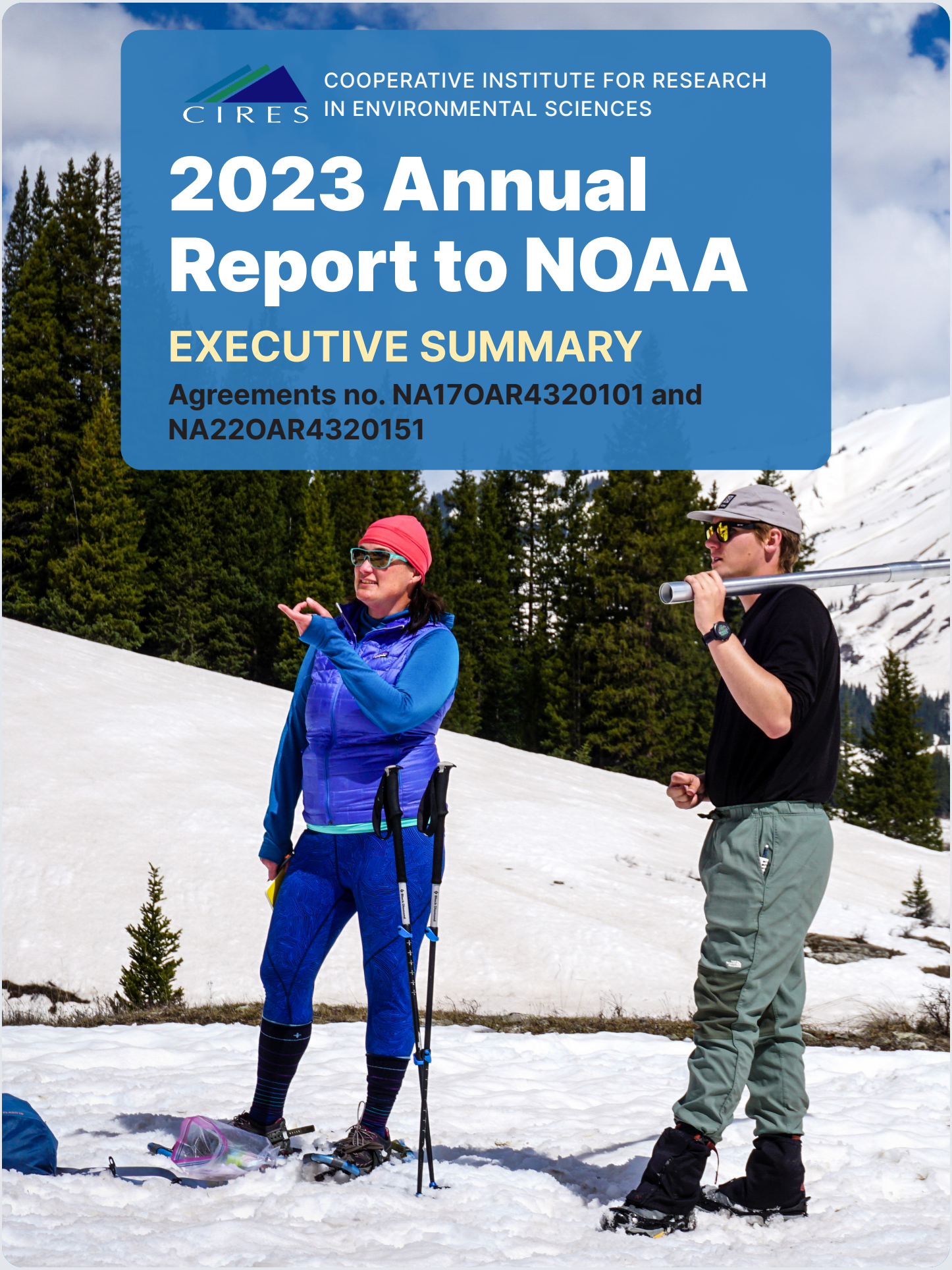


COOPERATIVE INSTITUTE FOR RESEARCH IN ENVIRONMENTAL SCIENCES

2023 Annual Report to NOAA

EXECUTIVE SUMMARY

Agreements no. NA17OAR4320101 and NA22OAR4320151

About CIRES

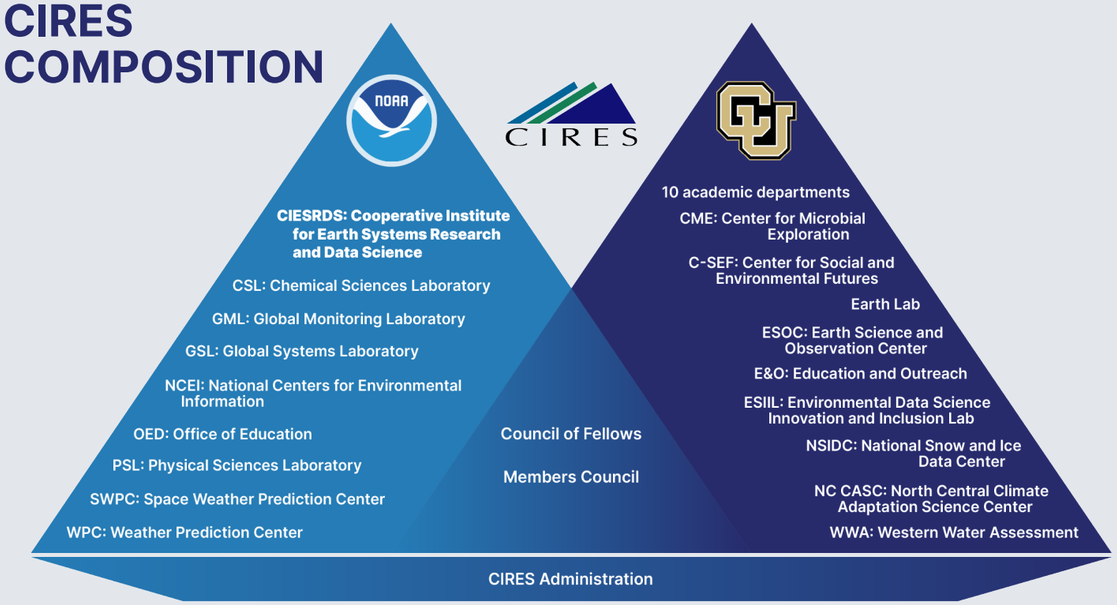
CIRES at CU Boulder has partnered with NOAA since 1967. In September 2022, we entered into a new cooperative agreement with NOAA: the Cooperative Institute for Earth Systems Research and Data Science (CIESRDS), which funds our research at NOAA labs for up to the next 10 years.

OVERVIEW

The Cooperative Institute for Research in Environmental Sciences (CIRES) brings together scientists from the University of Colorado Boulder and the National Oceanic and Atmospheric Administration (NOAA) to explore the dynamic Earth system. This partnership encourages innovation, rapid-response capabilities, and an interdisciplinary approach to complex environmental challenges. CIRES helps strengthen the scientific foundation upon which NOAA's environmental intelligence services depend, and our partnership allows coordinated studies on a scale that could not be undertaken by university research units or NOAA alone.

CIRES is the largest research institute at CU Boulder, employing more than 900 scientists, engineers, developers, students, and others who focus on science to benefit society. CIRES scientists conduct innovative research that makes navigation and communication safer; saves lives and property with research that improves forecasting at all scales; and builds society's resilience to environmental change.

CIRES COMPOSITION



CIRES researchers based in Boulder, Colorado, conduct research on the CU Boulder campus (left), at NOAA's David Skaggs Research Center (right), and around the world. Left photo: CIRES. Right photo: NOAA.

NOAA PARTNERS

Chemical Sciences Laboratory
Advancing scientific understanding of the chemical and physical processes that affect Earth's atmospheric composition and climate.

Global Monitoring Laboratory
Collecting, maintaining, and understanding long-term records of atmospheric greenhouse gases, aerosol particles, clouds, and surface radiation.

Global Systems Laboratory
A research and development lab for improving weather data, forecasts, and computing techniques used by industry, decision-makers, and stakeholders.

National Centers for Environmental Information
Stewardship and archiving of environmental data from the depths of the ocean to the surface of the Sun.

Office of Education
Providing opportunities for undergraduate students to gain hands-on experience in STEM while pursuing research and educational training in NOAA-mission sciences.

Physical Sciences Laboratory
Research to better observe, understand, model, and predict weather, water, and climate extremes and their related impacts.

Space Weather Prediction Center
Real-time monitoring of Earth's space environment and forecasting of space weather, including geomagnetic storms.

Weather Prediction Center
Synthesizing the nation's daily weather story and championing the operational prediction of rain, winter storms, and extreme temperature events for the protection of life and property.

CIRES BY THE NUMBERS FY2023

More than
$100M
in funding from NOAA, CU Boulder, contracts, and grants

911
researchers, faculty, students, and staff

668
papers published in academic journals

Accomplishments

In the past year, CIRES scientists accelerated Earth and environmental research; mentored and trained the next generation of Earth system scientists; promoted diversity, equity, and inclusion at CIRES; and supported public understanding of environmental science. CIRES scientists published 668 peer-reviewed papers in 2022, improving scientific understanding of weather, climate, and humans' ability to adapt to a changing planet.

PROFESSIONAL DEVELOPMENT

The CIRES Mentoring Program, which served 34 mentor-mentee pairs this year, connected staff of various career tracks and stages across the institute. CIRES' FieldSafe program, a workshop series designed to minimize environmental and interpersonal risks in remote field environments, served dozens of people from CIRES, NOAA, and other regional organizations.

CIRES postdoc Garima Malhotra (left) and Visting Fellow Sergio Ibarra-Espinosa. Photo: Ryan Vachon/CIRES.

DIVERSITY, EQUITY, AND INCLUSION

The CIRES DEI Director and others developed and led training programs that support diversity and inclusion in our workforce and attract broader and more diverse participation. Dozens of CIRES employees took advantage of these opportunities last year, which included taking anti-racism courses through Coursera, participating in weekly discussions on reducing political polarization, and learning how to conduct inclusive job searches and hires.

Additionally, CIRES scientists worked with GSL to support an undergraduate research internship program that encourages people from rural communities or groups underrepresented in STEM fields to participate; and CIRES scientists served on groups and councils that engage with Tribal and Indigenous communities.

EDUCATION AND OUTREACH

CIRES scientists partnering with OED strengthened the award-winning Climate Literacy and Energy Awareness Network (CLEAN), providing educators with high-quality materials on climate and energy topics. Their efforts led to a 30 percent increase in visits to the online CLEAN resources pages over the past year and growth of the CLEAN network to more than 800 members.

CIRES scientists are better educating the general public about space weather events through improvements to the SWPC website, including an aurora dashboard that has boosted visitor count.

NOAA workshop participants play the HEARTForce wildfire resilience simulation game. Photo: Kathy Bogan/CIRES.

RESEARCH

Atmosphere and climate

CIRES scientists in GML provided updated levels of global greenhouse gases in Earth's atmosphere and assessed their direct radiative forcing. These contributions have been included in key climate assessments such as the IPCC Indicators of Global Climate Change and NOAA's Annual Greenhouse Gas Index.

CSL scientists' work studying the ash plume from the 2022 Hunga Tonga-Hunga Ha'apai eruption has improved our understanding of how volcanic eruptions impact Earth's climate system. CIRES work modeling the transport of atmospheric pollutants has served key partners such as Nevada's Clark County, which used improved air-quality modeling in an ozone reduction plan.

Weather forecasting and prediction

CIRES scientists in SWPC developed a new geoelectric field map for the United States and Canada that was implemented in June 2023. The new map informs electric grid operators of impacts to the grid from space weather-induced geomagnetic storms, increasing situational awareness for operators of the 37 major power transmission lines connecting the two countries.

CIRES scientists have replaced components of NOAA's Global Forecasting System with newer and more efficient processes, leading to more accurate precipitation and hurricane forecasts. PSL scientists have also identified areas where research and development can lengthen the lead times for precipitation forecasts over California, a state that needs accurate forecasts for smart reservoir management.

Resource management

CIRES scientists used species distribution and ocean models to predict that nine out of 12 top marine predators in the northwest Atlantic Ocean will lose on average 30 percent of their habitat by the end of the century. The details of their assessment provide vital information to marine and coastal resource managers.

PSL scientists developed an innovative drought metric that lays the groundwork for the nation's first daily drought forecast. Their work helps advance forecasting of acute food insecurity in the United States and around the world.

Earth system data stewardship

CIRES data experts improved the accessibility and utility of sea-ice extent data captured by satellite microwave sensors, data critical to supporting operations at Earth's poles and for long-term climate records.

In NCEI, CIRES scientists enhanced the quality, utility, and accessibility of marine geophysical data. Their work archiving and quality controlling data from a January 2022 tsunami enhances our understanding of past tsunami events and improves real-time tsunami forecasts.

CIRES scientists take a field course in Gunnison Valley, Colorado. Photo: Katya Schloesser/CIRES.

Impact

CIRES scientists are world leaders in Earth and environmental research, but the impact of our work goes beyond basic science. In the past year, CIRES research and researchers have supported decision-making at local, state, and national levels and protected lives and property through improved weather monitoring and forecasting.

SUPPORTING DECISION-MAKING

This year, CIRES scientists in NCEI partnered with the U.S. State Department to complete mapping of the U.S. Extended Continental Shelf area, with a public announcement planned for late 2023. Their work gives the United States sovereign rights to conserve, explore, or exploit nearly one million square kilometers of additional seafloor.

CIRES researchers in CSL are critical to our efforts to understand the atmospheric chemistry that contributes to poor air quality. As a direct result of CIRES research detailing air quality impacts of bromine emissions from a magnesium refinery in Salt Lake City, Utah, state legislators passed a bill requiring the development of an inventory of halogen emissions. CIRES scientists were also involved in response to the Marshall Fire, which swept through Louisville and Superior, Colorado, at the end of 2021. Their work elucidated the effects of this devastating suburban wildfire on air quality indoors and outdoors.

CIRES scientists contributed to NOAA's annual Arctic Report Card and BAMS State of the Climate Report, providing highly-cited summaries of Arctic and global climate conditions used by scientists, policymakers, journalists, and others. NOAA estimated that the Arctic Report Card, lead-edited by a CIRES scientist, appeared in approximately 870 media outlets from December 2022 until early January 2023, with a potential reach of 3.7 billion people.

CIRES scientists in GML helped quantify unreported emissions of the ozone-depleting chemical CFC-11. Their efforts have had a lasting impact on the international community, bringing many governments to the table to discuss the need to resolve this violation of the Montreal Protocol as well as the need to improve atmospheric measurements of ozone-depleting substances and their replacements.

Left: A polar bear in Greenland. Photo: Thomas Johansen/NASA. Right: Bakken oil and gas fields in North Dakota. Photo: Jeff Peischl/CIRES.

Left Graduate students take soil samples near burned homes after Colorado's Marshall Fire. Photo: Katie Weeman/CIRES. Right: Shepherd's Flat Wind Farm in Oregon. Photo: Wikimedia Commons.

PROTECTING LIVES AND PROPERTY

CIRES scientists continue to improve the reliability of the Evaporative Demand Drought Index, an experimental monitoring and early warning tool for drought and wildfire risk. Their work helps decision makers understand and prepare for high-impact, weather-driven events.

CIRES scientists in WPC developed techniques to more accurately identify extreme precipitation events, improving NOAA's weather forecasting capabilities. WPC scientists also conducted the annual Winter Weather Experiment, bringing together the research, forecasting, and academic communities to address challenges in predicting heavy rainfall, flash flooding, and winter weather.

CIRES scientists continue to advance forecasting of acute food insecurity worldwide through the Famine Early Warning Systems Network. Their work provides hydroclimatic data and crop yield forecasts, and the team shares findings with stakeholders and decision-makers worldwide in monthly briefings.

CIRES scientists used remote-sensing techniques to better observe meteorological processes that impact renewable energy production. Their work helps evaluate NOAA's numerical weather forecasts that are used daily by utilities and transmission operators to ensure the smooth integration of renewable energy onto the electric grid.

AWARDS AND HONORS

CIRES researchers won or were part of teams that won many prestigious awards in the past year, including five Department of Commerce Bronze Medals and a Department of Commerce Silver Medal.

CIRES researchers were honored with the CO-LABS Governor's Award for High-Impact Research in 2022 for their work coordinating risk assessment, outreach, and real-time data collection during the devastating Marshall Fire in December 2021.

Clarivate Analytics named three CIRES scientists "highly-cited researchers" in 2022, placing them among the one percent most cited in their fields: Jennifer Balch, Noah Fierer, and Julienne Stroeve.

Alice Hill checks a map in the field. Photo courtesy of Alice Hill.

ADDITIONAL PHOTO INFORMATION

Cover image: Researchers in the field for the SPLASH campaign. Photo: Stephanie Maltarich/CIRES.

Aerial view of CU Boulder and the Flatirons. Photo: CU Boulder.

CIRES scientists do fieldwork in Flat Creek Basin, Alaska. Photo: Ethan Welty.

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