# C P A E S S

## 2020 REVIEW

UCAR COMMUNITY PROGRAMS

CPAESS
Cooperative Programs for the Advancement of Earth System Science

# From the Director

This past year has been extremely challenging on many levels. The pandemic had most of us working virtually, but we adapted to forge ahead whether that meant holding a virtual school over 8 different time zones, working in long shifts to protect communities from increasing hurricane threats, or dissecting fish for research in a garage work station. In spite of it all, the CPAESS team rose to the occasion. I am tremendously grateful and appreciative to all of CPAESS staff in Boulder, Colorado and across the country. They have proven themselves in these difficult times -- continuing to ably serve this country and our global community through scientific excellence -- in spite of these challenges.

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.
- Scientific Community Building efforts — including conferences, the NASA Heliophysics Summer School, and a host of other scientific meetings.

The hard work of the entire CPAESS team has enabled us to enter 2021 in a strong position. I have no doubt this excellent 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 Mannella

# Inside the Newsletter

# AGU's Ocean Sciences Conference

The American Geophysical Union held its biennial Ocean Sciences Conference in San Diego in mid-February, 2020 (before the pandemic forced us into virtual meetings and conferences). CPAESS had a booth there and it was bustling! We were thrilled to be able to communicate the opportunities CPAESS provides for the ocean community, such as the NOAA Okeanos Explorer-in-Training internships, the NOAA Climate and Global Change postdoctoral program, and the many workshops available through our U.S. CLIVAR program. We also were able to speak on our partnerships with the National Hurricane Center (NHC), NOAA's National Ocean Service (NOS), the U.S. Naval Research Laboratory (NRL), NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML), and NOAA's Office of Ocean Exploration and Research (OER).

We had a small meeting space at the booth and were happy to receive many different employees and sponsors as guests. UCAR president Tony Busalacchi took the time to stop by to see how we were doing.

CPAESS staff held or participated in nine town halls, gave three presentations and had three posters. Fifteen CPAESS employees attended the conference this year, with a great showing from our staff at the Geophysical Fluid Dynamics Laboratory (GFDL). Some of our scientific meetings included U.S. CLIVAR in the World Climate Research Programme (WCRP) Town Hall, The Future of Argo Town Hall, The Atlantic Meridional Overturning Circulation Town Hall, The Indian Ocean Observing System 2 Town Hall, as well as the Surface Currents in the Coupled Ocean-Atmosphere System Workshop at the Scripps Research Institute.

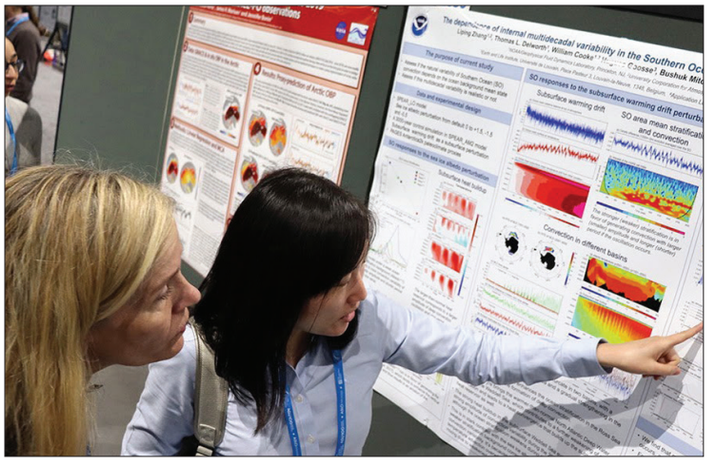
CPAESS Director Hanne Mauriello and Manager Melanie Russ met with numerous sponsors exploring potential future developments: the possibility for expanded staffing with NOAA OER, while the EPA was in touch about a possible internship program.

We also had the chance to share with attendees the great work from other parts of the UCAR Community Programs family: COMET's hurricane products, Unidata's internships, and SciEd's SOARS program; as well as NCAR's ASP Fellowships. It was a great deal of fun, and folks seemed genuinely happy to hear about all the wonderful work that UCAR does supporting the Earth system science community.

### "We are tied to the ocean"

Our global oceans play a critical role in climate change and weather modeling, so it is no surprise that we have brilliant staff all over the world whose work focuses on 71% of our Earth's surface — our oceans. CPAESS employs scientists who work in these ocean-centered agencies: NASA Ocean Observations, NOAA Centers for Environmental Prediction (NCEP), NOAA National Hurricane Center, NOAA National Ocean Service, U.S. Naval Research

*Young scientists and students were excited to visit our table.*

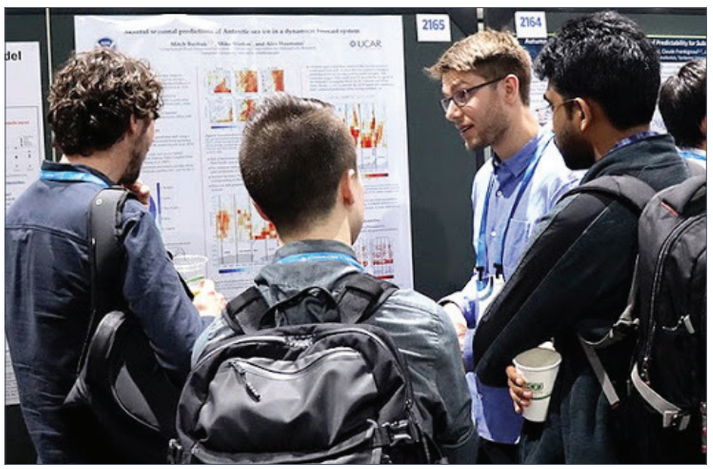


*CPAESS Project Scientist Liping Zhang explains her latest research at GFDL to CPAESS Director Hanne Mauriello.*

*CPAESS Director Hanne Mauriello enjoys a conversation with David Legler, Director of NOAA's Global Ocean Monitoring and Observing Program.*

Laboratory, NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML), NOAA Global Ocean Monitoring and Observation (GOMO), NOAA National Environmental Satellite, Data, and Informational Service (NESDIS), NOAA National Office of

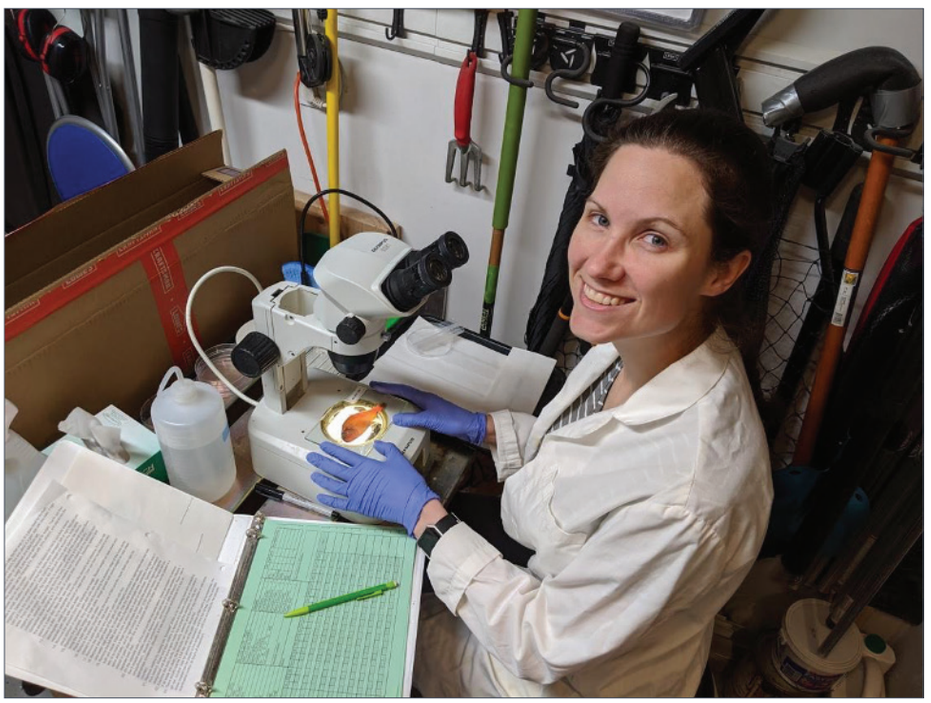
*NOAA's Atlantic Oceanographic and Meteorological Laboratory's Deputy Director Molly Baringer chats with CPAESS Director Hanne Mauriello and CPAESS Program Manager Emily Smith of NOAA's Global Ocean Monitoring and Observing Program office.*



*Mitchell Bushuk, CPAESS Project Scientist at GFDL speaks on Skillful seasonal predictions of Antarctic sea ice.*

Ocean Exploration and Research (OER), and US CLIVAR. In addition to that, we have NOAA Climate and Global Change Fellows whose research focuses on the ocean sciences. A great many of our other staff critically consider ocean impacts in their work. In honor of World Oceans Day, June 8, 2020, we asked some of our ocean staff to share a peek into their worlds. Here's a sampling of their great work.

One of our current NOAA Climate and Global Change Fellows, Danielle Claar, explained "I am studying fish parasites as bioindicators of El Niño impacts on ecosystems. Specifically, I am studying coral reef fish in the Central Pacific both before and after the major 2015/2016 El Niño event. The goal of this project is to investigate how climate oscillations influence parasitism, and how we can use this to understand the impacts of heatwaves on marine communities. Due to the lockdown, I have been continuing this work by dissecting fish in my garage (along with working on my computer for writing and data analysis)." Way to adapt to change, Danielle, and thanks for talking with us!



*Above: Danielle Claar (NOAA postdoc fellow) performing underwater field work last season. Below: During the pandemic she has transformed her garage into a lab where she dissects fish for her research.*

At NOAA's Office of Ocean Exploration and Research (OER) we have Rachel Gulbraa, who works in communications helping to promote and document, among other things, the NOAA Okeanos Explorer-In-Training program. NOAA's *Okeanos Explorer* is the only federal vessel whose sole purpose is dedicated to exploring our deep ocean, closing the prominent gap in our basic understanding of U.S. deep waters and seafloor, and delivering the ocean information needed to strengthen the economy, health, and security of our nation.

While onboard the *Okeanos Explorer* Rachel helped provide online coverage to scientists, resource managers, students, members of the general public, and others, enabling them to actively experience ocean exploration. In support of


*Rachel Gulbraa of NOAA OER onboard the Okeanos Explorer in 2019.*


*Check out this interview with Taylor Trogdon, one of our Storm Surge Unit employees, talking about the fascinating, important work done at the National Hurricane Center.*

federal guidance to slow the spread of COVID-19, the *Okeanos Explorer* expeditions were put on hold for the 2020 summer season. However, you can check out these ocean exploration webinars that Rachel organized, wrote, and moderated. OER also worked with Ocean Exploration Trust and created a coloring book (scroll down) for kids in honor of World Ocean Day. Recently published are new videos featuring the beautiful macrophotography and the hydrothermal vent of sea life from *Okeanos* expeditions which she helped put together and edit. NOAA's Explorer-In-Training program continues this year in a revised format.

CPAESS also has six staff members in the Storm Surge Unit of NOAA's National Hurricane Center. This team is pivotal in determining when and where watches and warnings need to be issued to protect people in the event of a tropical storm making landfall. The storm surge that accompanies these extreme weather events accounts for the majority of deaths with these storms, and this team works very hard to reduce those fatalities with predictive modeling, communication, and cooperation with emergency personnel. CPAESS officially has six staff members on the Storm Surge Unit: Taylor Trogdon, Laura Alaka, Tarah Sharon, William Booth, Ethan Gibney, and Andrew Penny. We are so proud of the important work of this team.

One of the programs CPAESS supports is the Climate Variability and Predictability Program—more familiarly known as U.S. CLIVAR—whose work centers on our oceans. Mike Patterson is the director and Jennie Zhu is the program specialist for U.S. CLIVAR. Of the program they said, "For 22 years US CLIVAR has played a vital role in coordinating U.S. science community efforts to accelerate our understanding of the ocean's influence on climate variability and change across timescales from weeks to decades and beyond. This CPAESS-hosted community program brings together experts across disciplines, promoting diversity in participation, to address pressing societally-important questions, such as 'Will the current regional drought, marine heat wave, or wildfires persist through the next season? What are the prospects of hurricanes impacting the US coasts this summer and fall? Can we expect an El Niño next year and how will it impact regional US precipitation and flooding? How will all of these phenomena change with a warming ocean over the next decades?' These questions and many others drive the research agenda of US CLIVAR, which helps define the requirements for

> *"We are tied to the ocean. And when we go back to the sea, whether it is to sail or to watch, we are going back from whence we came."*
>
> *- John F. Kennedy*

a sustained global ocean observing system, the mounting of numerous ocean-based field campaigns to understand fundamental processes, and the ongoing improvement of ocean models used for predicting and projecting the future state of the ocean and the response of the climate system." Thanks, Jennie and Mike, for the critical work that US CLIVAR provides the ocean community and all of us.

Dr. Kathy Tedesco says of her ocean work, "One of the programs that I support as a CPAESS Program Manager in the NOAA Global Ocean Monitoring and Observing Program (GOMO) is the U.S. Global Ocean Ship-based Hydrographic Investigations Program, or U.S. GO-SHIP. The U.S. GO-SHIP program, funded by NOAA GOMO and the NSF, contributes to the International GO-SHIP network of 55 globally sustained hydrographic sections to monitor changes in inventories of heat, freshwater, carbon, oxygen, nutrients and transient tracers, covering the ocean basins from coast to coast and full depth of the water column, with global measurements of the highest required accuracy to detect these changes."

"Prior to serving as Program Manager for U.S. GO-SHIP, I was a seagoing oceanographer and was lucky enough to have sailed on seven hydrographic cruises collecting and analyzing chlorofluorocarbons and sulfur hexafluoride in seawater via gas chromatography." Thank you, Kathy, for your ongoing work to help us better understand our world's oceans.

*Above left: Collecting seawater samples from Niskin bottles on the CTD rosette. Above right: Kathy Tedesco crossing the Antarctic Circle onboard the R/V Knorr.*

# Class of 2020: NOAA Climate & Global Change Fellows

Kudos to the 2020 NOAA Climate and Global Change Postdoctoral Fellows! We are excited to congratulate the eight C&CG postdoc Fellows appointed in 2020. This was an increase over the previous four Fellows per year, so we are thrilled!

"It is an honor for CPAESS to manage this critical program. We are delighted that NOAA has doubled its investment this year in fostering brilliant young scientists on the frontlines of climate and global change science," said Hanne Mauriello, Director of UCAR's Cooperative Programs for the Advancement of Earth System Science (CPAESS).

Over the next two years, the new fellows will be hosted by mentoring scientists at U.S. universities and research institutions, conducting projects focused on observing, understanding, modeling, and predicting climate variability and change. Here are the 2020 candidates and their research topics:

### Rebecca Beadling

**Proposal Topic**: Mean state representation and the reorganization of subtropical gyre systems under continued warming with implications for regional and global climate

**Host**: Dr. John Krastling, NOAA Geophysical Fluid Dynamics Laboratory
**Ph.D. Institution:** University of Arizona, Department of Geosciences

### Andrea Jenney

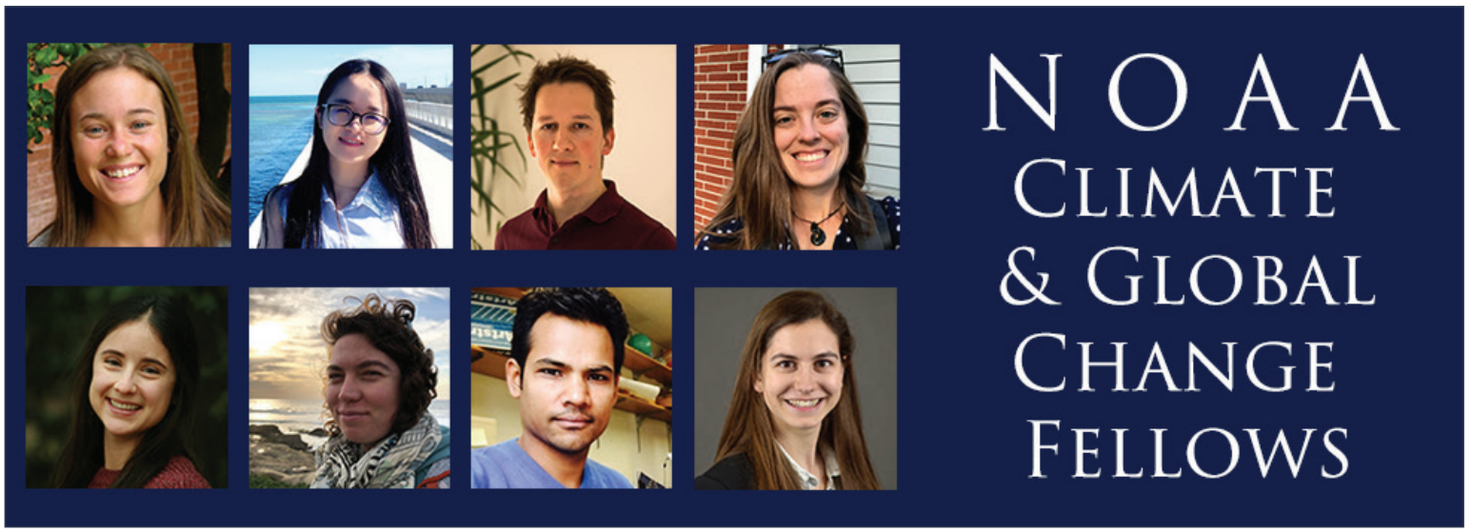
**Proposal Topic**: Understanding the impacts of the vertical distribution of atmospheric stable layers on convection
**Host**: Dr. Michael Pritchard, University of California, Irvine
**Ph.D. Institution**: Colorado State University, Department of Atmospheric Sciences

### Xiaomeng Jin

**Proposal Topic**: Reactive nitrogen from wildfires: Emissions, chemical evolution and impacts
**Host**: Dr. Ronald Cohen, University of California, Berkeley
**Ph.D. Institution**: Columbia University, Lamont-Doherty Earth Observatory

### Isabel McCoy

**Proposal Topic**: Understanding the role of cloud morphologies in low cloud feedbacks
**Host**: Dr. Paquita Zuidema, University of Miami, Rosenstiel School of Marine and Atmospheric Sciences
**Ph.D. Institution**: University of Washington, Department of Atmospheric Sciences



**Sebastian Milinski**
**Proposal Topic**: Constraining the contribution of SST warming patterns to the uncertainty in estimates of climate sensitivity by combining large ensembles and observations
**Host**: Dr. Clara Deser, NCAR Climate and Global Dynamics Division
**Ph.D. Institution**: Max Planck Institute for Meteorology and International Max Planck Research School on Earth System Modelling

**Uday Thapa**
**Proposal Topic**: Investigating changes in springtime water availability to inform water management in the Himalayas
**Host**: Dr. Samantha Stevenson, University of California, Santa Barbara
**Ph.D. Institution**: University of Minnesota, Department of Geography

**Nina Whitney**
**Proposal Topic**: 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
**Host**: Dr. Caroline Ummenhofer, Woods Hole Oceanographic Institution
**Ph.D. Institution**: Iowa State University, Department of Geological and Atmospheric Sciences

**Madeleine Youngs**
**Proposal Topic**: Northern hemisphere climatological storm tracks under climate change: A dynamical systems perspective
**Host**: Dr. Edwin Gerber, New York University, The Courant Institute of Mathematical Sciences
**Ph.D. Institution**: Massachusetts Institute of Technology - Woods Hole Oceanographic Institution Joint Program for Oceanography

The NOAA Climate and Global Change Postdoctoral Fellowship Program—founded in 1990 by former NOAA Climate Program Office Director Dr. J. Michael Hall—helps create and train the next generation of leading researchers needed for climate studies. Over the past 30 years, the Fellowship has hosted more than 230 C&GC Fellows and developed an outstanding reputation for attracting the best and the brightest Ph.D.s in the sciences relevant to climate and global change. We look forward to hearing about their wonderful research.

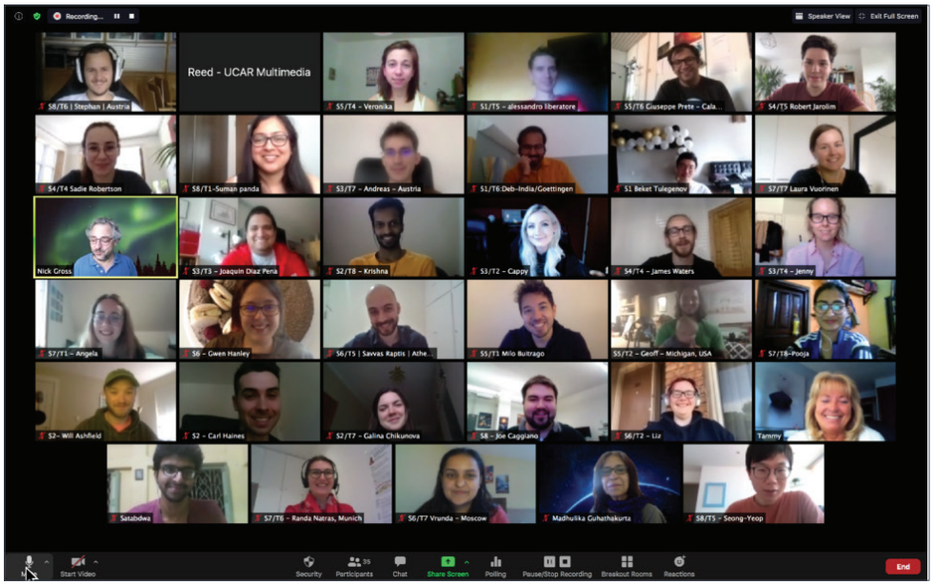
Find out more about the program and check out NOAA's write up as well. The selection process for this year's fellows in currently underway.

## NASA Heliophysics Summer School

Each summer CPAESS manages NASA's "Living With a Star" Heliophysics Summer School (HSS) on UCAR's Boulder campus. This year we had to figure out how to translate a two-week long in-person course including faculty lectures, modeling laboratories, student development exercises, career panels, and poster sessions, into a virtual setting. To make things more complicated we had students from eight different time zones across the world participating, and needed to adjust the schedule accordingly. With a bit of ingenuity this year's summer school was held from July 6-17th.

The trick for professors is always the same—engagement—whether you are in-person or not. Anyone can present material for hours on end, but keeping your students interested and actively participating is the hallmark of a great educator. Fortunately, we had those, with School Facilitator Nick Gross of Boston University, and School Deans Dana Longcope of Montana State University and Amitava Bhattacharjee of Princeton University.

To begin to create a community among the students and faculty members we created an HSS Slack channel and asked both students and faculty to complete a Slack profile which included their picture and a short introductory message about themselves. Students were given pre-readings and activities to look at prior to the start of classes.




*Screenshot of a group session at 2020 international virtual Heliophysics Summer School. .*

They were then sorted into eight time zone groups to complete asynchronous lab work and assigned activities. Any questions or results were posted to the Slack channel that was monitored by the school Deans and faculty members. Students were also assigned to synchronous groups for questions and answer sessions and lecture discussions. The synchronous groups were changed at the beginning of Week 2 to allow students to work with a broader cross-section of students.

Students began their first live session by delivering their elevator speeches in Zoom breakout rooms. Throughout the two weeks they were treated to many guest lecturers including lead program scientist for NASA's "Living With a Star" initiative, Dr. Madhulika Guhathakurta. The 32 students were also able to listen to the expertise of Drs. Delores Knipp, Janet Green, Jiong Qiu, Tim Fuller Rowell, W. Kent Tobiska, and William Murtagh.

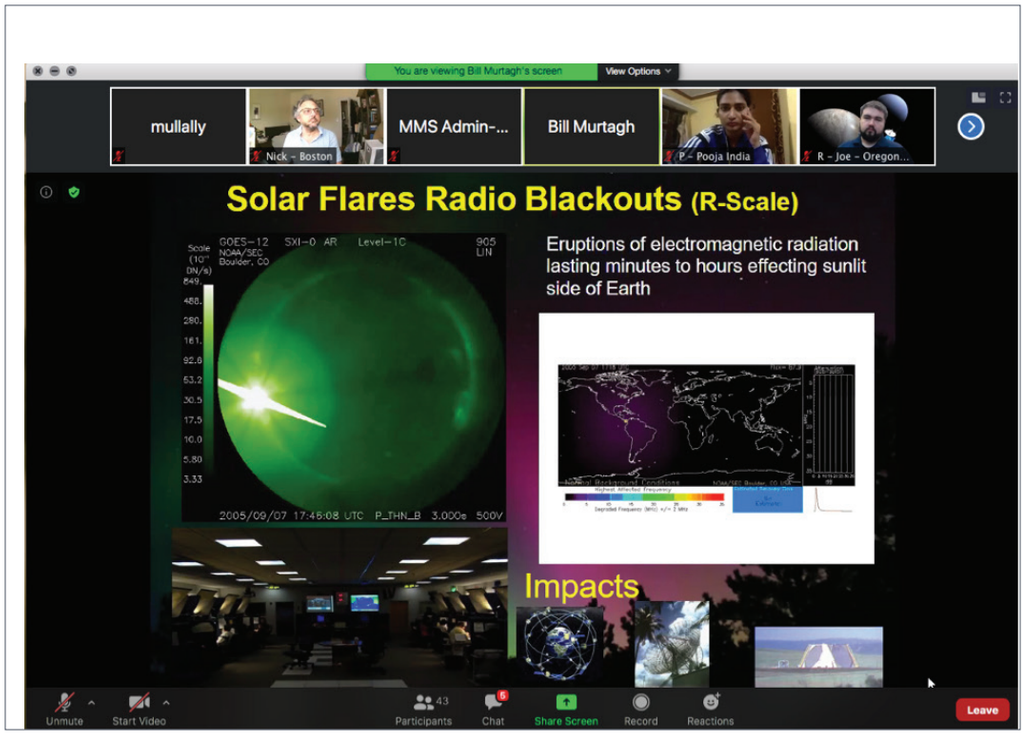
Additionally, career panelists Educational Director Claire Rafferty of the National Solar Observatory; Research Scientist Hazel Bain of the University of Colorado Boulder and NOAA Space Weather Prediction Center; and Senior Research Scientist Andres Munoz-Jaramillo of the Southwest Research Institute all answered questions generated by the students. At the end of the panel they broke into three breakout rooms. Each room had a panelist and a Dean or the School Facilitator Nick Gross. The students could then join each breakout room to talk to the panelists and ask them questions in a less formal environment.

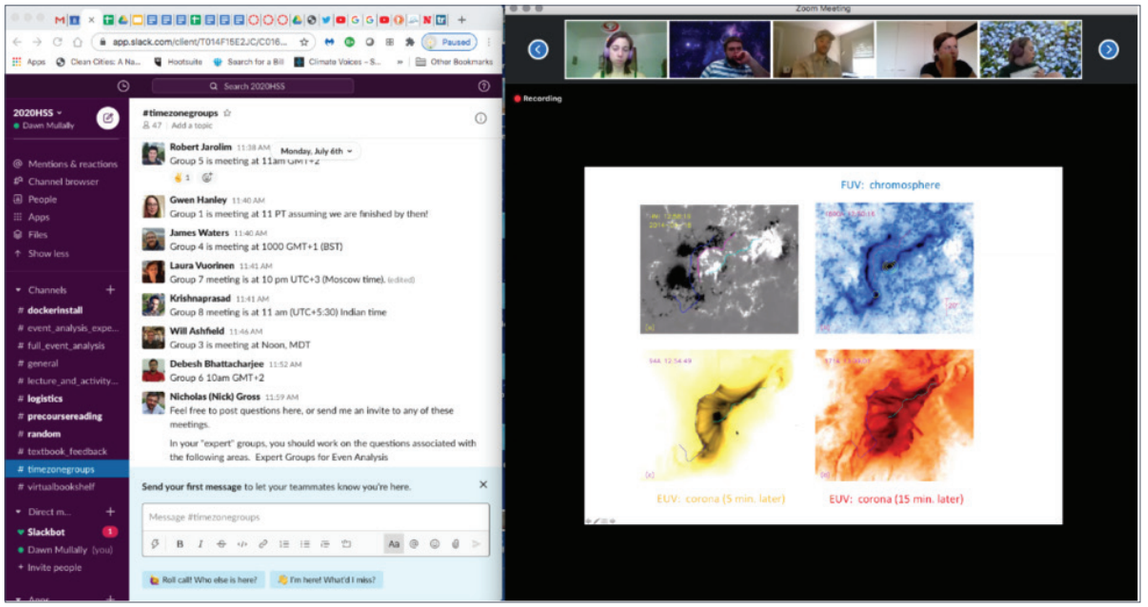
Students watched previously recorded heliophysics core lectures on the CPAESS YouTube channel, and then met in online Zoom sessions to review the lecture content, have question and answer sessions, and work on assigned activities in breakout groups. The Zoom breakout rooms were used

> *"I really enjoyed the experience. I was struck by the diversity of speakers: multiple women, multiple people of color, faculty members, industry employees, civil servants. That's the first time that I've seen so many women and people of color on the schedule to purely talk science."*
>
> *– 2020 Heliophysics Summer School Student*

to work on their lab and assigned activities from the free online textbook *Principles of Heliophysics: A textbook on the universal processes behind planetary habitability*, written by Karel Schrijver, et al. The Deans and Nick would join the breakout rooms to answer questions if they came up while the students were working. Office hours were held on Zoom before and after each day's sessions allowing students to speak with various lecturers on questions that pertained to their individual research needs. Class materials including the textbook, presentations, support videos, and articles were all uploaded onto our website.

Because this was our first foray into building a virtual school, we surveyed students along the way to improve the process and level of engagement as we went along. Some comments we received included: "Everyone is respected. Opinions are freely expressed. The discussion is active and everyone is engaged in the work." Also "I really enjoyed the experience. I was struck by the diversity of speakers: multiple women, multiple people of color, faculty members, industry employees, civil servants. That's the first time that I've seen so many women and people of color on the schedule to purely talk science...Thank you so much for running this




*Top: A peek at the sorting of students by time zone in Slack. Bottom: Slide from Bill Murtagh of NOAA's Space Weather Prediction Center giving a guest lecture on Zoom.*

program, again I really enjoyed it and would absolutely recommend it in the future." When we asked generally about how the school was going, we were delighted to hear that "organizers seem to be so accessible, it's nice and I think it makes everyone feel very comfortable."

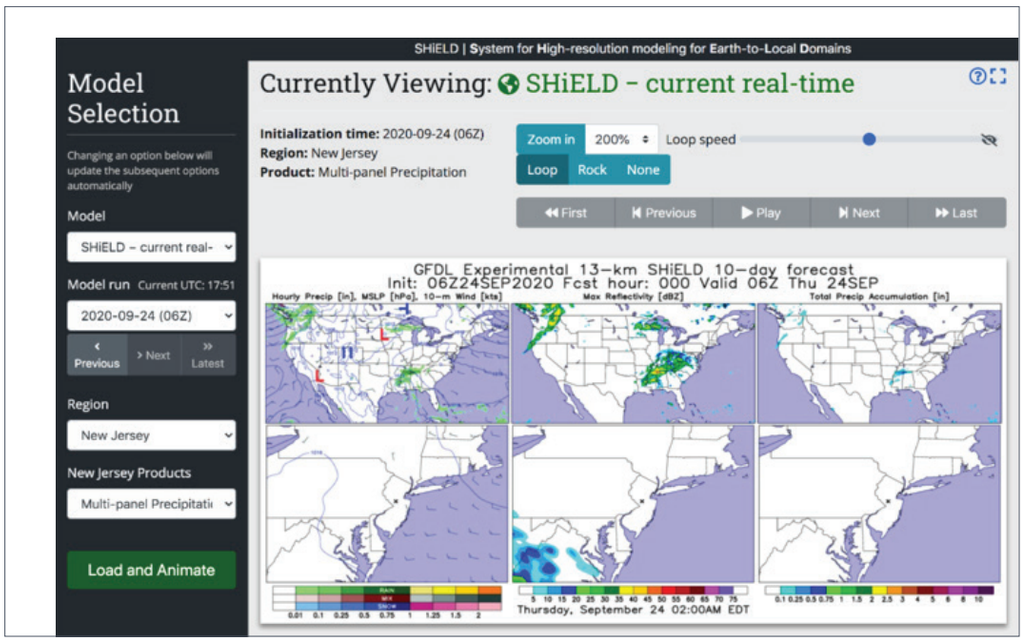
CPAESS Program Administrator Kendra Greb and our Meeting Planner Tammy Kepple worked with the Summer School Deans and Nick Gross to create an effective program in a virtual setting. Based on student feedback, we feel it went well. "The multimedia staff are total rock stars!" "You did amazing work and organization! Even during such a terrible time. A great THANK YOU!" We are so delighted the excellent education this program provides was able to effectively continue through the pandemic. A sincere thank you for the efforts of many scientists, educators, and staff that made it possible.

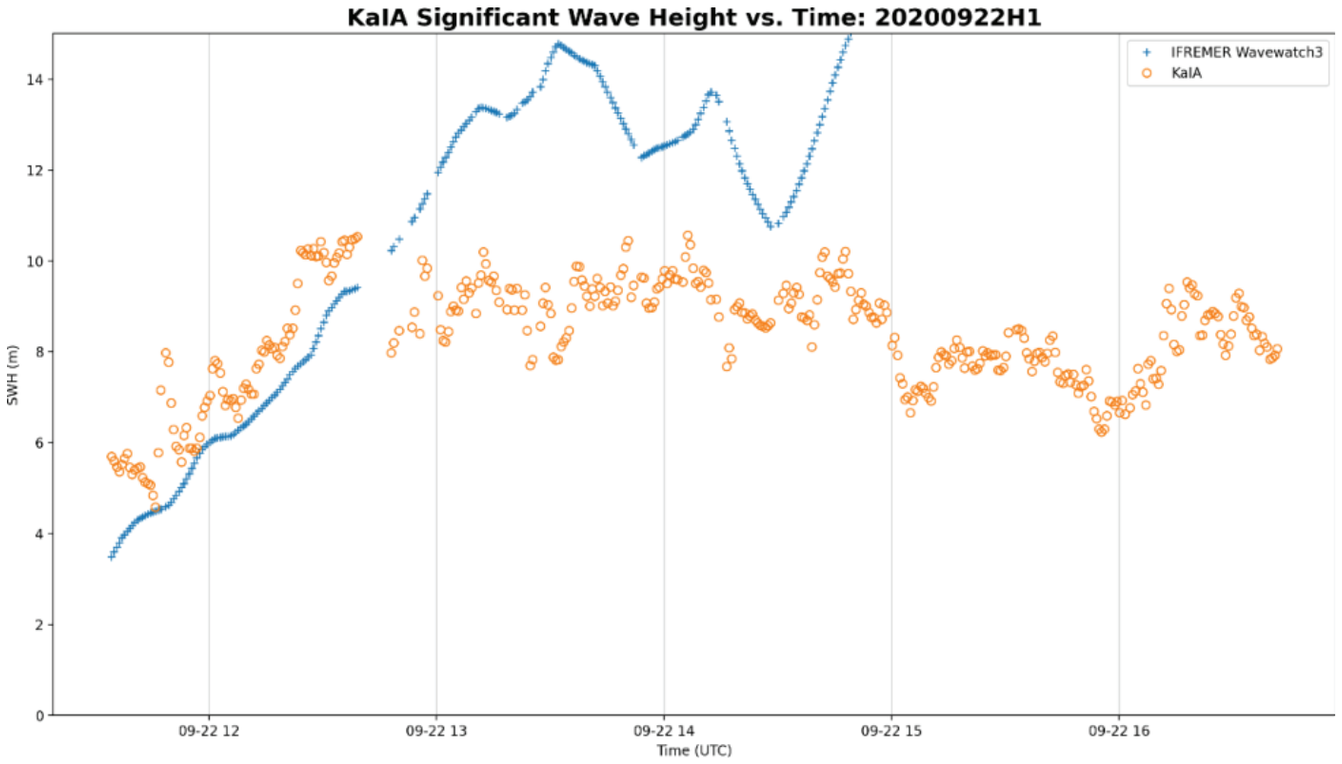
## Improving Forecast Capability

CPAESS visiting scientist Matthew Morin and CPAESS software engineer Jason Alvich work at GFDL, and recently were able to update the real-time SHiELD weather forecast model website. SHiELD stands for "System for High-resolution prediction on Earth-to-Local Domains (SHiELD), an atmosphere model coupling the nonhydrostatic FV3 Dynamical Core to a physics suite originally taken from the Global Forecast System. SHiELD is designed to demonstrate new capabilities within its components, explore new model applications, and to answer scientific questions through these new functionalities. A variety of configurations are presented, including short-to-medium-range and subseasonal-to-seasonal (S2S) prediction, global-to-regional convective-scale hurricane and contiguous US precipitation forecasts, and global cloud-resolving modeling. Advances within SHiELD can be seamlessly transitioned into other Unified Forecast System (UFS) or FV3-based models, including operational implementations of the UFS (Harris et al, 2020).

"SHiELD, an experimental globally-uniform ~13 km resolution configuration, is run four times daily out to 10 days with the GFS initial conditions. Additionally, two C-SHiELD Contiguous-US 3-km nested grid forecasts are run each day, and during the Atlantic Hurricane season (July–October) T-SHiELD Atlantic 3-km nested grid forecasts are run four times per day (GFDL)."

The updated version they worked on has many features that make it more user-friendly including information on model updates, ADA compliance, and a better keyboard interface. This is the culmination of a year's work perfecting the site which can be found here. Their plan is to continually improve this site. Congratulations and thank you on your hard work, Jason and Matt!






## Into the Hurricane

CPAESS scientist Zorana Jelenak, who works at NOAA National Environmental Satellite, Data, and Informational Service (NESDIS) was able to provide real-time significant wave height (SWH) data from her NOAA P-3 flight into Tropical Storm Teddy (later, Hurricane Teddy). Zorena has been known to fly into the eye of a hurricane for science. In this case she and the crew used NOAA's P-3, an aircraft specifically used for meteorological and oceanographic research because of its "unprecedented variety of scientific instrumentation, radars, and recording systems for both in-situ and remote sensing measurements (NOAA)."

The data they gathered was used by the NWS Ocean Prediction Center (OPC) and the National Hurricane Center (NHC) forecasters. This season NOAA had the goal of providing SWH data to NHC in near real time from the Ka-band Interferometric Altimeter (KaIA). The KaIA information provides a "two-dimensional image of the surface (Aviso)" of waves.

Zorana and NOAA's Aircraft Operations Center (AOC) Crew 42 flew into Teddy to retrieve this wave data. Forecasters were able to incorporate that data in real-time and compare it with the IFREMER WAVEWATCH model predictions, leading to further insight into how to improve the model and more accurate understanding of how the storm would unfold. The real-time incorporation of data like this continued through the rest of the hurricane season and into the winter in Alaska.

Given the small timeframe and the challenges of COVID, their ongoing efforts have been no small task. Congratulations to Zorana, Crew 42, members of NOAA's Center for Satellite Applications and Research (STAR) team, and all who contributed to this effort. This difficult work translates into not only a greater understanding of climate science, but increased safety and security for the public. Our sincere thanks!

# Outgoing Jack Eddy Scholars

> *"I was hooked by the fact that things happening in the vast empty space outside of Earth's atmosphere is changing every day and affecting our daily lives."*
>
> *- Natsuha Kuroda*

One of the postdoctoral programs that CPAESS manages is NASA's Jack Eddy "Living With a Star" Fellowship. The program matches early career Ph.D.s with experienced scientists at U.S. research institutions. Hosting scientists mentor the postdocs during their two-year Fellowships. The goal of the program is to train the next generation of researchers needed for the emerging field of Heliophysics.

Heliophysics embraces all science aspects of the Sun-Earth connection and includes many of the basic physical processes that are found in our solar system, the laboratory, and throughout the universe. The study of heliophysics informs many critical and practical applications such as space weather impacts on Earth weather and GPS signal interference.

Two of our Class of 2018 students are Natsuha Kuroda and Karanam Ramesh. We asked them some questions about their time as NASA Jack Eddy Fellows and their research, and they were gracious enough to answer.

Karanam Ramesh received his Ph.D. from Sri Venkateswara University. His Fellowship was working with NCAR's Anne Smith of the Atmospheric Chemistry, Observations & Modeling (ACOM) laboratory here in Boulder, Colorado on the Solar and Tidal Influence on Upper Atmosphere CO2 Cooling. Of his work he had this to say:

**What is your Ph.D. in and what inspired you to study this field?** As the terrestrial atmosphere is the region where we breathe, this field of research attracted me due to its importance for the existence of life. There is tremendous research going on in the lower atmosphere, but the knowledge on middle and upper atmosphere is inadequate. During Ph.D. study, my research work was mainly on the radiative, dynamical, and chemical processes in the mesosphere and lower thermosphere (MLT). Also known as 'ignorosphere', this region is least explored by the research community due to the complications in probing. One of the interesting and striking features is the mesospheric inversion layer (MIL). The limited sets of ground-based and space-borne observations inspired me to investigate the challenging problem of formation of MILs.

**What did you hope to discover with your postdoctoral work?** The anthropogenic increase of CO2 not only affects the lower atmospheric climate but also the upper atmospheric processes. I did hope to investigate the impact of solar radiation and atmospheric tides on the upper atmosphere CO2 cooling, which is poorly understood. I was also interested to investigate the impact of CO2 cooling on ozone and contraction of the atmospheric layers.

**What did you end up discovering with your postdoctoral work?** I believe that I finished the proposed research work to some extent. As part of my postdoctoral work, I ended up investigating the long-term effect of solar radiation, CO2, ozone depleting substances on the changes in temperature and in atmospheric tides in the middle and upper atmosphere. The results are expected to be revealed soon. The work is not yet completed and there is a lot more to explore.

**Is there a pragmatic application to this sort of discovery?** Yes, the increasing CO2 enhances infrared cooling and leads to declining thermosphere density. As a result, the lifetime of near Earth-orbiting satellites and other hazardous space debris could increase. In addition, the thermospheric con-

traction causes downward displacement of ionospheric layers and significantly influences electron density. Hence, in view of these consequences, there is a pressing need to investigate the long-term behavior of upper atmosphere CO2 cooling.

**Anything you want to add?** The Jack Eddy Postdoctoral Fellowship gives an excellent opportunity to explore potential research of interest. The upper atmosphere is always puzzling, influenced by solar energy from the top and various complex processes from the bottom. I am so excited learning by research and the high impact discoveries in this field!

Natsuha Kuroda received her Ph.D. from the New Jersey Institute of Technology. For her Fellowship she chose to work with Dr. Martin Laming at the United States Naval Research Laboratory (NRL) in Washington, D.C. Kuroda's project was on the Evaluation of the Magnetic Null Points as the Locations of the Solar Energetic Particle Seed Population Production.

**What is your Ph.D. in and what inspired you to study this field?** My Ph.D. is in applied physics, specifically in solar physics. I had always some interest in space and learned the fun of physics during my high school. When I was a physics major undergraduate, I learned about space weather and got specifically interested in what I am doing right now. I was hooked by the fact that things happening in the vast empty space outside of Earth's atmosphere is changing every day and affecting our daily lives.

**What did you hope to discover with your Postdoctoral work?** I hoped to develop the method to predict the seed population of the harmful Solar Energetic Particles from routine observation of the Sun. Currently, there is no direct observation of these seed particles, but they are thought to be extremely important in determining the severity of space weather events. I hoped to use my background knowledge gained in radio and X-ray solar physics during my Ph.D. to develop a new method in predicting these seed particles.

**What did you end up discovering with your postdoctoral work?** My work is unfinished, and I am planning to continue the project where I was hosted. I discovered that the energetic electrons, which can be observed in radio wavelength, has still a lot more to be explored at the space where it wasn't really focused before—at some height away from the vicinity of sunspot where "everything" has been thought to happen, when events such as solar flares occur.

**Is there a pragmatic application to this sort of discovery?** Yes, the Solar Energetic Particles are one of the most harmful of space weather events, as they can break satellites in orbit and harm astronauts. So, it is forecasting crucial to modern society.

**Anything you want to add?** I feel that the field of space weather is very special—it lets you work with the wonders of the universe while being critically needed by society (you usually don't get both, in my humble opinion). I feel lucky to have found passion in this field.

Thank you both so much for giving us insight into your research, Karanam and Natsuha. We wish you all the best as you continue your work and make new strides in this critical, emerging field.

# Life-Saving Forecasts

CPAESS scientists at NOAA's Climate Prediction Center (CPC) African Desk, part of the National Weather Service (NWS), are saving lives every day by transforming weather forecasting into life-protecting tools against climate extremes. Equipped with a variety of tools and training programs, this team is engaging meteorological offices and health services to forewarn populations on likely weather events and the negative health impacts they might bring.

The National Centers of Environmental Prediction (NCEP), a Division of NOAA's National Weather Service, has nine different national centers including CPC, that produce global forecasts. CPC's International Desks, including the African Desk, focus on monitoring and forecasting weather systems in various parts of the world. While NWS is primarily focused on the United States, the International Desks support various international efforts. The African Desk was established as the United States had an increasing need for weather information in Africa, particularly as it relates to humanitarian help. USAID needed real-time forecasting to inform their decision-making concerning the delivery and distribution of food and safe drinking water. With this foundation of real-time weather forecasting, the African Desk has continued to expand their services to increase their impact and usefulness to not only USAID, but also citizens throughout Africa.

The African Desk has created real-time weather forecasting tools to assist decision makers concerning food security, water resource management, and agriculture. Whether a flood or drought

*Left to right: Sarah Suzanne Niarum Diouf, Pierre-Honore Kamsu Tamo, Hanne Mauriello, and Ibrahima Diouf at CPAESS Staff meeting in Washington, D.C.*

is forecast could dramatically change what crops are being planted, which areas might need mosquito mitigation, and where heat might have bigger impacts on the health of vulnerable populations. This real-time information is a powerful tool in protecting the health and well-being of millions of people.

The African Desk was established at CPC in 1994 as part of the U.S. contributions to the World Meteorological Organization (WMO) Voluntary Cooperation Program (VCP). The objective is to help build capacity in climate predictions, monitoring, and assessments at African meteorological institutions. The African Desk was expanded in 2006 to include weather in support of the WMO Severe Weather Forecasting Demonstration Project (SWFDP) for Africa. The African Desk is fully integrated with CPC International projects including the support to the USAID Famine Early Warning System Network (FEWSNET) and the Disaster Risk Reduction Program of the Office of Foreign Disaster Assistance (OFDA)(DRR), and the NOAA-USDA Joint Agricultural Weather Facility (JAWF).

The NCEP African Desk consists of 10 people under the direction of NOAA's Wasilla Thiaw. Five of these team members are CPAESS/UCAR employees and include Endalkachew (Endalk) Bekele Biratu, Associate Scientist; Sarah Suzanne Niarum Diouf, Associate Scientist; Ibrahima Diouf, Associate Scientist; Pierre-Honore Kamsu Tamo, Associate Scientist; and Malasala Murali Nageswararao Rao, Visiting Scientist. CPAESS scientists move the lofty goals of the organization forward in a variety of ways.

In addition to the weather forecasting work, part of this team's work is training meteorologists from Africa. The WMO has enlisted this team to train meteorologists from the 54 countries in Africa on how to utilize these forecasting tools. This is done through appointments to a residency training program lasting four months which occurs in NOAA offices.

Endalk focuses on training meteorologists on medium-range forecasting tools of one to two weeks. Pierre focuses on helping fellow meteorologists

*Top - Left to right: Wassila Thiaw of NOAA and leader of this team, and Endalkachew (Endalk) Bekele Biratu; and Bottom: Malasala Murali Nageswararao Rao at work.*

understand the monthly and seasonal forecasting tools. In addition, trainees are educated on tools to monitor the evolution of climates in their area. By tracking the precipitation and temperature, better model outputs can be created even within the

season, helping people in the region understand the likelihood of droughts or floods to improve or to worsen.

The WMO divides up the world into six regions for the purpose of forecasting. Africa is Region 1 and Region 4 includes the United States, Canada, Mexico, Central America, and the Caribbean Islands. Sarah works to create the real-time forecasting tools that this team has created for Africa to assist meteorologists in Mexico, Central America, and the Caribbean Islands. Her work is ensuring these same meteorological tools are available for the Americas.

*Not only is this team's work critical in USAID's food security investment planning, but it has a tremendous positive impact on millions and millions of lives.*

The profoundly helpful impact of this information has led this team to expand their reach and develop capacity for health decision-making connected to climate variability. NWS funded workshops in Africa to facilitate training on how these forecast tools could be utilized to predict risks for infectious disease outbreaks such as malaria and heat-related illnesses. By enabling the health community to understand heatwave forecasting, health services can map out communities where heat related illnesses are likely to become problematic for vulnerable communities and prepare to assist them. CPAESS scientists Murali, Sarah, and Endalk work on these heatwave forecasts that are so useful to the health community.

Forecasting areas which are likely to see an increase in heat-related illnesses, like cardiovascular and respiratory issues, is tremendously useful in preventing health problems. This team's work also includes experimental predictions of vector-borne diseases in collaboration with the health sector. Ibrahima's work connects weather forecasting to malaria, which is caused by mosquitoes and is a major health concern. He uses models that are sensitive to precipitation, humidity, and temperature and connects them to malaria incidents. Additionally, Ibrahima relates this to statistical models of ocean temperatures because there is limited availability of epidemiological data. In doing this he can relate malaria incidences with climate variability. Malaria can be controlled by medication, insecticides, and netting. With the help of forecasting, malaria cases can be actively prevented.

This team hopes to expand their work with the health sector as much more can be done in the mitigation of heat-related diseases. They have been working with the Ministry of Health in Senegal to create a heat and health early warning system with the Senegalese Meteorological Service. The World Health Organization (WHO) is interested in working with them to expand this type of work to the Americas.

Not only is this team's work critical in USAID's food security investment planning, but it has a tremendous positive impact on millions and millions of lives. We are extremely proud of this team's research, and their innovative and interdisciplinary approach to serving humanity. Our sincerest thanks to you all!

## Bill Lapenta Internship

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

*2020 Bill Lapenta Interns: First Row (left to right) Eric Roy, Julianna Christopoulos, Donald Long, Jr. Second Row (left to right) Leah Hopson, Jack Barker , Margaret Orr*

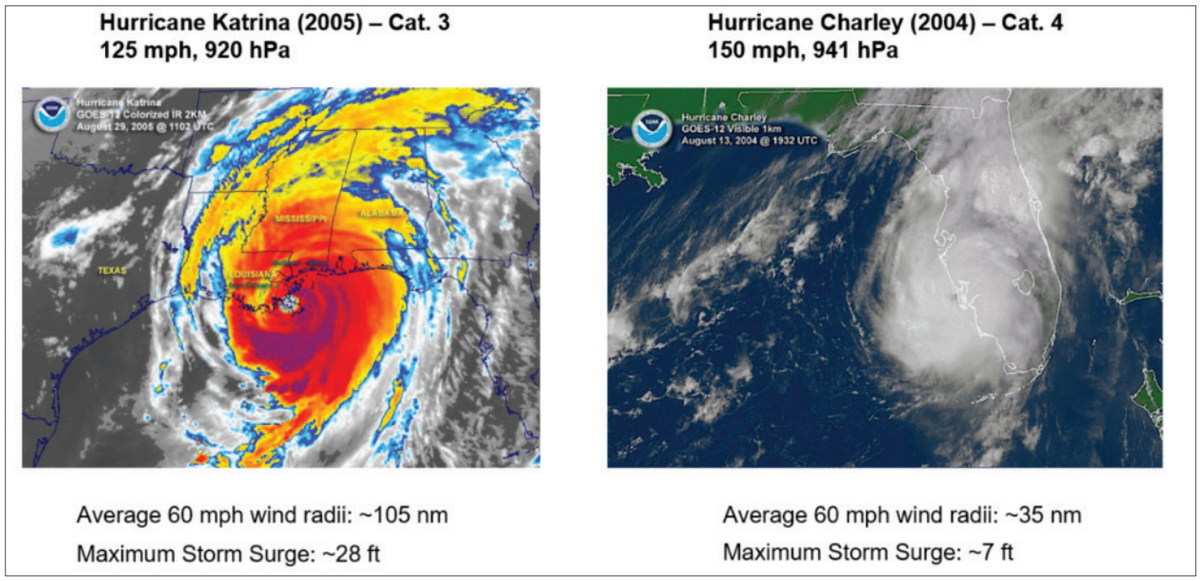
next generation of meteorologists. The Bill Lapenta Internship is an expansion of a National Weather Service internship that has been evolving under the guidance of Genene Fisher, OER; Jackie Alexander, NWS; Monica Bozeman, NWS; and Todd Christenson, NOAA CPO, who graciously spoke with us about the internship.

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 are designated to NOAA's Oceanic and Atmospheric Research (OAR) program. It is hoped that

the OAR portion of interns can expand to around 20 in 2021. The areas of study are anticipated to expand 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.




*Comparison between Hurricanes Katrina and Charley.*

This past summer the interns worked virtually and created their own cohort of sorts with the NOAA Hollings scholars. By happenstance, many of the 2020 summer interns focused on science communications. Interns were Leah Hopson of the University of Maryland, Julianna Christopoulos of Cornell University, Jack Barker of the University of Colorado - Boulder, Eric Roy of the University of Massachusetts - Lowell, Donald Long, Jr. of Howard University, and Margaret Orr of the University of Georgia. An example of the type of work these student's accomplished is Jack Barker's web-based story map exploring questions like "What happens to water you use for dishwashing after it goes down your drain?" Check it out here.

We are delighted to help support the growth of up-and-coming meteorologists and those who strive to support climate science in its many facets. Congratulations to all the 2020 summer interns - we wish you the very best in your developing careers!

The 2021 William M. Lapenta NOAA Student Internship Program application period is from November 20, 2020 - February 1, 2021. Full application informa-

## Better Hurricane Threat Predictors

CPAESS has numerous scientists working at the National Hurricane Center's Storm Surge Unit. One of them is Ethan Gibney. In his recent publication *Surface pressure a more skillful predictor of normalized hurricane damage than maximum sustained wind*, Ethan discussed how this research impacts hurricane prediction. He explains, "Essentially, we argue that mean sea level pressure (MSLP) is a better predictor of damage from hurricanes than maximum sustained winds (Vmax). We found this to be especially true for the U.S. East coast. Currently winds are the primary metric used by forecasters to communicate the 'threat' posed by storms to the public via the Saffir-Simpson Hurricane Wind Scale. Our main hope with the research, I think, was to make a case to NHC forecasters to consider a storm's MSLP and perhaps weigh it more heavily

than Vmax when communicating potential impacts to affected areas."

To illustrate this point Ethan shared a comparison between Hurricanes Katrina and Charley (see graphic). Using the typical maximum sustained winds Charley should have been more destructive, but, as we all know, Katrina was much more so. "While Katrina was officially classified as a Category 3 at landfall, Charley was a 4. Katrina had a much lower landfall pressure than Charley, was much larger, and caused a much larger and catastrophic storm surge." According to this research, based on MSLP, Katrina would have been classified as a Category 5. "While Katrina took the lives of approximately 1,836 in the U.S., Charley killed 15." In like manner "while Charley caused $22B in damage, Katrina was responsible for $170B (CPI-adjusted to 2020 USD)." So, this is a poignant comparison between the typical Vmax measurement and the MSLP measurement as a predictor of hurricane damage.

We understand that additional articles are in process for publication. CPAESS director, Hanne Mauriello, shared "I am so grateful for the continued efforts of Ethan and his colleagues. Noting new predictive variables is critical for our models to improve, and for lives and property to be protected. Thank you for your ongoing efforts to keep us safe. I truly appreciate them."

## Carbon Cycle Developments

CPAESS is delighted to host the U.S. Carbon Cycle Science program. This program's work focuses on the decades of coordinated U.S. and global climate change experimental, observational, monitoring and modeling efforts that have advanced the understanding of feedbacks between anthropogenic and natural carbon cycle components. These are showcased in the U.S. Carbon Cycle Science Plan (2011) and the Second State of the Carbon Cycle Report (SOCCR2) reports.

During the December 2020 American Geophysical Union (AGU) Annual Meeting, the U.S. Carbon Cycle Program continues examining research that further enhances our understanding of the carbon cycle, as well as its potential application, and progress within carbon cycle science.

Some of the U.S. Carbon Cycle's Town Hall presentations included:

- A Decade of Discoveries for Blue Carbon Ecosystems
- IOC-R: A vision of Coordinated Ocean Carbon Research and Observations
- Quantifying the ocean carbon sink for 1994-2007
- Autonomous ocean CO2 flux observing
- Towards an international atmospheric carbon observing system
- Divergence in Quantifying Terrestrial Fluxes of Carbon in Global Carbon Budgets
- Quantifying the effect of carbon cycle feedback uncertainty in concentration and warming projections under RCP emissions scenarios

- Observing, resolving and predicting terrestrial carbon cycle and its sensitivity to climate
- Asymmetry in the climate-carbon cycle response to positive and negative CO2 emissions
- Understanding Carbon Dioxide Removal and Management within an Integrated Research Program for Evaluating Climate Intervention Strategies
- Sustainable intensification or natural climate solutions?

Videos of the presentations will also be made openly available on the U.S. Carbon Cycle Science program's YouTube channel soon including these talks: A Decade of Progress in Global Carbon Cycle Science, A Decade of Progress in Global Carbon Cycle Science II Posters, and our Town Hall: Building on Successes: Strategic Planning and Implementation for the Next Decade of the U.S. Carbon Cycle Science Program and North American Carbon Program.

The U.S. Carbon Cycle Science Program represents 14 federal agencies and departments with research and funding portfolios encompassing carbon and pertinent biogeochemical cycles across land, water, air and society. To discover more about this important climate science subscribe to their newsletter and check out their upcoming Carbon Fridays in March through the 7th Open Science Meeting of the North American Carbon Program (NACP).

## Silver Poster Award

Eric Simon, CPAESS scientist who works at the Naval Research Laboratory (NRL) in Monterey, California was recently awarded second place or Silver Poster at the 22nd International TOVS Study Conference . The conference took place in Saint Sauveur, Quebec, Canada from 31 October - 6 November 2019 and there were about 120 posters in total at the conference covering a range of topics relevant to space-based weather observations.

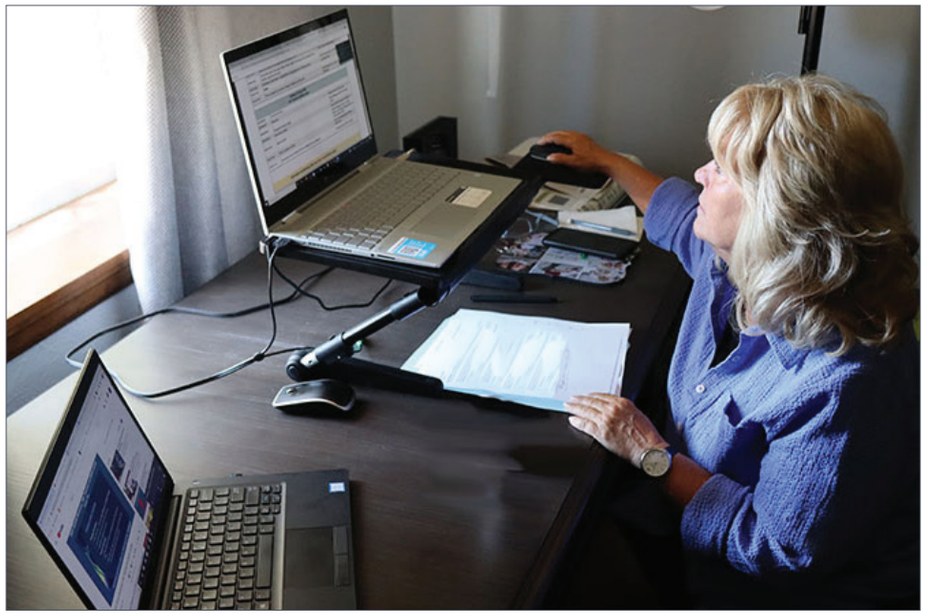
> *"... this will also help in the effort to protect certain frequencies for weather sensing which is a very relevant issue given recent international meetings concerning frequency use for 5g communications."*
>
> *- Eric Simon*

"My poster...shows work that I've done in finding and analyzing anomalies in SSMIS [Special Sensor Microwave Imager/Sounder] 19 & 22 GHz brightness temperatures. The first part of my poster describes my use of machine learning to help separate out the anomalies I wanted to investigate from other known instrument glitches, etc."

"The second part of my poster presents my analysis of these anomalies, specifically that they repeatedly occur at certain locations, and with a unique look angle at each location. Many are clustered around major cities (especially Europe and Africa), suggesting focused beams are being transmitted from these locations. Over the US,

*Eric Simon, CPAESS scientist who works at the Naval Research Laboratory (NRL)*

the anomalies are more scattered across certain regions, and further analysis of the reflection angles of these anomalies suggests they originate from three distinct geostationary orbit locations. These locations match known commercial broadband internet satellites that are authorized to transmit on/near these frequencies. At the present, this is manageable since quality control processes could anticipate when a sensor is looking directly into the reflected signal of one of these known satellites. However, SpaceX has authorization for several thousand satellites transmitting on these frequencies in low earth orbit - both the quantity and non-stationary orbit will make them extremely difficult to account for."



*Tammy Kepple monitoring the NASA Heliophysics Virtual Summer School.*

To put this in context, "We have satellites that measure things related to weather (that are critical to weather prediction), and occasionally some of their measurements are skewed by transmissions from other satellites (i.e. those used for TV and internet) or ground-based communications equipment. My work identified the sources of interference for a particular type of weather satellite, and this will help us develop a model to identify and ignore corrupted measurements in the future so it doesn't corrupt our weather forecasts. My work also raises the alarm that thousands of satellites that are similar to those already causing this interference are due to be launched soon, and that the interference from these future satellites will be even more difficult to identify. Hopefully this will also help in the effort to protect certain frequencies for weather sensing (which is a very relevant issue given recent international meetings concerning frequency use for 5g communications)."

Congratulations on your award-winning work, Eric. Thank you for taking the time to help us understand your science and its impact on our world.

## CPAESS Virtual Worlds: Virtual Meeting Capacity

During the pandemic many of the critical in-person meetings, conferences, and workshops that typically occur have ground to a halt. Nevertheless, the idea-sharing and brainstorming that are the fruit of these meetings are critical to move science forward.

Many people have been utilizing a variety of methods to meet virtually. The problem is that managing a meeting and babysitting its technological aspects detracts an organizer's attention from the content of the meeting and its scientific purpose. As professional meeting planners, CPAESS is pleased to let our partners do the science, while we take care of the rest. Here are some recent examples of virtual meetings we've managed.

**CEDAR** - This year's NSF 2020 Coupling, Energetics and Dynamics of Atmospheric Regions (CEDAR) conference was converted from an on-site meeting initially to be held in Santa Fe, New Mexico, to

a virtual conference. CPAESS provided the virtual meeting support for this workshop held 22 - 26 June 2020. The meeting was held in collaboration with NCAR's High Altitude Observatory (HAO). Virtual talks were recorded on Zoom and broadcast onto our YouTube channel. Breakout sessions utilized various programs based on host preference. Posters & abstracts were hosted on a YouTube channel with 10-15 minute individual presentations. Questions and answers as well as further interactivity was facilitated with Slido.

**NASA's "Living With A Star" Heliophysics Summer School** - CPAESS managed a 2-week long virtual NASA Heliophysics Summer School held 6-17 July 2020. Lectures, labs, career panels, and office hours were all managed virtually over eight different time zones. The meeting was held in collaboration with NCAR's High Altitude Observatory (HAO). Lectures took place on Zoom then were later uploaded onto YouTube. Laboratory activities and school office hours were held on Slack and Slack groups based on time zone. Class materials—textbook, lecture notes, support videos—were all uploaded to a website and a YouTube channel.

**SIMA** - CPAESS managed the virtual community workshop System for Integrated Modeling of the Atmosphere (SIMA) held 29 June - 1 July 2020. This NSF-sponsored event was executed in collaboration with NCAR's Climate & Global Dynamics (CGD) Laboratory. Meetings were conducted through Zoom and Zoom Meetings, and a variety of interactivity software was utilized for questions and discussion.

In addition to virtual technologies, our staff members are professional meeting planners who will create websites, registration portals, and who have years of experience managing a variety of logistics. So, while the pandemic has changed the nature of scientific gatherings for now, we are ready to continue facilitating the important growth that comes because of them. More information can be found here.

## NOAA C&GC Fellow Ongoing Work

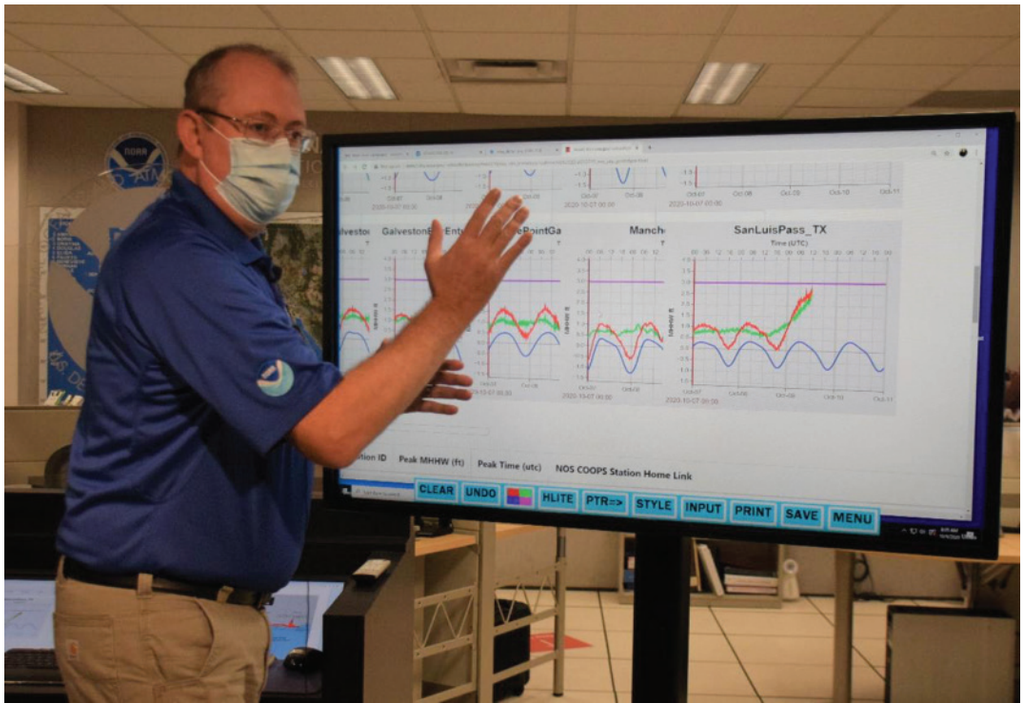
Our NOAA Climate & Global Change Fellows continue to make their mark in the science world. Recently www.climate.gov interviewed Class 21's Emily Fischer, a fellow from 2011-2013. The entirety of this great interview by NOAA can be found here, but here is what she had to say about her postdoctoral experience.

**"What did you study for your NOAA postdoc (2011-2013)? What role did that postdoc experience play in advancing your career?**
"I learned how to use the GEOS-Chem atmospheric chemistry model to understand the precursors to peroxyacetyl nitrate (PAN). PAN is a compound formed in the atmospheric oxidation of non-methane volatile organic compounds (NMVOCs), and it serves as a thermally unstable reservoir for nitrogen oxide radicals (NOx = NO + NO2), permitting NOx to impact the global distribution of ozone and OH.

*Dr. Emily Fischer, former NOAA Climate and Global Change Fellow and current professor at Colorado State University.*

This experience was fundamental to advancing my career. The mentoring at Harvard was exceptional, and I left with an entirely new toolkit.

While at Harvard, I worked on a widely used global chemical transport model. This model is commonly used to understand air quality problems, identify the impact of different classes of air pollutants, and investigate the composition of the remote atmosphere. I specifically worked on the representation of PAN in the model. My work involved using recent observations from surface sites (including my own), aircraft, and satellites to identify problems in the model and potential missing emissions or chemical processes."




*NHC Director Ken Graham using a new visualization interface created by William Booth during a national media briefing.*

Emily is currently an associate professor at Colorado State University's Atmospheric Science department, teaching and researching. Recently she's been a lead investigator on a National Science Foundation-funded initiative aimed at recruiting more women to the geosciences. We appreciate your efforts to make Earth system science more inclusive, along with your continued research in climate science.

## Science in Color

At the National Hurricane Center (NHC) the visualization system that shows observed water levels (storm surge) during landfalling hurricanes needed a little improvement. So CPAESS scientist William Booth went to work to make this happen.

"William Booth created a visualization webpage to illustrate a big picture view of real-time National Ocean Service's (NOS) Center for Operational Oceanographic Products and Services (CO-OPS) station observations relevant to landfalling hurricanes. NWS National Hurricane Center forecasters find this tool especially useful during operations because it automatically 'tiles' all affected stations into a simple-to-use interface displaying tide predictions, observations, and surge data referenced to Mean Higher High Water; the best possible approximation of the threshold at which inundation can begin to occur. Using NOS CO-OPS API data and Vega Visualization Grammar, William wrote python scripts to obtain and organize the data into a graphic plotting library, then displayed the graphics on a streamlined webpage. The visualization library with its many options proved to be his most difficult challenge. William wanted to be sure the web page configures a display that is efficient, repeatable, and adaptable to ensure automation

for the duration of a storm." NOAA: Alexandria Andonian

The initiative that William took in improving the visuals to better enable a solid understanding of what is going on during a hurricane is the sort of work that helps translate science. His leadership and dedication to the NOAA mission, and in helping us all understand relevant hurricane and storm science is greatly appreciated.

## UCAR Award Nominations

We would like to share three CPAESS staff members who were nominated for the UCAR Outstanding Achievement Awards. In the area of Scientific and/or Technical Advancement Jan-Huey Chen, Project Scientist at NOAA Geophysical Fluid Dynamics Laboratory (GFDL) was nominated for her scientific contributions and significant leadership in advancing our understanding of tropical cyclone predictability on short-term and sub-seasonal time scales. Also nominated for Scientific and/or Technical Advancement was Matthew J. Morin, Associate Scientist at NOAA Geophysical Fluid Dynamics Laboratory (GFDL) for his extensive work developing GFDL's Hurricane Model ensemble forecast system. Hiroyuki Murakami, Project Scientist at NOAA Geophysical Fluid Dynamics Laboratory (GFDL) was also nominated for Detection of Climatic Change in Global Distribution of Tropical Cyclones published in the 2020 Proceedings of the National Academy of Sciences (PNAS).

*Left to Right: Jan-Huey Chen, Matthew J. Morin, and Hiroyuki Murakami*

Congratulations to each of you for your innovative research and ongoing efforts in serving humanity through good science.

## Publications

CPAESS scientists are prolific in their research and publications. Here is their work that has been listed in UCAR's OpenSky from the year 2020.

Pincus, Robert, Stefan A. Buehler, Manfred Brath, Cyril Crevoisier, Omar Jamil, K. Franklin Evans, James Manners, Raymond L. Menzel, Eli J. Mlawer, David Paynter, Rick L. Pernak, Yoann Tellier, 2020: **Benchmark calculations of radiative forcing by greenhouse gases.** *Journal of Geophysical Research: Atmospheres.*

Palmerio, Erika, C.O. Lee, I.G. Richardson, N.V. Nitta, M.L. Mays, J.S. Halekas, C. Zeitlin, J.G. Luhmann, S. Xu, 2020: **Tracking a CME and SIR to Earth and Mars during the deep minimum of Solar Cycle 24.**

Palmerio, Erika, C.O. Lee, I.G. Richardson, N.V. Nitta, M.L. Mays, J.S. Halekas, C. Zeitlin, J.G. Luhmann, S. Xu, 2020: **Tracking a CME and SIR to Earth and Mars during the deep minimum of Solar Cycle 24**.

Thapa, Uday Kuwar, S. St. George, V. Trouet, 2020: **Poleward excursions by the Himalayan subtropical jet over the past four centuries**. *Geophysical Research Letters.*

Kang, Sarah M., Shang-Ping Xie, Yechul Shin, Hanjun Kim, Yen-Ting Hwang, Malte F. Stuecker, Baoqiang Xiang, Matt Hawcroft, 2020: **Walker circulation response to extratropical radiative forcing**. *Science Advances.*

Barnes, Will, Mark Cheung, Monica Bobra, Paul Boerner, Georgios Chintzoglou, Drew Leonard, Stuart Mumford, Nicholas Padmanabhan, Albert

Shih, Nina Shirman, David Stansby, Paul Wright, 2020: aiapy: **A Python package for analyzing solar EUV image data from AIA.** *Journal of Open Source Software.*

Liu, Terry Z., Chih-Ping Wang, Boyi Wang, Xueyi Wang, Hui Zhang, Yu Lin, Vassilis Angelopoulos, 2020: **ARTEMIS observations of foreshock transients in the midtail foreshock**. *Geophysical Research Letters.*

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Wang, Bin, Hiroyuki Murakami, 2020: **Dynamic genesis potential index for diagnosing present-day and future global tropical cyclone genesis.** *Environmental Research Letters.*

Harris, Lucas, Linjiong Zhou, Shian-Jiann Lin, Jan-Huey Chen, Xi Chen, Kun Gao, Matthew Morin, Shannon Rees, Yongqiang Sun, Mingjing Tong, Baoqiang Xiang, Morris Bender, Rusty Benson, Kai-Yuan Cheng, Spencer Clark, Oliver D. Elbert, Andrew Hazelton, J. Jacob Huff, Alex Kaltenbaugh, Zhi Liang, Timothy Marchok, Hyeyum Hailey Shin, William Stern, 2020: **GFDL SHiELD: A unified system for weather-to-seasonal prediction.** *Journal of Advances in Modeling Earth Systems.*

Morosan, D. E., Erika Palmerio, J. E. Räsänen, E. K. J. Kilpua, J. Magdalenić, B. J. Lynch, A. Kumari, J. Pomoell, M. Palmroth, 2020: **Electron acceleration and radio emission following the early interaction of two coronal mass ejections.** *Astronomy & Astrophysics.*

Liu, Terry Z., Xin An, Hui Zhang, Drew Turner, 2020: **Magnetospheric multiscale observations of foreshock transients at their very early stage.** *The Astrophysical Journal.*

Datar, Gauri, Geeta Vichare, C. Selvaraj, Ankush Bhaskar, Anil Raghav, 2020: **Causes of the diurnal variation observed in gamma-ray spectrum using NaI (Tl) detector.** *Journal of Atmospheric and Solar-Terrestrial Physics.*

Halperin, Daniel J., Andrew B. Penny, Robert E. Hart, 2020: **A Comparison of Tropical Cyclone Genesis Forecast Verification from Three Global Forecast System (GFS) Operational Configurations.** *Weather and Forecasting.*

Bakhtyar, R., K. Maitaria, P. Velissariou, B. Trimble, H. Mashriqui, Saeed Moghimi, A. Abdolali, A. J. Van der Westhuysen, Z. Ma, E. P. Clark, T. Flowers, 2020: **A new 1D/2D coupled modeling approach for a riverine-estuarine system under storm events: Application to Delaware river basin.** *Journal of Geophysical Research: Ocean.*

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An, Xin, Terry Z. Liu, Jacob Bortnik, Adnane Osmane, Vassilis Angelopoulos, 2020: **Formation of foreshock transients and associated secondary shocks**. *The Astrophysical Journal.*

Kilpua, Emilia K. J., Dominique Fontaine, Simon W. Good, Matti Ala-Lahti, Adnane Osmane, Erika Palmerio, Emiliya Yordanova, Clement Moissard, Lina Z. Hadid, Miho Janvier, 2020: **Magnetic field fluctuation properties of coronal mass ejection-driven sheath regions in the near-Earth solar wind.** *Annales Geophysicae.*

Rouppe van der Voort, L. H. M., B. De Pontieu, M. Carlsson, J. de la Cruz Rodríguez, S. Bose, Georgios Chintzoglou, A. Drews, C. Froment, M. Gošić, D. R. Graham, V. H. Hansteen, V. M. J. Henriques, S. Jafarzadeh, J. Joshi, L. Kleint, P. Kohutova, T. Leifsen, J. Martínez-Sykora, D. Nóbrega-Siverio, A. Ortiz, T. M. D. Pereira, A. Popovas, C. Quintero Noda, A. Sainz Dalda, G. B. Scharmer, D. Schmit, E. Scullion, H. Skogsrud, M. Szydlarski, R. Timmons, G. J. M. Vissers, M. M. Woods, P. Zacharias, 2020: **High-resolution obser-**

**vations of the solar photosphere, chromosphere, and transition region**. *Astronomy & Astrophysics.*

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