a particular program's goal, or demonstrate leadership toward process improvement of a significant magnitude. Dr. Sullivan was particularly invested in reaching down into the organization to recognize those who made extraordinary efforts to keep the mission moving forward.

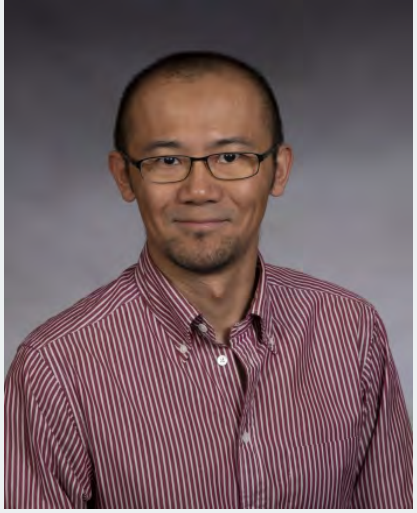
Ann is recognized "for going above and beyond her core duties at the NOAA Chemical Sciences Laboratory by taking on extra responsibilities related to students, education and outreach, especially mentoring of interns and organizing the summer intern program, and related to diversity, equity, inclusion, and accessibility issues for CSL, ESRL, and OAR. She has volunteered many times to help other laboratories, for example to cover absences in human resources staff, because her goal over three decades of service has been to make all the ESRL laboratories successful."

People of CSL — Staff Spotlight

Siyuan Wang

CIRES/CSL scientist Siyuan Wang joined the Regional Chemical Modeling research program in November 2020..

What do you do here at CSL?
I use a variety of models (from global chemistry-climate models to high-resolution turbulence-resolving models; from 3D models to 1D column models to 0D box models) to study a variety of chemical and physical processes in the atmosphere, with a current focus on wildfires.



Where are you from/where did you grow up?
Born and raised in Xinjiang, China, I enjoy a hot/dry summer and a proper cold/snowy winter. We eat a lot of kawap (a kind of kebab) and naan back at home.

What was your career path to get here?
I did my PhD in Hong Kong where I spent lots of time looking at multi-phase chemistry and halogen chemistry. Then did a postdoc in Michigan running CIMS and 0D/1D models. Then I moved to Colorado and spent 3 years at NCAR (first as an ASP postdoc then a project scientist) running 3D models (CESM and WRF). Then I moved across the town in late 2020 and joined CSL.

Name one thing about you that people wouldn't/don't expect.
About two months before my PhD defense I flew to Thailand, and joined a Muay Thai camp in Chiang Mai. I stayed in a youth hostel and trained for 6+ hours every day. I was this close to participating a local tournament but chickened out for the fear of participating my PhD defense with blackened eyes.

Learn more about Siyuan

Lucas Meyer

Lucas Meyer is a Budget Analyst in CSL's Administrative Office. He joined the Lab in July of 2023.

Where are you from/where did you grow up?
Spent youth in Germany then Iowa

What was your career path to get here?
Army, private sector, police, state law enforcement, DOJ, Army NG, NOAA

What did you want to be when you grew up?
Radiologist

Name one thing about you that people wouldn't/don't expect.
Eagle scout, professional boxer, pastor, knight

Wait...knight??
June 11th, 2022 I went to negotiate treaties in Jerusalem and was Knighted afterward in England before my return trip. So yes, my formal title is Sir Lucas Meyer, but Luc is fine!

What do you enjoy doing in your spare time?
Hang out with my son

If time travel existed, when would you go?

1774

Learn more about Lucas