RESEARCH | MENTORING | COMMUNITY > CONTINUING IN THE TIME OF COVID-19

EARTH, WIND, SEA, AND SKY

SOARS Main Office: After summer visit and tour to Foothills Two Lab in Boulder.
Left to right: Max Gould-Meisel, Natalie Ponsford, Protégé Anne Maytubby (back), Protégé Katurah McCants, Protégé Miranda H. Miranda, and Kadidia Thiero.

We are excited to share this 2021 edition of **Earth, Wind, Sea, and Sky**; showcasing the summer research of the Protégés from the Significant Opportunities in Atmospheric Research and Science (SOARS) Program. SOARS began in 1996, and remains true to its mission of increasing the diversity of the atmospheric and related sciences, by engaging students from historically marginalized communities in STEM, in genuine research. The Protégés' ability to do excellent work in such a short period of time, and in a virtual environment, is a credit to their hard work and dedication; and to the exceptional training, care, and guidance of their mentors. We are ever so grateful for the mentors' commitment to the Program.

The hallmark of the SOARS mentoring structure, which includes up to five (5) types of mentors and a supportive learning community; continues to be the heart of the program and remains relevant. The Geoscience community continues to evolve and our scientific challenges change. As such, SOARS continues to adapt and grow, meeting the new needs of the field. Now in the sixth year, the SOARS computation and scientific data workshop (CDW) recognizes the movement of geoscience literature toward sharing data and code; preparing Protégés with tools to flourish in an open-access environment. This year's CDW complemented the scientific communication and writing workshop (SCW) with weekly sessions. We recognize new careers in the atmospheric sciences are emerging that make use of weather and climate products; and there is a need for scientists to translate these products for fields as diverse as agriculture, emergency management, insurance policy, and space weather, to name a few. Our professional development series exposes our Protégés to the many opportunities available to them, and prepares them to succeed not only in graduate school, but in careers pathways as well.

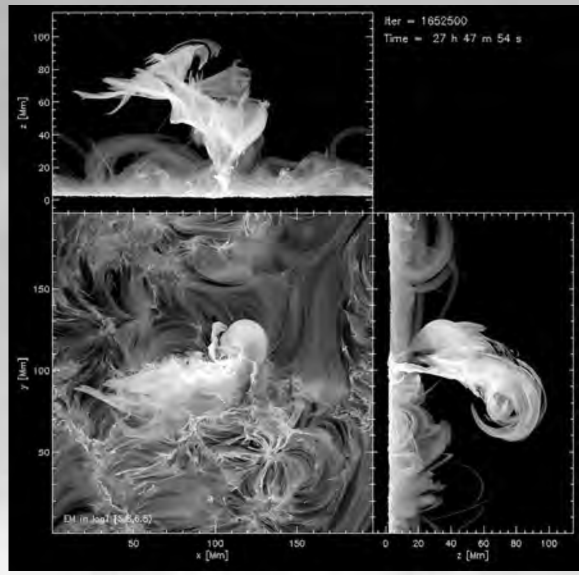
Because of the 25+ years' legacy and success of SOARS, we are able to tap into the strengths of our Alumni. Our Alumni also serve as mentors, panelists, graduate-school selection advisors, and on the SOARS Steering committee. Beyond SOARS, our Alumni are filling leadership roles in our national societies, federal, state, and local government, industries, and universities. Their perspective and leadership, along with that of our mentors sponsors, and partners, help SOARS advance and remain a leader and valued partner in the geoscience community.

As the geosciences continue to evolve and our planet and climate face rapid change; the need for diverse voices has never been greater, particularly those who can connect science, leadership, and community. SOARS has an ongoing role and responsibility in helping develop these voices. The network of Protégés, Alumni, Mentors—current and former, staff, and partners continues to grow; and their voices and leadership are making vital contributions to the science and safety of our planet. We are grateful for your ongoing support and are extremely proud to be part of this amazing community!

We hope you enjoy this publication of **Earth, Wind, Sea, and Sky**. Please join us in congratulating the 2021 Cohort of Protégés!

EARTH, WIND, SEA, AND SKY

Kadidia Thiero | SOARS Program Lead | UCAR Center for Science Education



NCAR | UCAR

The **University Corporation of Atmospheric Research** (UCAR) is a nonprofit consortium of more than 120 North American colleges and universities focused on research and training in the Earth system sciences. UCAR is the experienced manager of the **National Center for Atmospheric Research** (NCAR) on behalf of the National Science Foundation. Founded in 1960 to fulfill this role, UCAR is the trusted administrator of the financial, human resources, facilities, and information technology functions that are essential to NCAR's success. Since UCAR's inception, collaborations between university researchers and our own scientists and engineers have helped push the boundaries of the Earth system sciences.

Activities in the **UCAR Community Programs** (UCP) include everything from training weather forecasters, firefighters, and emergency managers (COMET), to supporting a constellation of atmosphere-observing satellites (COMET and JCSDA). The Unidata program develops internship programs and educational resources, provides real-time data and software analysis tools, and manages projects and staffing for scientific programs across the country and around the world. UCP provides a suite of innovative resources, tools, and services to researchers, educators, and practitioners in the Earth system science community.

NCAR provides the atmospheric and related Earth system science community with state-of-the-art resources, including supercomputers, research aircraft, sophisticated computer models, and extensive data sets. Each year, hundreds of people from universities, labs, and the weather enterprise collaborate with NCAR staff, and rely on NCAR resources, in order to carry out vital research and applications.

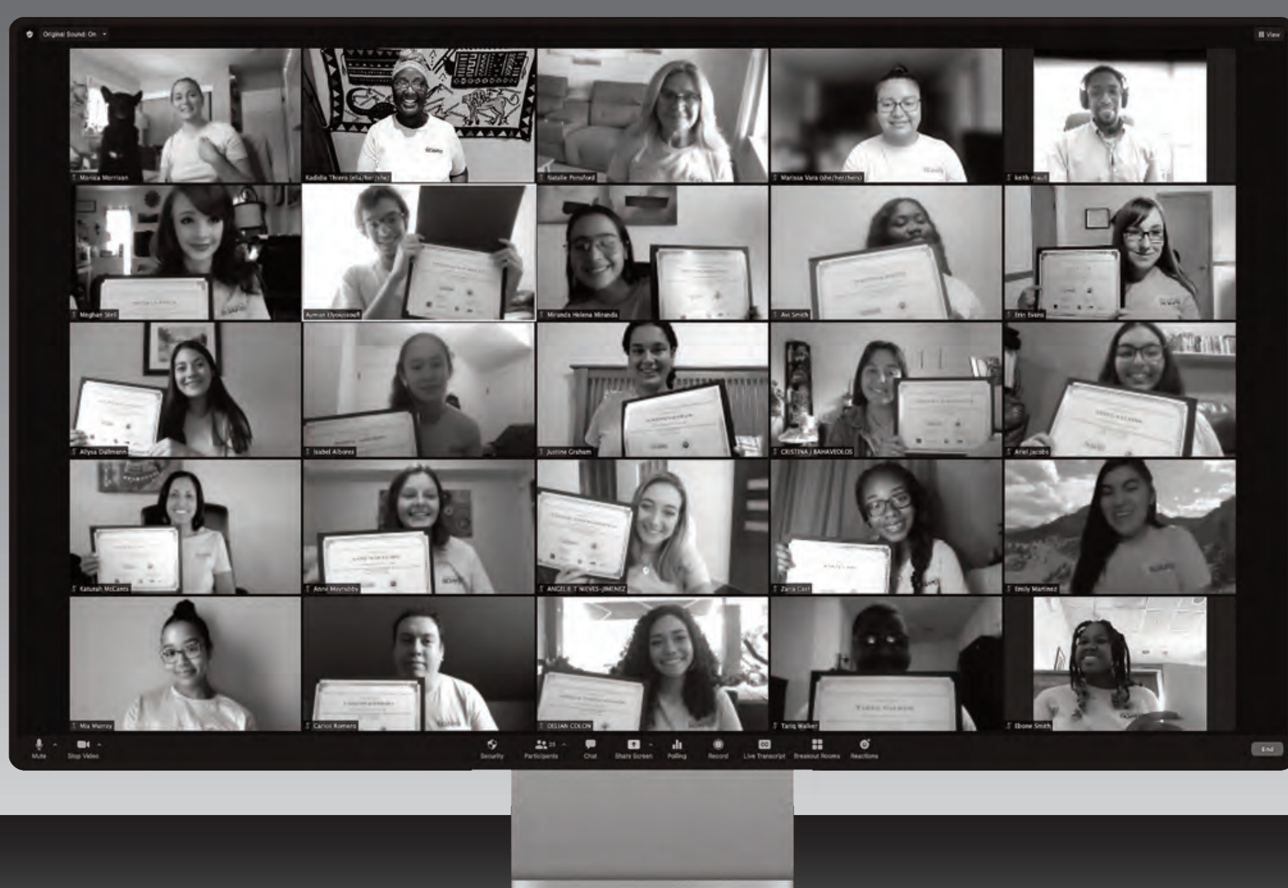
NCAR and UCAR have been supporting the SOARS Program since its inception in 1996. Institutional support and the mentoring of their scientists, engineers and staff have been the key to the success of SOARS. We are grateful for the support of NCAR|UCAR leadership and our growing number of mentors who make SOARS possible.

TABLE OF CONTENTS

SIGNIFICANT OPPORTUNITIES IN ATMOSPHERIC RESEARCH AND SCIENCE • SIGNIFICANT OPPORTUNITIES IN ATMOSPHERIC RESEARCH AND SCIENCE •

research | mentoring | community

SOARS®



Since 1996, SOARS continues to provide authentic research experiences with world-class scientists and engineers for historically marginalized communities in the atmospheric and related sciences. As an undergraduate-to-graduate bridge program, SOARS is designed to broaden participation in the geosciences. By supporting students from diverse backgrounds and experiences, SOARS guides participants to enter and succeed in graduate school; contribute to research, and become leaders in the geoscience com munity. SOARS complements academic institutions' mission in preparing students for career pathways in academia, research, and industry by combining summer research experiences with year-round mentoring, conference travel, and supportive community.

During this summer, SOARS Protégés conducted research at the National Center for Atmospheric Research (NCAR), the University Corporation for Atmospheric Research (UCAR), the National Oceanic and Atmospheric Administration (NOAA), the University of Colorado at Boulder, and the Cooperative Institute for Research in Environmental Sciences, as virtual experiences online. During the past 25 years, research projects were also conducted with partnering laboratories, and universities to gain experience in the geosciences field. Topics of research span the disciplines of climate and weather, computing, and engineering in support of atmospheric sciences, oceanography, and solar physics. Protégés are supported in their research by up to five (5) types of mentors, including research/scientific, writing, computing, peer, and community coach. In addition to this authentic research experience, which culminates in end-of-summer poster and oral pre-sentations by the Protégés; the summer program incorporates a comprehensive, professional development series, relevant to STEM research, academia, as well as various career pathways. After the summer, Protégés remain engaged through webinars, one-on-one career counseling, and participation at professional, national conferences.

Protégés may participate in SOARS up to four (4) years, gaining additional independence in subsequent years to select, focus, and direct their research. By the time SOARS Protégés enter graduate school, they are well-prepared to succeed in independent research. Many use SOARS as an opportunity to expand their research, through contacts and facilities available at national laboratories. It is also common for Protégés and their advisors to collaborate and publish with mentors beyond their SOARS research experiences. In addition, SOARS provides publishing and field campaign support to our Protégés and Alumni, encouraging connections with the wider community.

SOARS is proud of our Alumni, the vast majority of whom excel in graduate school; and move on to careers in atmospheric science and/or related STEM fields. Many are now faculty, and we are excited to partner with Alumni to spread the SOARS mission. Partnerships include the pilot SOARS Satellite programs at Emory University and at the University of Illinois–Urbana Champaign (UIUC). Wherever their careers take them, our SOARS Alumni remain connected to the SOARS community, committed to the SOARS mission of increasing diversity in the sciences, and play an important role in increasing the capacity and diversity of the national STEM workforce.

West Coast Wildfires and Transported Pollution: How did the 2020 Wildfires Affect Air Quality in Regions of the United States?

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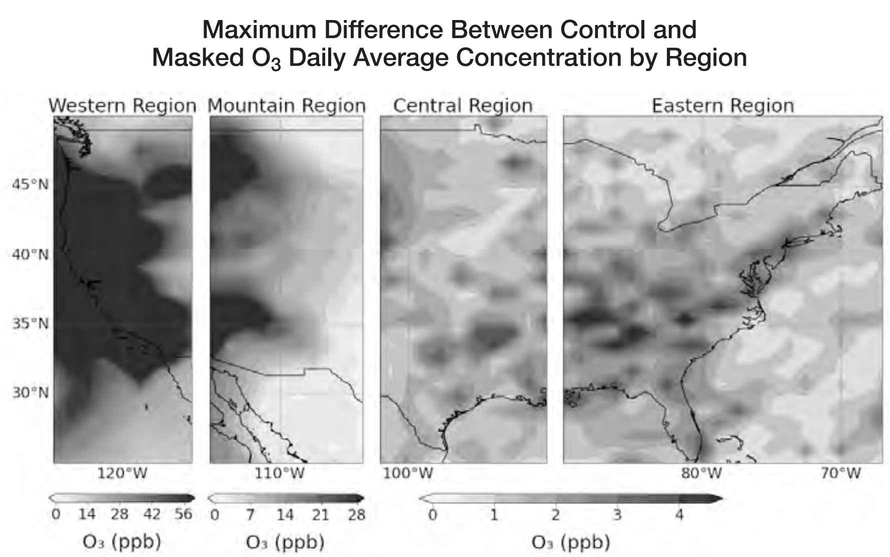
Fires impact atmospheric composition through the emissions of gases and aerosols, affecting air quality close to the location of fires, as well as in areas downwind through transported pollution. The wildfire season in the Western United States (U.S.) was anomalously large in 2020, with some areas emitting over 500% of the average 2001–2019 emissions of carbon monoxide (CO). We used the Community Atmosphere Model version 6 with Chemistry (CAM6-chem), a component of the Community Earth System Model version 2 (CESM2), to investigate how the 2020 fires in the Western U.S. affected air quality locally as well as in the surrounding regions that received transported pollution. We conducted simulations with and without fire emissions over the Western U.S. (32.5–49 N, 115–125 W) in July–December 2020 and compared results to determine average changes in concentration across the country. Between the simulations, the average differences in concentration of black carbon aerosols (BC), fine particulate matter ($PM_{2.5}$), CO, and ozone (O_3) over the U.S. were 0.0295 ppb,1.597 μg/m³, 20.569 ppb, and 0.8356 ppb, respectively. Health-relevant O_3 exhibited substantial impacts from transportation of fire pollution to the Eastern U.S., with up to 6.259 ppb increases in daily average O_3 concentration at some locations. Overall, the 2020 wildfires in the Western U.S. had significant air quality repercussions, suggesting the need for attention to potential health impacts, especially since these extreme events are likely to worsen in future years as climate change is predicted to increase wildfire activity.



Various regional plots over the U.S. of the maximum daily change in ozone concentration from July to December between the CAM6-chem simulations with and without fire emissions from the Western U.S. (32.5–49 N, 115–125 W). The darker tones indicate a higher ozone concentration in the model that included the fire emissions. Note that negative changes are not shown, since the maximum change in ozone concentration between models was greater than or equal to zero in every area of the country. Additionally, the color bar values differ for the regions, and the Eastern and Central regions share a color bar.

Influence of Transported Anthropogenic Pollution on Regional Tropospheric Ozone using NOAA Aircraft Measurements

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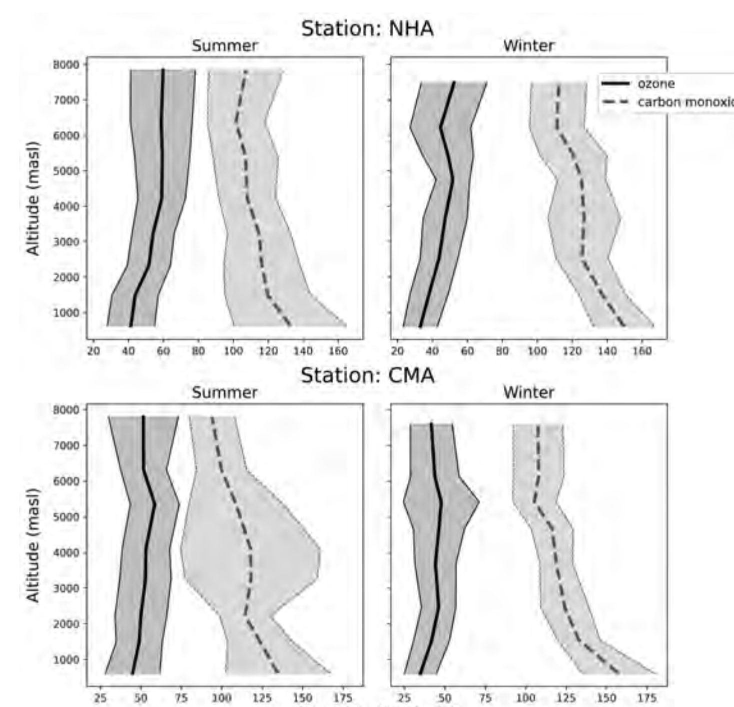
Anthropogenic pollution can travel long distances through the troposphere to impact the air quality of communities, regions, and countries downwind of emissions sources. In this study, carbon monoxide (CO)—a tracer of anthropogenic emissions—is used to quantify the influence of transported anthropogenic pollution on regional tropospheric ozone (O_3)—a predominant secondary pollutant. Both O_3 and CO data were sourced from two offshore NOAA aircraft sampling sites (NHA = 42.95°N, 70.63°W, CMA = 38.83°N, 74.32°W) located in the northeast United States downwind of a megalopolis, from 2006 through 2016. Differentiation between the sampling of fresh pollution plumes and atmospherically aged air masses was detected and removed from analysis using threshold CO/CO_2 ratios. An ordinary least squares method analysis was conducted within altitude layers (lower = 0–3 kmasl, middle = 3–6 kmasl, upper = 6–8 kmasl) for summer and winter. Tropospheric O_3 and CO were found to be weakly correlated (r2 < 0.2) within all altitude layers and seasons at both sites; except for the upper troposphere during winter at the CMA site (r2 = 0.72). This did not align with the results of previous studies for this region. The low correlations can be attributed to multiple inverse relationships between O_3 and CO. Quantification of the tropospheric O_3–CO relationship in the northeast United States using NOAA aircraft data requires additional analyses to detect and isolate the sources of these inverse relationships; such as fresh anthropogenic pollution plumes and stratospheric intrusion events.



Tropospheric altitude profiles for ozone and carbon monoxide during the summer and winter at two NOAA aircraft sampling sites: NHA (top) and CMA (bottom). Profiles were constructed from the mean and one standard deviation of 1km altitude bins for the years 2006 to 2016. Higher variability in concentration during the summer, especially at the CMA site, highlights the seasonality of anthropogenic pollution transport to each site.

Correlating Tower Observations and the Twentieth Century Reanalysis at Utqiaġvik, Alaska

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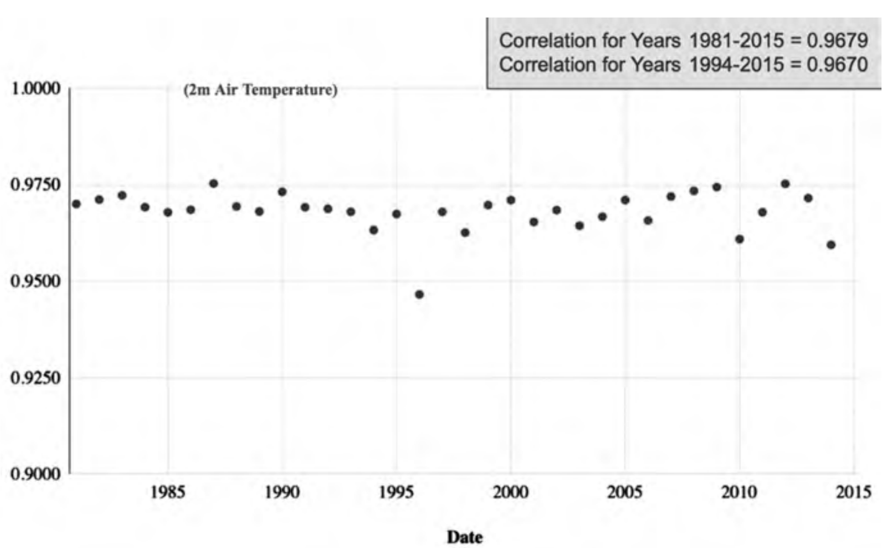
The Arctic has accumulated many climate changes over a short period of time. This research focuses on Utqiaġvik, in the North Slope of Alaska; which is one of the few places in the Arctic where people have collected weather observations. We wanted to help give an understanding about the Arctic weather changes when it comes time for planning. With the need of history and past observations the Twentieth Century Reanalysis (20CR) gives a perspective view. It is a tool used to show in 3D form all types of weather data at different times and locations. The purpose of this research is to validate the 20CR because there are few observations in the area when needed for comparisons from the past. The original plan was to use radiosonde data from 2002-2015, but in the end, we decided to use 2m and 10m temperature from the Barrow Tower with years 1981-2015. The focus was to find the correlation of the tower and 20CR data. The correlation of 2m temperatures was 0.9679. The correlation of 10m temperatures was 0.9670. Though the two correlations are similar, they are strongly positive, meaning that they are flowing together rather than away from each other. Year to year the correlations would vary a bit, but overall, they were strongly positive. Also, vertical temperature gradients were an input for this study. The correlation for the gradient was 0.1435, positive but very weak. We separated the gradients due to wanting to know what the tower observed, more of an inversion or no inversion. Inversion showed a positive correlation, and no inversion showed a negative correlation. The results show that 20CR temperatures at 2m and 10m correlate very well with the Tower. We hope for the future to expand on our work by considering radiosonde data that was not used for this part of our project.

Utqiaġvik Correlation Per Year

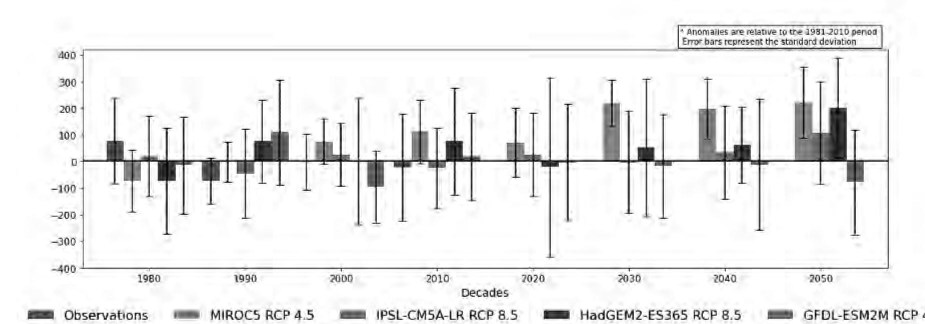


The correlation of 2-meter Air Temperature from 20CR and Tower, per year.

Decadal-Scale Changes in Drought-Related Climate Parameters: Assessing the Consistency of Global Climate Models in Projecting Changes in the Northern Great Plains

A warming climate is expected to increase the risk of extreme drought events in ecosystems with a high climate variability, such as the Northern Great Plains (NGP). We examined decadal-scale projections in drought-related climate metrics for the NGP, in the early-to-mid 21st Century period. First, we compared decadal-scale changes between observations (based on gridMET) and the mean of 40 downscaled-GCM projections (MACAv2-METDATA) for four climate variables (potential evapotranspiration, precipitation, temperature, and water deficit) to assess how the long-term trend based on ensemble mean compares to observations. Our results show large differences in the calculated linear trends between the two for all variables—both annually and seasonally—except for Fall. The dry decade of the 1980s strongly affects the magnitude of linear trends in the observations. Next, we examined projections from four individual models that span the uncertainty in future projections to assess decadal-scale changes across different climate scenarios and to get a better assessment of decadal variability. We find that the decadal-scale variability plays a very significant role in influencing long-term climate trends in the Northern Plains region, and scenarios-based analyses help us to assess decadal-scale changes by providing the assessment of both decadal-scale variability and climate change. Overall, our results point to an increasing trend in water-deficit (i.e., greater drought stress) in the coming decades, particularly during summer, despite increases in the annual precipitation.

Northern Great Plains: Water Deficit (mm) Anomalies (Jan–Dec)



Decadal anomalies in annual water deficit (PET minus precipitation) for four climate scenarios in the Northern Great Plains. Increasing positive values of water deficit signify increasing risk of drought. All scenarios, except GFDL-ESM2M, show an increasing trend in water deficit in the coming decades.

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Searching for the Blob: Physical and Biogeochemical Characteristics of the North Pacific Marine Heat Wave in Ocean Models

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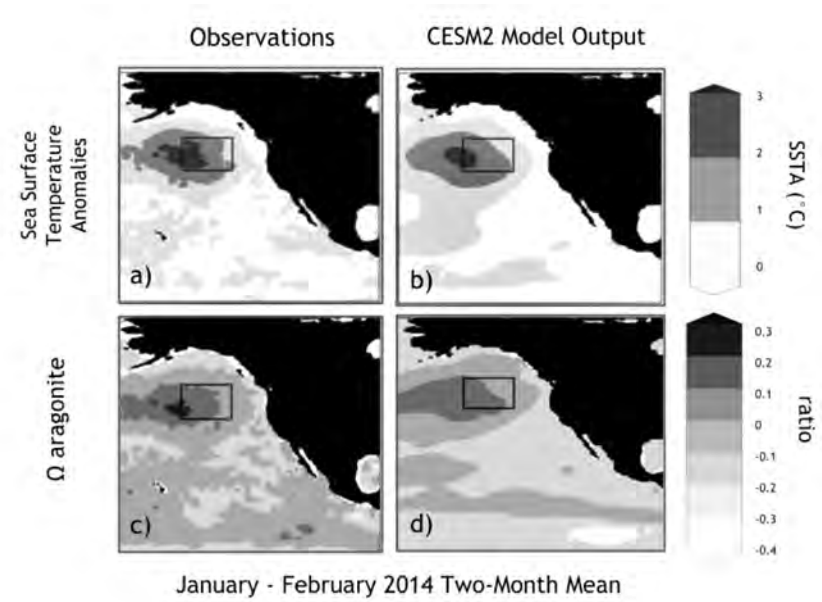
In July of 2013, a marine heat wave, a period of anomalously warm sea surface temperatures, emerged in the northeastern Pacific Ocean and lasted until June of 2016. This significant event, referred to as the North Pacific Blob, had a large influence on marine ecosystems across the North Pacific Ocean. While studies have examined the physical and ecological ramifications of the Blob using observations collected at sea, it is unknown whether state-of-the-art oceanographic models can reproduce this event. Here, we identified and described the physical and biogeochemical characteristics of the Blob using output from simulations of four models that were contributed to the 6th Coupled Model Intercomparison Project (CMIP6) Ocean Model Intercomparison Project Version 2 (OMIP2). During the Blob period in the Northeastern Pacific Ocean, OMIP2 models simulated anomalously warm sea surface temperatures (SSTs), anomalously low dissolved inorganic carbon (DIC) concentrations, and anomalously high saturation states for the mineral aragonite ($\Omega_{aragonite}$), as compared to pre-Blob climatological conditions. These findings were consistent with observations of the surface ocean in the real world during this period, though the magnitude of the SST, DIC, and $\Omega_{aragonite}$ anomalies differed across different model structures. Our analysis revealed that the Blob influenced the physical and biogeochemical properties of the upper 100m of the ocean in each OMIP2 model. Our results suggest that ocean models are generally capable of capturing the physical and biogeochemical characteristics of marine heat waves and show how the Blob was associated with a temporary relief of ocean acidification, an ongoing environmental problem.



Physical and biogeochemical analysis of variables from January and February of 2014.
a) Observational sea surface temperature anomalies
b) CESM2 sea surface temperature anomalies
c) Observational $\Omega_{aragonite}$ anomalies
d) CESM2 $\Omega_{aragonite}$ anomalies.

Relationship between Adverse Weather and Traffic Conditions

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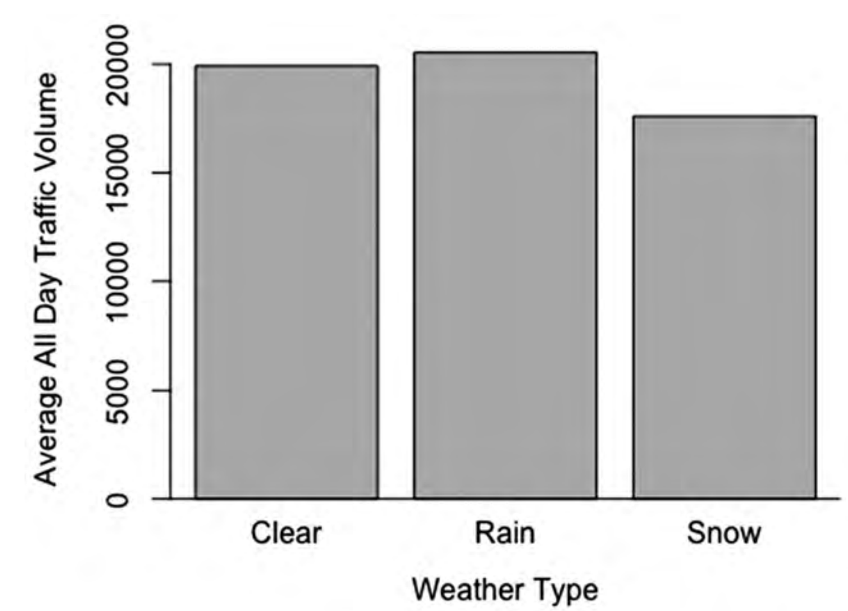
Scripps–UC–San Diego

Adverse weather conditions negatively impact mobility and safety of drivers on roads. In an average year, approximately 21% of U.S. highway crashes are weather-related. Collectively, these crashes result in over 5,300 fatalities each year. Using 2019 weather and traffic data along Colorado Highway 119 between Boulder and Longmont, this research analyzed the relationship among adverse weather and traffic conditions. The data were classified into distinct weather types and the direction of travel. Traffic information included metrics such as volume, speed, trip length, trip duration, and the purpose of travel. The data showed that snow days had a smaller traffic volume than clear and rainy days, with an all-day volume of approximately 18,000 vehicles for each direction of travel as opposed to 21,000 vehicles for both clear and wet conditions. Despite the volume reduction, the data showed that the percentage of travel between home and work locations was 21.4% throughout a snow day compared to 20.6% for rain and 19.6% for clear days. The overall traffic volume reduction during snow days is likely due to drivers deciding to avoid commuting; however, the relative increase in the home-work percentage is attributable to less discretionary travel in lieu of essential work travel. In comparison, the increase in traffic volume during rainy days is due to commuters being less likely to walk, bike, or take public transit during inclement weather. This work demonstrates the importance of analyzing the effects of human behavior during adverse weather travel.



Average daily 2019 traffic volume (number of cars) along Colorado Highway 119 (Diagonal Highway) between Longmont and Boulder sorted by weather type categories.

2021 SOARS Abstracts Significant Opportunities in Atmospheric Research and Science

PROFESSIONAL DEVELOPMENT

SOARS Protégés participated in weekly professional development activities to enhance their skills and knowledge in career pathways, graduate school, and timely national discussions on racism in STEM.

IMPORTANCE OF MENTORING

Our mentors provide research, writing, computing, and personal support; and the relationships often last long after the Protégés leave our laboratories and departments. Mentors tell us that our Protégés inject new ideas, energy, and an opportunity to build new connections into their research; a true win-win for all.

Wait Forever, then all at Once: Exploring the Atmospheric Connections Related to Temporal Clustering of Extreme Precipitation Events

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B.S.–Geography-Meteorology

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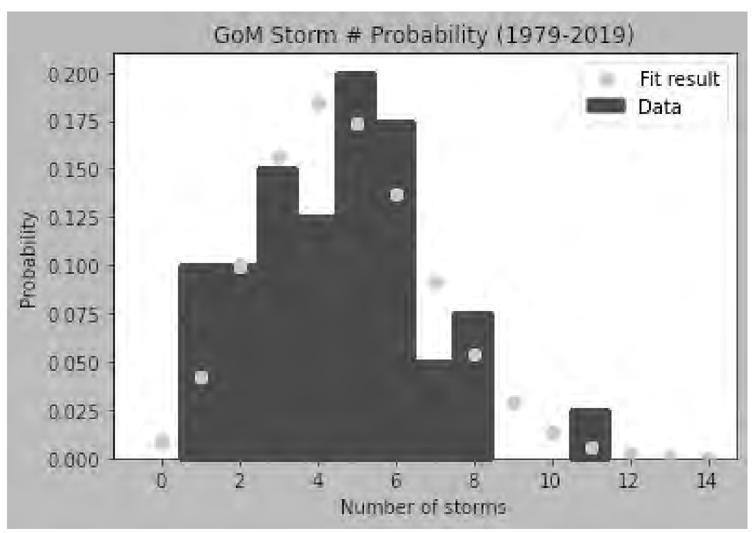
Extreme precipitation can cause major hazards and when many extreme precipitation events group into an episode, these impacts can be exacerbated and cause detrimental impacts to society. When precipitation becomes temporally clustered, those in charge of planning and strategizing against these events can be caught unprepared for these increased impacts. This research looks into why precipitation events tend to cluster spatially and temporally and identify what connections in the atmosphere may cause these episodes. This was done in a case study format; two unrelated temporally clustered precipitation episodes with different driving mechanisms were chosen for investigation. The first case study identified was a multi-day atmospheric river event that occurred in 2014 during one of California's worst drought periods in recent history; while the second case study investigated clustering in the Gulf of Mexico throughout the 2020 Atlantic hurricane season. These case studies highlight the different mechanisms, timescales, and impacts that can be associated with the clustering of extreme precipitation episodes. The results revealed several different characteristics of the atmosphere that were related to these episodes. These include upper wind patterns, sea level pressure anomalies, sea surface temperatures, and precipitation anomalies. Understanding these characteristics and the phenomena associated with them is vital for understanding how to forecast, plan, and prepare for the additional hazards associated with the clustering of extreme precipitation.



A histogram that shows the probability of a season having a certain number of storms track into the Gulf of Mexico, and a Poisson distribution of the mean, based on data from 1979-2019. Though not on this graph, 2020 had ten storms track into the Gulf, and 2020 was calculated to be 2.4 standard deviations above the mean number of storms for this time period.

Evaluating Rap-Chem Air Quality Forecasts

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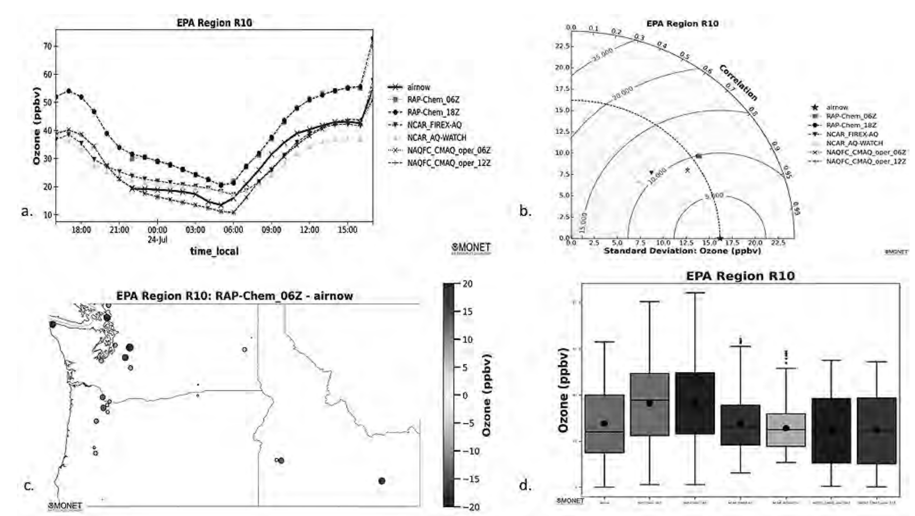
Jesse Nusbaumer, NCAR

Several models such as NCAR's Weather Research and Forecasting model coupled with Chemistry (WRF-Chem) and NOAA's National Air Quality Forecasting Capability (NAQFC) have been developed and evaluated to provide forecasts for potentially hazardous species such as ozone (O_3) and fine particulate matter ($PM_{2.5}$). Rapid Refresh with Chemistry (RAP-Chem) is an experimental forecast model being actively developed at NOAA Global Sciences Laboratory providing forecasts since August 2020. There is a strong need to consistently evaluate operational and experimental forecast models, with specific focus on RAPChem as its physics/chemistry packages are likely to form the basis for the next-generation of air quality forecasting at NOAA. Here we present a methodology to conduct a multi-model evaluation in near real time. We created a shell script to compile forecast data and pair them with ground based O_3 and $PM_{2.5}$ observations. The Model Observation Evaluation Toolkit (MONET) package is incorporated into our script in which several plots and statistics are generated. Our methodology will let developers compare several models at once followed by diagnosing bugs and fixing model deficiencies quickly. We present an example of a daily evaluation to demonstrate the capability of our script and knowledge gained by a single day's evaluation. RAP-Chem forecasts of O_3 and $PM_{2.5}$ are compared against surface observations and several other models. Overall, we find overprediction of O_3 and underprediction of $PM_{2.5}$ from RAP-Chem. We demonstrate the utility of the system by investigating regional differences as well as the diurnal cycle of O_3. Further and sustained use of our method will be required to develop a meaningful evaluation.



Examples of time series (a), Taylor plot (b), spatial bias (c), and boxplot (d) outputs from our near-real time multi model evaluation system comparing Rapid Refresh with Chemistry (RAP-Chem) surface ozone forecasts to EPA AirNOW observations and models National Air Quality Forecasting Capability (NAQFC) and Fire Influence on Regional to Global Environments and Air Quality (FIREX-AQ).

SOARS 2021 RETROSPECTIVE & 25TH ANNIVERSARY SYMPOSIUM SUMMARY

By Kadidia Thiero

SOARS® is thrilled to introduce the 25th Cohort of Protégés, as we celebrate 25 Years of broadening impact and access to the atmospheric, and the related earth system sciences!

The 2021 SOARS Program began with March selections, including nine (9) incoming students, deferred from 2020; seven (7) finalists, and four (4) returning Protégés. SOARS received 100 applications for the 2021 Cohort. While the world continued dealing with the COVID-19 pandemic, the decision was made to hold the SOARS Program virtually again.

There are 20 total Protégés in the cohort; representing 18 colleges and universities: Arizona State University, Columbia University, Dartmouth College, George Washington University, Iowa State University, Jackson State University, Kennesaw State University, Metropolitan State University of Denver, Ohio University, Pennsylvania State University, Salisbury University, University of Oklahoma, University of Puerto Rico, Mayagüez, University of San Diego, University of Tennessee at Martin, University of Texas at El Paso, University of Wisconsin-Madison, and Williams College.

Of the 20 Protégés, seven (7) recently graduated, earning the Bachelor's of Science degree; and all are planning to continue with graduate studies. There are 17 women in the cohort, and multiple ethnicities represented amongst the Protégés.

The research projects exemplify various areas of earth systems sciences including the NCAR laboratories, UCAR|UCP Programs, NOAA ESRL divisions, CIRES (Cooperative Institute with NOAA and CU), and some departments at the University of Colorado, Boulder. The 65+ mentors are representative of multiple research entities, as well as some institutions of higher education.

Despite the increased scheduling of meetings, authentic, original research and comprehensive mentoring, continued to enhance the critical pillars of Research, Mentoring, and Community. The SOARS experience began on May 17th with an introduction to the SOARS Team and various presentations and trainings. Included in the first week were two (2) Leadership Training Sessions, Diversity, Equity, and Inclusion training, a presentation on UCAR policies on ethics and harassment, and Cohort-building activities. On Friday, May 21st, the Protégés were introduced to the SOARS Instructors for the Scientific Communication and Writing Workshop (SCW), and the Computation and Data Science Workshop (CDW). For professional development, individual meetings with the SOARS PI/Program Lead focused on short- and long-term objectives.

All of these requirements, made more difficult in a virtual environment, included written abstracts of the research project, speaking at our Research Colloquium, the creation of a poster, and a final paper. With respect to research and skills, one Protégé remarked that, *"...SOARS has helped me to see that I do have a place and future in atmospheric science. It allowed me to discover that I am smart and capable enough to conduct intensive research. My project has become a research topic that I plan to pursue in graduate school and I feel that SOARS has opened up the door to both graduate school and my future as an atmospheric scientist that did not feel possible before."*

The summer's Professional Development series provided Protégés opportunities to learn from experts in the field, as well as SOARS Alumni in areas of scientific communications and virtual presentations. Opportunities to experience live tours virtually at the NCAR Mesa Lab, and the Geological collections at the Denver Museum of Nature and Science, enhanced the other activities, including a graduate school panel, and a facilitated discussion on being marginalized in STEM fields.

SOARS remains true to its mission of providing research experiences for marginalized communities in STEM, and continues the legacy of access and broadening participation in the atmospheric and related sciences.

As 2021 progressed, during the summer, SOARS hosted a two-days 25th Anniversary Symposium virtually, which served as a celebration and seminar, commemorating impact and longevity of the Program. There were many activities and opportunities to mingle and interact. On Friday, June 25th, later in the afternoon following the annual "Practice Talks," there was an official kick-off, alumni toasts and roasts, a virtual gathering environment, replete with individual video-avatars to simulate in-person connections. Alumni and advocates shared poignant moments about the leadership of SOARS throughout the years; and participants had the opportunity to catch up, play SOARS-related Bingo, and reminisce.

The second day of the Symposium, Saturday, June 26th, there were exciting breakouts, as well as SOARS Team trivia to enhance networking. The first session was comprised of breakouts according to industry sectors, that fueled discussions based on: teaching, academia and education, research, undergraduate and graduate school, government and public service, the private sector, and non-traditional sectors. The afternoon continued with DEI themes, that highlighted various challenges and on-going efforts in higher education, the workforce, and at NCAR|UCAR.

The Symposium wrapped up with conversations discussing the future of SOARS, and increased alumni engagement. Many supporters shared well-wishes and congratulations on the padlet, an accompanying virtual notepad, that was activated prior to the Symposium. Pictures from the various Cohorts, including the "Flatirons" group pictures, were also included on the padlet. In marking a quarter Century of broadening impact, SOARS took advantage of the community support, and structured a meaningful event to celebrate the milestone of the Program.

The Observed Influence of the Oceanic Cold Wake on Hurricane Maria's Atmospheric Boundary Layer

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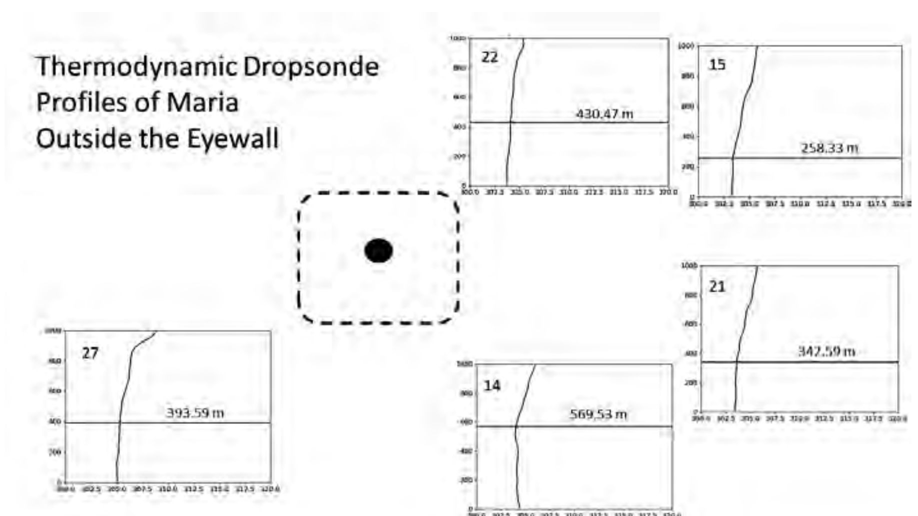
Air-sea moisture, heat and momentum exchanges that govern hurricane intensification occur within the hurricane boundary layer (HBL). However, the HBL is under-sampled due to the dangers of flying crewed aircraft within this turbulent region. In 2017, a novel instrument called the Coyote, a small uncrewed aircraft system (sUAS), was deployed in Atlantic Hurricane Maria after the storm weakened following its traverse of Puerto Rico. Flights one (1) and three (3) from this dataset, along with nine (9) dropsondes from the surrounding times, were used to compare observed boundary layer characteristics with the current theoretical understanding of the boundary layer above a hurricane's cold wake. The cold wake is an area of anomalously low sea surface temperatures created by the upwelling and mixing of colder water up to the ocean's surface by the hurricane. In atmosphere-ocean coupled models, the cold wake creates a stable boundary layer in the storm's right-rear quadrant. In the observational analysis of Maria, thermodynamic stability, thermodynamic hurricane boundary layer (THBL) height, and dynamic hurricane boundary layer (DHBL) height were calculated in a storm-relative framework. The lower virtual potential temperatures in the right quadrants showed evidence of the cold wake. The boundary layer heights decreased toward the eye of the storm and the DHBL heights were higher than the THBL heights, which agreed with previous findings. The THBL also showed the stable layer was the shallowest in the right-rear quadrant. Due to the small sample size, the methods should be repeated with a larger dataset to see if the conclusions hold.



Virtual potential temperature profiles of the dropsonde profiles outside of Maria's eyewall. The x-axis is the virtual potential temperature in Kelvin. The y-axis is height in meters. The dashed line indicates a ~50km radius of the center fix of the storm (black dot). The horizontal line on each profile is the THBL top. The soundings are placed in relative location to the center of the storm, but the diagram is not to scale.

Changes in Atmospheric River Activity over the Northeast Pacifiac: A Study with Large Climate Model Ensembles and Machine Learning

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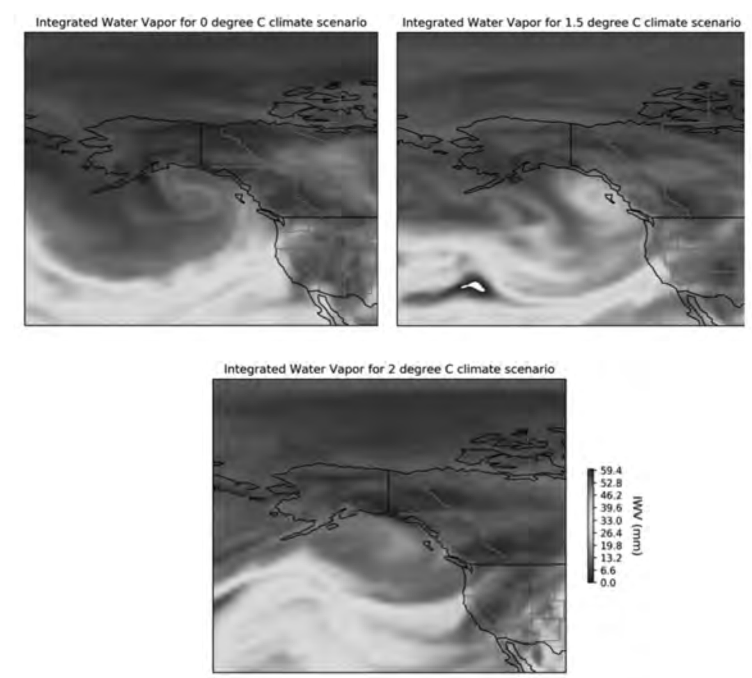
Atmospheric rivers (AR) are elongated, concentrated bands of water vapor located in the lower troposphere of the atmosphere. Atmospheric rivers are important sources water supply in western North America, replenishing lakes, reservoirs, soil moisture and groundwater. Since the new millennium, western North America has experienced one of the biggest droughts it has seen in decades. The 21st Century mega-drought has led to devastating consequences including magnified frequency and intensity of wildfires, decreased mountain snowpack, and lower levels in lakes and reservoirs, which threatened human health and food security. As it is, AR brings rainfall that can significantly relief the drought conditions. About 30-50% of precipitation in the west coast comes from atmospheric rivers. Yet, while AR can provide relief from drought, it can also cause heavy storms which result in severe flooding, affecting millions of people residing in the lowlands, particularly in coastal terrain. As a result, it is important to understand how the frequency and intensity of atmospheric rivers will change in a warming climate. In order to determine the magnitude of such a change, we conduct statistical analysis on AR events detected in a large climate model ensemble using advanced machine learning methods. We compare the statistics of AR occurrence in three different climate scenarios (present day, 1.5°C above preindustrial levels, and 2°C above preindustrial levels). Our findings provide a preliminary understanding of how warming will change frequency and intensity of atmospheric river as well as insights to changes and challenges associated to modeling hydrological cycle.



Integrated Water Vapor (IWV)
plotted for one year, one ensemble number
for three climate scenarios.

Response of an Idealized Tropical Cyclone to a Sudden Decrease in Sea Surface Temperature

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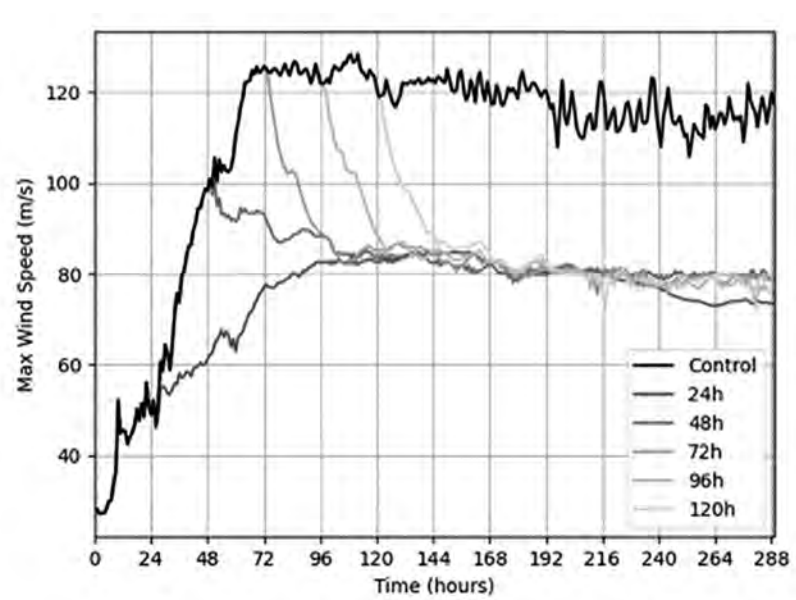
Sea surface temperature (SST) is known to be the essential fuel that drives tropical cyclone (TC) development and intensification. Because TCs interact with the underlying ocean and decrease SSTs, leaving behind a cold wake, a subsequent TC passing over the same region could encounter the cold wake left behind by an initial TC. In this study, the effect of a decrease in SST on TC dynamics was analyzed utilizing an axisymmetric, uncoupled model of an idealized TC. To simulate a TC encounter with the cold wake of another TC, a sudden 4°C SST decrease was introduced at various stages throughout the TC lifecycle. Six experiments with SST decrease introduced at different times were compared to understand how storm parameters, such as maximum wind speed, radial wind extent, and integrated kinetic energy changed. Simulations showed that an idealized TC decreases in intensity in response to an SST decrease and the final intensity converges to a similar value regardless of when in the TC lifecycle the SST cooling is introduced. In addition, changes in storm structure, including radial decreases in tangential wind speed and reflectivity, were observed, with all experiments converging to a similar final size, as with intensity. Lastly, decreases in surface enthalpy fluxes in response to the SST decrease provided an explanation for the simulated changes in intensity and structure. The results of this study emphasized the crucial relationship between surface fluxes and reduced SST in the development of TCs.



Maximum wind speed (intensity) over time for each experiment. Experiments include a control experiment with no SST reduction and experiments with SST reduced at 24, 48, 72, 96, and 120 hours.

Comparing In Situ Flight Observations and GOES-16 Satellite-Derived Icing Products duringthe In-Cloud ICing and Large-drop Experiment (ICICLE)

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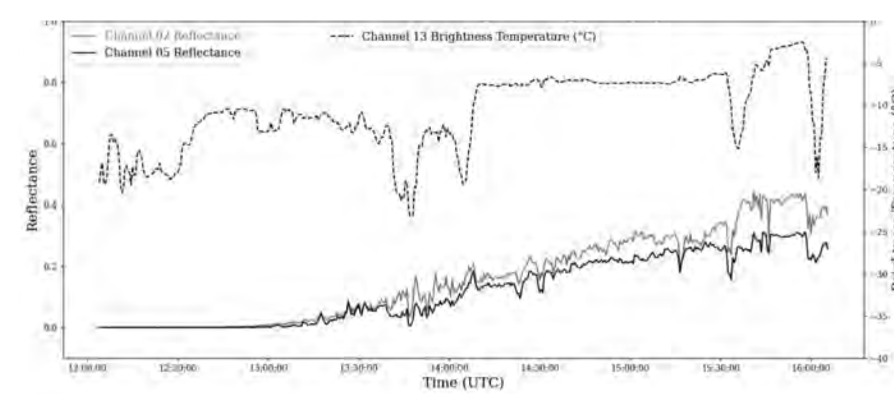
Aircraft icing continues to be a serious problem resulting in multiple aviation accidents each year. Inflight icing conditions are created when supercooled liquid water (SLW) adheres to the aircraft, increasing its weight and drag while decreasing lift. Many products have been developed over the years to assist pilots in determining the current and forecasted locations of icing conditions on the ground and aloft. The new series of Geostationary Operational Environmental Satellite (GOES) satellites has provided new products to assist in detecting icing conditions in-cloud. To test the efficacy of these icing products, a flight campaign was undertaken to obtain high quality in situ observations of icing conditions aloft. The In-Cloud ICing and Large-drop Experiment (ICICLE) utilized the National Research Council of Canada Convair-580 aircraft to collect data on icing conditions inflight, including atmospheric aerosols, cloud particle size distributions, particle phase, and total water content concentrations over the Midwest United States from late January to early March 2019. GOES satellite observations including daytime cloud phase and nighttime microphysics were obtained for comparison against the aircraft sensor data. Two flights were chosen for analysis due to the variety of different icing environments that occurred. Though the satellite products are accurate in identifying the presence of supercooled liquid at cloud tops, their ability to differentiate between SLW droplet sizes and characterize mixed phase clouds still needs to be improved. As satellite red-green-blue (RGB) products continue to improve, it will further help to increase safety throughout the aviation community.

Flight 17: 2019-02-17 12:04 UTC to 16:05 UTC
GOES RGB Reflectance & Brightness Temperatire[°C]



Time series of GOES-16 Daytime Cloud Phase RGB product for Flight 17. Channel 13 represents emitted radiation from surfaces and cloud-tops. Channel 02 is used to determine clear sky versus cloud cover. Channel 05 is used to differentiate between liquid and ice cloud particles.

Identifying Global-Wind Patterns Driving Sub-Seasonal Surface-Ozone Variability

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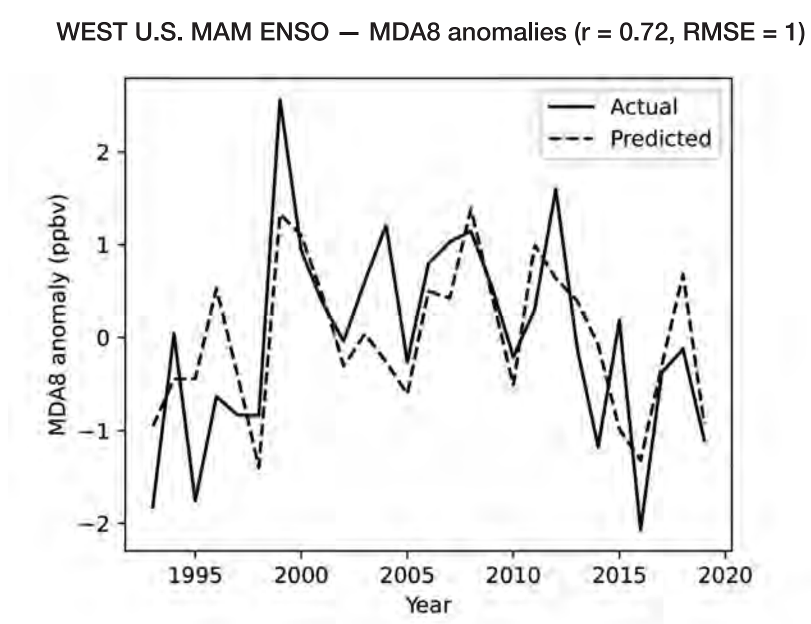
Ground-level ozone has been linked to increased mortality due to respiratory and cardiovascular diseases. Being able to predict when surface ozone will be higher than normal would allow us to better prepare for poor air quality days. To predict surface ozone weeks inadvance, we needed to identify global wind patterns with significant relationships to ozone on sub-seasonal timescales. We hypothesized that surface ozone over the United States (US) on these time scales is influenced by two large-scale processes: The El Niño-Southern Oscillation (ENSO) and the Quasi-Biennial Oscillation (QBO). ENSO is a tropical tropospheric oscillation of sea surface temperatures composed of a warm phase (El Niño) and a cold phase (La Niña). The QBO is a tropical stratospheric wind oscillation between an easterly and westerly phase. Both of these phenomena cause changes in global wind and climate patterns, which in turn could impact US air quality. We composed 8-hour averaged Maximum Daily Ozone data (MDA8) by the two phases of ENSO and the QBO. Our results showed that La Niña favors higher than normal ozone over the South-Eastern US in fall. La Niña also favors higher ozone over the Western US in spring, where ENSO alone can largely explain MDA8 variations (figure below). Additionally, the QBO easterly phase tends to be associated with higher ozone concentrations across the US, but lower concentrations over the South and South East; the opposite is found for the westerly phase. We showed that predicting ozone using the QBO and ENSO might be possible.



Solid line: MDA8 Anomalies averaged over the Western US in springtime (March, April, May)

Dashed line: MDA8 Anomalies as predicted by a linear regression model using the ENSO index as a predictor.

Identifying Land Cover Change Trajectories in Xilinhot, Inner Mongolia using the LandTrendr Segmentation Algorithm

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Geography

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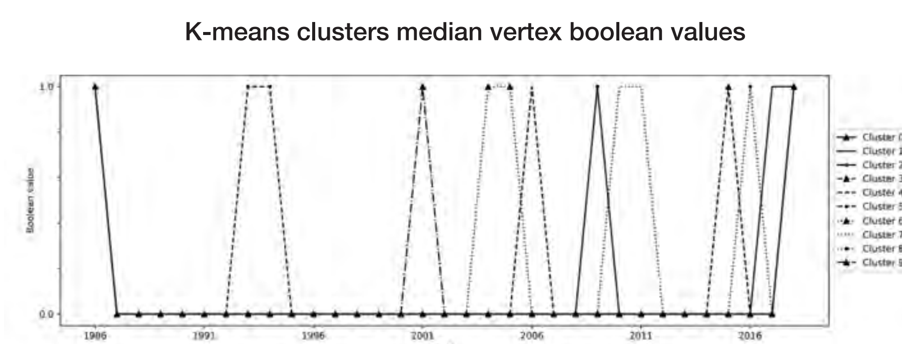
Current modeling of land use and land cover of rangelands is limited by shortcomings in the ontological and methodological approaches to classification. For example, current classification schemes often limit range-land cover types into one of a small number of categories; typically, grassland, shrubland, or barren. However, investigators of rangeland research are interested in the complex dynamics happening within a given class. A more nuanced classification of grasslands that represents the dynamics occurring within a class would contribute meaningfully to policy and management practices throughout the region. In this study, we assess a novel method for classifying land cover change, focused on Xilinhot, a city located in Xilingol League, Inner Mongolia, located in one of the largest remaining arid grassland regions of the world. The region has faced rapid development and land use conversion in recent decades, and grassland condition is declining in many areas; but the mechanisms of these changes are difficult to assess with traditional land cover data.

In this study we apply the LandTrendr (LT) segmentation algorithm to a time-series of Landsat imagery to capture changes in 30+ years of vegetation cover in Xilinhot. The LT segmentation algorithm is a set of spectral-temporal segmentation algorithms that extracts information for change detection in a time-series of moderate resolution imagery. We then apply an unsupervised k-means clustering scheme to iteratively assign each data point to one of k groups based on feature similarity. We identified ten unique classes in the data; these classes represent unique trajectories in the time-series. These classes reflect the result of changes in the physical features of Xilinhot's grasslands that coincide with changes in management and land use. These data on the influence of past intervention on pixel-level responses can be used to help build predictive models, to better understand the potential impact of future policy and management changes.



The median of the k-mean clusters was calculated to show whether the Booleans had a value of 1 or 0. For the median Boolean value, it is telling us whether 50% or more of the points in each cluster has a vertex (1) or not (0).

SOARS: ALWAYS CREATING A SAFE SPACE TO BELONG

By Marissa A.Vara

SOARS 2021 Summer was once again virtual; however, we had 20 Protégés including four (4) returning compared to last summer's eight (8) Protégés. Although more than a year since the initial COVID shutdown, the decision to have the regular cohort was the best option to advance the program forward. We needed to be sure that the program remained inclusive of all Protégés, and that we fully supported them financially, and mentally as well.

As we know, SOARS was created to focus on students from marginalized backgrounds and/or communities. With the social justice movement gaining strength during the summer of 2020; the SOARS team implemented a mental health specialist to work through the struggles of the pandemic, as well as experiencing the US's racial reckoning/uprising as a person who identifies as BIPOC (Black, Indigenous, and People of Color). This created a space for the students to participate in the summer program and have a place to talk and heal from the past year's events at the same time. Focusing on DEI (Diversity, Equity, and Inclusion) and the mental health and well-being of the Protégés was the theme throughout the 2021 Summer.

The SOARS summer program began with orientation week, which included a presentation on the History of SOARS given by the Inaugural Director and Senior Advisor, Dr. Thomas Windham. The orientation week sets the tone for the summer, allowing a safe space for all Protégés to bring their full selves to the program and UCAR. A Protégé remarked that *"Learning the history of SOARS, with regard to racial challenges in the field, strengthened the meaning and sense of honor associated with being a part of the program."*

Additionally, SOARS professional development workshops included mental health and DEI sessions throughout the summer. Moreover, three (3) of these professional development workshops were created to specifically discuss DEI and mental health with the Protégés, all of which included experts. The Time and Stress Management workshop led by Dr. Lori Kleinman focused on the mental health of the Protégés and how to manage stress. The SOARS team decided this session would be best between Dr. Kleinman and the Protégés, to provide a safe and open space for all. Furthermore, the Protégés provided feedback on this session sharing that they appreciated the sessions as a safe place to talk and recommended more of these sessions throughout the summer.

Another professional development workshop that focused on mental health and DEI was the "Can We Talk?" movie discussion with the filmmaker, Dr. Kendall Moore, and panelists, Ms. Catalina Martinez and Dr. Aradhna Tripati. For this workshop, the Protégés screened the movie before the discussion with the entire group. The movie shared experiences of BIPOC STEM professionals, students, and others immersed in these fields, and the treatment they experienced from others. After we all watched the documentary, we came together and had a thoughtful and honest discussion with each other. The three special guests were all women of color in the STEM fields; therefore, the impact of them sharing their stories and providing advice and guidance to the Protégés was recognizable and appreciated by the SOARS staff and the Protégés.

At the end of summer, the program closed with reflections from the summer. For this event, our newest SOARS team member, Marissa Vara, led a DEI Privilege Workshop with the Protégés. This workshop asked Protégés to identify their privileges, acknowledge them, and then learn how to work with them to better oneself, and others. The workshop started with laying down some ground rules with each other and allowing each other space, regardless of background. Marissa shared some of her privileges and experiences with the group, explaining that as a woman of color, she had some privileges, and did not have some; and that gave a different perspective, that many others have not considered in the STEM fields. This provided an example of the intersection of different privileges and marginalized identities in society that we may not always consider when having these discussions. This led to further conversations and thought on marginalized and societal identities. Following the societal identities discussion, we watched a video with people from different backgrounds, participating in the identifying privilege exercise. The exercise provided a series of questions for people to answer whether they've experienced the prompt/example in their lives, and at the end, shared the amount of privilege for each participant. The exercise was distributed to the Protégés to complete on their own time. After the video, the floor was open to comments, questions, and discussion. The discussion with the group was eye-opening for the SOARS staff and Protégés. The space created sincere discussions about others' experiences, and feelings were shared amongst peers. This built a sense of belonging, as well as the realization that internal feelings one might have, were similar to others in the group.

The workshops, discussions, and orientation collectively provided safe spaces for the Protégés to feel a sense of belonging, that we as a team hope they feel during each summer. We realize to continue making an impact, DEI and mental health must continue to be a consistent theme throughout the program for the foreseeable future [years to come]. As one Protégé commented, *"I felt that the prioritization on mental health this summer was very clear, and I appreciated it so much. I feel like the research process is not only stressful on its own but as a minority, there are a lot of other complications in the field that are very present either physically or psychologically. The fact that SOARS highlighted those problems and gave us the space and voice to talk about them and cope with them was very appreciated."*

The SOARS Program demonstrates support for the Protégés in more than their research and academia but also, Protégés as their whole selves. The more confident they are in bringing themselves to research, the more they will be able to advocate for themselves outside of the SOARS program. Of course, our SOARS staff will always support the Protégés and Alumni, and remind them all how much they matter!

SOARS PROTÉGÉS 2021

Effects of Dry Air Layers on Idealized Tropical Cyclones with Vertical Wind Shear

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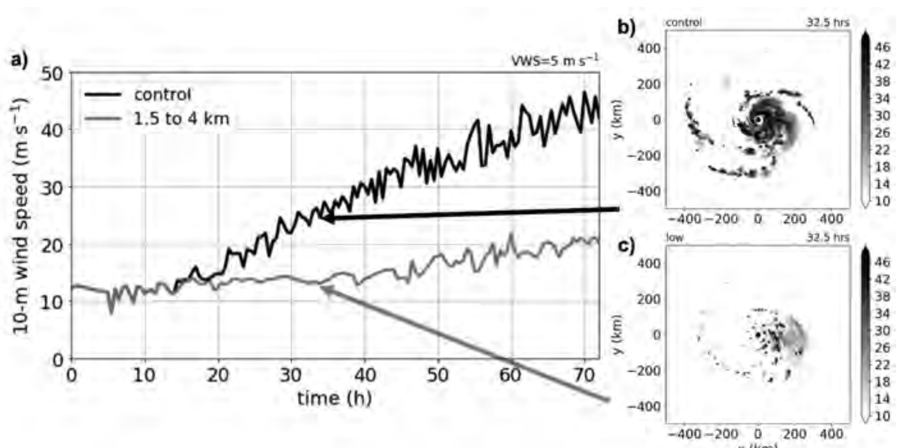
Tropical cyclones (TCs) under the influence of moderate environmental vertical wind shear (VWS) generally have storm-relative flow through the vortex and a vertical tilt, both of which can change a TC's structure. Studies have shown that this storm-relative flow and tilt can lead to dry air entrainment into the inner core, thus limiting TC development. Idealized numerical simulations of weak TCs allows for controlling the environment and determining how dry air layers influence the TC at early stages of development. In the four experiments conducted in this study, a westerly 5 m/s VWS is applied identically to each experiment, whereas the effect of a change in moisture within three different vertical layers (LOW, MID, UPPER) is isolated. The vertical moisture profiles keep relative humidity (RH) constant at 80% throughout, except in the layer in which RH of 20% is nudged in along with the VWS starting at 12 hrs. This approach is important to understand the relationship of thermodynamics and the structure of the TC at early stages of development with moderate VWS. Results indicate that the most detrimental dry air layer is that from the LOW experiment (between 1.5–4 km). This layer results in weaker nearsurface winds, a substantially larger tilt, and a more asymmetric rainfall structure. The tilt and associated asymmetries allow dry air to entrain into the inner core and modify the thermodynamics. For the MID and UPPER experiments, ventilation aloft is not as detrimental to TCs as ventilation at low levels.



a) Time series of TC intensities (m/s) for the control (black) and 1.5 to 4 km dry air layer (grey) simulations.

b) TC instantaneous reflectivity (dBZ) at z=1 km and t=32.5 hrs for the control simulation.

c) TC instantaneous reflectivity (dBZ) at z=1 km and t=32.5 hrs for the 1.5 to 4 km dry air layer experiment.

Changing Precipitation Patterns in Sub-Saharan Africa: Climate Change and its Impacts on Ecosystems and Economies

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PEER
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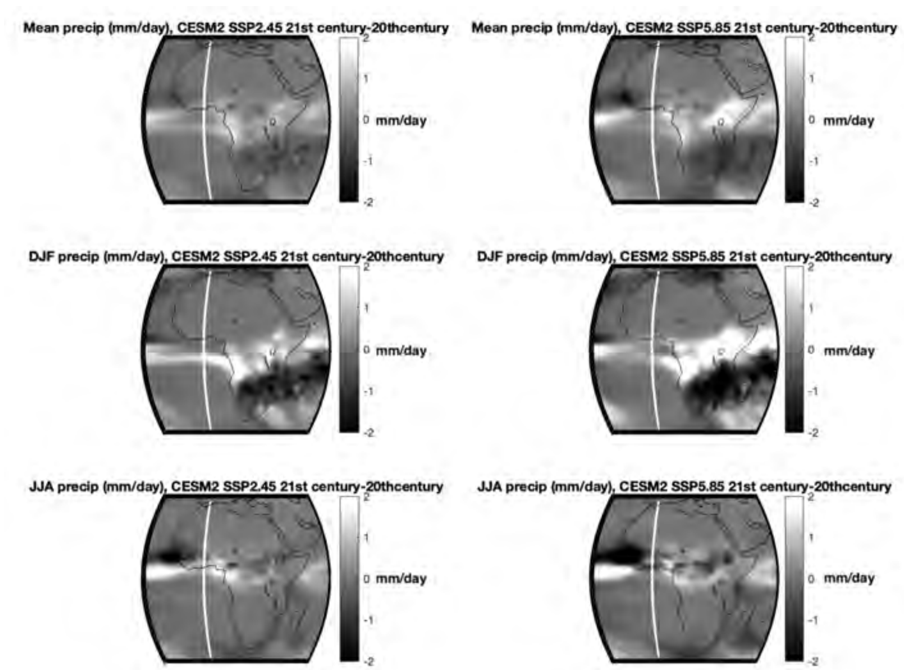
For decades, international scientific organizations like the Intergovernmental Panel on Climate Change (IPCC) have concluded that human activity, such as deforestation and carbon emissions, are causing the Earth's climate to change. Many climate models show that one of the most robust responses to climate change are regional changes to the hydrological cycle which includes precipitation and evaporation. These changes include increases in droughts, extreme precipitation events, precipitation variability, and floods. These impacts are not expected to occur uniformly in space and time; Sub-Saharan Africa is generally agreed upon as one of the regions most vulnerable to such impacts, as well as one of the most understudied. This study aims to investigate spatial changes in precipitation that can be expected in the region by the end of the century (2071-2100) using observational data from the Global Precipitation Climatology Centre (GPCC), and simulations from the Community Earth System Model version 2 (CESM2). Our research includes examination of observed trends, a comparison between the model and observations, and predictions about future precipitation changes under two different Shared Socioeconomic Pathways (SSP's). Our research showed that CESM2 was effective at simulating precipitation trends that were comparable to observations, with realistic predictions of precipitation over continents and good accountability for seasonality. Additionally, CESM2 showed that different parts of the continent could become drier, wetter, or remain the same, under both SSPs, and we identified some of the implications that these changes could have on those who live there, such as increasing food insecurity and poverty.



The left panel contains three subplots that show the difference in mean precipitation in mm/day across annual, JJA (June, July, August), and DJF (December, January, February) timescales across the African continent in the CESM2 SSP 2.45 simulation. The difference plots cover the time period of 2071-2100 vs. 1951-1980. The right panel shows the same three kinds of subplots but with data from the CESM2 SSP 5.85 scenario.

Comparing the High- and Low-Resolution Version of the WACCM-X Model: How Do Small Scale Gravity Waves Impact the Ionosphere?

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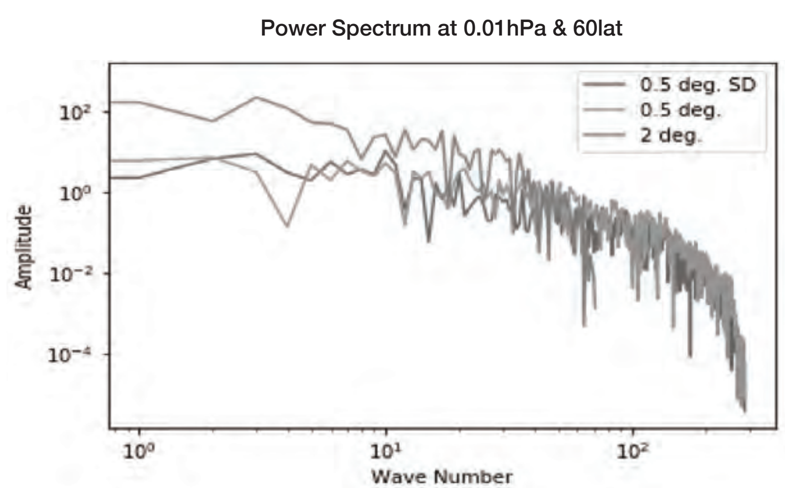
Small scale gravity waves impact the ionosphere in ways that affect GPS functions, radio communication and satellite communication. It is therefore important to understand how well global climate models that extend into the ionosphere can simulate small-scale waves. In this paper we compared the high (0.5°) and low (2°) resolution versions of the Whole Atmosphere Community Climate Model with thermosphere-ionosphere eXtension (WACCM-X), which is a model of the whole atmosphere from the surface to ~500 km, to evaluate the impact of model resolution on small scale gravity waves. The analysis was conducted at different latitudes and levels of pressure to study how well the waves would resolve in the model. The lower resolution version of WACCM-X produced a steeper, coarser slope. It did not resolve the smallscale gravity waves as well as the high-resolution version, which was expected. Two configurations of the higher resolution were evaluated. The first simulation was free running with no constraints. The second simulation included specified dynamics; it was constrained in the lower part of the atmosphere up to about 50km. The two high resolution simulations both produced similar power spectra. Overall, increasing the resolution of the WACCM-X model improved its ability to resolve small-scale gravity waves. Furthermore, adding constraints to the model simulations did not alter the small-scale waves in the model.



Power spectra at 60 degrees north of the equator at a pressure of 0.01 hPa. Where the slope changes indicates that wave numbers larger than that are no longer being resolved.

Generating Maps of Rainfall Forecast Uncertainty for Tropical Cyclones using a Bayesian Model

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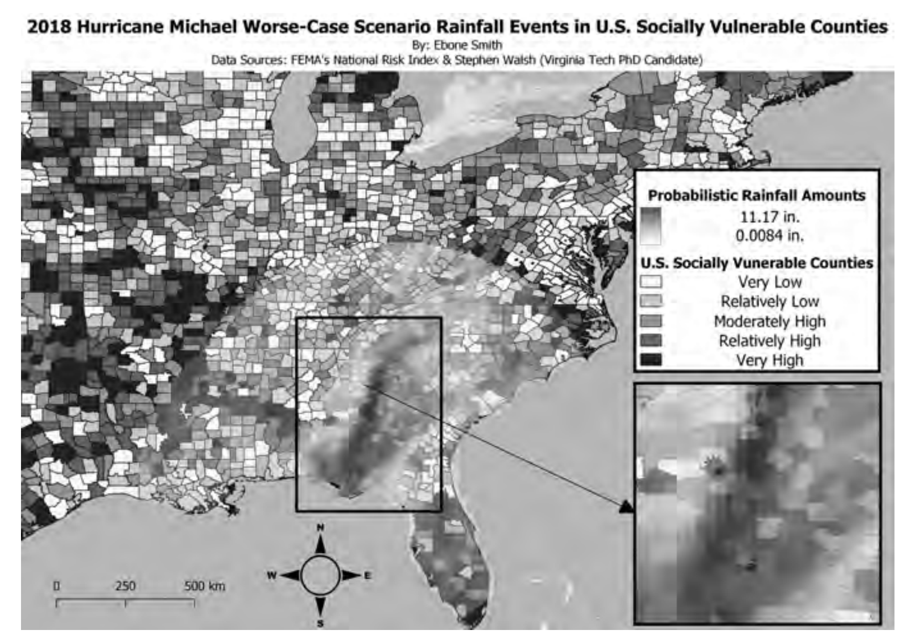
Hurricanes have presented grave risks to coastal communities in the US. Strong winds, storm surge, flooding, and heavy rainfall have resulted in billions of dollars of damage to homes, infrastructure, and agricultural resources, as well as casualties. Forecast models have been used by meteorologists to predict the hazardous impacts of hurricanes and to develop warning systems for vulnerable communities. To build community resilience in geographically, socially, and economically vulnerable areas, it is critical that scientists gain insight into model rainfall uncertainty patterns to improve public warnings. This study investigated forecast model uncertainty by comparing the North American Mesoscale (NAM) model forecasted total rainfall with the observed rainfall from 2018 and 2019 landfalling tropical cyclones. NAM model forecast errors from 47 tropical storms were calculated and input in a Bayesian model to evaluate how the forecasted precipitation errors varied in 1000 hypothetical rainfall scenarios. Three statistical approaches were used for each of the storms: 1) a distribution analysis of the Bayesian-generated error magnitudes, 2) a comparison of rainfall patterns from the NAM model, Stage IV observations, and scenarios generated by the Bayesian model, and 3) an evaluation of worse-case scenario rainfall events in vulnerable communities. The worse-case storm maps created each generated extreme rainfall values covering different geographical locations with varying social vulnerability levels. Some of the storms had very concentrated regions of rainfall, whereas other storms had rainfall more widespread across the US, which threatened counties with social vulnerability levels ranging from 'very low' to 'very high.'



Map showing the forecasted worse-case scenario rainfall events for 2018 Hurricane Michael for socially vulnerable counties in the US. The box in the bottom-right corner zooms into the region in the US that is most socially vulnerable, and at risk of large quantities of rainfall from Hurricane Michael.

Bringing Water to the West: Microphysics and Dynamics of Orographic Clouds Influenced by Atmospheric Rivers

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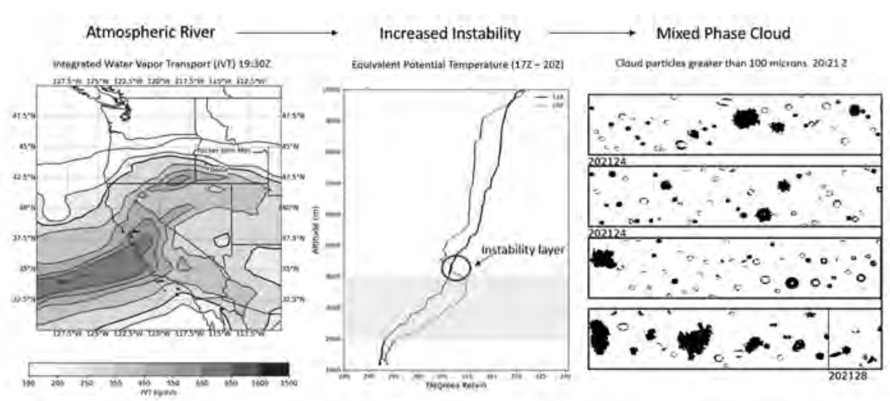
Atmospheric Rivers (ARs) are important sources of moisture in the Western United States. Inland-penetrating ARs influence the microphysics and dynamics of orographic clouds leading to precipitation. Because the west is experiencing a worsening drought, understanding the processes that bring moisture to the west will improve forecasting of future precipitation and drought conditions. The focus region for this study is the Payette River Basin in Idaho.

Data from the Atmospheric River Tracking Method Intercomparison Project (ARTMIP) was used to identify ARs and quantify their strength. Two ARTMIP Atmospheric River Detection Tools (ARDTs), which provided the most coverage for inland areas, were chosen for this analysis. The Seeded and Natural Orographic Wintertime clouds: the Idaho Experiment (SNOWIE) project (January–March 2017) provided aircraft-based radar and in-situ microphysics data and radiosondes provided thermodynamic data.

The connection between ARs and cloud microphysics and dynamics was investigated in a case study using SNOWIE flight (IOP) 12 (February 7, 2017). This IOP was chosen because ARTMIP data strongly indicated the presence of an AR in the study area.

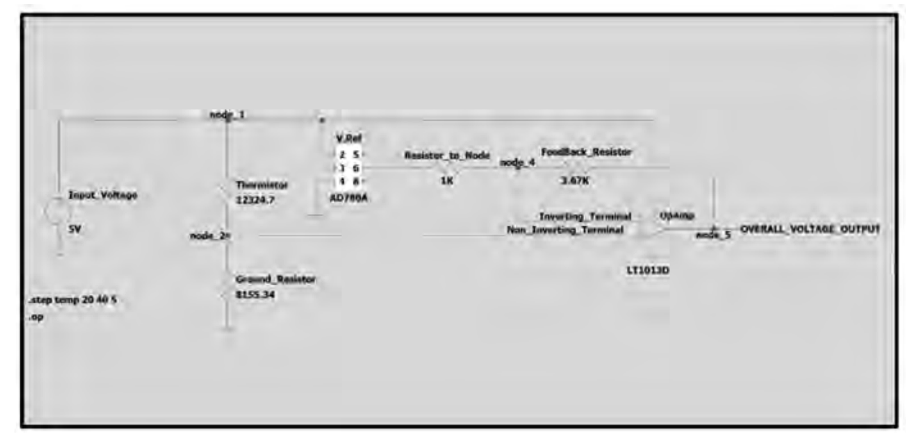
Sounding data before and during the IOP show that an incoming atmospheric river noticeably influenced the moisture and wind profile. The increased moisture led to an increase in instability in the atmosphere, which induced stronger, elevated convective clouds during the IOP. Analysis of the in-situ microphysics showed low cloud droplet concentrations and mixedphase conditions in the convective clouds. Outside of the convection, shallow orographic cloud tops were mostly liquid and contained supercooled drizzle.



Presence of atmospheric river over study region (left) shown in values of IVT and its impacts on atmospheric thermodynamics (middle) and microphysics (right).

Designing a Precision Current Source for a Thermistor Measurement System for Use on a CubeSat

The Sun is responsible for many radiative processes that are vital to maintaining life on Earth, including the fundamental input of warmth and light to our planet. Yet, the Sun also produces harmful particles and radiation which reach the Earth in the form of space weather. These charged particles can be directed towards the Earth's poles by the Earth's geomagnetic field and cause beautiful phenomena such as the Northern Lights. Much of the harmful radiation is absorbed by the ozone layer in the upper earth's atmosphere, but there are still impacts from the Sun's emissions capable of causing harm, most notably arising from the Sun's coronal magnetic field. Those issues include interference of air to ground communication, and the harm of space electronics within orbit. The focus this summer for NCAR's high-altitude observatory (HAO) was towards the development of a space-qualified optical filtering system to measure these coronal magnetic fields. Specifically, the primary stages of the development of a thermistor-based temperature measurement system aboard an Electronic Tuning Control Board (TCB). Although, this goal was not achieved, we were able to understand how to use thermistors as a vital component within the system for temperature measurement, corresponding to specific resistances and voltage readings. This clear understanding led to the success of simulating a prototype circuit within a circuit simulation software. With the success of the simulation, we can build a physical circuit that shall measure temperatures between +20 to +40 degrees Celsius.



Shown above is the schematic for a simulated prototype NTC temperature measurement circuit.

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ATOC	CU Department of Atmospheric and Oceanic Sciences
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CPAESS	Cooperative Programs for the Advancement of Earth System Science
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GWU	George Washington University
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