CPAESS

2021 REVIEW

UCAR COMMUNITY PROGRAMS

CPAESS

Cooperative Programs for the Advancement of Earth System Science

From the Director

The pandemic continued to present challenges for us all, fortunately, we are adaptable and have continued to make great strides in spite of atypical conditions. I am tremendously grateful and appreciative to the CPAESS staff in Colorado and across the country. The CPAESS team has proven themselves capable in these difficult times, continuing to ably serve this country and our global community through scientific excellence.

We are delighted to have secured renewed agreements with NOAA for the Science Collaboration Program (SCP) as well as the Climate Adaptation and Mitigation Program (CAMP). We also just learned that we secured a renewed award for the NASA Heliophysics Program. Please know that it is my privilege to work with scientists placed in NOAA with such a wide variety of expert scientific and technical skills from hurricane forecasting; to climate prediction and adaptation; to deep ocean exploration; and drought monitoring. It is truly an honor to continue to be able to partner in enabling the execution of this diverse and important research.

As you may know, CPAESS will be hiring for a new position – the CPAESS Deputy Director. I am looking for an individual with a scientific background who is an expert at empowering people with the tools and support they need to succeed in their field. If you have any suggestions as to whom you may feel is a good fit, please leave their name here so we can provide them with information about the position. Please find the posting here. Thank you.

This publication includes a sampling of this great work from the past year. Highlighted in these articles is the work of CPAESS' three service areas. These include Scientific Partnerships — with staff serving across the breadth of federal agencies and the private sector; Scientific Programs — such as the U.S. Carbon Cycle Science Program and U.S. CLIVAR, as well as early career programs like the NASA and NOAA fellowships, the NOAA Explorer in Training Program, and the NCEP Collaborative Research program; and Scientific Community Building efforts — including conferences, the NASA Heliophysics Summer School, and a host of other scientific meetings.

The excellent work of CPAESS staff has enabled us to enter 2022 in a strong position. I have no doubt this great work will continue. I look forward to our ongoing collaborations and innovative efforts. Thank you for your partnership and support. You are the reason we strive to always deliver the very best scientific programming possible.

Respectfully,

Hanne Mannie Mauriello

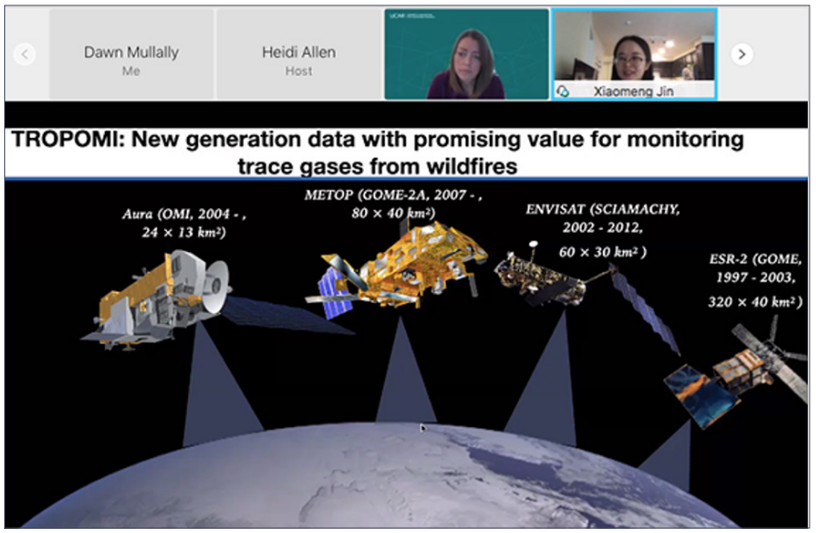
Inside the Year In Review

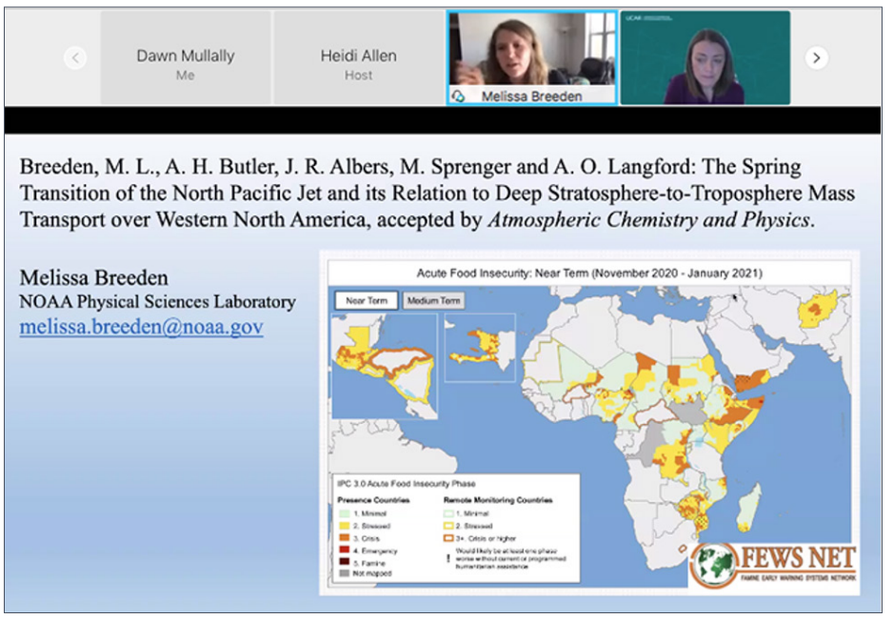
Growing the Climate Change Science Community

The Cooperative Programs for the Advancement of Earth System Science (CPAESS) manages the NOAA Climate and Global Change Postdoctoral Program on behalf of the NOAA Climate Program Office. The overarching purpose of the program is to help create and train the next generation of leading researchers needed for climate studies. The program focuses on observing, understanding, modeling, and predicting climate variability and change on seasonal and longer time scales.

In order to create a greater sense of community, foster new relationships, share research, and provide networking opportunities among current fellows, alumni, and senior scientists, CPAESS holds a Summer Institute every two years. Due to COVID this year's institute has been postponed. However, the excellent work of these scientists continues. To facilitate ongoing scientific sharing and community building, CPAESS has begun monthly meetings for fellows, alumni, and NOAA scientists.

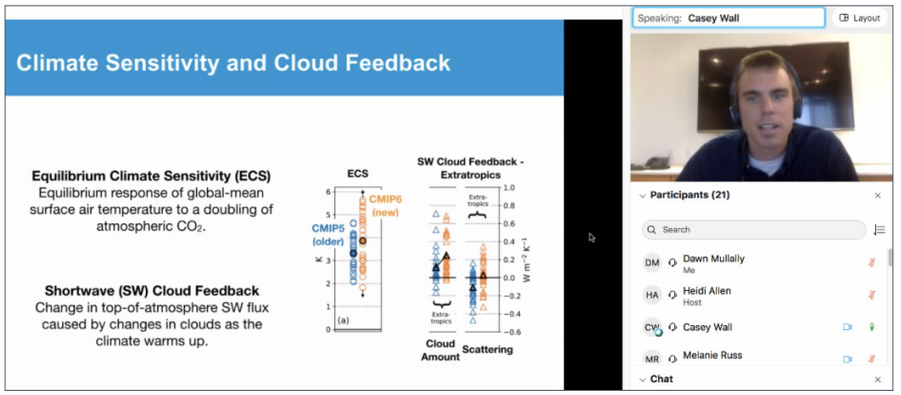
The first of these NOAA C&GC Virtual Seminar & Networking Series meetings was held on January 27th, 2021. Melissa Breeden (NOAA/CSL), a current fellow from the 29th class presented on "The spring transition of the North Pacific jet and its impact on stratosphere-to-troposphere mass transport over western North America." Following her, 30th class fellow Xiaomeng Jin (UC Berkeley) presented on her research concerning "Emissions and chemical evolution of trace gases from wildfires." Lastly, NOAA's Dr. Joshua (Shuka) Schwarz spoke on "FIREX-AQ: A melting pot for science." It was an information-packed session enabling all present to get a taste of some of the current research underway. It also provided the scientists an opportunity to see some of their new colleagues. CPAESS' hope is to continue fostering this climate community, whose work is becoming increasingly important to our world.





Our second meeting was held on February 24, 2021 with Casey Wall (University of Washington), Sebastian Milinski (Max Planck Institute), and Yi Ming (NOAA Geophysical Fluid Dynamics Laboratory). Casey presented on the "Southern Ocean Cloud-phase Feedback Interred from Observations." He kindly summed up this work by saying "As Earth's climate warms up due to greenhouse-gas emissions, clouds can change in ways that act to amplify or

dampen the warming. One potentially powerful but highly uncertain mechanism involves a conversion of ice cloud to liquid cloud in a warming atmosphere. We developed a framework to quantify the importance of this mechanism using satellite observations."

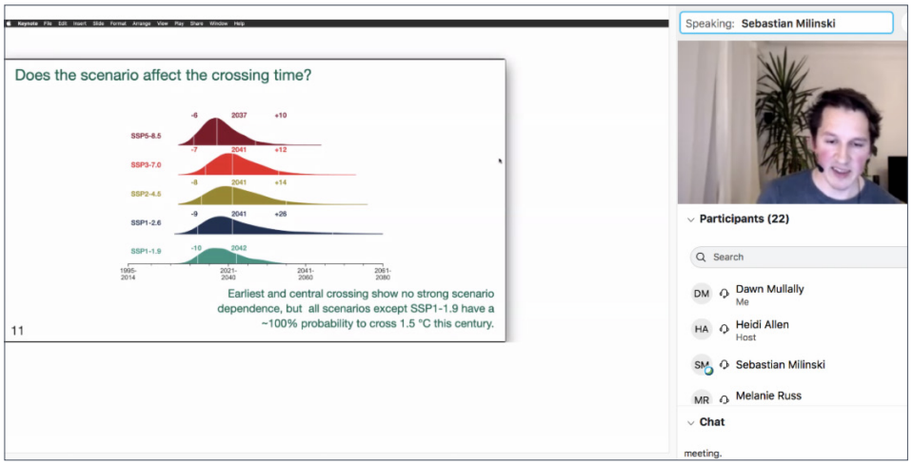


Following Casey, Sebastian Milinski who is a new fellow being hosted by NCAR's Climate and Global Dynamics (CGD) Division presented "Will we cross 1.5 °C / 2 °C? A new framework for quantifying and constraining uncertainties in future temperature projections." It was a very informative talk referencing the Intergovernmental Panel on Climate Change (IPCC) temperature projections, goals, and likelihoods through the lens of a climate modeler.

We were delighted to have Dr. Yi Ming from NOAA's Geophysical Fluid Dynamics Laboratory (GFDL) and Princeton University join us as our guest speaker. With his background in regional hydroclimate variability and change, climate dynamics, and atmospheric physics/modeling he was able to give the fellows some insight into his work at GFDL and possible avenues for their future.

These networking meetings are a wonderful opportunity for fellows, current and past, to share the excellent research they are engaged in, learn from current NOAA professionals, and get to know each other a bit more. We are inspired by everyone's engagement and look forward to future presentations.

A special thank you to Kendra Greb and Heidi Allen for facilitating and managing these networking sessions. For more information about the NOAA Climate and Global Change Fellowship please explore here.



Expansion of our NOAA Global Ocean Monitoring & Observation (GOMO) Staff

CPAESS proudly partners with numerous federal agencies providing them critical scientific staff who work across the globe engaging in research reflective of the breadth and depth of Earth system science. We have recently added two new scientists working with NOAA's Global Ocean Monitoring and Observation (GOMO) division under the supervision of Dr. Kathy Tedesco. They are Cheyenne Stienbarger and Ann-Christine Zinkann and have both had experience working with NOAA as Knauss Fellows last year.

Cheyenne will divide her time between two important GOMO activities: The Ocean-Weather Observing Project and The Tropical Pacific Observing System (TPOS 2020) Project. Her

other effort will be in support of Ocean-Weather Observing, including extreme events, based partly on recommendations from the Extreme Events Ocean Observations (EEOO) workshop. This will require engagement with the ocean and weather communities including relevant GOMO programs, the OAR Ocean and Weather Portfolios, and across line offices such as the National Weather Service and the National Ocean Service. Cheyenne will act as a bridge to help the diverse groups work together to improve aspects of forecasting such as intensity forecasting and lead time for hurricanes. Any ongoing improvements could go a long way in saving lives. Last hurricane season we had 30 named hurricanes.

The Tropical Pacific Observing System (TPOS 2020) Project is an international effort to enhance and redesign the observations of the tropical Pacific. While this observing system has been around for almost 30 years, the goal of the TPOS 2020 Project was to continue improving this system, particularly the ENSO (El Nino-Southern Oscillation) observations whose activity has global implications in forecasting. Cheyenne will serve as the GOMO Program Manager for TPOS and support the project as it moves from the design phase to the implementation phase.

Even though Cheyenne grew up in the land-locked state of Missouri, her love of animals led her to ocean sciences. As an undergraduate, she was able to expand her academic biological education to marine wildlife with a field course in the Florida Keys. This shifted her gaze seaward, and as a graduate student, she studied marine biology at the University of North Carolina in Wilmington. While there, Hurricane Florence hit Wilmington and destroyed their science building on campus. “So now the fact that I am working with people who actually do hurricane forecasting - I just think that it is such a cool full-circle moment.” After graduate school, Cheyenne became a Knauss Fellow working with NOAA and we are now lucky to have her as a new addition to our team.

Our other new CPAESS employee at GOMO is Ann, who will divide her time among the All-Atlantic Observing System (AtlantOS); the Global Ocean Observing System (GOOS), the Observations Co-

ordination Group (OCG); and the U.N. Decade of Ocean Science for Sustainable Development (U.N. Decade) work. She grew up in Germany, rather than a coastal country, yet managed to find her way into arctic research for her university studies and has since expanded her reach even further.

With the All-Atlantic Ocean Observing System (AtlantOS) program work, Ann will support U.S. engagement within GOMO to support cooperation, alignment of interests, and the implementation of efforts. The purpose of this international body, composed of the Atlantic facing countries, is to unite their ocean work, and help leverage their varied research and activities to assist each other and create new partnerships.

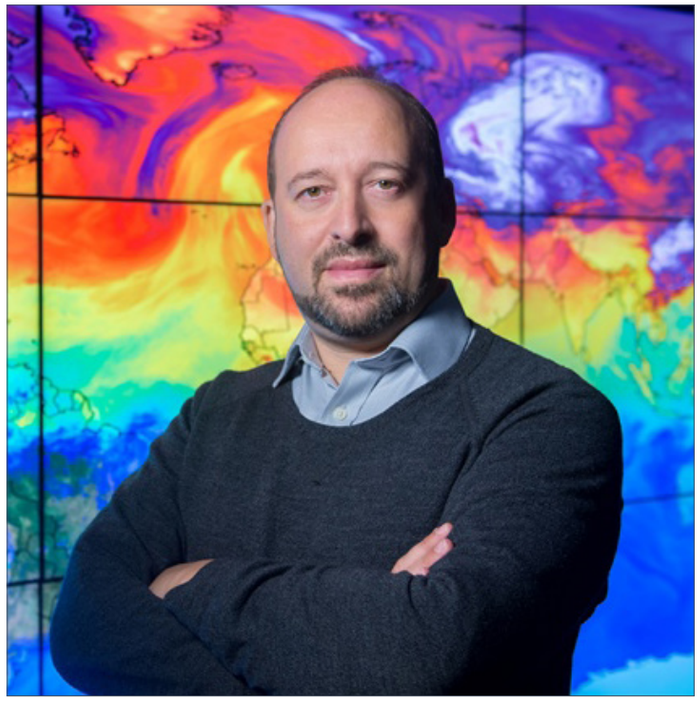
She also supports the GOMO Director and the Global Ocean Observing System Observations Coordination Group Chair to implement the 2021-2025 OceanOPS Strategic Plan. Here Ann will expand outreach and help with best practices on such things as how to optimally utilize data and continue to actively engage with the capacity development group.

Lastly, she will have a specific focus on international U.N. Decade of Ocean Science for Sustainable Development efforts. Ann's work will ensure that scientific efforts are holistic in their pursuit and execution, bridging societal needs with research.

CPAESS is proud and delighted to have you both Cheyenne and Ann onboard. We appreciate your efforts to protect and help predict the movement of our world's oceans.

Congratulations NOAA Climate & Global Change Alumnus!

CPAESS has long partnered with NOAA on its Climate and Global Change postdoctoral fellowship program. The overarching purpose of the program is to help create and train the next generation of leading researchers needed for climate studies. The program focuses on observing, understanding, modeling, and predicting climate variability and change on seasonal and longer time scales. This includes the documentation and analysis of past, current, or possible future climate variability and change as well as the study of the underlying physical, chemical, and biological processes.



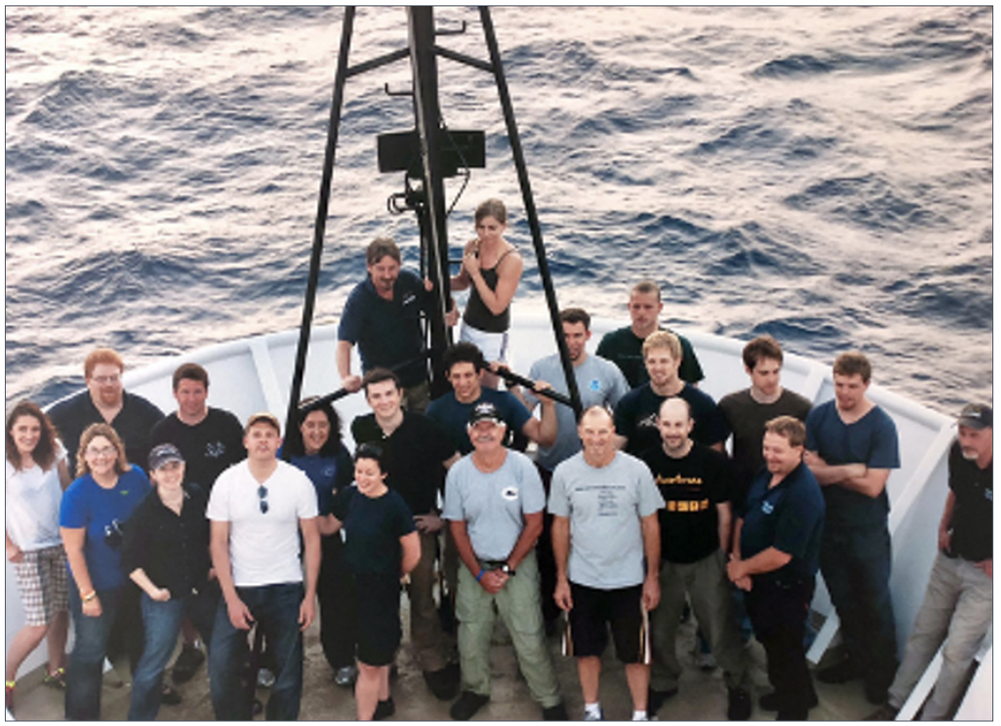
Over the past 30 years, the fellowship program has hosted 238 NOAA Climate and Global Change Fellows and has developed an outstanding reputation of attracting the best and the brightest PhDs in the sciences relevant to the NOAA Climate Program Office. Appointed fellows are hosted with mentoring scientists at U.S. universities and research institutions to work in an area of mutual interest.

This program's excellent reputation is once again made manifest in the new honor given to an alumnus from our 6th class to Gavin Schmidt. A hearty congratulations to Gavin for his appointment to the Biden Administration as the Senior Climate Advisor until a permanent appointment can be

made. Gavin is currently the director of the NASA Goddard Institute for Space Studies (GISS).

Gavin was in the NOAA Climate and Global Change class from 1996 - 1998. We are in the midst of choosing our 31st class now. The intent of the NOAA Climate & Global Change fellowship is to grow the future leaders for global climate science. We cannot think of a better example. Congratulations Gavin!

To find out more about Gavin please go here, and to find out more about the NOAA Climate and Global Change program please go here.



Diving Deep into Ocean Exploration

Special thanks to Trish Albano of NOAA for her written updates on students in this article

CPAESS has been a proud partner of NOAA's, managing the Okeanos Explorer-In-Training program since 2009. Over 120 students have participated in this unique opportunity which equips students with skills to meet the current and future demands of the ocean exploration workforce, providing meaningful experiential learning opportunities that support NOAA's Office of Ocean Exploration and Research (OER) mission, and inspiring ocean literacy for the next generation.

Using the latest tools and technology, OER explores previously unknown areas of our deep oceans, making discoveries of scientific, economic, and cultural value. Through live video streams, online coverage, training opportunities, and real-time events, OER allows scientists, resource managers, students, members of the general public, and others to actively experience ocean exploration. These opportunities expand available expertise, cultivate the next generation of ocean explorers, and engage the public in exploration activities. From such exploration, OER makes available the collected data needed to understand our oceans so we can maintain ocean health, sustainably manage our marine resources, accelerate our national economy, and build an appreciation of the value and importance of the oceans in our everyday lives.

The Explorer-In-Training program features two internship options: 10-week, summertime opportunities, or 2 to 4-week expedition-based opportunities. The 10-week internships give students an experiential opportunity to develop and improve their skills and knowledge through long-term projects supported by OER mentors. The 2 to 4-week expedition-based internships will involve providing support for specific OER-expeditions, giving students the chance to contribute to mission efforts while gaining tangible skills that benefit their future pursuits. For 2021, only the 10-week Summer internships are available for application.

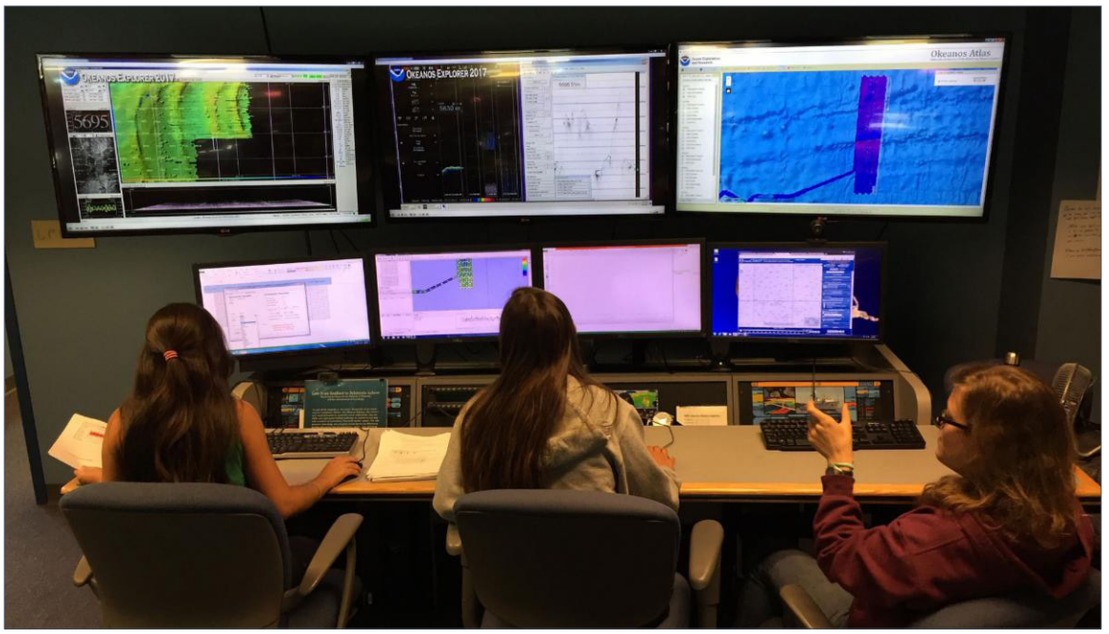
Typically, the 2 - 4 week expeditions occur on the NOAA Ship Okeanos Explorer—the nation's only federal vessel dedicated strictly to ocean exploration. The ship is equipped with advanced tools that support the systematic exploration of unknown ocean regions. High-resolution sonars, deep-water remotely operated vehicles, and telepresence technology are used to collect baseline information in unexplored areas. Due to COVID, applications for Okeanos expeditions will not be accepted this year. However, several themes have been developed for the 2021 10-week summer internships including:

- Exploration Education, Media, & Science Communication (10-week Summer internship): OER strives to improve ocean literacy for learners of all ages through educational programs. To achieve our mission of community-driven exploration, we employ a suite of communication strategies and media tools that bring our discoveries to the public. Interns will work on cross-disciplinary projects to gain experience in scientific communication, ocean education programming, and media use.

- Expedition Operations & Coordination (10-week Summer internship): At the forefront of OER's activities are expeditions to explore previously unvisited areas of the oceans. To accomplish this, we develop mission plans that provide a suite of services needed to virtually take scientists and managers to high-priority, yet otherwise inaccessible, areas of the ocean aided by remotely operated vehicles (ROVs). Explorers-in-Training will gain tangible skills in operational project management, software tools to support planning and execution, and knowledge of ocean exploration data resources.

- Ocean Exploration Science & Technology (10-week Summer internship): Exploration often leads to discoveries that highlight areas, features, resources, and/or processes that are new to ocean science and need further study. To accomplish these discoveries, OER promotes the innovative use of existing technologies while investing in new technologies that will help to better understand deep-water areas and more effectively target future research efforts.

To learn more about applying to be an Explorer-In-Training please go here and to see more about the program's past work, here. CPAESS received a record 357 applications for this summer's NOAA Ocean Exploration and Research Explorer-in-Training Program.



Standing watch: Explorers-in-Training Laura Almodovar, Victoria Dickey, and Kelsey Lane standing mapping watch at the University of New Hampshire Center for Coastal and Ocean Mapping (CCOM)/Joint Hydrographic Center. Image courtesy of CCOM.

NOAA Explorer In Training: Pandemic Pivot Class

CPAESS is proud to work with NOAA Ocean Exploration's Explorer-in-Training Program. Due to safety considerations in regard to the COVID pandemic, adjustments had to be made for this summer's Explorer-in-Training program. In response, NOAA both adapted and expanded the program's scope. This summer's interns included Noelle Helder, Hannah Miller, Marcel Peliks, Anna Takagi-Berry, Treyson Gillespie, and Paola Santiago.

NOAA Ocean Exploration's operations include exploring previously unvisited areas of the ocean through expeditions. "To accomplish this, the office develops mission plans that provide a suite of services needed to virtually take scientists and managers to high-priority, yet otherwise inaccessible, areas aided by tools such as remotely operated vehicles (ROVs). Noelle worked with the ROV Expedition Coordinator team to gain tangible skills in operational project management, software tools to support planning and execution, and knowledge of ocean exploration data resources. Some of her main objectives include creating interactive maps for expedition planning, compiling and analyzing data to make ROV dive plan recommendations for upcoming expeditions, and synthesizing materials from previous exploration efforts to inform future expedition plans (Trish Albano, NOAA)." Check out some of the technology demonstration in this video.

NOAA's Ship Okeanos Explorer is the only federally funded vessel used exclusively for discovery and exploration. (Photo courtesy of NOAA)

As we have seen before with CPAESS communications personnel at NOAA Ocean Exploration, Christa Rabenold and Rachel Gulbraa, that the office strives to help the public learn and become involved in this cutting edge exploration work. "NOAA Ocean Exploration employs a suite of communication strategies and media tools that bring discoveries to a wide range of audiences." Explorer-in-Training Hannah worked on an "interdisciplinary project with the Communications Team and Science & Technology Division to gain experience in scientific communication by creating content for the web, interviewing scientists to gather information about ocean exploration tools, and supporting engagement efforts via telepresence during the 2021 NOAA Ship Okeanos Explorer field season. Some of her main objectives included revitalizing the Exploration Tools section of the website and various writing tasks such as a short article covering one of NOAA Ocean Exploration's federally-funded projects and

expedition feature articles for the current Okeanos Explorer field season (Trish Albano, NOAA)."

Pivotal to NOAA Ocean Exploration's Explorer-in-Training program is seafloor and deepwater mapping. "The NOAA Ocean Exploration mapping team has capitalized on the capabilities of cloud-based workspaces to allow for shore-based, remote mapping operations that would typically be conducted at-sea. This emerging technology allowed for an innovative way to train students in deepwater mapping while complying with the pandemic limitations for at-sea personnel. The NOAA Ocean Exploration mapping team is working with four Explorers-in-Training to pilot this technology as the students conduct mapping efforts from their home bases (Trish Albano, NOAA)." The cloud mapping interns were Marcel Peliks, Anna Takagi-Berry, Treyson Gillespie, and Paola Santiago.

CPAESS is very proud to support and be a part of NOAA Ocean Exploration's Explorer-in-Training program. If you are interested in learning more please go here or here. If you'd like to check out NOAA's videos of their work and new discoveries on these voyages please go here.

Congratulations 2021 NOAA Climate & Global Change Fellows

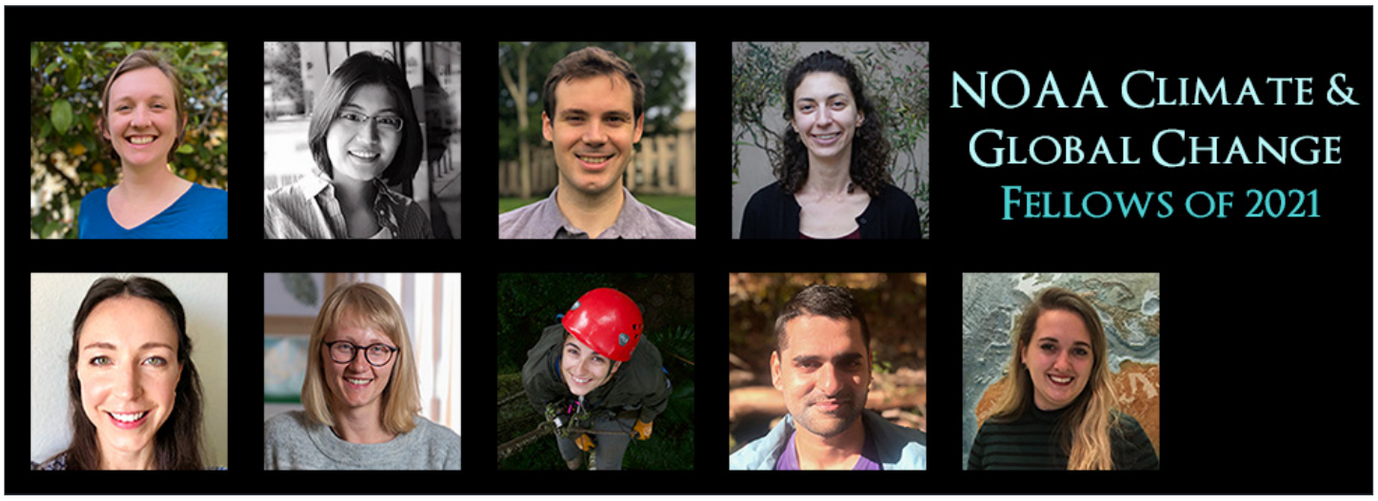
A hearty congratulations to our new class of NOAA Climate and Global Change Fellows! This prestigious postdoctoral fellowship produces the next generation of leading climate scientists. This is the 31st class that we have partnered with NOAA on for this program and we couldn't be more proud.

Here is a brief overview of each new fellow and the research they will be embarking upon.

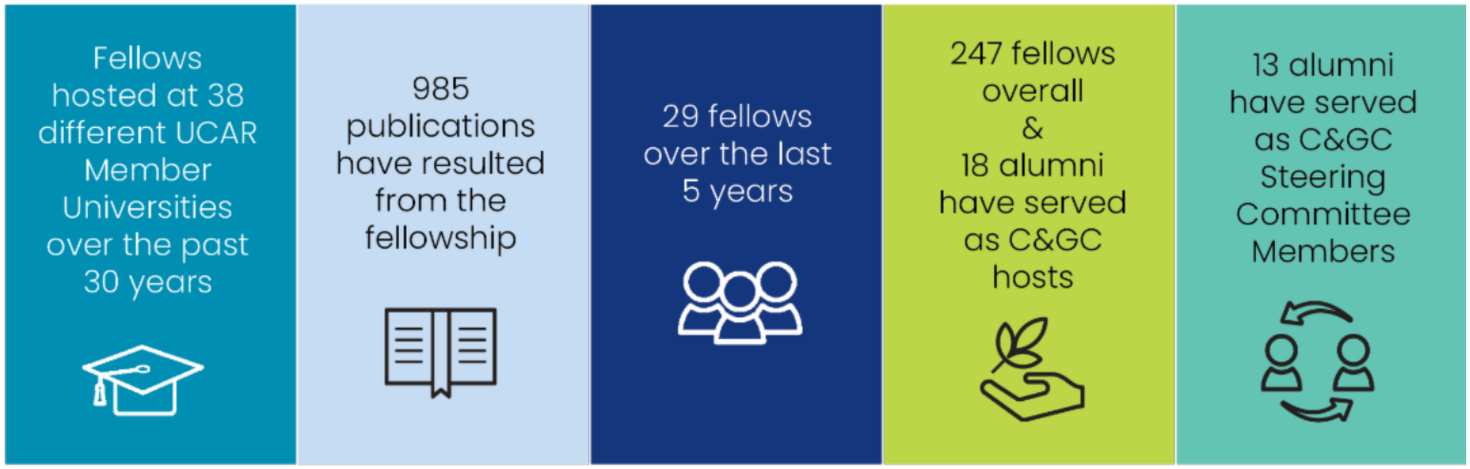
Yue Dong
Research Topic: Understanding the pattern of recent tropical Pacific sea-surface temperature trends
PhD Institution: University of Washington
Host: Dr. Lorenzo Polvani, Columbia University

Henri Drake
Research Topic: Parameterization of Bottom Mixed Layer Eddies and Their Impact on Climate
PhD Institution: Massachusetts Institute of Technology/Wood Hole Oceanographic Institution
Host: Dr. Sonya Legg, Princeton University

Brittany Hupp
Research Topic: Utilization of Northern California Current Historical Records for Paleoproxy Development
PhD Institution: University of Wisconsin-Madison
Host: Dr. Jennifer Fehrenbacher, Oregon State University



NOAA Climate & Global Change Stats



Laura Larocca
Research Topic: An Arctic-wide assessment of glacier and ice cap lifespans
PhD Institution: Northwestern University
Host: Dr. Darrell Kaufman, Northern Arizona University

Lindsay McCulloch
Research Topic: Can canopy gaps resolve the large uncertainty in tropical forest nitrogen cycling and carbon capture?
PhD Institution: Brown University
Host: Dr. Ben Taylor, Harvard University

Mukund Palat Rao
Research Topic: The fate of forest carbon from photosynthesis to biomass under drought and climate change
PhD Institution: Columbia University
Host: Dr. Troy Magney, University of California, Davis

Lettie Roach
Research Topic: Hemispheric contracts in the seasonal cycle of sea ice
PhD Institution: Victoria University of Wellington
Host: Dr. Ian Eisenman, University of California, San Diego

Katherine Siegel
Research Topic: Impacts of forest management types on wildfire severity, ecological assemblages, climate change resistance, ecosystem processes, and socially vulnerable communities in the western US
PhD Institution: University of California, Berkeley
Host: Dr. Laura Dee, University of Colorado, Boulder

Barbara Wortham
Research Topic: Assessing the role of global CO2 variability on plant function throughout the last 55ka in California
PhD Institution: University of California, Davis
Host: Dr. Daniel Stolper and Dr. Todd Dawson, University of California, Berkeley

The overarching purpose of the program is to help create and train the next generation of leading researchers needed for climate studies. The program focuses on observing, understanding, modeling, and predicting climate variability and change on seasonal and longer time scales. This includes the documentation and analysis of past, current, or possible future climate variability and change as well as the study of the underlying physical, chemical, and biological processes.

Over the past 30 years, the fellowship program has hosted 247 NOAA Climate and Global Change Fellows and has developed an outstanding reputation of attracting the best and the brightest PhDs in the sciences relevant to the NOAA Climate Program Office. Appointed fellows are hosted with mentoring scientists at U.S. universities and research institutions to work in an area of mutual interest. Check out NOAA's Announcement here. More information on the program can be found here.

Space Weather Workshop

A wonderful democratization is occurring due to virtual meetings, and a fine example of this is this year's Space Weather Workshop. Traditionally this event is held annually in Boulder and garners an international group of scientists and students. This year the workshop was virtual and free. Registration was over 1,000 people, which is about three times its typical attendance. This year the workshop was held on April 20-24th.

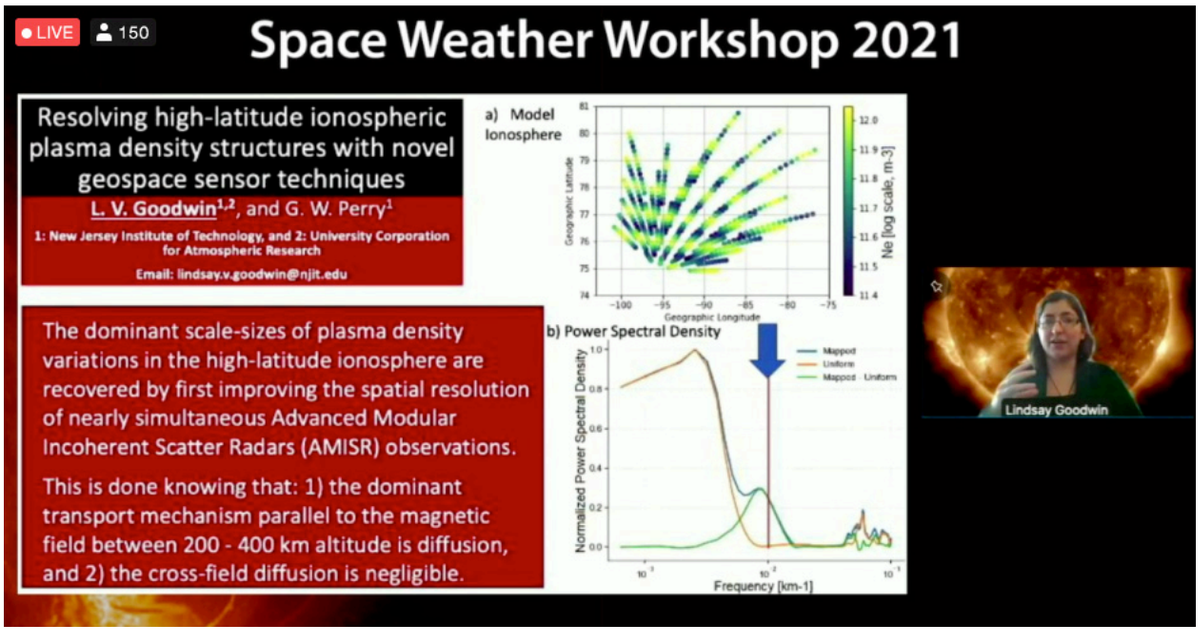
The Space Weather Workshop is an annual conference that brings industry, academia, and government agencies together in a lively dialog about space weather. What began in 1996 as a conference for the space weather user community, Space Weather Workshop has evolved into the Nation's leading conference on all issues relating to space weather. Efforts are consistently made to include students and foster the next generation of scientists.

The conference addresses the remarkably diverse impacts of space weather on today's technology. The program highlights space weather impacts in several areas, including communications, navigation, spacecraft operations, aviation, and electric power. The workshop will also focus on the highest priority needs for operational services that can guide future research and new high-value capabilities that can be transitioned into operations. The conference fosters communication among researchers, space weather service providers, and users of space weather services.

The 2021 conference had 1095 registrants from 47 countries. It included 80 oral presentations, with 18 poster lightning talks, and 80 posters. Participants also included 193 graduate students and 55 undergraduates who participated in an evening networking session and lunch session. There were 21 session chairs. Poster presentations utilized VirtualPosterSessions software which enabled numerous scientists to show their poster while giving a 3-5 minute lighting talk. Opportunities for questions and answers followed.

Workshop sessions included a breadth of topics relevant to space weather and its potential impacts here on earth. Sessions included: Space Weather Policy, Space Weather Programs, Space Situational Awareness, Support for Human Space Exploration, Meeting the Needs of the Energy Sector, Meeting the Needs of Global Aviation Services, Observing and Modeling the Ionosphere: Supporting Communications and Navigation; O2R & SBIR selected topics & speakers; New and Future Observations to Advance Understanding and Forecasting; and Advances in Space Weather Modeling and Services.

Space Weather Workshop was organized by the University Corporation for Atmospheric Research



Above: CPAESS scientist and NASA Jack Eddy Postdoctoral Fellow Lindsay Goodwin presents her research at the Space Weather Workshop.

(UCAR) Cooperative Programs for the Advancement of Earth System Science (CPAESS), along with a community-based organizing committee and co-sponsored by the NOAA Space Weather Prediction Center, the NSF Division of Atmospheric and Geospace Sciences, and the NASA Heliophysics Division. All in all, this year was quite successful and included this feedback from an attendee. "I was amazed at how well the meeting went in the virtual environment. I have attended many a virtual conference. But this was by far the best from a content and from a seamless running perspective. The poster sessions were really useful. And no major AV/IT issues. Not many groups can say that."

Re-Visioned Heliophysics Website

CPAESS has a long relationship with NASA, managing some of their critical heliophysics programs. This relationship was borne from NASA scientist Madhulika "Lika" Guhathakurta's working with CPAESS (JOSS/VSP) to promulgate the value of the interdisciplinary science known as heliophysics, and create programs that will usher in the next generation of heliophysicists.

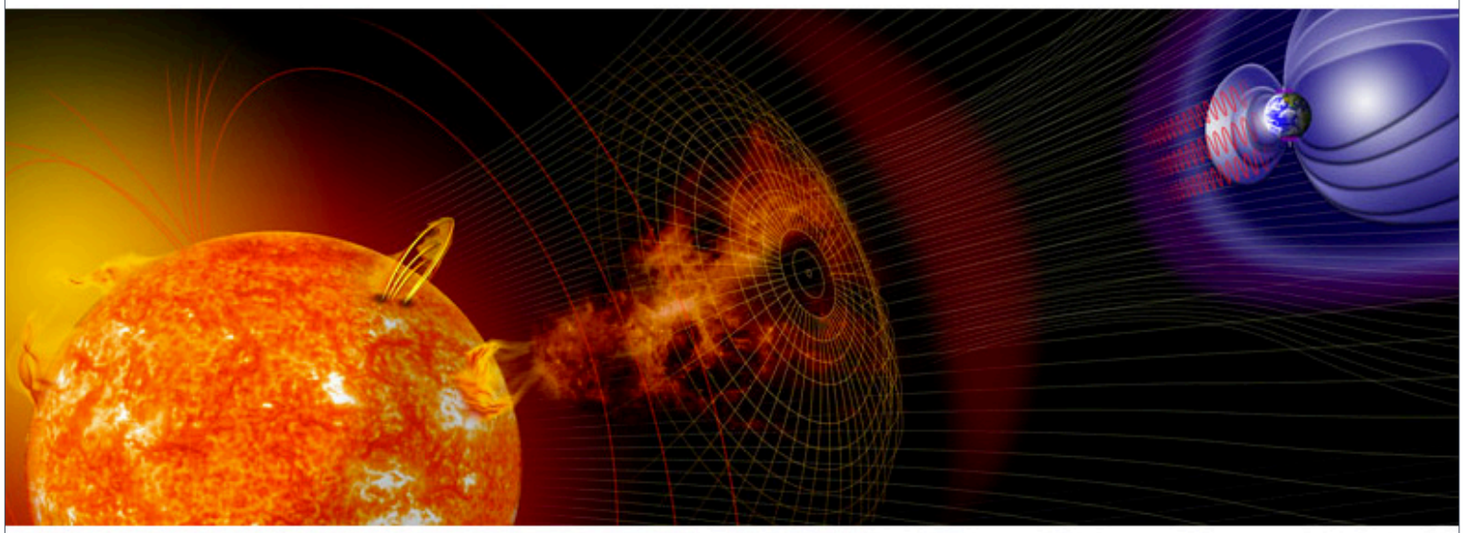
We were recently asked to redesign the heliophysics website to better tell the fascinating story of this partnership, and how this critical new science is serving our world through these programs. Please see and hear for yourself what the many brilliant minds who have worked with us over the years have to say about heliophysics science and our programs.

Heliophysics Home The new homepage introduces both the layperson and scientist to the uniqueness of the interdisciplinary field of heliophysics and its great value to our society, along with our heliophysics programs and outreach: the Heliophysics Summer School, the Jack Eddy postdoctoral fellowship program, the Living With A Star Institute meetings, and our Heliophysics Resources.

History Page This page tells the unique and innovative story of how Lika and other leading scientists chose to foster this brand new interdisciplinary science. As Lika had worked with NCAR's High Altitude Observatory (HAO), a partnership with UCAR | CPAESS to create these programs was a natural evolution.

Vision Page As this interdisciplinary science has grown, its value in space weather and its effects on

Space weather forecasting will remain a strategic goal



Artist illustration of events on the sun affecting Earth's protective magnetosphere. Credit: NASA

Earth's weather, GPS, and our technological infrastructure continue to be critical. However, its relevance is much grander, including how heliophysics can inform the behavior between exoplanets and stars in future space exploration.

Heliophysics Summer School Page Here we dive into the Heliophysics Summer School, which is the cornerstone of our partnership with NASA and has a wonderful international presence. It has even inspired former students to bring the field of heliophysics into college curriculums across the globe.

Jack Eddy Explore Page Inspired by Jack Eddy and his open-minded, interdisciplinary approach to this science, this fellowship has enabled postdoctoral students to explore unique niches in the science and pursue breakthrough discoveries.

Resources Page This section of the site hosts a wealth of knowledge freely available to universities across the globe. In addition to textbooks, there are videos, labs, and problem sets from past Summer Schools, and much more.

We would like to extend a special thank you to all the scientists who generously shared their time to speak with us about these programs including Lika Guhathakurta, Karl Scheiver, Dick Fisher, Tom Bogdon, George Siscoe, Jan Sojka, Nicholas Gross, Amitava Bhattacharjee, Dana Longcope, Andres Munoz-Jaramillo, Fran Bagenal, Ericka Palmerio, Maurice Wilson, and Ryan McGranaghan.

The team who executed this work includes Tania Sizer, Steve Deyo, Dawn Mullally, and Sylvia Quesada who did the lion's share of the work. A sincere thank you to you all.

The Many Facets of Carbon Science

CPAESS is proud to support the critical work of the U.S. Carbon Cycle Science Program, whose goal is to help coordinate and facilitate activities relevant to the carbon cycle science, climate and global change issues in North America with the Carbon Cycle Interagency Working Group (CCIWG) under

the U.S. Global Change Research Program (USGCRP).

Each Friday in March, the U.S. Carbon Cycle program hosted the North American Carbon Program's 7th Open Science Meetings. These meetings consisted of a welcome session, the keynote talks, agency updates, numerous discussions, student poster speed talks, and break-out sessions, depending on the day. The topics addressed in these talks touched on the breadth and depth of their work: issues from climate change and extreme hydrologic events; to Indigenous peoples and multinational experiences; to vulnerability, resilience, adaptation, and mitigation in the context of carbon-climate feedbacks. A wide range of topics was covered, with expertise shared by a host of different speakers.

The keynote talks included the following (click the name of the talk to watch the recording):

- What does the carbon science community owe communities of color, future generations, and other underrepresented groups?
- Why do we need IPCC special reports?
- How are North American Cities advancing carbon science and management?
- What is the science needed for Alternative Carbon Futures?

Scientists from federal agencies, universities, businesses, and the public sector presented and shared their unique perspectives on a wide variety of carbon science-related issues. Their ongoing collective work informs federal decision-making as it pertains to the carbon cycle and strives to advance this interdisciplinary science.

The U.S. Carbon Cycle Science Program is under the direction of Dr. Gyami Shrestha in Washington, D.C. Every 10 years, this program publishes the State of the Carbon Cycle Report in North America as a sustained assessment product of the U.S. Global Change Research Program. Read the Second State of the Carbon Cycle Report here, learn more about the ongoing work of the U.S. Carbon Cycle Science Program here, and subscribe to their newsletter here.

Below: Keynote speakers during the "What does the carbon science community owe communities of color, future generations, and other underrepresented groups?": Crystal Chissell, Julian Brave NoiseCat, Darcy L. Peter, Sarra Tekola, and Alexandria Villaseñor.

Global Recognition

Congratulations to CPAESS scientists Hiroyuki Murakami & Anthony Rosati, both of whom made Reuters Hot List of the world's top climate scientists! Both Anthony and Hiroyuki work at NOAA's Geophysical Fluid Dynamics Laboratory.

This list illustrates Reuter's ranking of "scientists who are having the biggest impact on the climate-change debate – their lives, their work and their influence on other scientists, the public, activists and political leaders."


THE LIST

The Reuters Hot List

This is the Reuters list of the world's top climate scientists. To build it, we created a system of identifying and ranking 1,000 climate academics according to how influential they are.

"To identify the 1,000 most influential scientists, we created the Hot List, which is a combination of three rankings. Those rankings are based on how many research papers scientists have published on topics related to climate change; how often those papers are cited by other scientists in similar fields of study, such as biology, chemistry or physics; and how often those papers are referenced in the lay press, social media, policy papers and other outlets." Source Congratulations gentlemen for this recognition of your hard work.

The Inclusivity of Virtual Meetings

We are all familiar with some of the work and education challenges the pandemic has brought with it. However, every cloud has a silver lining, and virtual meetings may well be one of them. Traveling to conferences to learn from worldwide experts has long included expenses, both time and money, that were not within reach for every scientist, particularly students. Virtual meetings have changed that.

One of CPAESS' three service areas is scientific community building. These efforts include managing conferences, a summer school and summer institute, and a host of other scientific meetings. The nature of this work changed dramatically when in-person meetings were no longer permissible or advisable. Nevertheless, CPAESS has continued to help foster excellent science and research with the use of virtual meetings. The metamorphosis of these meetings through technology has also created an unforeseen opportunity.

Many of the virtual meetings we are managing are available at little or no cost. This is opening wide the doors of opportunity to people who might otherwise not have been able to immerse themselves in the wealth of knowledge these community-building events provide.

Feel free to investigate any of the meetings we manage and those across UCAR and NCAR. You might be pleasantly surprised at how the virtual aspect of these gatherings can increase your opportunity to learn from a larger community of scientists. Find out more about CPAESS virtual meetings, upcoming meetings, and scientific community building management.

NASA Heliophysics Summer School

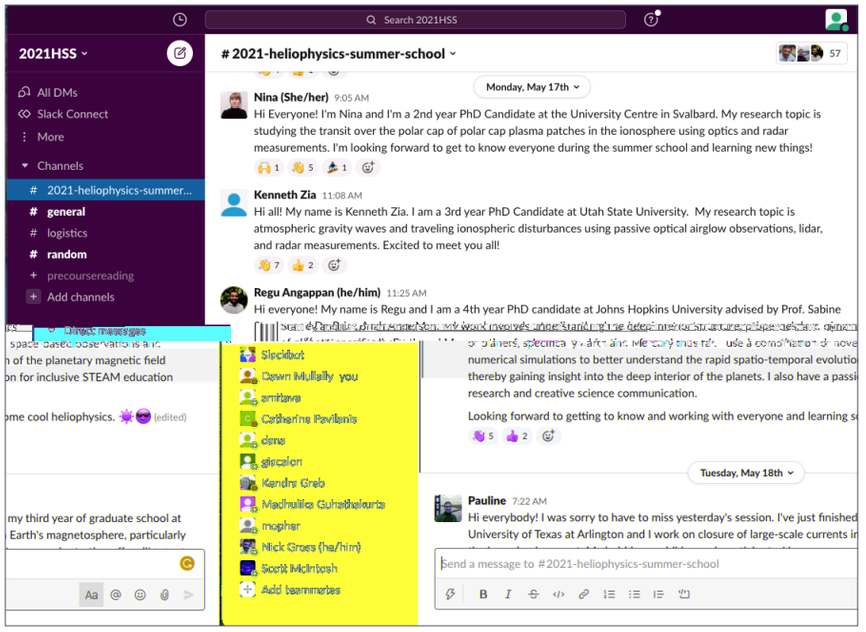
CPAESS was delighted to manage the NASA Living With A Star Heliophysics Summer School which occurred virtually again from June 14-25, 2021. Designed for advanced graduate students and first- or second-year postdoctoral fellows, the NASA

Heliophysics Summer School is an interdisciplinary exploration of the physical processes connecting the Sun, solar system planets, and interplanetary space. Over eight days, students examine topics ranging from the solar dynamo to the heliosphere's interaction with the interstellar medium. Space weather impacts and observational technologies are also studied.

Each year the summer school has a unique theme, and this year it was "Long-Term Solar Activity: Earth and Space Climate." The Summer School program consists of lectures, interactive labs, professional development opportunities, and social activities. This year kicked off with 3 pre-sessions with instructor Nick Gross to help the students with community building. The students also developed 1-minute elevator speeches and were able to ask questions of a panel of NASA Jack Eddy Fellows.

Faculty for this year's summer school included: Amitava Bhattacharjee of Princeton Plasma Physics Laboratory, Nicholas Gross of Boston University, Dana Longcope of Montana State University, and Madhulika Guhathakurta of NASA's Living With a Star program. NCAR's High Altitude Observatory always lends a hand to explain to students the science coming out of their laboratory, as well as provide some history of HAO and their work in connection to heliophysics.

This year the students worked on Slack and well as MURAL digital workspaces for collaboration and laboratory exercises. Online poster sessions were held utilizing virtualpostersession.org. Students also participated in an online brainstorming session to develop White Paper concepts for the upcoming Decadal Survey. This year's class had 33 students, from 10 time zones, who represented 11 countries. Class details for this year's summer school can be found here.



Screenshots of HSS Instructor Nick Gross chatting with students, and under that an example of a Slack discussion where students introduced themselves.

The Heliophysics Summer School is the brainchild of Madhulika Guhathakurta, lead program scientist of NASA's Living With a Star (LWS) program. In 2005, a key LWS goal was the integration of solar,

heliospheric and space physics as one connected science. Guhathakurta realized that a solution lay in educating early-career scientists; but heliophysics students needed heliophysics textbooks, and none existed.

No one had the range of expertise to write such books, Guhathakurta thought. But one could synthesize them out of lectures given by experts in each subdiscipline. The idea of a seminar-style summer school set in Boulder, Colorado, where she had spent her postdoctoral years, was born.

A partnership was created between NASA LWS and UCAR's Cooperative Programs for the Advancement of Earth System Science (CPAESS) to establish a school. The first Summer School was held in 2007; the first textbook was published in 2009. Since then, the Summer School has produced five textbooks, which serve as the framework for today's Summer School learning experience. In 2019, these textbooks were condensed into a single online volume, Principles of Heliophysics.

The summer school lectures provide students with a broader perspective, so they can understand exactly how heliophysics encompasses their own research and that of their fellow classmates. Learn more about the Heliphysics Summer School here.

Diving into the Deep

CPAESS has several staff members who work at NOAA's Ocean Exploration and Research. They include new staff member Jennifer Le, who is an associate scientist; and two writer/editors, Christa Rabenold and Rachel Gulbraa. Recently Rachel updated us on her voyage aboard NOAA's *Okeanos Explorer* whose purpose was testing new ocean exploration technologies. For this voyage, Rachel hosted the live event, and was the web coordinator onboard for web updates, social media postings, and the creation of short videos interviewing scientists. Christa did a great deal of engagement planning for the tech demonstrations and moderated incoming questions during a live-streamed event in anticipation of the cruise.

Picture of NOAA's Okeanos Explorer. Okeanos is Greek for the Latin Oceanus, a Titan god. Photo courtesy of Rachel Gulbraa.

This expedition took place from May 14-27, 2021 on the Okeanos Explorer which is the "only federal vessel dedicated to exploring our largely unknown ocean for the purpose of discovery and the advancement of knowledge about the deep ocean (Source)." The voyage was from Cape Canaveral, Florida, to Norfolk, Virginia.

The reason for this trip was to conduct field trials for new technologies to see if they could help advance ocean exploration. Scientists from NOAA's Northwest Fisheries Science Center, Woods Hole Oceanographic Institution, and the NASA Jet Propulsion Laboratory were on the expedition to test autonomous underwater vehicles (AUV) among other things. Typically, *Okeanos Explorer* fieldwork has utilized remotely operated vehicles (ROV) which are tethered and controlled from the ship. So being able to utilize AUVs could enhance exploration opportunities greatly. The AUVs tested were called *Orpheous* and *Uridisee*.

AUVs were not the only thing scientists tried on this journey. Software, which could be useful both in space and sea exploration was also tested. Deep-sea and space missions have some important commonalities, so this testing was useful on both frontiers. Additionally, Environmental DNA (eDNA) sampling was conducted. eDNA essentially collects water and soil samples and parses out community DNA in a sample. This creates a biological

Picture of Rachel Gulbraa in a small boat filming the launch of autonomous vehicle Orpheus from NOAA Ship Okeanos Explorer. Image courtesy of Art Howard, Global Foundation for Ocean Exploration.

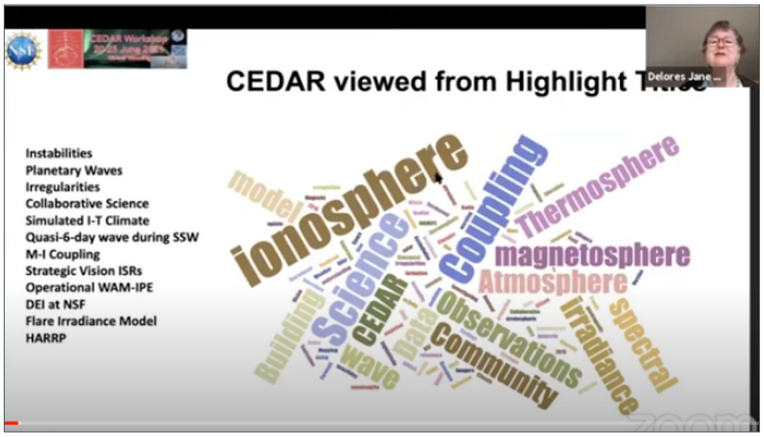
snapshot of the types of life and range of biodiversity in an organic community existing in a particular area and time.

This voyage produced a wealth of information. Please check video and photographs of the technology demonstrations here. Learn more about the eDNA project here. Find out about the expedition planning and features here. Similar events are planned for this summer and fall. We are so delighted to have staff involved in these critical advancements in ocean exploration.

2021 CEDAR Workshop

CPAESS managed the 2021 CEDAR Workshop, in partnership with NCAR's High Altitude Observatory (HAO) on from 20 - 25 June 2021. The Coupling, Energetics, and Dynamics of Atmospheric Regions (CEDAR) Program is funded by the National Science Foundation's Atmospheric and Geospace Sciences Division and studies the interaction region of the Earth's tenuous upper atmosphere. The CEDAR mission is to understand the fundamental properties of the space-atmosphere interaction region; identify the interconnected processes that define the global behavior of the ionosphere-thermosphere region, evolution, and influence on the Sun-Earth system; and to explore the ionosphere-thermosphere predictability.

The agenda was packed with speakers from everywhere from Massachusetts Institute of Technology to Clemson University to our neighborhood University of Colorado in Boulder. Our own current NASA Jack Eddy Fellow Lindsay Goodwin spoke on "Investigating the formation, evolution, and properties of high-latitude irregularities and their relevance in magnetosphere-ionosphere-ther-



CEDAR Chair Delores Kipp with a wordle representing the range of topics to be discussed in the workshop.

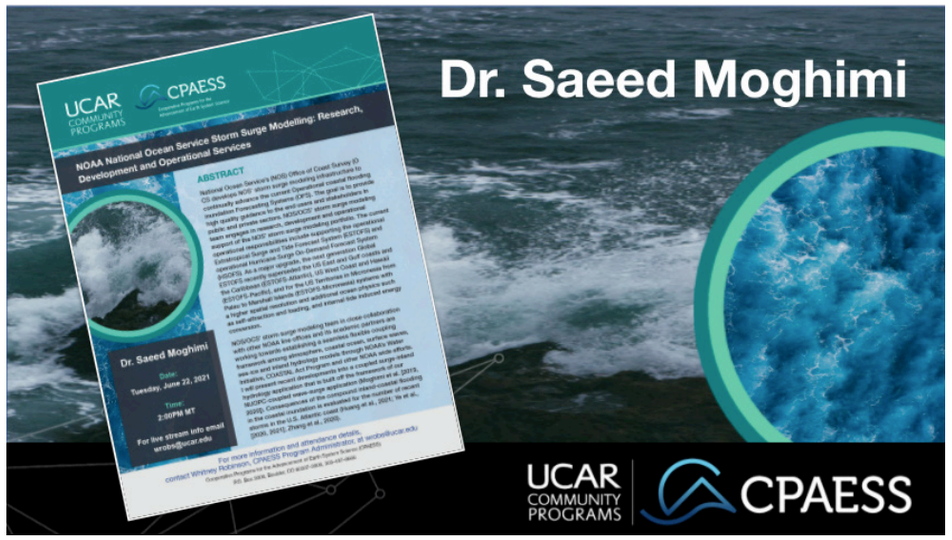
mosphere coupling" and also "Joule Heating" on behalf of her postdoctoral school, the New Jersey Institute of Technology. Jack Eddy alumnus, Ryan McGranaghan, now of ASTRA, spoke on "Data Science in CEDAR." There were incredible speakers representing science across the globe, including some of the NCAR High Altitude Observatory's (HAO) brilliant minds.

CEDAR had 887 registrants representing 42 countries. 251 of which were undergraduate and graduate students. 162 of the participants were early career (PhD less than 5 years), and 392 attendees registered for the Student Workshop held on Sunday, June 20.
Additionally, there was an excellent virtual poster session with 134 different posters represented. The diverse poster categories included: Coupling of the Atmosphere with Lower Altitudes, Data Assimilation and Management, Equatorial Ionosphere or Thermosphere, Long-Term Variations of the Ionosphere-Thermosphere, and Polar Aeronomy. Video presentations of CEDAR can be found on the CEDAR YouTube channel.

Saeed's Seminar

CPAESS was delighted to host a seminar with Dr. Saeed Moghimi on his research at NOAA's National Ocean Service. His talk was called Storm Surge Modelling: Research, Development, and Operational Services and was held on Tuesday, June 22, 2021 2:00pm MST. About 40 people attended and were actively engaged.

His abstract details can be found here and the recorded session can be seen here. If you have a scientific talk that you would like us to host and promote, please contact us. It is important to CPAESS



to provide free and open access to the scientific talks and other intellectual resources created at UCAR for the advancement of the atmospheric and related sciences.

2nd Eddy Cross-Disciplinary Symposium

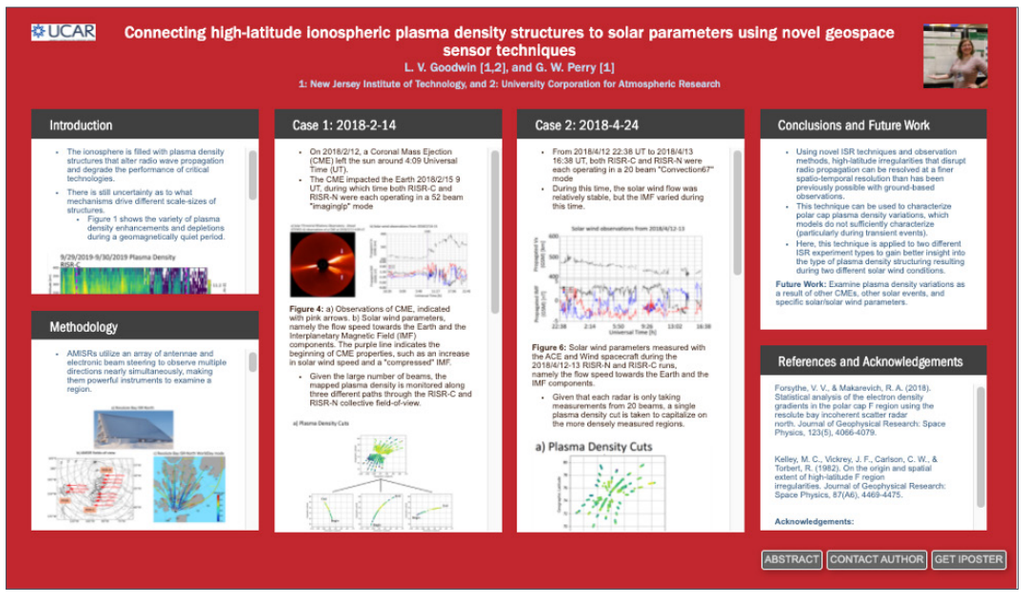
CPAESS hosted the NASA 2nd Eddy Cross-Disciplinary Symposium during the second week of June 7-10th. Held in coordination with the NASA Living With a Star Program, it's goal was to bring together diverse groups from data science, and Earth and space sciences.

Of the symposium's purpose it was stated, "We live in a rapidly changing social and technological society, one that presents threats to our Earth systems. In turn, humanity faces global threats from Earth's rapidly changing climate, globally transmitted disease, changing ecosystems and an unprecedented dependence on electrical and electronic infrastructure.

New phrases such as 'climate change,' 'severe weather events,' and 'space weather' are now in common use."

"Our global vulnerabilities have prompted massive investments in research across the Earth and space sciences in an attempt to understand how to adapt as a society to our complex surroundings. The result has been a deluge of information coming from new instruments in space and on the ground, across laboratories, projects, and individuals, presenting a grand challenge to the scientific community to make sense of diverse, intricately connected and complex datasets. Technological advance has also brought immense capabilities for the investigation and discovery of nature, holding promise across Earth science, astro- and helio-physics alike."

"We wish to identify and promote novel opportunities for budding scientists, to take advantage of powerful new techniques from computational and data science, including machine learning and AI techniques (Source)."



Poster from current NASA Jack Eddy Fellow, Lindsay Goodwin.

The symposium represented "a community of scientific facilitators for an uncommon opportunity to advance cross-disciplinary conversations and research into the areas of Sun-Earth relations, weather-climate connections, and novel star-planet interactions" which included: Early career and senior researchers, Data scientists and machine learning practitioners, and Domain and cross-disciplinary scientists.

A poster session, utilizing iPoster, held their presentations on Monday, June 7th but were available for viewing throughout the symposium. The symposium attracted 257 registrants representing 41 countries. This event was particularly important to new and upcoming scientists as 117 attendees were undergraduates, graduate, or postdoctoral students; and 41 identified themselves as early career scientists. The symposium also had 8 tutorial breakout sessions.

The agenda and the presenters represented a breadth of topics and expertise from "AI and Science, a perfect duo & Discussion" from Massimo Mascaro of Google; to "From paleo-climate to high-energy physics: Solar drivers of multi-disciplinary science & Discussion" from Gavin Schmidt, NOAA Climate & Global Change alum, now of Director of the NASA Goddard Institute for Space Studies (GISS) and Senior Climate Advisor to the Biden Administration; to "Open science in the cloud: what will it take to realize this promise?" from Fernando Pérez, co-founder of Project Jupyter. Engagement was so lively that an impromptu Slack channel was opened to facilitate conversations and networking.

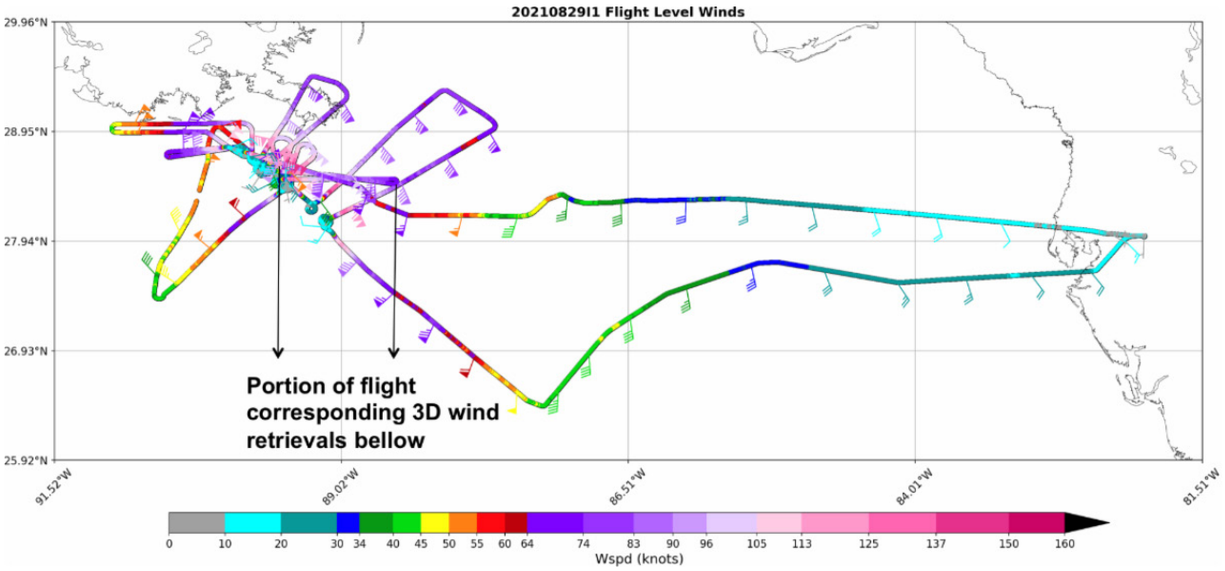
A special thank you to the Eddy Symposium Steering Committee consisting of Phil Judge, Committee Chair, NCAR High Altitude Observatory; Madhulika Guhathakurta, NASA Headquarters; Ankush Bhaskar, ISRO, Vikram Sarabhai Space Centre; Rajesh Gupta, Department of Computer Science and Engineering, University of California, San Diego; King-Fi Li, Department of Environmental Sciences, University of California, Riverside; Dan Marsh, NCAR Atmospheric Chemistry Observations and Modeling Laboratory; Ryan McGranaghan, ASTRA; and Erika Palmerio, Space Sciences Laboratory, University of California, Berkeley. Ankush and Ryan are Jack Eddy Fellowship alums and Erika is a current fellow.

Scientist in the Eye of the Hurricane

Special thank you to Julie Philipsen of UCP for authoring this article

When Hurricane Ida made landfall in Louisiana and the gulf coast of the U.S with devastating

The eye of Hurricane Ida, photographed by Zorana Jelenak aboard a NOAA P-3 aircraft

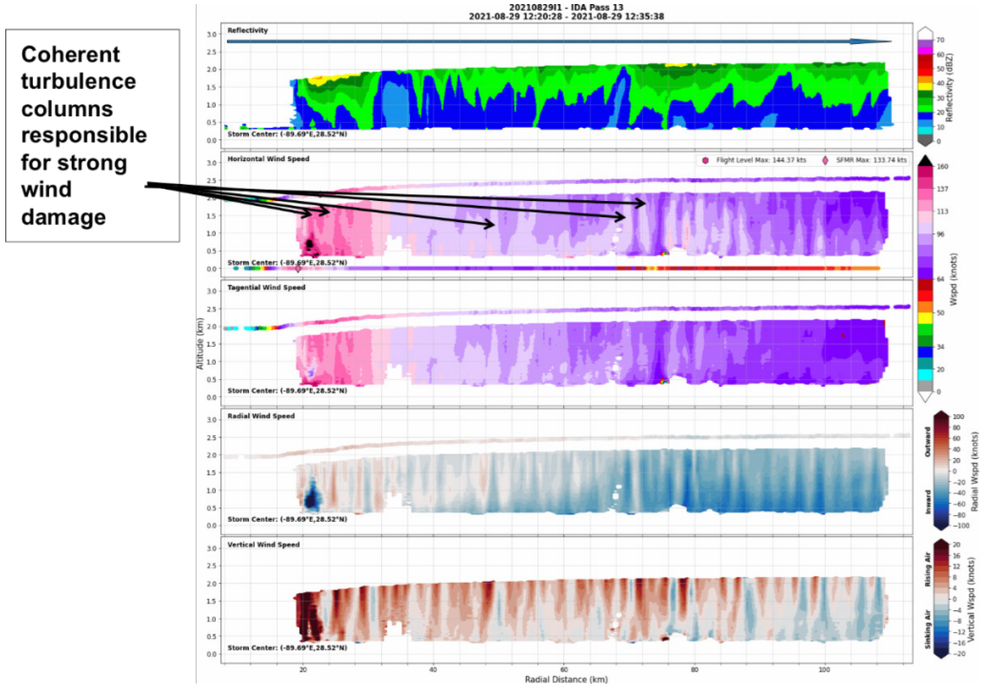


This figure represents a flight pattern flown during NESDIS research landfalling mission into Hurricane Ida.

force. In the days leading up to Hurricane Ida's arrival, CPAESS scientists played a critical role in plotting the storm's course and intensity.

CPAESS scientist Zorana Jelenak, who works at NOAA's National Environmental Satellite, Data, and Information Service (NESDIS) was on the front line aboard NOAA's P-3 aircraft as a member of Ocean Winds Team from the Center for Weather and Climate Prediction (NCWCP).

"We flew into Ida for three days in a row, Aug. 26-28. Our last mission on Sunday, Aug. 28, during which Ida's intensity peaked, was an NESDIS-tasked research mission. We worked closely with our colleagues from the Hurricane Research Division and extensively sampled the ocean and atmosphere in areas of highest rain and wind regimes just before the landfall. We provided data to the National Hurricane Center (NHC) in real-time and adjusted our flight pattern to accommodate requests from NHC forecasters. It was a hugely successful flight for both research and operations," she said.



This figure represents Doppler reflectivity, horizontal, tangential, radial and vertical wind speeds during one eyewal penetration. High resolution measurements reveal coherent turbulent structures responsible for wind damage on the ground even 80km from the storm center.

Above: Zorana Jelenak monitoring Hurricane Idea aboard a NOAA P-3 Aircraft. Below: NOAA's P-3 Aircraft use to measure hurricane forces.

The Ocean Winds Team utilizes advanced radar systems on the NOAA P-3 aircraft to support product development and calibration/validation of satellite remote sensing products in the extreme environmental conditions found in tropical and extratropical cyclones. These radar systems include a dual-frequency (C- and Ku-band) profiling scatterometer system also known as IWRAP (Imaging Wind and Rain Airborne Profiler) and a Ka- and Ku-band altimeter also know as KaIA (Ka-band Interferometric Altimeter). IWRAP is capable of measuring the volume reflectivity and Doppler velocity in these storms in the presence of rain at finer spatial resolutions than have ever been measured before, Zorana explained. IWRAP also measures the surface backscatter, and combined with KaIA is able to characterize what is happening at the air-sea interface in these extreme conditions at a level of detail that hasn't been possible before.

"This year, with support of the NOAA OAR AWARD (NA19OAR4590328) to UCAR CPAESS, the team has configured IWRAP to provide next-generation observations of the three-dimensional (3D) hurricane boundary layer (HBL) and ocean surface vector winds in near real time. Due to its intimate connection to the dynamics of intensity change, HBL is a critical region of a tropical cyclone; and therefore, frequent high resolution sampling of this region is of

critical significance for both research and operations," Zorana said.

Turbulence within the HBL plays an important role in air-sea exchange, drives anomalous storm surge, and causes direct wind damage, producing significant human impacts.

"For the first time during our last Ida flight we were able to see these high resolution turbulent structures in near real time," she said. (See Figure to the left on coherent turbulance.).

As NOAA is looking for the heavy aircraft and instrumentation replacements for the P3's, the datasets collected by IWRAP and KaIA will also provide the scientific support of the business case for next generation remote sensing equipment. The Airborne Phased Array Radar (APAR) being designed by NCAR's Earth Observing Laboratory (EOL) is one such example. The remote sensing capabilities possible today from IWRAP and KaIA allow us to demonstrate in real-time the value of the very fine spatial resolution measurements to the human forecasters and to the modeling systems of the Earth's ocean and atmosphere.

This week, Jelenak is aboard another NOAA P-3 aircraft tracking Hurricane Larry. Click here to view a video that was taken as the crew flew over the eye of Hurricane Larry on Sept. 7. You can learn more about SPS | CPAESS and the Ocean Surface Winds team.

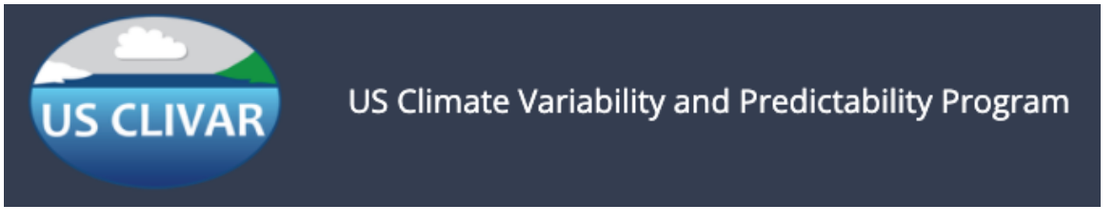
US CLIVAR Panels

US CLIVAR recently hosted virtual summer meetings for the program's three Panels to formulate new recommendations and community activities for the upcoming year. Currently in the works are seven workshops and meetings for March-June 2022. Most, if not all, are planned as hybrid events and open to the community. In addition to the larger workshops and meetings, US CLIVAR has multiple town halls and sessions proposed at the upcoming AGU, AMS, and Ocean Sciences Meetings.

On the literature front, the program released the Climate at the Coasts White Paper, an addendum to the US CLIVAR Science Plan which outlines the motivation, scope, research directions, and collaborative partnerships for this newly established ten-year Research Challenge and the Water Isotopes and Climate Workshop Report, a report resulting from the 2019 workshop which summarizes successful applications of water isotopes to addressing pressing climate and water cycle questions, identifies barriers hindering integration of water isotopes into climate research, and recommends specific measurement, modeling, and data stewardship efforts to make progress within the community.

Additionally, US CLIVAR will be releasing a series of calls in the upcoming months including the Fall 2021 call for US CLIVAR-supported workshop, call for new US CLIVAR Working Groups, call for new US CLIVAR Panel members, and call for nominations for the US CLIVAR Early Career Scientist Leadership Awards. All calls are open to the public and will be announced on the US CLIVAR website and mailing list.

Lastly, the US CLIVAR website was migrated to a new version of the Drupal Content Management System (CMS). The technical migration and redesign was performed by CPAESS' web developer Tania Sizer, and the content redesign was performed by Jennie Zhu and Mike Patterson of the US CLIVAR Program Office. The new site went live this July and is mobile friendly. There is a plethora of information on the site and numer-

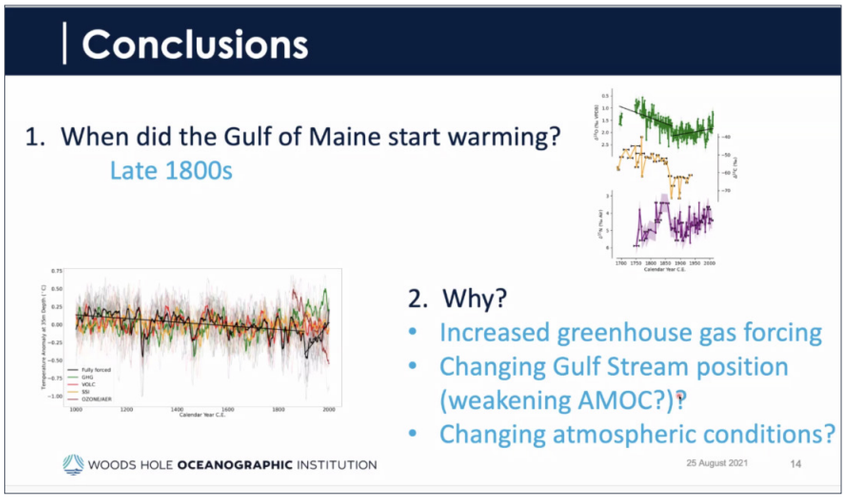


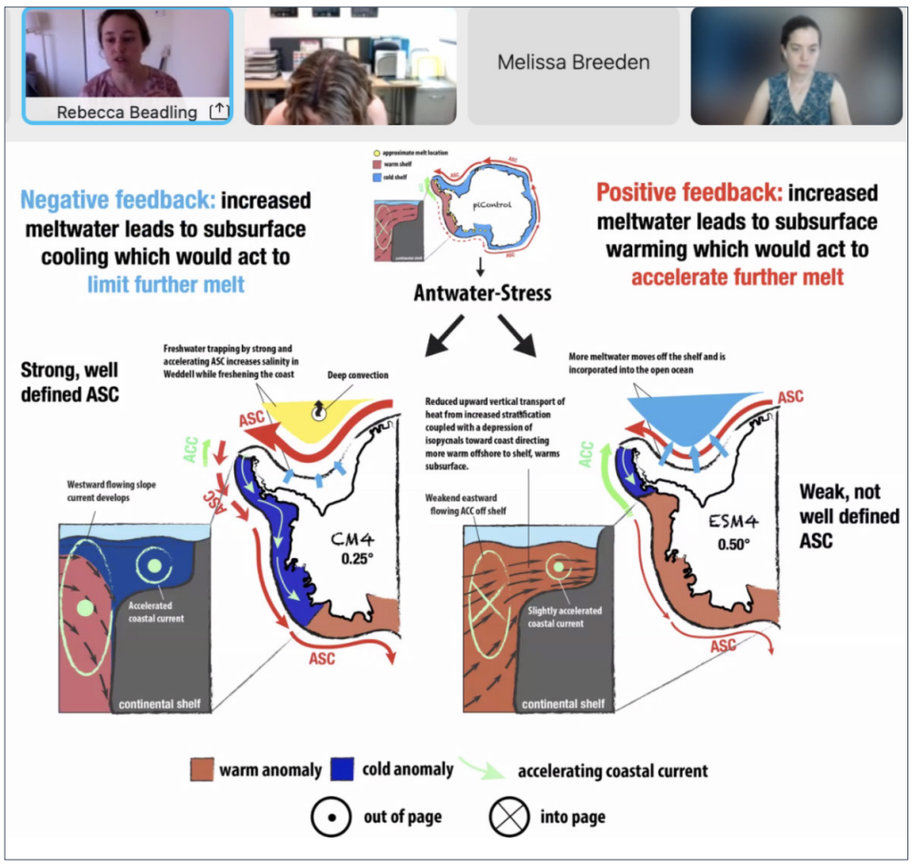
ous opportunities for the scientific community to get involved in their important work. Please [check it out.]

Ongoing NOAA C&GC Networking

In the midst of the pandemic, CPAESS has worked hard to ensure that we stay connected and that information sharing and networking remained intact. To facilitate this with our NOAA Climate and Global Change fellows and alumni we have been hosting monthly talks. August 25, 2021 was our most recent virtual seminar.

This discussion featured two fellows from Class 30, Rebecca "Becky" Beadling and Nina Whitney, along with a special speaker from NOAA, Dr. John Krasting, to help orient the fellows to another aspect of the breadth of NOAA's work. Rebecca "Becky" Beadling is working with Dr. John Krastling at NOAA Geophysical Fluid Dynamics Laboratory on the *Mean State Representation and the Reorganization of Subtropical Gyre Systems under Continued Warming with implications for Regional and Global Climate* for her postdoctoral research. During this seminar she presented on the "Importance of the Antarctic Slope Current on the transient response of the Southern Ocean to Antarctic ice sheet melt and projected wind stress change."





After her, Nina Whitney whose research is under Dr. Caroline Ummenhofer at Woods Hole Oceanographic Institution spoke. Nina's postdoctoral work is on *Assessing Long-Term Atlantic Meridional Overturning Circulation Variability over the Late Holocene using High-Resolution Water Mass Proxies from the Western North Atlantic and Numerical Model Simulations*. At this seminar she presented research on "Combining shell-based isotope records with numerical model simulations to investigate the time of emergence of widespread warming of the western North Atlantic shelf."

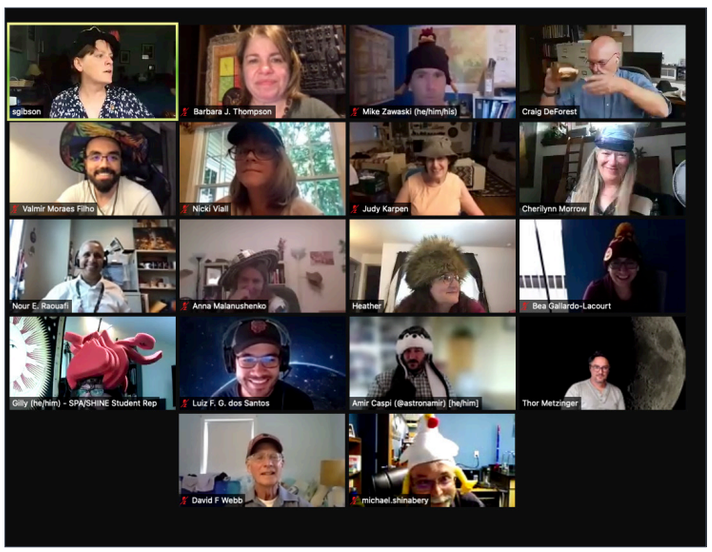
Both talks were very informative and there were quick question and answer sessions following each. Then our guest Dr. John Krasting of NOAA's GFDL joined to share his presentation "Seamless modeling of the Earth system from weather to climate timescales: an overview of NOAA-GFDL's research activities." Dr. Krasting is a climate scientist and numerical modeler in the Ocean and Cryosphere Division at NOAA's Geophysical Dynamics Laboratory. His work focuses on understanding the ocean's role in the climate system by focusing on heat and carbon uptake and their associated impacts. John has been involved with the development of two generations of coupled Earth System Models at NOAA-GFDL and is a strong advocate for using process-based diagnostics and analyses to understand and improve model performance.

PUNCH Science Meeting

From August 9-11, 2021 CPAESS managed the second PUNCH (Polarimeter to UNify the Corona and Heliosphere) Science Meeting. This was an in-development NASA mission that will image the outer corona and solar wind throughout the inner heliosphere. Major science topics include origin and evolution of the ambient solar wind and turbulence within it, and the physics and predictability of transient events including coronal mass ejections (CME), corotating interaction regions (CIR), and shocks. CPAESS worked on this meeting in partnership with NCAR's High Altitude Observatory (HAO) led by meeting planner Michelle McCambridge.

The meeting was virtual and consisted of formal invited presentations, short contributions with discussion, and free plenary discussion. PUNCH took place over the course of three days, and after the first day held an icebreaker social event which served to connect people and insert a little fun into the meeting.

Topics the first day included The Global Evolving Solar Wind; Solar Wind Microstructures and Turbulence; and The Global Evolving Solar Wind; Microstructures and Turbulence as well as discussions



During the PUNCH icebreaker participants played games and had to turn off their camera and then find a hat. The first to come back won a prize.

on PUNCH Science Operations Center (SOC) Design and Data Products. The following day's presentations included issues such as Alfven Zone – Boundary of the Heliosphere; CIR Formation and 3D Dynamics; as well as Heliospheric Boundaries and CIRs. On the final day of the meeting CME Trajectory, 3D Structure and Evolution; Shock 3D Dynamics and Morphology; and CMEs and Shocks were addressed among other topics.

There were 171 participants at the PUNCH Science Meeting who represented 19 countries. It was a robust and fruitful meeting for all in attendance.

NOAA Bill Lapenta Internship Program

The NOAA Bill Lapenta Internship Program is a unique 10-week long opportunity open to U.S. citizens who are sophomore or junior undergraduates, or in a graduate program. Students are matched with NOAA mentors and study a breadth of work from modelling and programming, to new data analysis techniques, and the incorporation of social science to communicate science.

Dr. William "Bill" Lapenta served as director of the National Centers for Environmental Prediction (NCEP) from 2013-2019, and was a champion for atmospheric science within NOAA. After his passing in 2019, the NOAA community created an internship in his honor to reflect his passion for mentoring the next generation of meteorologists. The Bill Lapenta internship is an expansion of a National Weather Service internship that has been evolving under the guidance of Genene Fisher, OER; Jackie Alexander, NWS; Monica Bozeman, NWS; and Todd Christenson, NOAA CPO, who graciously spoke with us about the internship.

CPAESS helps manage this program by hiring the interns as visitors and taking care of all of their logistics. NOAA matches them with mentors, and the students learn and get a "hands on" education during the summer. This internship has traditionally focused on modeling and programming but can cover a wide range of skills depending on the mentors available. They include: how to improve understanding of forecasting problems, operational model development, new data analysis techniques, improving forecast tools (including use of GIS), coding and testing of data visualization systems, the development of datasets for the Science on a Sphere, the incorporation of social science to communicate science, improving air quality and dispersion models, and contributing to the development of the National Climate Assessment and other reports (NOAA).

These summer internships are ten weeks long and are open to U.S. citizens who are sophomore or junior undergraduates, or in a graduate program. They are matched with mentors and may be placed at the "NOAA Office of Oceanic and Atmospheric Research (OAR) facilities: Climate Program Office (Silver Spring, MD), Office of Weather and Air Quality (Silver Spring, MD), Air Resources Laboratory (College Park, MD), and the Center for Satellite Applications and Research (STAR) (College Park, MD) (NOAA)."

Among the students in this internship, a certain portion of them is designated to NOAA's Oceanic and Atmospheric Research (OAR) program. The areas of study are expanded and delve more

into earth system science with climate as a cross disciplinary area. In particular the space where ocean and atmosphere converge. Depending on mentor availability the internships could address the breadth of OAR's mission.

This addition of OAR-mentored students created a record-breaking number of interns to 34 this summer. A special thanks to Whitney Robinson, Heather Koch, and Katy Lackey for their support of this summer's internship program. Find out more about this opportunity.

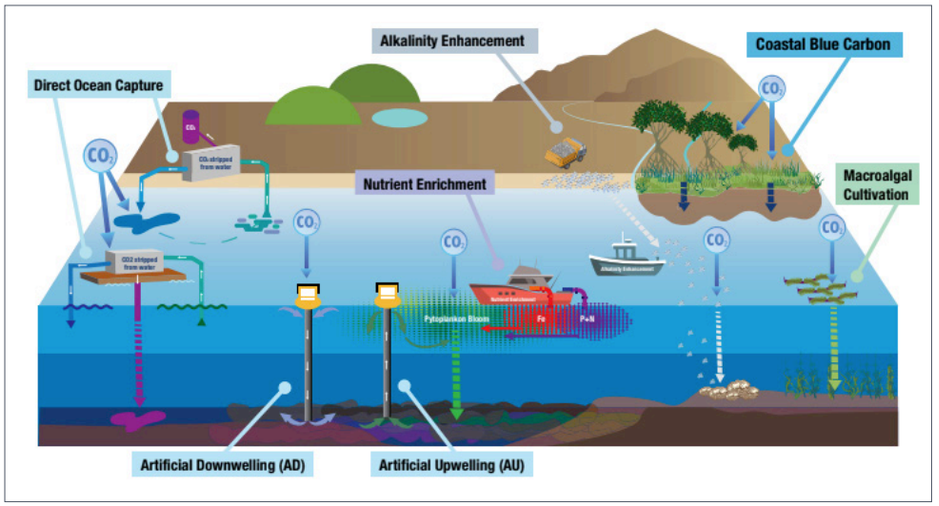
Student Research: NOAA Bill Lapenta Interns Research

As mentioned in an article above, this year we had a recording breaking 34 interns participate in the NOAA Bill Lapenta Internship Program. Here are highlights from a couple of these students to give you an idea of their excellent work.

Michael Michaud, who received his doctorate from the University of Delaware in Disaster Science and Management, was a participant in this year's cohort of NOAA's Bill Lapenta internship. His mentor was Leah Dubots of WPO. During his time with the program he worked on policy and communication support for the Earth Prediction Innovation Center (EPIC) Program and the Unified Forecast System (UFS) including their current work and future plans. As a social scientist he worked with them on the development of a community model. "Through interviews with key stakeholders in EPIC and the UFS community, I identified common elements that constitute the building blocks for the social components of community modeling. With these interviews, I also captured perceptions of the community from members, as well as their different goals and values. It is very clear that values and motivations are different between the private, public, and academic sectors, and between researchers and those in operations."

"To assist the EPIC team with ongoing community development, I am completing a report that outlines how the community defined community modeling, and recommendations for future development. It seems EPIC best aligns with a Community of Practice (CoP) framework that has been well researched as a successful initiative. Using CoP frameworks, EPIC can use the recommendations to cultivate a thriving modeling community around the UFS (Michael Michaud)." Connecting the behavior of people with this climate modelling work is a critical niche, and we are delighted you were able to work with NOAA scientists to delve into this project.

One of our own Program Managers, working at NOAA's Global Ocean Monitoring and Observing (GOMO) office, Kathy Tedesco was able to mentor another of the Lapenta interns. Sylvie Alexander is working on her bachelor's degree from Scripps College in Environmental Analysis and worked with Kathy and Jessica Snowden on creating educational materials regarding ocean carbon capture.



NOAA has an initiative specifically around Carbon Dioxide Removal (CDR) and Sylvie worked at length with CPAESS graphic designer, Alex Meyer to create illustrations that simply conveyed the complex and numerous ways that carbon behaves in and near the ocean. She did this for the NOAA CDR Science Strategy white paper and the development of a summary document for senior leadership. Sylvie also engaged with other federal agencies through the USGCRP Carbon Cycle Interagency Working Group (our own Dr. Gyami Shrestha is the director of the U.S. Carbon Cycle Program) as part of their interagency CDR efforts.

With the goal of meeting White House directives and IPCC projections in terms of climate change, Sylvie set about showing how the ocean could be utilized in stabilizing the climate by removing CO2. The approaches outlined included marine technologies such as macroalgal cultivation, ocean alkalinity enhancement, direct ocean capture, nutrient enrichment, and artificial upwelling and downwelling. From the coastal perspective, she highlighted blue carbon or sequestration via photosynthesis in the soils and biomass of the coast. Check out her brochure here.

Quinn Bustos is a technical communication student at the New Mexico Institute of Mining and Technology. As a Lapenta intern, she worked with other interns, Nicole Hilton and Lauren Crane, under her mentor Frank Niepold to create an inventory of federal programs that advance the nation's Action for Climate Empowerment (ACE) agenda. "Action for Climate Empowerment (ACE) is a term adopted by the United Nations Framework Convention on Climate Change (UNFCCC)...The overarching goal of ACE is to empower all members of society to engage in climate action, through education, training, public awareness, public participation, public access to information, and international cooperation on these issues (UNFCC)." So investigating how NOAA and other federal agencies fit into this goal is an important assessment.

Bustos and her team combed through a great variety of federal programs to determine which ones served the specific goals of ACE. Not all programs include a climate public awareness component, although NOAA's programs frequently did. Quinn notes that "we had inventoried over 200 programs in seven agencies and departments." This inventory process also enabled her to examine the audience most served by these programs, which was the public, an important element of ACE education goals.

Another Lapenta intern was Anna Sitzman who attends Loyola University in New Orleans. Her internship focused on the Great Lakes and she is

Left: Dock showing low level in Grand Traverse Bay, Mi in 2013 | Right: High waves in Chicago, IL in 2014

continuing this work for her senior capstone project. Anna was mentored by Nancy Beller-Simms and Ned Gardiner researching stormwater infrastructure in the Great Lakes region. She analyzed data on precipitation, lake level changes, and river flood stages in addition to learning the history of the water infrastructure in the region. "My research culminated into an ArcGIS Storymap titled *Combined Sewer Systems, Climate Change Impacts, Vulnerability, and Adaptations in the Great Lakes Region*."

Sitzman created interactive maps for each Great Lake state exploring changing precipitation statistics in these areas, their adaptations such as in engineering and flood prevention, personal stories associated with climate changes in the area, and generally creating a snapshot of the effects of climate change for viewers.

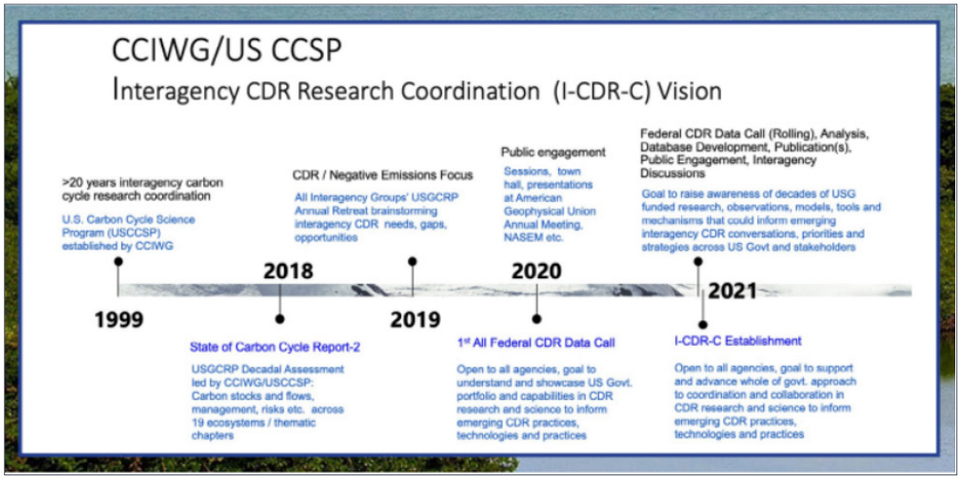
"After working in CPO, I have a greater appreciation for interdisciplinary work after seeing the AdSci and WaRT groups work together. They bring so many perspectives and specialties to work toward a common goal of improving education and people's lives."

The NOAA Bill Lapenta Internship covers a wide range of climate-change related educational mentorship experiences ranging from how to improve understanding of forecasting problems, operational model development, the incorporation of social science to communicate science, and earth system science with climate as a cross-disciplinary area.

U.S. Carbon Cycle Science Program

One of the programs that CPAESS hosts is the U.S. Carbon Cycle Science Program which works with fourteen federal agencies and departments on carbon cycle science and climate and global change. At its helm is Dr. Gyami Shrestha who works with Carbon Cycle Interagency Working Group (CCIWG) to support peer-reviewed research of carbon cycle science across the federal government. The CCIWG is responsible for defining program goals, setting research priorities, and reviewing the progress of the research programs that contribute to carbon cycle science.

Recently the U.S. Carbon Cycle Science Program has been supporting and advancing coordination in federal and interagency carbon dioxide removal (CDR) research across terrestrial, oceanic, atmospheric and societal dimensions. Check out this recent brochure which gets into much more



detail about these efforts. CPAESS' own Alex Meyer had the pleasure of helping design this important science layout.

The U.S. Carbon Cycle Science also organized a special session at the Annual Meeting of the Ecological Society of America on the Decadal Strategic Planning and Implementation: U.S. Carbon Cycle Science Program and the North American Carbon Program which occurred on August 4, 2021.

US CLIVAR Updates

US CLIVAR recently hosted virtual summer meetings for the program's three Panels to formulate new recommendations and community activities for the upcoming year. Currently in the works are seven workshops and meetings for March-June 2022. Most, if not all, are planned as hybrid events and open to the community. In addition to the larger workshops and meetings, US CLIVAR has multiple town halls and sessions proposed at the upcoming AGU, AMS, and Ocean Sciences Meetings.

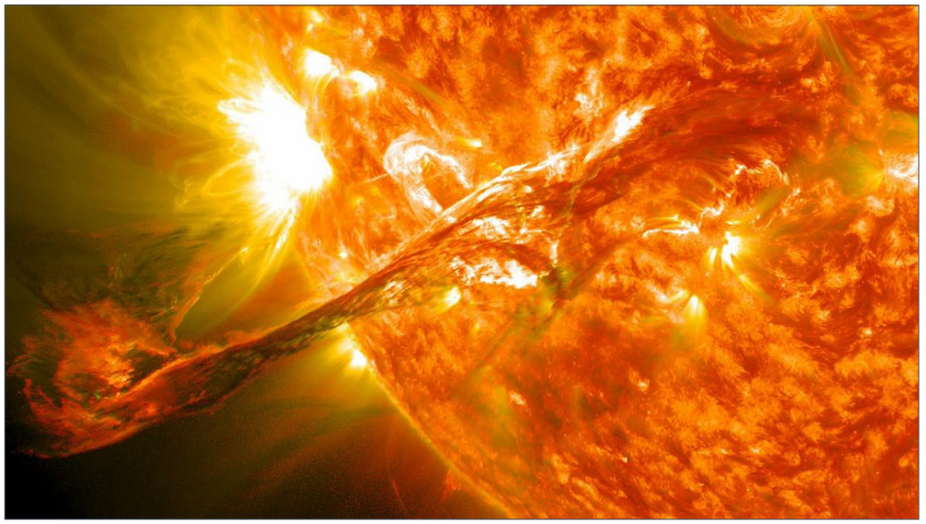
On the literature front, the program released the Climate at the Coasts White Paper, an addendum to the US CLIVAR Science Plan which outlines the motivation, scope, research directions, and collaborative partnerships for this newly established ten-year Research Challenge and the Water Isotopes and Climate Workshop Report, a report resulting from the 2019 workshop which summarizes successful applications of water isotopes to addressing pressing climate and water cycle questions, identifies barriers hindering integration of water isotopes into climate research, and recommends specific measurement, modeling, and data stewardship efforts to make progress within the community.

Additionally, US CLIVAR will be releasing a series of calls in the upcoming months including the Fall 2021 call for US CLIVAR-supported workshop, call for new US CLIVAR Working Groups, call for new US CLIVAR Panel members, and call for nominations for the US CLIVAR Early Career Scientist Leadership Awards. All calls are open to the public and will be announced on the US CLIVAR website and mailing list.

Lastly, the US CLIVAR website was migrated to a new version of the Drupal Content Management System (CMS). The technical migration and redesign was performed by CPAESS' web developer Tania Sizer, and the content redesign was performed by Jennie Zhu and Mike Patterson of the US CLIVAR Program Office. The new site went live this July and is mobile friendly. There is a plethora of information on the site and numerous opportunities for the scientific community to get involved in their important work. Please check it out.

Searching for the Secrets of Coronal Mass Ejections

CPAESS Scientist Dr. Camilla Scolini is currently a NASA Jack Eddy Fellow working with Dr. Reka Winslow at the University of New Hampshire. Recently her research led to a number of publications concerning the evolution of coronal mass ejections (CMEs) as they travel from the Sun. A CME is a mass ejection of highly magnetized plasma from the Sun's corona into space. They travel at speeds from "250 kilometers per second (km/s) to as fast as near 3,000 km/s (NOAA)." These eruptions can create beautiful auroras



(Coronal Mass Ejection - CME, courtesy of NASA)

here on Earth, but can also cause radio and magnetic disturbances with the potential to have great impacts on GPS, communications, satellites, and electrical grids.

One of the larger questions Scolini was investigating is whether the changes to CMEs as they travel are based on their intrinsic nature or because they are influenced by interactions with other forces. In her quest to find answers about the nature of CMEs, Scolini used a combination of computational modeling and observations. While there is a need for increased observational data near our Sun, Scolini was able to use data recorded by spacecraft in radial alignment with each other (two different points on the same trajectory) of several CMEs. This information shows what a CME looks like at one point of its journey from the Sun, and then at a later point on that same journey. This data is used in conjunction with different forecasting models to examine whether the evolution of a CME's magnetic structure changes due to its inherent nature, or if it is due to an outside influence such as large-scale solar wind structures.

In conjunction with observational data, Scolini also used numerical models. She exploited their 3D nature to get a hypothetical view of a global CME structure in the heliosphere. Her findings show that both observational and computational findings are complementary in their results. This is good news for research, particularly until we can get more spacecraft observations near the Sun.

Dr. Scolini's recent research publications with colleagues include: "First Simultaneous In Situ Measurements of a Coronal Mass Ejection by Parker Solar Probe and STEREO-A" which examines measurements from the Parker Solar Probe and STEREO-A gathered in 2019. This past July, The Astrophysical Journal also published "The Effect of Stream Interaction Regions on ICME Structures Observed in Longitudinal Conjunction" examining two CMEs observed at Mercury and Earth's orbit. Then in August, Scolini published the "Evolution of Interplanetary Coronal Mass Ejection Complexity: A Numerical Study through a Swarm of Simulated Spacecraft" finding that "the interaction with large-scale solar wind structures, and particularly with stream interaction regions, doubles the probability to detect an increase of the CME magnetic complexity between two spacecraft in radial alignment, compared to cases without such interactions." Each paper answers aspects of the question regarding the evolution of CMEs.

Soon to be published is the "Causes and Consequences of Magnetic Complexity Changes within Interplanetary Coronal Mass Ejections: a Statistical Study" where the "first statistical analysis of complexity changes affecting the magnetic structure of interplanetary coronal mass ejections" is examined.

When asked what the major take-aways were from her current research, Dr. Scolini said that "interactions with other solar wind structures have a much larger impact on CME structure than typically acknowledged." And that "changes in the magnetic complexities of CMEs seem to be driven by interactions with other interplanetary structures

rather than being intrinsic to the CME evolution in general."

This unique research is laying important groundwork in understanding CMEs and the changes they undergo through space. It has far-reaching implications both broadly and as the relationship between the Sun and the Earth continues to be examined. While we understand that CMEs can negatively impact the Earth's satellites and weather, our understanding of the nature of CMEs is nascent and evolving. The work of Dr. Scolini and her fellow scholars lay a critical foundation for better understanding the complexity and nature of CMEs, and by extension ultimately how they influence space weather and affect us here on Earth.

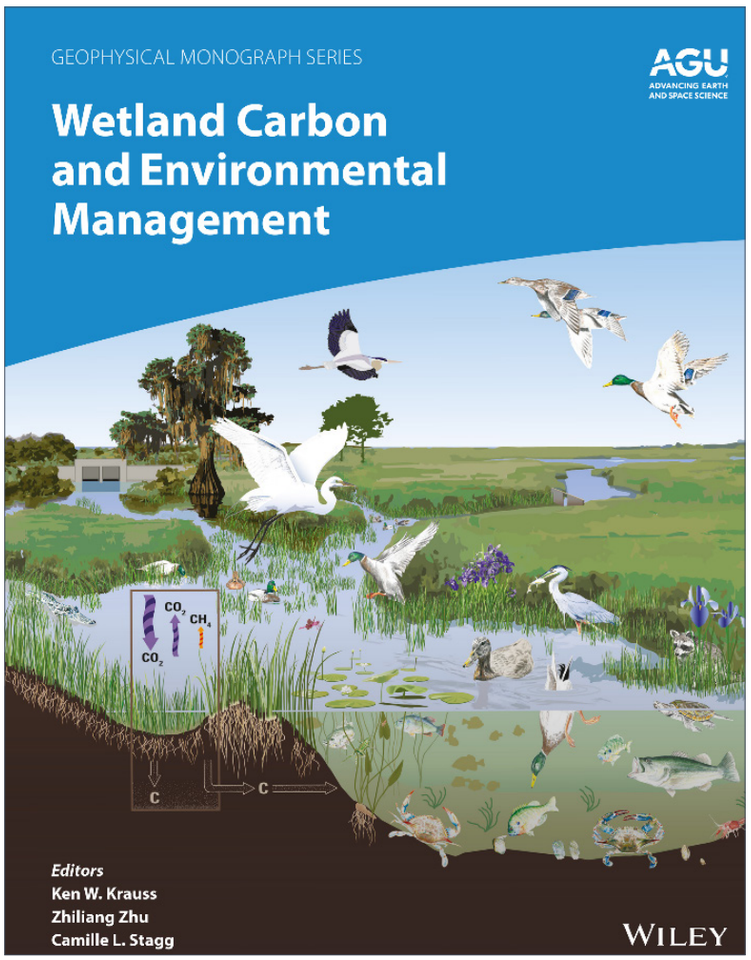
Discover more information about the NASA Jack Eddy Fellowship and the field of Heliophysics on our website.

News from the U.S. Carbon Cycle Program

The U.S. Carbon Cycle is excited to announce its recent publication: Wetland Carbon and Environmental Management which addresses how the management of wetlands can influence carbon stocks and fluxes. Please check out their AGU presentations including the Next Decade, CDR and a U.S. Interagency Carbon Information, Monitoring, and Decisions System.

Lastly, the U.S. Carbon Cycle Science would like to announce its Call for Applications for the U.S. Carbon Program Leadership Award. The U.S. Carbon Cycle Science Program, in collaboration with the North American Carbon Program (NACP), is pleased to announce the first U.S. Carbon Program Leadership Award in support of the North American carbon cycle community's engagement, communication and collaboration opportunities. This award activity is aimed at advancing our broader diversity, equity, inclusivity, accessibility and justice goals which are essential for fulfilling our national and global science priorities and mandates in support of the 1990 Global Change Research Act to understand, assess, predict, and respond to human-induced and natural processes of global change. This activity also aims to support our mission to coordinate and facilitate federally funded carbon cycle research, and provide leadership to the U.S. Global Change Research Program (USGCRP) on carbon cycle science priorities.

This award will support the meeting or workshop travel costs (accommodations, transportation and per diem for in-person meeting; registration costs for virtual or in-person meeting) of early career and/or under-represented students, scientists and practitioners primarily from North America (U.S., Canada and Mexico). Find out more details and explore the application guidelines found here.



NOAA C&GC Pre-AGU Networking Meeting

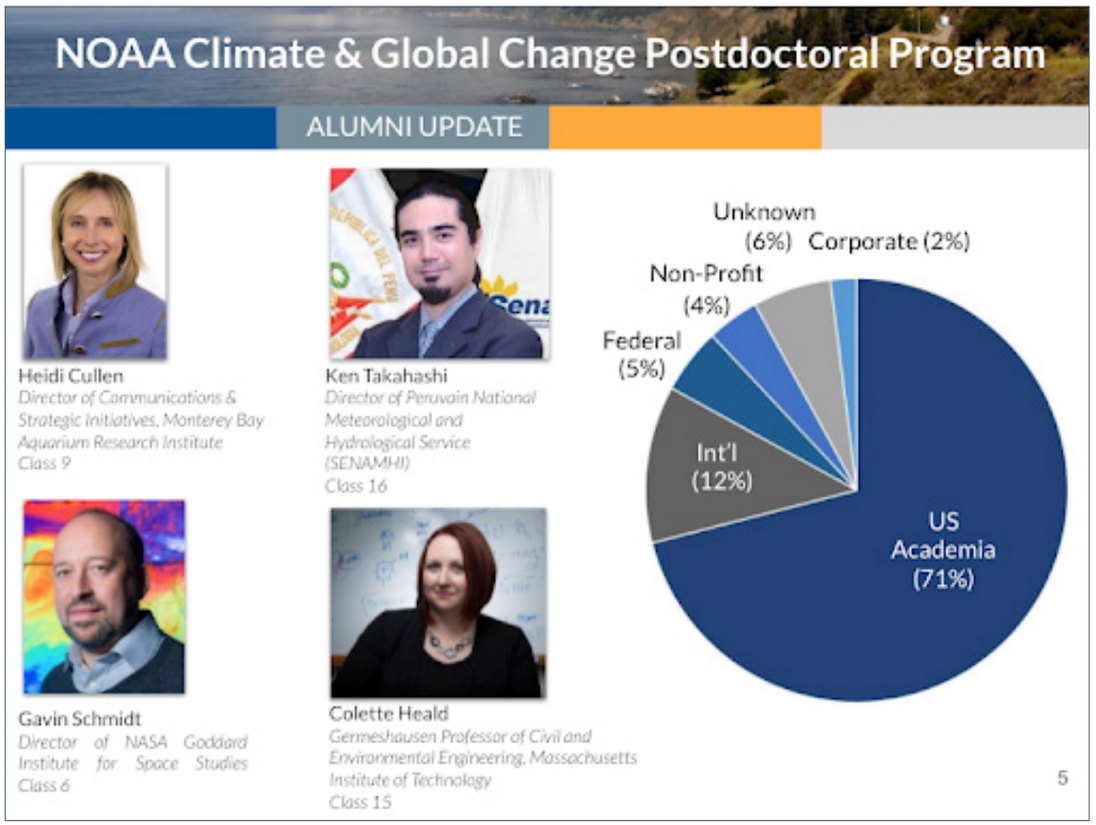
On the afternoon of December 3, 2021, CPAESS hosted a Pre-AGU Networking Meeting for the NOAA Climate and Global Change Fellowship Program. In light of the pandemic, this was arranged to facilitate connectivity and networking among NOAA leadership, alumni, and current fellows. NOAA leadership was able to express their thoughts on the value of this program, and for current fellows to highlight their work. About 50 people attended the meeting. Kendra Greb was the lead facilitator, and Hanne Mauriello gave opening remarks.

Dr. Wayne Higgins, head of NOAA's Climate Program Office shared that "I have no reservations saying that within my portfolio, this is my favorite program." The NOAA Climate and Global Change Fellowship was founded by Michael Hall in 1990 and has been managed by UCAR since its inception. Higgins gave an overview of the program, congratulated, and welcomed our 2021 fellows. He noted that this program has had 247 postdoctoral fellows, who averaged 4 publications each during their fellowship. The postdocs have been hosted in 63 different U.S. institutions, and currently work in 134 institutions worldwide. Their membership even includes 2 MacArthur Fellowship "Genius Grant" awardees.

After that each current fellow gave a brief overview of their current research. Here is a brief overview:

Henri Drake is at Princeton and NOAA GFDL. He is a physical oceanographer studying dynamical theory, numerical modeling, and climate impacts of rotating and stratified ocean flows. He is exploring how to integrate deep ocean climate dynamics into global climate models.

Robert Fabjer is at the University of Washington and is researching the connection between atmospheric dynamics and climate feedbacks and applying it to the Arctic. The Arctic is uniquely difficult because there is such a large predictive spread of temperature change.



Brittany Hupp is at Oregon State University and studies paleoceanography and paleo-climatology by measuring calcium in plankton. Her goal is to see how high latitude marine waters have dealt with climate changes in the past.

Andrea Jenney is at the University of California in Irvine and is researching atmospheric vertical microstructure, in

particular of shallow stable layers, cloud resolving models, and cloud processes.

Xiaomeng Jin is an atmospheric chemist at the University of California in Berkeley studying how wildfires influence NOx emissions, both short term and lifetime, as well as what air quality impacts they ultimately influence.

Isabel McCoy is at the University of Miami using satellite, ship, and flight observations to understand the role that mesoscale cloud morphologies play in our climate. In particular, whether shifts in cloud morphology occurrence will contribute a low cloud feedback under climate change.

Lindsay McCulloch is at Harvard and in her research pairs field-based measurements of symbiotic N fixation in Neotropical canopy gaps with remotely sensed data of canopy gap height and their prevalence to improve our understanding of terrestrial N cycling, and how much carbon ecosystems can store.

Sebastian Milinski is working at NCAR and uses climate model simulations to separate the chaotic internal variability and externally forced signals. He is currently researching why the eastern Pacific has cooled in recent decades and what this means for the Earth's climate sensitivity.

Mukund Rao is working at the University of California in David on trying to better understand the forest carbon cycle by studying the environmental controls of carbon uptake via photosynthesis and its allocation in tree growth, and how it affects their role as carbon sinks. (See Mukund in the picture above)

Above is Mukunk Rao and below is Nina Whitney, both engaged in their research field work.

Lettie Roach is studying at Scripps at the University of California, San Diego exploring processes driving the seasonality of sea ice extent in the Arctic and Antarctic with the goal of gaining insight that might improve climate projections and modeling.

Katherine Siegel is at the University of Colorado in Boulder using econometric causal inference methods, geospatial analysis, ecological functional trait analysis, and ecosystem service modeling to explore the links between forest management, wildfire severity, post-fire changes in vegetation communities and ecosystem services.

Uday Thapa is a paleoclimatologist studying at the University of California in Santa Barbara. He is using tree rings and climate model simulations to better understand our earth's climate over the past several centuries/millennia, including the dynamics of the subtropical jet over the Himalayas (Himalayan jet) during the past millennium.

Nina Whitney is at Wood's Hole at MIT researching the hydrographic history of the rapidly warming western North Atlantic over the last millennium to discover the primary drivers of hydrographic variability. She is using isotope geochemistry in ocean quahog shells and high-resolution ocean model simulations (CESM-LME and FOCI-VIKING10) as a means of finding these drivers.

Barbara Wortham is at the University of California in Berkeley to develop a record of how trees are recording carbon fixation vs. photosynthesis in a deposit of fossilized Juniper trees from the La Brea tarpits.

Madeline Youngs is at New York University studying how Southern Ocean circulation at topography and associated carbon fluxes vary with climate, as well as how mid-latitude atmosphere storm tracks change with climate.

Needless to say, the breadth and depth of their research is impressive. After the scientific snapshots of each fellow's work, Dr. Jin Huang spoke about our virtual monthly networking sessions which connect both fellows and alumni with NOAA scientists. Dr. Jin Huang is a great champion of this program, and the fellowship has made great gains in the number of fellowships available under her direction. She is hopeful that any potential budget increases to her program, can ultimately translate into more research funding opportunities for the fellowship and students.

The NOAA Climate and Global Change Fellowship is a prestigious program with alumni actively working on climate change and engaging with each other. Applications for next year's class are due January 7, 2022. Find out more about this program here and how to apply here.

CPAESS Discovery Seminars

This coming year CPAESS will begin our Seminar Series! Many of you have expressed an interest to share your research, and to connect more with the greater UCAR | NCAR Community. This is an opportunity for you to do both. Much like several of the NCAR labs, CPAESS will have a speaker present their research for about 45 minutes of the allotted 1 hour-long seminar. These presentations will be advertised within the UCAR | NCAR Community and our extended university and academic community. They will be broadcast by UCAR's multimedia services and our meeting planners will manage the seminar itself. After the presentation, we will have a brief question and answer period. These talks will be recorded and uploaded onto our website, and YouTube for future access. Each talk will be given on a Wednesday at 11:00 am MST.

The CPAESS Seminar Series will give you the opportunity to connect with the greater UCAR | NCAR community and share your research. Please note that we will need you to get permission to speak from your sponsor agency, and understand that they may have parameters for you concerning the content of your talk. Certain organizations may have more rigorous requirements in terms of permissions, so please keep that timing in mind if you sign up to present a seminar. Here is the sign-up sheet. Please know that If we have a lot of requests to speak, we will do our best to expand this new program. If you have any questions please reach out to Dawn Mullally.

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