LARAMIE HIGH TIDINGS

ANNUAL NEWSLETTER OF THE DEPARTMENT OF ATMOSPHERIC SCIENCE AUTUMN 2023

The new University of Wyoming King Air configured with test shapes as part of certification test flights.

NEW UW KING AIR AIRCRAFT DEVELOPMENT

Development of the next-generation University of Wyoming King Air (UWKA-2) research aircraft continues as we are now 2.5 years into this project. In summer 2020, the University purchased a lightly used, King Air 350i aircraft (s/n FI-862). Since that time, nearly every aspect of that original aircraft has been modified; including new, bigger engines, heavy-weight landing gear, more powerful electrical generators, and updated avionics. In addition, more than 50 research-specific modifications have been designed and completed. Some of these include an extended nose and nose-boom, underwing pylons for instrument mounting, two large nadir ports for radar and lidar and two large upper ports for radar, several smaller upper ports for aerosol and trace gas inlets, and belly hardpoints for installation of larger instrument under the fuselage.

Earlier this fall, a major milestone was reached as all of the major modifications to the airframe were completed. The aircraft is now going through FAA flight testing for certification (see above image with the aircraft fitted with test shapes for flight tests). When completed, the new aircraft will be dual-certificated; able to operate in Commuter category when ferrying to and from project locations and operating Restricted category when instruments are installed it is conducting research. Flight testing is schedule to be complete in early 2024 after which the aircraft will go to the paint shop before the final delivery to UW, expected in March of 2024.

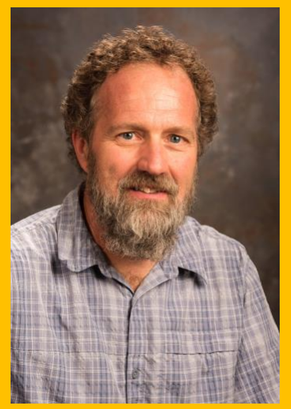
Once the aircraft arrives in Laramie, attention will turn towards installing and testing research equipment. This period of testing will continue through 2024 and into 2025, as we bring both existing and new capabilities online. The aircraft has already been allocated for a project to be flown based out of Salt Lake City in summer 2025; and several other projects remain under consideration by the National Science Foundation for possible deployments in 2025 and 2026.

The new aircraft is essential to the strategic vision of the Department of Atmospheric Science to retain national prominence in airborne atmospheric observations, an expertise that uniquely defines us. It will enable research in areas such as air quality, fugitive emissions, wildfires, severe storms, winter weather and cloud processes affecting water availability.

For more information and updates visit:
www.uwyo.edu/atsc

UW College of Engineering and Physical Sciences Atmospheric Science

MESSAGE FROM JEFF FRENCH, DEPARTMENT HEAD



Greetings and welcome to another addition of the *Laramie High Tidings,* the annual newsletter from the University of Wyoming Department of Atmospheric Science. This past year included many changes in the department including the addition of two new tenure-track faculty along with several new research scientists, engineers, and technicians. The department is now home to 26 full-time staff with three more hires expected in early 2024. We also have 3 full-time post-docs and anticipate hiring 3 to 4 more by summer of 2024. The department is as big as it ever has been and we continue to expand. This is all very exciting for our future, although finding space is becoming difficult!

Over the last couple of editions of this newsletter, you may recall reading about University plans for merging the departments of Atmospheric Science and Physics and Astronomy. Earlier this year, the University decided to abandon plans for that merger allowing us to re-focus our attention on developing the future of our department. As you will read about in this issue, the development of the next generation University of Wyoming King Air (UWKA) research aircraft is nearing completion. We anticipate welcoming the new aircraft with a ground-breaking celebration sometime in spring 2024. Also, several new project efforts were awarded/launched to department faculty. Three of those projects are highlighted in this newsletter that include significant funding from three major national agencies: NASA, DOE, and NSF.

This newsletter will reach you during the annual American Geophysical Union (AGU) annual meeting in San Francisco. ATSC will have a large presence at this year's meeting with four of seven faculty and several students attending and presenting. We will also host a booth (partnered together with UW Department of Geology/Geophysics) for recruiting potential graduate students and also meeting with friends and alumni of the department. If you are at AGU, plan to stop by. If you miss us at AGU, we will also have a presence at the American Meteorological Society (AMS) annual meeting in Baltimore in early 2024. A similar booth will be setup during the AMS career fair on Sunday evening, and if you're around please swing by, say hi, and meet some of our faculty and current students.

We had a special treat earlier this fall as alum Dr. Russ Schnell stopped into the department for a visit. Dr. Schnell holds the distinctive honor of being the first person awarded a degree (both M.Sc. and Ph.D.) from the department. Russ spent his lunch visiting with our current graduate students and inspired them with stories of his many great achievements over his illustrious career with NOAA and the UN. Following lunch, Russ presented a seminar describing the changing atmosphere and the challenges that we all face in addressing those changes. I would also like to thank Russ for his wonderful support over many years. Russ and his wife continue to support the department through monetary contributions that allow us to offer quality educational opportunities to our students.

Lastly, I want to give a special thanks to Dr. Wayne Sand. For many years, Wayne piloted the UWKA; and while he worked as a pilot, he also earned his Ph.D. in the department. Earlier this year, Dr. Sand donated to begin the Wayne Sand Fund for Student success. Thank you, Wayne, on behalf of our faculty and our students!

LOOKING INTO THE FUTURE OF ELK MOUNTAIN OBSERVATORY

Elk Mountain Observatory sits at 10,861 ft an hour west of Laramie. Clouds and high wind speeds result in strong vertical gradients of cloud droplets and ice crystals at the mountain-atmosphere interface and the peak is immersed in clouds frequently during the winter. EMO was established in the early 1960s primarily for cloud seeding and related cloud-aerosol process studies. Funding to develop much of the site was provided through Project Skywater at the Bureau of Reclamation. From 1960-1980 EMO was key to ATSC's research on ice particle nucleation and growth, chemical processes between aerosols and clouds, and atmospheric aerosol characterizations. ATSC maintained an active research program utilizing EMO until the early/ mid –2000's. The last large scale research campaign was EMLACE (Elk Mountain Laramie Area Closure Experiment) in 2004 and the last instruments (meteorological and particulate matter) were removed for roof work about 2018. Since the mid-2000's very little research has been conducted utilizing EMO.

EMO has largely lain fallow since the mid 2000s, but new interest has been sparked across the university. In September, 2023

Elk Mountain Observatory: Then and Now. Department personnel along with University administration visited EMO on a cloudy September day.

Department Head Jeff French showing the EMO instrument platform to School of Computing director Gabrielle Allen

President Ed Seidel, his chief-of-staff Kelsey Kyne, Provost Kevin Carman, and School of Computing director Gabrielle Allen visited EMO with ATSC faculty. Following this visit, faculty in ATSC have been tasked with providing a white paper to the Office of the President laying out opportunities for revitalizing EMO's research mission and establishing an educational mission for the facility. This white paper is co-chaired by an interdisciplinary group including ATSC faculty and staff (Burkhhart, French, Saito, Murphy, McCoy), Dean Koprowski of the Haub School, and Dr. Sara Germain of Botany. The white paper included expressions of interest from 21 faculty spanning colleges across UW and 8 letters of support from external scientists from national labs, federal and state agencies, and industry.

ATSC GEAR STORE

Thanks to the efforts of Drs. Dana Caulton and Daniel McCoy; the Department of Atmospheric Science is now offering gear highlighting the department logo! The gear store is open now through December 31. The shop offers shirts, jackets, and hoodies in a variety of colors and styles, all featuring the department logo (also in a variety of colors).

If you're interested in getting some gear, visit the store now! Orders will ship after the store closes in early January. At this time, we anticipate offering gear again, once a year, in the fall, so this is your last opportunity until 2024.

ATSC students Morgan, Kyle, and Katie modeling some of our cool, new gear!

ATSC GEAR:
GET YOURS NOW!

https://uwatmoscience23.itemorder.com

ATSC RESEARCHERS COLLABORATE WITH NASA CENTERS TO PREDICT FUTURE WATER STRESS

Two ATSC faculty have been awarded a three-year, $750,000 NASA grant titled "Global to Regional: Origins of Water Stress (GROWS)" which began June 1 and will end May 31, 2026. The project is among 15 funded through a NASA-EPSCoR grant program. ATSC assistant professors Drs. Daniel McCoy and Dana Caulton serve as science PIs and will lead the research efforts. The team is collaborating with NASA's Jet Propulsion Lab, Goddard Space Flight Center and Goddard Institute for Space Studies.

Global atmospheric circulation carries moisture from warm, tropical regions and deposits it as precipitation far from its sources. Changes in evaporative fluxes and atmospheric circulation can bring either deluges or drought. To tackle this issue, GROWS will use the NASA GISS-E3 Earth System Model (ESM) coupled with machine learning techniques and observations to understand how moisture gets into the Rocky Mountain West and Wyoming. The end goal: understand how this moisture affects the state's water resources to predict how moisture fluxes will change on the scale, ranging anywhere from decades to centuries.

"Water availability and stress can have profound regional consequences for agriculture, tourism and quality of life. Even though the impacts are regional, the global atmosphere and ocean dictate how moisture converges and precipitates," McCoy says. "To be able to provide accurate predictions of water stress and availability on the time scale of years to decades, we need global ESMs that are accurate and reliable. To do this, we need to explore many possible ESM configurations and evaluate these configurations with our best observations."

McCoy will fund Dani Jones, a UW junior from Gillette majoring in environmental systems science, to help with the project. Caulton will advise Samuel Ajibade, a UW Ph.D. student from Nigeria. Travis Aerenson, a Ph.D. student from the University of Washington, will start as a postdoc in spring 2024.

"Observations are key to benchmarking model output. However, there is a large mismatch between the scales at which observations are made and global models that produce output," Caulton says. "We can use the historical record of aircraft and ground observations, along with new observations, to understand how much natural variability exists. This can allow us to understand how much difference between models and observations is acceptable and eliminate future projections that do not conform to reality."

The research will create a framework for NASA and UW to offer predictions of future moisture convergence for the western U.S. The framework will be designed in a flexible way so that it can be applied to other regions around the globe. This will place UW, in collaboration with NASA, as a center of hydroclimate modeling with global impact.

ATSC ON SOCIAL MEDIA

Check out ATSC's presence on Facebook, Instagram, X (formerly Twitter):
'U Wyoming Atmospheric Science', @wyomingatmospheres, and @uwyoatsc.
On these platforms you will find open student, researcher, and faculty positions. We also showcase current student, staff, and other personnel, and promote our seminar series.

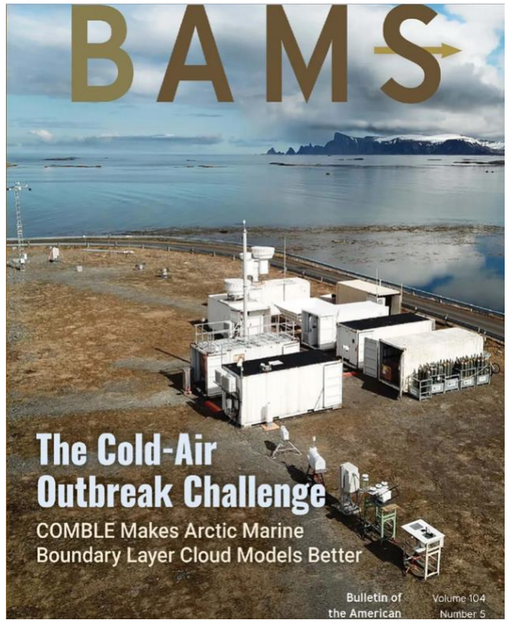
ALUMNI NEWS

We want to hear from you! If you have something new to share with the Department and with other alumni, post it on our FaceBook page or email Charlotte While at cfoster6@uwyo.edu

CAESAR: COLD AIR OUTBREAKS EXPERIMENT IN THE SUBARCTIC REGION

The Department of Atmospheric Science has been studying lake-effect snow and clouds in marine cold-air outbreaks for some time, including a series of UW King Air flights over Lake Michigan in Jan 2004 (the **ROLLS** project) and over Lake Ontario in the winter of 2013-14 (the **OWLeS** project, Ontario Winter Lake-effect Snow). More recently, we led a Department of Energy (DOE) Atmospheric Radiation Measurement (ARM) Mobile Facility (AMF) deployment on an island in coastal northern Scandinavia, the **COMBLE** project (Geerts et al. 2022, BAMS), Cold-air Outbreaks in the Marine Boundary Layer Experiment. The AMF instrument array, shown in the image below, sampled the clouds forming over a fetch of ~1000 km of open water during marine cold-air outbreaks originating in the Arctic. In some cases, these "boundary-layer" convective clouds grow a stunning 5 km deep into dry, slowly-subsiding air over that fetch, all driven by surface heat fluxes. Initially, close to the ice edge, clouds appear as shallow turrets aligned in cloud streets by helical roll circulations. Further downwind, open cells appear, a morphology driven by moist-convective dynamics, which in turn are affected by aerosol-cloud-precipitation interactions. This poorly understood transition alters the cloud radiative effect. COMBLE observational work is accompanied by a Large Eddy Simulation (LES) model intercomparison effort with some 10 collaborating institutions worldwide, an effort led by Tim Juliano, a UW-ATSC alumnus now at NCAR.

The original plan was for NSF/NCAR C-130 to fly over the Norwegian Sea during COMBLE (conducted from Dec 2019 to May 2020), complementing point with airborne measurements. NSF funding decisions, a pandemic, and aircraft issues resulted in that airborne component, called **CAESAR** (Cold Air outbreaks Experiment in the SubArctic Region), to be delayed to early 2024. It remained uncertain until recently whether the C-130, after a long stand-down, could actually go. The C-130 will be carrying an array of UW instruments, including the Wyoming Cloud Radar (WCR), the Wyoming Cloud Lidar (WCL), the Ka-band Profiling Radar (KPR), and in situ aerosol probes. Another key instrument is the Multi-Aspect Raman Lidar (MARLi-2). Several of these instruments were built/upgraded as part of our NSF Mid-scale Research Infrastructure (MSRI) award, and this will be their maiden deployment. Scientists from 11 institutions are participating in CAESAR, including our own Profs Jeff Snider, Jeff French, and Bart Geerts, and several of our scientists, engineers, and technicians from the King Air Facility.

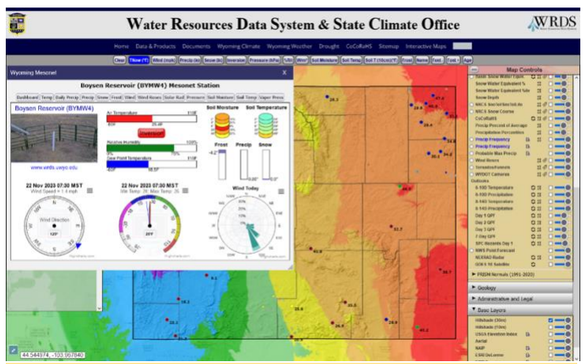


WYOMING WATER RESOURCES DATA SYSTEM

On 01 January 2021 the Wyoming Water Resources Data System and State Climate Office (WRDS/SCO) (www.wrds.uwyo.edu) officially became part of the Department of Atmospheric Science. WRDS started in 1968 to assist with the initial Water Planning efforts authorized by the Wyoming Legislature. Fifty-five years later, WRDS is still heavily involved in the water planning efforts lead by the Wyoming Water Development Commission/Office and is their technical arm. The unit consists of Director Tony Bergantino, Research Associate IIs Bryce Marston and Eva Cordtz, and a Digital Archivist, Barbara Muller.

WRDS/SCO serves the citizens and State of Wyoming by providing water and climate data together with expert analysis and other resources to a broad list of requesters consisting of State and Federal Agencies, local municipalities, news media, consultants, and private individuals. WRDS/SCO maintains the Wyoming Mesonet and also serves as the Drought Focal Point for the State, coordinating weekly input to the US Drought Monitor.

A variety of data and products can be found on the WRDS/SCO websites including the recently released Water and Climate Explorer. Through this mapping interface, users may retrieve a wide range of information on surface water amounts and quality; temperature normals, extremes, and inversions; precipitation frequency, amounts, and normals; water development products; dams and reservoirs; drought; groundwater depths, yields, and quality; snowpack and many others.



Example image from the Wyoming Water and Climate Explorer Interactive Map Server. Visit WRDS website for this and other fascinating tools. http://www.wrds.uwyo.edu

EARTH SYSTEM MODEL DEVELOPMENT IN ATSC

ATSC Faculty Daniel McCoy and Dana Caulton received a U.S. Department of Energy (DOE) grant totaling $998,587 for their project titled "Creating the Framework for the Next-Generation Energy Exascale Earth System Model (E3SM) at PROCEED (Perturbed Physics Ensemble Regression Optimization Center for ESM Evaluation and Development)."

To understand and predict the global environment, global models are needed. Earth system models (ESMs) are the foundation of how we will predict what Earth will look like in future decades. PROCEED seeks to develop new methods to improve the robustness of ESMs as well as understanding the underlying physical processes linking chemistry, clouds, aerosol, and precipitation to global climate.

PROCEED focuses on the DOE E3SM model. DOE is one of many agencies, both national and international, that are developing ESMs. Modelling centers are constantly developing, improving, and evaluating ESMs by comparing what they predict to what is seen from the surface, aircraft and satellites. The end goal of this process is to make sure ESMs are providing reliable predictions of the future.

"ESMs have a tough job. They need to be able to calculate how storm systems a thousand miles wide will deluge us with rain or batter us with wind. At the same time, droplets in clouds less than a millimeter in size form on aerosols," McCoy says. "The way that droplets form in clouds affects the way that these storms develop. ESMs have to tackle both problems at the same time. These processes are critical to our understanding of the historical record and to predict what our planet will look like in the future."

Within ATSC, McCoy and Caulton will collaborate with Jennifer Griswold, an associate professor of atmospheric sciences and department chair at the University of Hawai'i-Mānoa. Gabrielle Allen, director of the UW School of Computing serves as a co-PI on the grant outside of ATSC. The grant will fund two full time postdoctoral scholars in ATSC.

NEWS FROM AROUND THE DEPARTMENT

In fall of 2023, we welcomed two new tenure-track assistant professors: Drs. Stefan Rahimi and Masanori Saito. Dr. Rahimi grew up in Oklahoma, but spent his summers in the Snowies and south of I-80 across from Vedauwoo. He became fascinated by the atmosphere from an early age, becoming hooked on the subject through the tornadic thunderstorms that were a mainstay of life growing up in central Oklahoma. He went on to earn his Bachelors and Master's degrees at U Oklahoma and joined ATSC in 2015 as a PhD student. During his time at UW, he studied the interplay between aerosols, clouds, and the general circulation of the atmosphere using computerized models of the atmosphere utilizing the NCAR/Wyoming Supercomputer. Finishing his Ph.D in 2019, he fled the state to California, joining the UCLA Center for Climate Science, where he continued to use supercomputers, but this time to study regional climate change in high-resolution. Stefan continues to study this subject now. Welcome back to ATSC Stefan!

Dr. Masanori 'Masa' Saito completed his Ph.D. in Geophysics at Tohoku University Japan in 2017, after which he came to the United States as post-doctoral researcher at Texas A&M University under the guidance of Dr. Ping Yang. Dr. Saito's research mainly focuses on remote sensing and atmospheric physics with a solid background in light-scattering, radiative transfer, and cloud microphysics. Masa is excited to join the department: "Remote sensing studies require high-quality observations and substantial computational resources. ATSC provides UW King Air (UWKA) cloud radar and lidar (WCR and WCL) observations, has access to the Derecho supercomputer, and hosts world-class engineering/science teams to support UWKA missions. I cannot imagine that there would be a better institution than UW in the world for observation-driven atmospheric science research and am so happy to be part of it." Masa also notes that he was born and grew up in a small town in Japan, from which mountains (e.g., Mt. Fuji) were always seen. The Snowy Range and Happy Jack (and elsewhere in the US Mountain West) will be part of his life from now on.

Drs. Natalie Kille and Eric Beamesderfer joined the UW King Air Science team this past summer. Dr. Kille completed her Ph.D. from the University of Colorado, Boulder, 2020. Her work at CU-Boulder had Natalie participating with the UWKA during the BBFlux field campaign in 2018. Dr. Beamesderfer his Ph.D. from McMaster University in 2019 (after receiving a M.Sc. from University of Wyoming in 2015). Both Drs. Kille and Beamesderfer are Associate Research Scientists focusing on in situ measurements from the UW King Air Research Aircraft.

Jobe Bell (Aircraft Maintenance Technician), Kevin Bernard (Master Technician), Ryan Kondratieff (Master Technician/Machinist), and Lewis Wright (Mechanical Engineer) joined the Engineering and Maintenance group supporting the UWKA facility and other instrument development efforts in ATSC. While Jobe, Ryan, and Lewis had ties to the local area; Kevin joined us from Portland, OR.

STUDENT NEWS

Ten students completed degree requirements in 2023 and joined the ranks of alumni!

- **Christian Lackner, PhD** (Fall 2023) Advisor: Bart Geerts
- **Shreta Ghimire, PhD** (Summer 2023) Shane Murphy
- **Timothy D. Corrie III, MS** (Summer 2023) Bart Geerts
- **Chuyan Tan, MS** (Summer 2023) Daniel McCoy
- **Geethma Werapitiya, MS** (Spring 2023) Daniel McCoy
- **Ci Song, MS** (Spring 2023) Daniel McCoy
- **Ethan Collins, PhD** (Spring 2023) Zach Lebo
- **Harrison Rademacher, MS** (Winter 2022/3) Shane Murphy
- **Yingjie Shen, PhD** (Winter 2022/3) Shane Murphy
- **Adam Majewski, PhD** (Fall 2023) Jeff French

Three of the MS completions (Corrie, Werapitiya, and Song) are continuing in the department towards their PhD.

The following eight students joined the department in fall of 2023:

- **Samuel Ajibade**, with a M.Sc. from Tennessee State University (Advisor: Dana Caulton)
- **Ebeneezer Boakye Yiadom**, with a B.Sc. from Kwane Nkrumah University of Science and Technology in Ghana, West Africa (Advisor: Masanori Saito)
- **Elena Goodspeed**, with a B.A. from University of Colorado-Boulder (Advisor: Shane Murphy)
- **Kyle Johnson**, with a B.Sc. from Millersville University (Advisor: Anna Robertson & Dana Caulton)
- **Shane Martrich**, with a B.Sc. from Millersville University (Advisor: Jeff French)
- **Evan Newman**, with a B.Sc. from Millersville University (Advisor: Bart Geerts)
- **Zakkary Trader-Gough**, with a B.Sc. from Embry-Riddle Aeronautical University (Advisor: Shane Murphy)
- **Victoria Wright**, with a B.Sc. from Auburn University (Advisor: Dana Caulton)