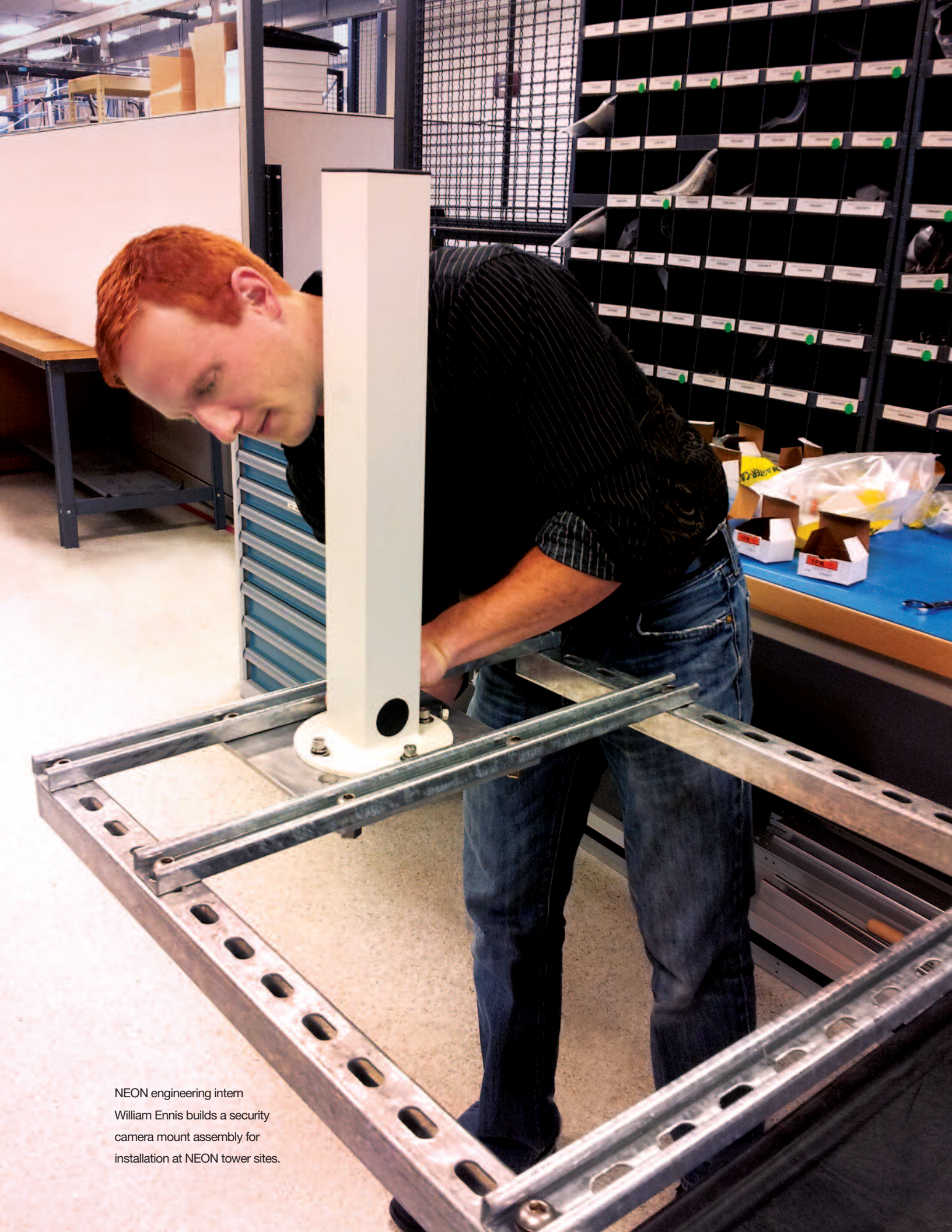
RESEARCH MENTORING COMMUNITY

Earth, Wind, Sea, and Sky

2013 SOARS, NEON, and Spark-NCAR PRE-COLLEGE INTERNSHIP Abstracts

2013



NEON engineering intern William Ennis builds a security camera mount assembly for installation at NEON tower sites.

We are very pleased to share with you the 2013 edition of **Earth, Wind, Sea, and Sky**, showcasing the summer research of 32 students from our three internship programs: Significant Opportunities in Atmospheric Research and Science, **SOARS**, the Undergraduate Internship Program at the National Ecological Observatory Network, **NEON**, and the **Spark-NCAR** (National Center for Atmospheric Research) Pre-College Internship.

Earth, Wind, Sea, and Sky

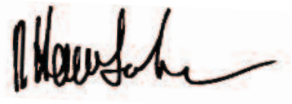
These three internship programs are designed to broaden participation in the science, technology, engineering and math (STEM) fields. The demand for well-trained scientists, mathematicians and engineers continues to increase in the United States. In addition, there remains a significant discrepancy between the demographic makeup of the STEM workforce and the country as a whole. Our internships are designed to help overcome this by building community, exposing students to world-class science facilities and pairing them with scientists and engineers who are at the cutting edge of their fields. We encourage students from groups that are historically under-represented to enter the ecological, atmospheric and related sciences, and help prepare them to succeed in college or graduate school and subsequently enter the professional workforce with advanced degrees.

While we are justifiably proud of our interns, we realize that their success would not be possible without the support and dedication of a number of people and organizations. The biggest thank you goes to our funders, our many partnering laboratories, and of course to our mentors. **Thank you for your careful guidance and teaching of the interns, and for modeling what an exciting science or engineering career looks like!** Without you these internship programs would not be possible.

We hope that you will enjoy this volume of abstracts. Please join us in congratulating our 2013 SOARS protégés, NEON interns and Spark-NCAR Pre-College interns!

Liz Goehring

Director of Undergraduate Internship Program, NEON



Rebecca Haacker-Santos

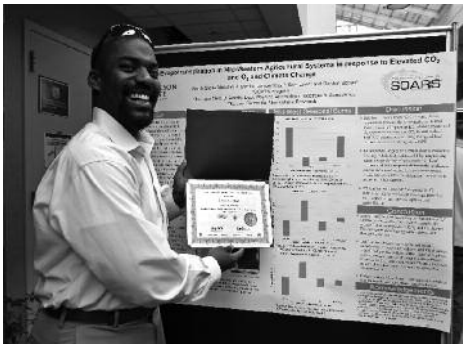
SOARS Director, Spark UCAR Science Education

Scott Landolt

Director of Spark-NCAR Pre-College Internship, NCAR

UCAR–NCAR

Since 1960, **UCAR**—the University Corporation for Atmospheric Research—has served as a national hub for research, education, and advanced technology development for the atmospheric and related Earth sciences. On behalf of the National Science Foundation (NSF) and the university community, UCAR manages the National Center for Atmospheric Research (NCAR) and the UCAR Community Programs (UCP), the organizational home for the SOARS and Spark-NCAR Pre-College Programs. UCAR's mission is to support, enhance and extend the capabilities of the university community, nationally and internationally; understand the behavior of the atmosphere and related systems and the global environment; and foster the transfer of knowledge and technology for the betterment of life on Earth. Its membership to date includes 104 North American institutions, including 77 members that grant doctoral degrees in the atmospheric and related sciences and 27 affiliates that offer other degrees.



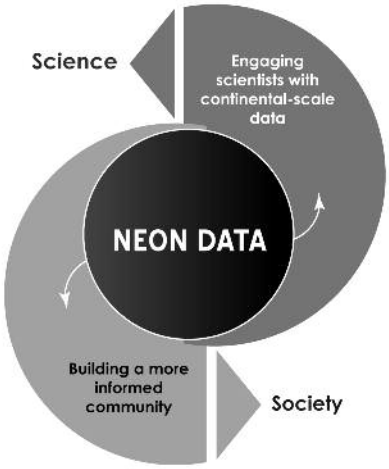
NCAR is a federally-funded research and development center, conducting a wide range of weather, climate, and solar science and related applications research. At the heart of this work is improving predictions about our atmosphere—how it behaves from moment to moment, day to day, and decade to decade, and the risks and opportunities associated with these changes. 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, and the Spark-NCAR Pre-College Internship since 2010. Their support and the mentoring by their scientists, engineers and staff have been a key to the success of these programs.

The SOARS proteges, NEON interns,and Spark-NCAR Pre-College interns discussed their research at the end-of-summer poster session. This event serves as preparation for the interns' presentations at national conferences.

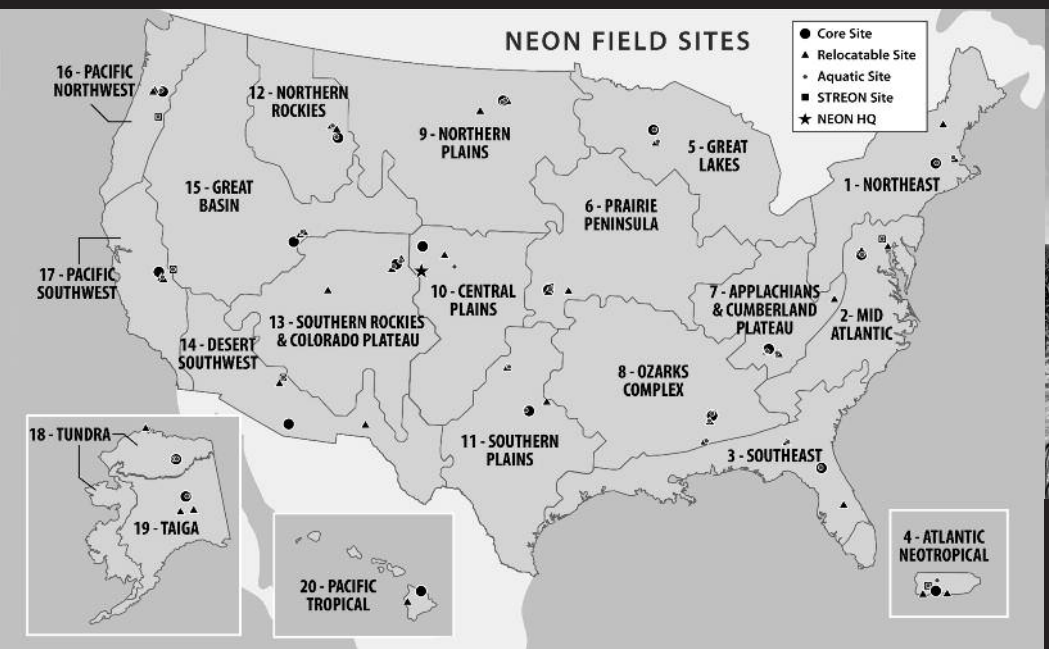
NEON

The National Ecological Observatory Network, **NEON**, is a continental-scale observatory system designed for examining critical ecological issues. Sponsored by the National Science Foundation (NSF) and managed under cooperative agreement by NEON Inc., NEON's mission is to enable understanding and forecasting of the impacts of climate change, land use change and invasive species on continental-scale ecology by providing infrastructure and consistent methodologies to support research and education in these areas.

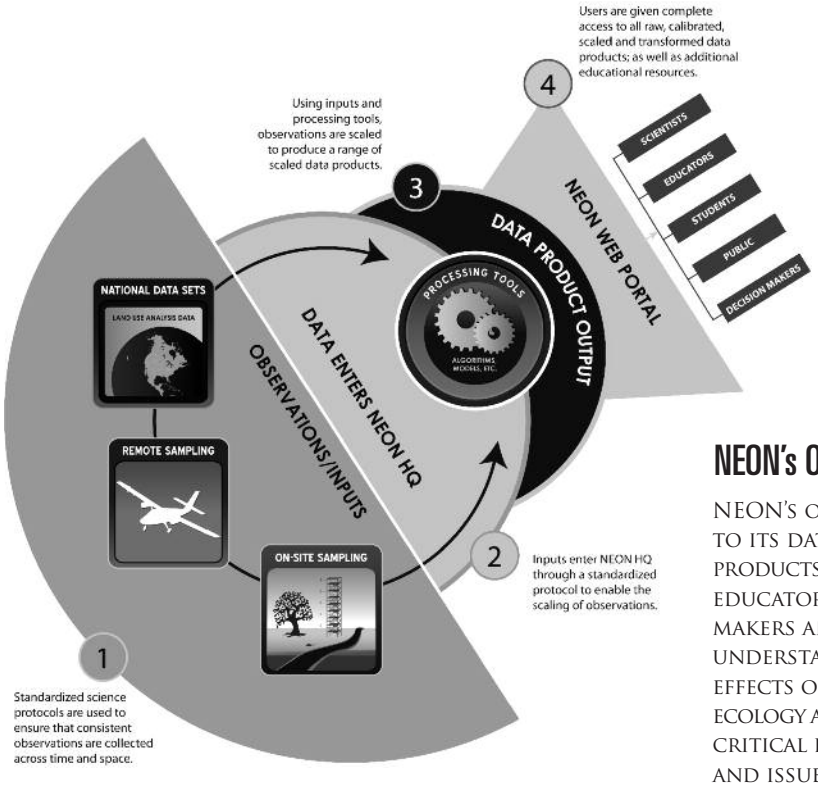


NEON is designed to gather and synthesize data over a 30-year period from 106 sites (60 terrestrial, 36 aquatic and 10 aquatic experimental) across the U.S. (including Alaska, Hawaii and Puerto Rico) using instrument measurements and field sampling. The sites have been strategically selected to represent different regions of vegetation, landforms, climate, and ecosystem performance. NEON will combine site-based data with remotely sensed data and existing continental-scale data sets (e.g. satellite data) to provide a range of scaled data products that can be used to describe changes in the nation's ecosystem through space and time.

Having successfully completed planning and design phases, NEON began construction in Spring 2012 and is currently building sites with full operation planned for 2017. As part of construction, NEON's Education team is building educational resources and programs to support its mission of enabling society and the scientific community to use ecological information and forecasts to understand and effectively address critical ecological questions and issues.



Two of NEONs educational goals are 1) to help educate the next generation of scientists and engineers and 2) to enhance diversity of ecological research and education communities. NEON is pleased to support its new Undergraduate Internship Program designed specifically to address these goals.



NEON's Open-Access Approach

NEON's open-access approach to its data and information products will enable scientists, educators, planners, decision makers and the public to map, understand and predict the effects of human activities on ecology and effectively address critical ecological questions and issues.

These renderings illustrate NEON scientists collecting data through a variety of field methods complementing atmospheric data collected by tower sensors, soil data from an array of ground sensors, and aerial data collected by an airborne remote sensing platform that flies overhead each year.

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SOARS PROTÉGÉS

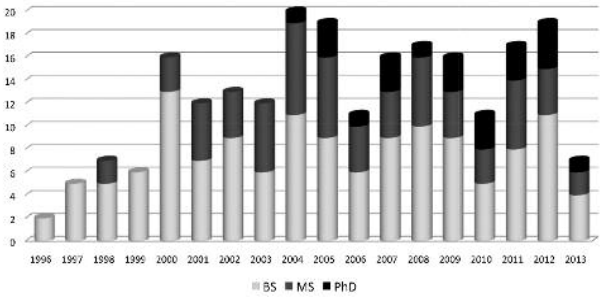
Significant Opportunities in Atmospheric Research and Science

SOARS is an undergraduate-to-graduate bridge program hosted at NCAR and designed to broaden participation in the atmospheric and related sciences. SOARS complements our partnering academic institutions' efforts in preparing students for careers in academia and research by combining a summer internship with year-round mentoring, conference travel and career support. During the summer, SOARS protégés work at NCAR and partnering laboratories and universities in Colorado to gain experience with what a career in academia and research could look like for them. In addition to this authentic research experience, guided by scientific mentors, the program includes a weekly communication workshop, seminars about graduate school and career choices, and end-of-summer poster and oral presentations by the students. Topics of research span the broad field of climate and weather, including computing and engineering in support of the atmospheric sciences. ❖ Protégés are able to return to SOARS for up to four summers, gaining additional independence in subsequent years to select, focus, and direct their research. By the time SOARS protégés move onto graduate school, they are well prepared to be successful in graduate research. Many use SOARS as an opportunity to expand their research through contacts and facilities available at a national laboratory, and it is common for students and their advisors to collaborate and publish with mentors beyond their SOARS research experiences. In addition, SOARS provides publishing and grant-writing support to their protégés and alumni, helping them stay connected with the wider community. ❖ SOARS is proud of their alumni, the vast majority of whom go on to excel in graduate school and move on to careers in atmospheric science or related STEM fields. They 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 strength and diverseness of the STEM workforce.

research | mentoring | community
SOARS®

Degrees Earned in STEM by Year

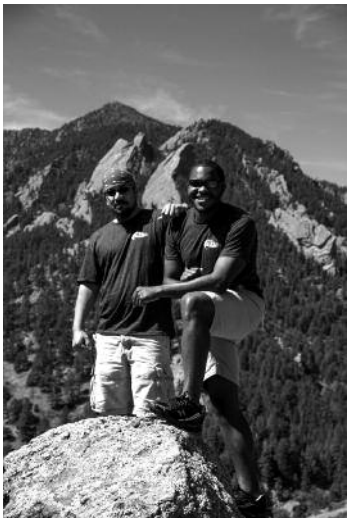
Degrees earned in science, technology, engineering or mathematics (**STEM**) by SOARS protégés and alumni, as of June 1, 2013



Protégés are pictured left to right:

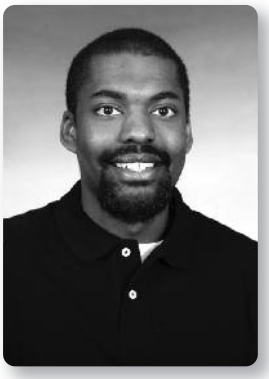
Front Row Sarah Al-Momar, Dereka Carroll, Jenine McKoy, Adrianna Hackett, Rosimar Rios-Berrios, Hsiao-Chun Lin, Ana Ordoñez, Meghan Applegate, Gabriela De La Cruz Tello

Back Row Stanley Edwin, Logan Dawson, Andre Perkins, Stone Abdullah, Jake Zaragoza, Jonathan Martinez, Alejandro Prieto, Matthew Burger, Diamilet Perez-Betancourt



An investigation of evapotranspiration rates within Midwestern agricultural systems in response to elevated carbon dioxide and ozone concentrations and climate change

Because the human population is expected to surpass 8 billion by the year 2050, food security is a pressing issue. In the face of elevated temperatures associated with climate change (CC), elevated carbon dioxide (CO_2) and elevated ozone (O_3) concentrations, food productivity is uncertain. Plant stomata must be open to gain carbon which simultaneously causes water loss. Research suggests rising temperatures, elevated CO_2 and elevated O_3 in the future may impact plant stomata and change the rate plants lose water and take up carbon, affecting plant productivity and crop yields. Evapotranspiration (ET), latent heat fluxes, leaf carbon and net primary productivity (NPP) were analyzed in the U.S Midwest where crop density is greatest. Four simulations were run using the National Center for Atmospheric Research (NCAR) Community Land Model version 4 (CLM4) component of the Community Earth System Model (CESM) with an extended carbon-nitrogen model (CN). Analyses were based on June-July-August seasonal averages through 2080-2100 to compare the individual effects of CC, elevated CO_2 and O_3, and combined effects of all drivers. Results from model projections show increased ET with CC and all drivers combined, but only small changes from O_3 or CO_2 alone. Further results show that NPP was reduced with CC and O_3 alone, but increased with CO_2 alone and only slightly reduced with interacting components. The combined driver simulation, which most accurately represents future global change, suggests deteriorating water usage efficiency, thus potentially decreasing carbon uptake and crop production. However, further research is needed for verification.



Warith Stone Abdullah

1st-year Protégé
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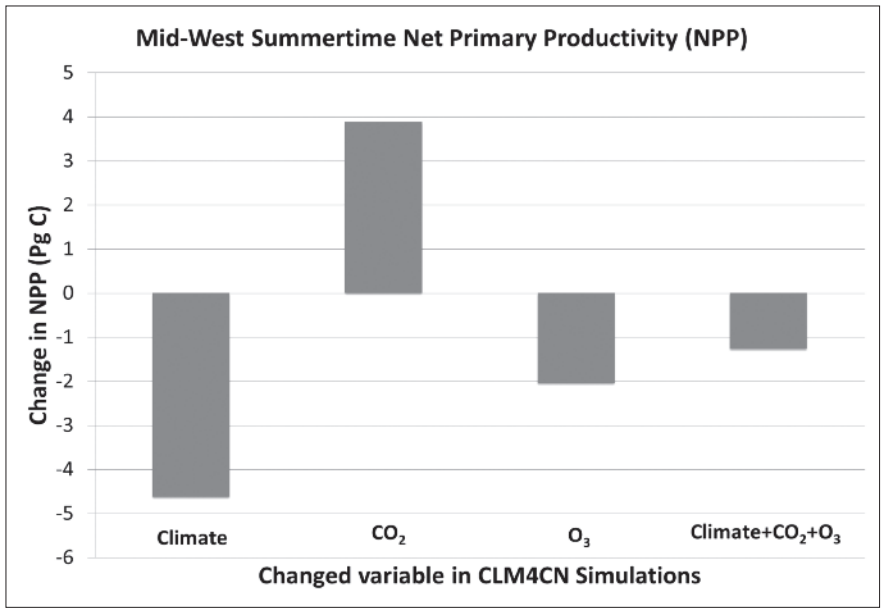
Danica Lombardozzi, Samuel Levis and Gordon Bonan, NCAR

WRITING & COMMUNICATION
Melissa Bukovsky, NCAR

COACH
Jeff Weber, UCP

PEER MENTOR
Andre Perkins, SOARS

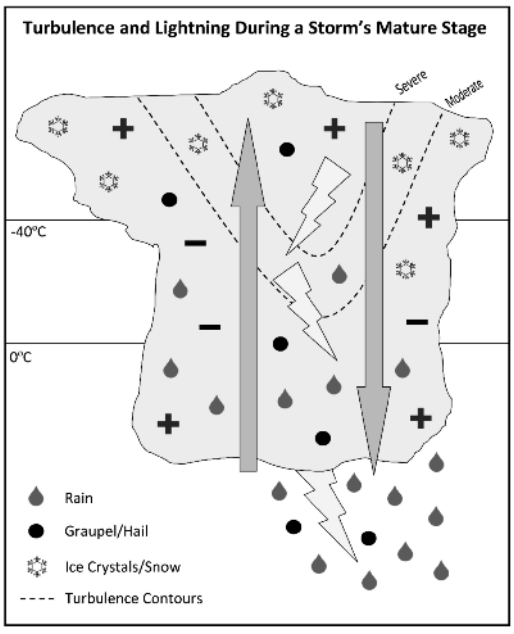


Midwest seasonal summation estimates for net primary productivity calculated by CLM_4CN model. Climate change, CO_2 and O_3 levels are predicted using IPCC RCP8.5 scenarios.

Relating total lightning and storm microphysics to in-cloud convective turbulence

Convectively induced turbulence (CIT) has been shown to influence a large portion of weather-related commercial aviation accidents. Determining areas of CIT is difficult since CIT is a relatively small scale, short-lived phenomenon. The Federal Aviation Administration issued specific guidelines for pilots to avoid thunderstorms, but simply flying around a storm can waste time and money. In-cloud CIT is created by dynamics within the cloud, such as the updraft. These same dynamics promote cloud electrification and subsequently, the generation of lightning. Therefore, lighting may be an indicator of a robust updraft and the likelihood of CIT. With the expected increase in availability of global lightning data through the launch of the GOES-R satellite, this relationship could improve the identification of CIT in otherwise data-sparse locations.

Data from the radar-based NCAR Turbulence Detection Algorithm were compared with total lightning data measured by the Colorado Lightning Mapping Array (COLMA) and dual-polarimetric radar data from the Denver, Colorado and Cheyenne, Wyoming WSR-88Ds. This was in order to determine possible temporal and/or spatial relationships of turbulence to electrical and microphysical storm properties. In several case studies of severe storms over Colorado, Wyoming, and Nebraska, it was observed that higher total lightning frequencies accompanied higher turbulence intensities. CIT often occurred prior to any lightning discharges. Likewise, COLMA detected lightning maxima were located within the mixed phase region of a storm, while the turbulence maxima occurred just above this region. Additionally, some level of turbulence was still observed within the storm after the last lightning strike.



Developed from previous studies and the reoccurring patterns observed in this research, the conceptual model above represents the microphysics, development of charge regions, and turbulent areas throughout a storm's lifecycle. During a thunderstorm's mature stage, its updraft is at its peak intensity. This updraft allows for the generation of ice crystals and riming hydrometeors in the mixed phase region, depicted as the area of the cloud between 0°C and -40°C. The collisions of these particles in conjunction with the updraft create charge separation, ultimately result in lightning in this region. In-cloud turbulence measurements, however, were observed to peak just above the mixed phase region.

Sarah Al-Momar

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How the chemical composition of the pre-storm and inflow regions compare to each other and to the outflow region of deep convection in the upper troposphere

Meghan Applegate

1st-year Protégé
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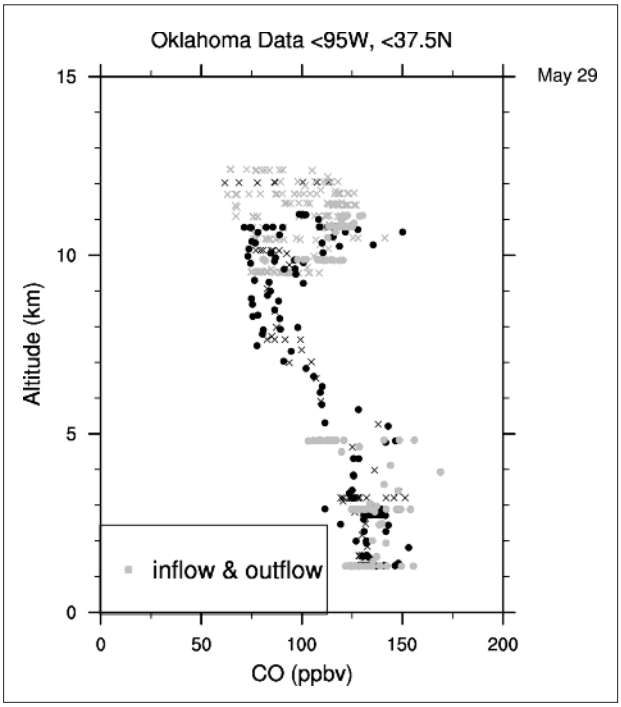
Ozone in the upper troposphere is considered a greenhouse gas, which can contribute to climate change. Convection in thunderstorms can carry ozone precursors upward from the boundary layer into the upper tropospheric region. Production of nitrogen oxides associated with lightning in the storm can also play a role in the transformation of the upper troposphere chemical composition. Data from the Deep Convective Clouds and Chemistry (DC3) Field Campaign were used to compare pre-storm, inflow, and outflow data using four different storm events in diverse regions. Vertical profiles of ozone, its precursors, and other related compounds were used to highlight aircraft measurements of the inflow and outflow in relation to pre-storm and near storm concentrations. This comparison allowed us to determine whether the pre-storm data can be used for the analysis of convective transport and scavenging of trace gases in the upper troposphere. It was found that the chemical species' concentration in the inflow didn't always match the concentration at other times in the boundary layer. Though some constituents showed similarities, there was variability among the different cases. Despite this variability, it may still be useful to incorporate pre-storm data for future studies. Comparison of the outflow data to the inflow data revealed the degree of scavenging for each constituent trace gas and aerosol for different boundary layer environments and storm types. It was found that while some species were consistently scavenged, others were not and showed that they were scavenged in some cases but not all. For the latter situation more detailed analysis of storm location and characteristics would be beneficial.



This figure shows a case from Oklahoma, May 29th and its vertical profile. This plot is of the chemical concentration of Carbon Monoxide (CO), a transported species. The crosses indicate data that was taken by the Gulfstream V (GV) aircraft and the dots represent data taken from the DC8 aircraft. The gray dots indicate inflow and outflow regions of the cases to compare with other points in the boundary layer and middle troposphere.

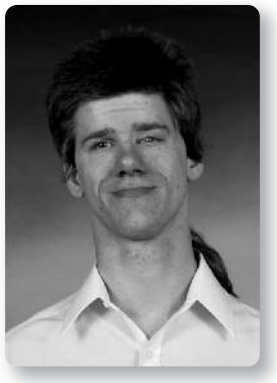
A climatology of severe thunderstorm atmospheric conditions

The effects of climate change on severe thunderstorm conditions are a topic of current debate. As a first step toward understanding the significance of these effects, a climatology of severe thunderstorm atmospheric conditions has been developed. This climatology was developed from radiosonde observations throughout the eastern two-thirds of the United States. Four quantities, including Convective Available Potential Energy (CAPE), Convective Inhibition (CIN), K-Index (KI), and Lifted Index (LI), were computed from 00 UTC soundings, corresponding to the most convectively active time of the day, for the months of March through November from 1983 to 2012. All data were evaluated based on quality and completeness. The 30-year monthly and seasonal averages were found for six regions east of 107 degrees west longitude. Results show the percentage of days with LI values between the ranges of -3 to -5°C and less than -6°C and KI values between 30 to 35°C and greater or equal to 36°C is greatest in the Southern Great Plains during the spring and along the Southeast Coast during summer and fall. The Southeast Coast has the most days with CAPE exceeding its thresholds of 1000 and 2500 J/Kg and CIN exceeding its thresholds of -120 and -60 J/Kg.

Percentage of summer days with severe thunderstorm probability based on thermodynamic quantities

Index	CAPE	CIN	KI	LI
Southeast Coast	60.75%	58.43%	17.13%	23.112%
Southeast	32.45%	48.03%	23.32%	10.31%
Southern Great Plains	27.85%	34.72%	36.17%	19.39%
Northern Great Plains	27.65%	24.82%	14.84%	17.15%
Great Lakes and Mid-West	17.46%	37.49%	12.36%	6.78%
Northeast	14.43%	28.42%	8.79%	3.84%

The averaged percentage of days during the summer (June-August) for six regions, when CAPE (> 2500 J/Kg), CIN (-60 to 0 J/Kg), KI (> 35C°), and LI (< -5 C°) are favorable for severe weather.



MATTHEW A. BURGER

4th-year Protégé
Ohio University, 2012
Meteorology

MENTORS

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COMPUTING
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Pacific Northwest ecosystem responses to atmospheric changes in the 21st century

Gabriela De La Cruz Tello

1st-year Protégé
Senior
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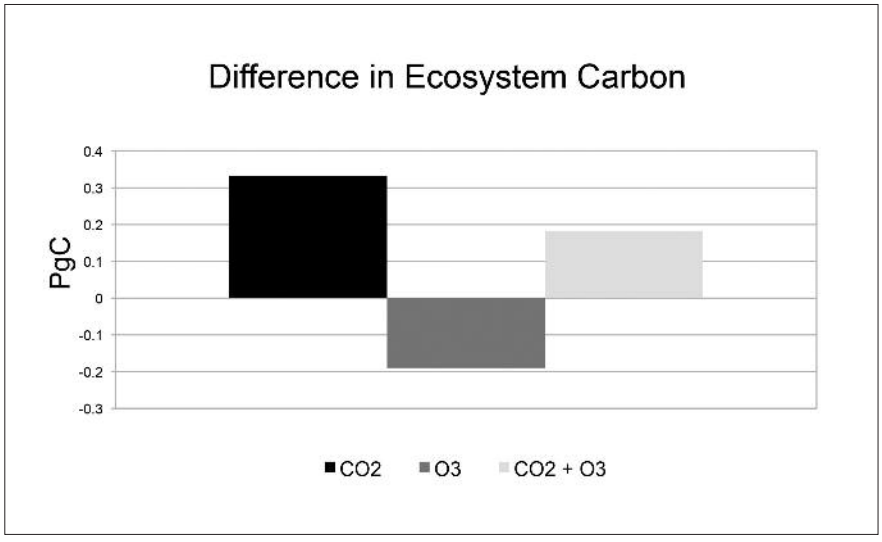
Carol Park, NCAR

PEER MENTOR
Ana Ordoñez, SOARS

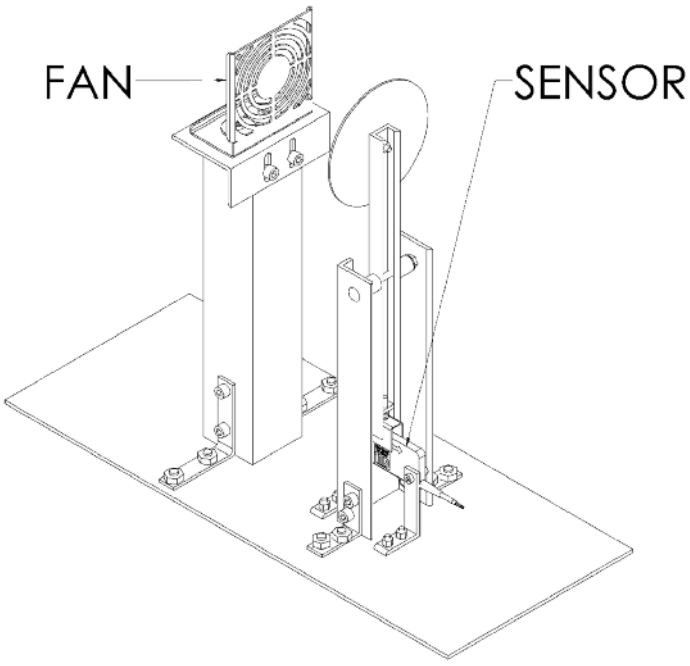
The terrestrial carbon cycle regulates carbon pools and fluxes throughout the Earth system. Currently, the Pacific Northwest is a carbon sink; it is gaining more carbon than it is releasing into the atmosphere. Investigating changes to this carbon sink is critical for understanding ecosystem responses to future environmental change. The Community Land Model version 4 (CLM4CN) was run with eight simulations for varying atmospheric changes. Half of the simulations ran using Qian climate data for 1948-2004, and half ran with climate data for 2075-2100 from the Representative Concentration Pathways 8.5 scenario (RCP8.5). One run from each group was forced with an increased carbon dioxide (CO_2) concentration of 937.87 parts per million (ppm), another was forced with an increased tropospheric ozone (O_3) concentration, the third included a combination of increased O_3 and CO_2 concentrations, and the fourth was a control. Carbon pools decreased with the RCP8.5 scenario in all simulations. An increased CO_2 concentration grew carbon pools in both climates. An increased O_3 concentration had the opposite effect. A combination of O_3 and CO_2 showed that carbon pools increased, and the increase was smaller than with CO_2 alone. Net primary production (NPP) and net ecosystem production (NEP) mirrored the carbon pool changes. Net ecosystem exchange (NEE) showed that an increased CO_2 concentration increased the carbon sink in both climates. The region became a source of carbon with increased O_3. The carbon sink increased with a combination of O_3 and CO_2, with the increase being smaller than the CO_2 alone.



The figure shows changes in the ecosystem carbon pool resulting from increasing gas concentrations in various simulations. The x axis represents the future climate scenario control. The black box represents the difference between the carbon pool with increased carbon dioxide (CO_2) and the control simulation. The grey box is the difference in the carbon pool between the simulation with increased ozone (O_3) and the control simulation. The white box is the carbon pool difference between the simulation with a combination of both gases and the control simulation. There is carbon pool growth for increased CO_2 (black box), growth for an increase in both O_3 and CO_2 (white box), and a decrease for increased O_3 (grey box).

Evaluation of Windows with LabVIEW for use as a telescope pointing control system

Solar telescope pointing requirements have increased over the past decade as research has driven finer spatial scales. This research reexamined an existing method for solar telescope tracking utilizing a traditional desktop operating system and a tracking and control program. A drawback of using traditional operating systems is the limitation in handling and processing interrupts. These inherent latencies can extend the turnaround time from pointing-error sensor signal to the output control signal. We performed a quantitative analysis of a Windows (64-bit) operating system running LabVIEW in controlling the position of a lever arm influenced by air flow from a fan. A comparative analysis of an interrupt-control operating system has led to three determinations: there exists an optimal time difference, or signal-phase shift, between the input signal and the controls reaction signal; the non-determinism of desktop computers used for tracking and control interferes with the optimization between sensing and reaction of said systems; tracking and control systems would benefit greatly without a non-deterministic operating system.



The fan-sensor assembly represents the basic fundamental idea behind tracking and control through feedback. The fan pushes the vane so the arm is positioned to a given place on the sensor.

Stanley G. Edwin

3rd-year Protégé
Senior
University of Alaska, Fairbanks
Applied Physics

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Dan Marsh, NCAR

Evidence for elevated stratopause events in modern and historical meteorological data (1957-present)

ADRIANNA HACKETT

3rd-year Protégé
Graduate Student
University of Colorado at Boulder
Atmospheric and Oceanic Science

MENTORS

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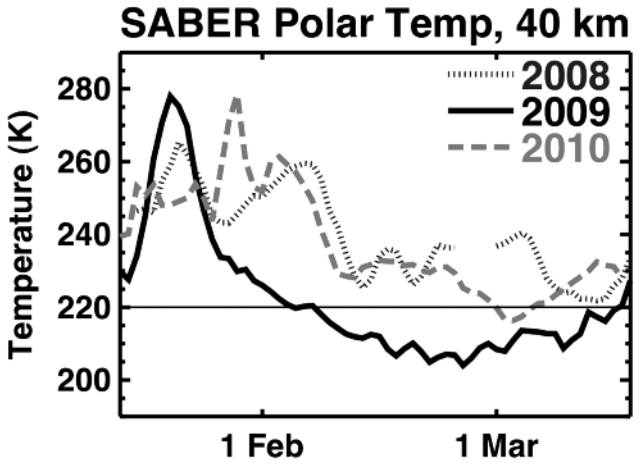
Cora Randall and Lynn Harvey, CU

WRITING & COMMUNICATION
Leslie M. Hartten,
CIRES/NOAA ESRL

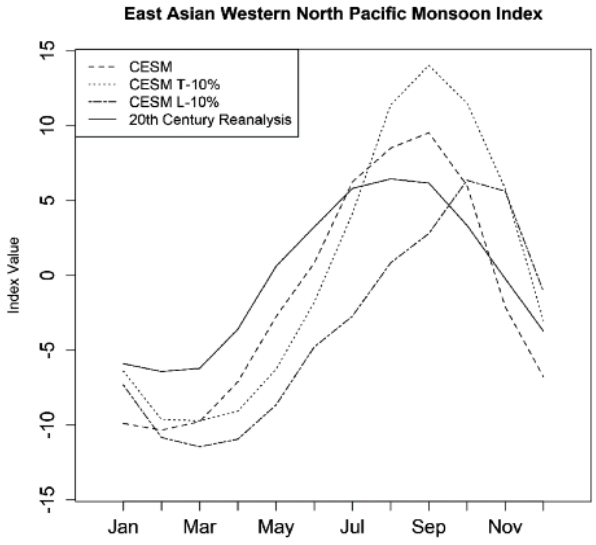
The stratospheric ozone budget is important to understand since ozone protects the Earth's surface from harmful ultraviolet radiation and plays a primary role in controlling stratospheric temperatures. One factor controlling the budget is descent of NO_X ($NO + NO_2$) from the mesosphere and lower thermosphere into the stratosphere where it catalytically destroys ozone. In northern hemisphere (NH) winters dynamical activity can lead to sudden stratospheric warmings (SSWs), which are sometimes followed by enhanced descent of NO_X in the mesosphere. In the region of enhanced descent the air compresses and warms, ultimately resulting in formation of a new, elevated stratopause (ES). This work examines historical records and modern satellite data to identify winters in which ES events occurred. Historical data sets extend only to ~50 km, which is below ES formation altitudes; thus ES events cannot be identified directly. This limitation is addressed by identifying a proxy indicator at lower altitudes. Satellite and modern reanalysis data show that temperatures at 40 km remain below 220 K for longer than 14 days during all recent documented ES events. While temperatures at 40 km do extend below 220 K for winters with major SSWs, the duration of cooling does not persist as with an ES event. Further analysis will be completed to apply this indicator to European Centre for Medium-range Weather Forecast (ECMWF) 40-year reanalysis (ERA-40) data to determine the frequency with which ES events, and thus most likely enhanced NO_X descent, occurred from 1957–present.



SABER (Sounding of the Atmosphere using Broadband Emission Radiometry) daily average temperatures for latitudes poleward of 70° N from 15 January to 15 March of 2008, 2009 and 2010, at 40 km altitude. Years with an elevated stratopause (represented by 2009) show lower temperatures at 40 km than years with only major sudden stratospheric warmings (represented by 2010) and years without warmings or an elevated stratopause (represented by 2008).

Links between regional monsoon circulation and local hydro-climate in Southeast Asia

The Asian summer monsoon, consisting of 3 major subsystems, is characterized by a distinct seasonal precipitation onset that affects the regions of India, the Indochina peninsula, and East Asia. Current monsoon indices for Southeast Asia and the Indian subcontinent capture the large-scale circulation patterns and, in turn, the hydro-climate of the specified area affected by the Asian Monsoon System. However, their skill in representing regional circulation features and links to the local hydro-climate are less understood. Here, the variability within the Dynamical Indian Monsoon Index, the East Asian Western North Pacific Index, and the South Asian Monsoon Index was assessed, as were their links to regional climate features over Southeast Asia, using various observations and reanalysis products at monthly resolution and an extended 1300-yr pre-industrial control run with the Community Earth System Model (CESM). The monsoon indices in the model compared well with those in the reanalysis, with similar statistical properties. Furthermore, composites of precipitation, sea surface temperatures (SST), wind fields and moisture advection during years with an extreme monsoon index (i.e. top and bottom 10%) were explored for the three monsoon indices in the reanalyses and model, respectively. Composites demonstrate large-scale changes in Indo-Pacific SST, circulation, and moisture advection in Southeast Asia, consistent with effects on seasonal precipitation within the region. The analysis further investigated the paleoclimate of Southeast Asia through the CESM control run to identify natural cold SST periods and their effects on circulation and precipitation patterns to understand extended drought periods identified in tree-ring chronologies in Southeast Asia.



Seasonal cycle of the East Asian Western North Pacific Monsoon Index (EAWNP) is plotted to assess the skill of the Community Earth System Model (CESM) in representing monsoon circulation features across Asia. The EAWNP index is based on the 20th Century Reanalysis product from 1871 to 2010 (solid) and a 1300-year CESM preindustrial control run (dashed). Also shown is the mean seasonal cycle during the upper/lower 10% monsoon index years.

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Evaluation of the planetary boundary layer derived from COSMIC GPS radio occultation soundings over the VOCALS-REx area

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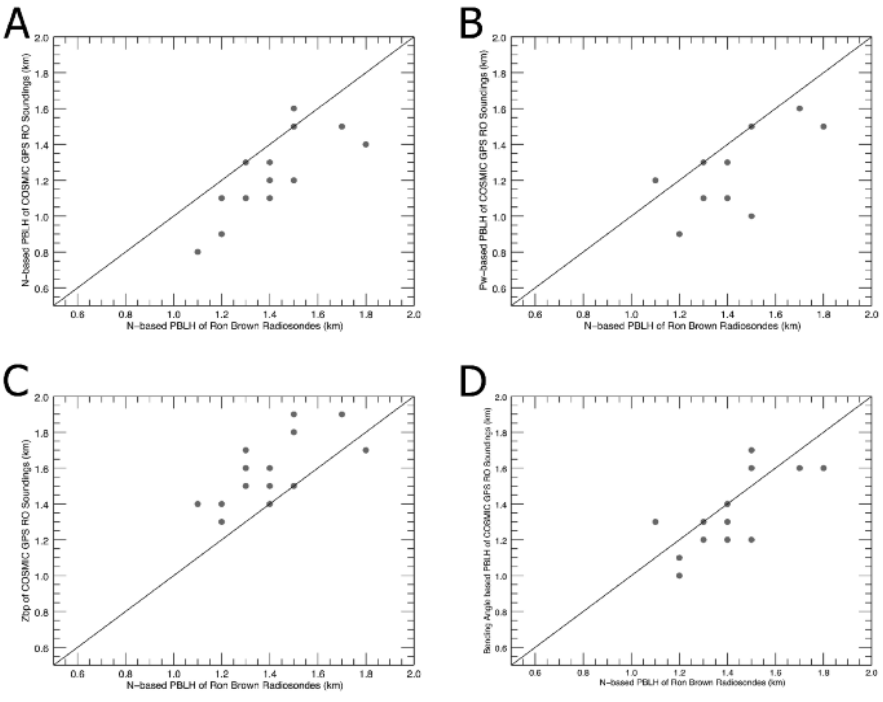
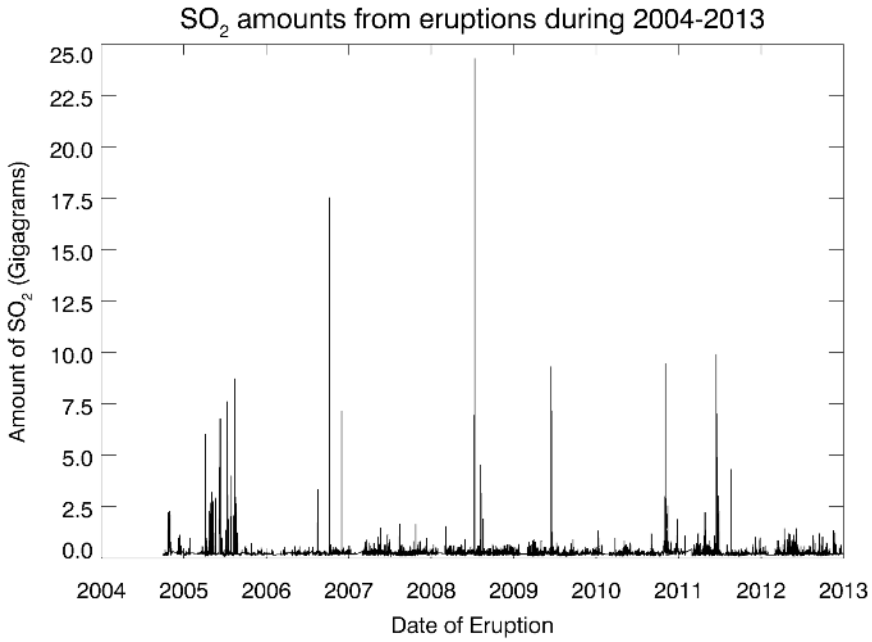
Earth's planetary boundary layer (PBL) plays an important role in water vapor and heat exchange between the surface and lower atmosphere through turbulent processes. Using data from the COSMIC/FORMOSAT-3 global positioning system (GPS) radio occultation (RO) soundings and high-resolution radiosondes launched during the VOCALS-REx (the VAMOS Ocean-Cloud-Atmosphere-Land Study Regional Experiment), PBL heights of collocated points between RO soundings and radiosondes launched onboard the NOAA R/V Ronald Brown ship were evaluated. Four definitions of PBL height (H) based on RO profiles were considered, two based on refractivity (N), one based on bending angle and the other based on partial water vapor pressure (Pw). One of the two methods based on refractivity defined H as maximum vertical gradient of N; the other defined H as the "break point" in the N profile, which is essentially the second derivative of N in the vertical. Results showed that, on average, PBLH from GPS RO soundings using the "break point" definition were slightly higher than those from radiosondes, while the H estimates from the other three methods were somewhat lower. The RO refractivities showed a negative bias compared to radiosondes below the PBL top. The likely reason for the negative N bias is due to super-refraction that occurs when the vertical gradient of refractivity exceeds the critical refraction value of ~157 N-unit km-1. Therefore, the reduced refractivity and its vertical gradient would then affect the N-based and Pw-based PBLH defined from GPS RO soundings. The comparison of the four methods for estimating PBLH from the RO observations indicated that those based on bending angle profiles were more consistent with estimations from radiosondes in this study.



Scatter plots of **a**) refractivity based PBL heights from COSMIC and radiosondes launched onboard the NOAA R/V Ronald Brown ship, **b**) partial water vapor pressure based PBL heights from COSMIC and refractivity based PBL heights from radiosondes, **c**) Zbp (the height of break point in refractivity profile) from COSMIC and refractivity based PBL heights from radiosondes, **d**) bending angle-based PBL heights from COSMIC and refractivity based PBL heights from radiosondes.

Determining the vertical distribution of volcanic plumes and SO_2 column amounts from 2004–2013

The statistics of volcanic eruptions and injections of sulfur dioxide (SO_2) into the atmosphere during 2004–2013 are determined using information gathered from the Smithsonian's Global Volcanism Program and the Ozone Monitoring Instrument (OMI), respectively. Volcanic eruptions are observed during this period, which is known as a quiescent period of no significant volcanic activity. A total of 6113 eruptions were analyzed during this period and we determined 93 instances of the volcanic plumes entering the stratosphere. The heights of the volcanic plumes are correlated to the corresponding SO_2 column amounts. We noted an increase in SO_2 column amount with increasing plume height in the Northern Hemisphere mid-latitudes while SO_2 amounts were more constant with increasing plume heights in the tropics. The amount of SO_2 injected into the atmosphere by the eruptions is calculated by using a $2^{\circ} \times 2^{\circ}$ grid surrounding the center of each volcano. The grid represented the bulk of the SO_2 that could possibly be carried into the stratosphere and have an impact on the stratospheric aerosol optical depth (AOD). We observed a total of 1.8 teragrams (Tg) of SO_2 injected into the atmosphere during this period. We noted a correlation between increased SO_2 from tropical volcanic eruptions and increased stratospheric AOD integrated from 15km to 40km. The research presented allows for further distinctions of the volcanic contributions of SO_2 in our atmosphere from anthropogenic sources of SO_2 such as those originating from thermal power plants.



Time series of the amount of SO_2 injected into the atmosphere from each volcanic eruption during 2004–2013 determined using a $2^{\circ} \times 2^{\circ}$ grid surrounding the center of each volcano.

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An electrified atmosphere: Parameterizing conduction currents from electrified clouds in a global model

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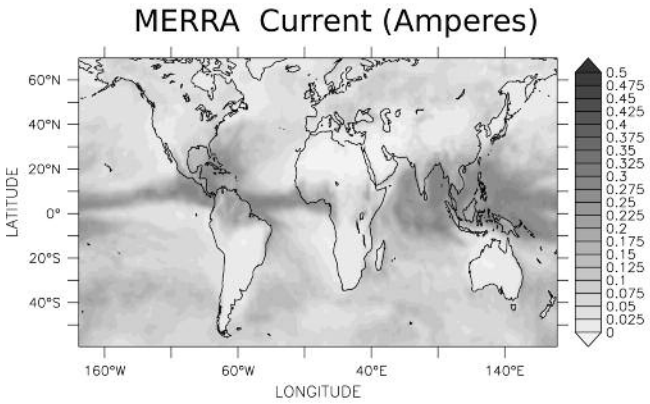
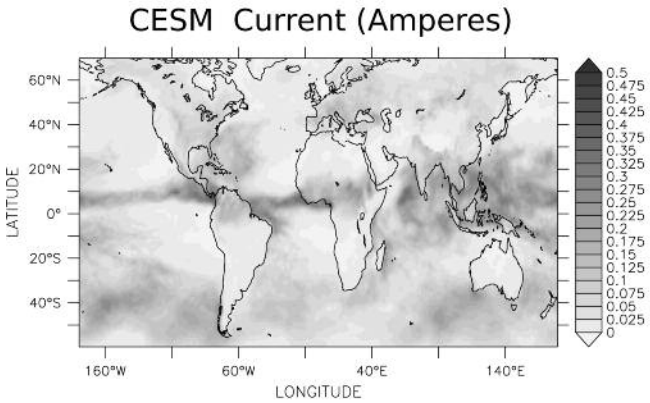
The Global Electric Circuit (GEC) is comprised of electrical currents controlled by a broad range of atmospheric events from the Earth's surface to the upper atmosphere. Electrified clouds in the Earth's atmosphere produce Wilson currents that flow from the top of the cloud. The electrification of these clouds and resulting Wilson currents may be described by cloud properties such as in cloud ice water path and convective mass fluxes. This research project concentrates on exploring whether characteristics of electrified clouds can be used in a global model to represent Wilson currents produced in the Global Electric Circuit. The characteristics of electrified clouds are modeled in the Community Earth System Model (CESM) and then verified by reanalysis data from the Modern Era Retrospective Analysis for Research and Application, MERRA. Then, a global distribution of Wilson currents was obtained by comparing measured oceanic and continental Wilson current distributions to oceanic and continental CESM and MERRA cloud characteristic distributions and relating cloud characteristics to these currents. The goal of this research is to develop an improved model parameterization of Wilson currents that furthers our understanding of how currents from thunderstorms affect the overall flow of current in the atmosphere and thus improves our understanding of the inner workings of the Global Electric Circuit.



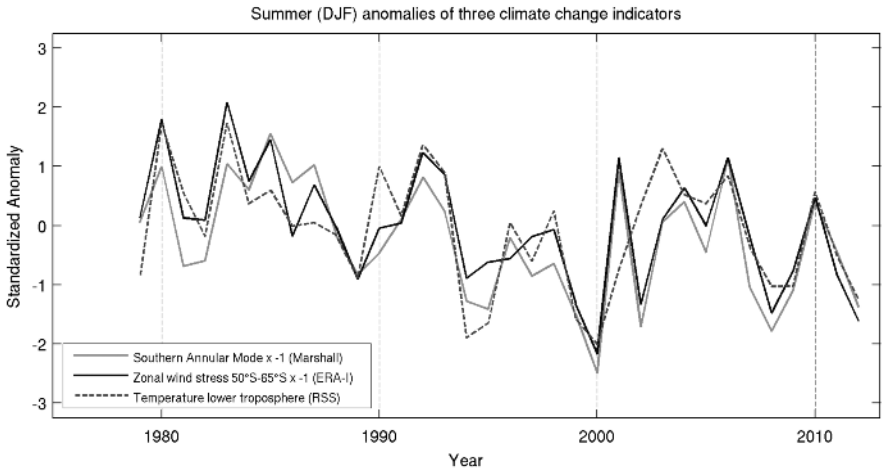


Global distribution of Wilson currents (A) parameterized from MERRA and CESM convection mass flux output intensities. The total global Wilson current produced by electrified clouds according to MERRA is 2695 A.

In contrast, the amount of current produced by the CESM model is 1982 A.

Antarctic climate change indicators

The Antarctic climate is both extreme and highly variable, but there are indications it may be changing. As climate change in Antarctica can affect global sea level and ocean circulation, it is important to understand and monitor it. Observational and model data have been used to study climate change in Antarctica and the Southern Ocean, though observational data is sparse and models have difficulty reproducing many observed climate features. For example, a leading hypothesis that ozone depletion has been responsible for sea ice trends is struggling with the inability of ozone-forced models to reproduce the observed sea ice increase. The extent to which this data-model disagreement represents inadequate observations versus model biases is unknown. This research assessed a variety of climate change indicators to present an overview of Antarctic climate that will allow scientists to easily access the synthesized data and compare indicators with other observational data and model output. Indicators were obtained from observational and reanalysis data for variables such as temperature, sea ice area, and zonal wind stress, with multiple datasets used for key variables. Monthly and annual anomalies from Antarctica and the Southern Ocean were plotted as time series on common axes for comparison. Trends and correlations were also computed. Several indicators, including sea ice and air temperature, had strong relationships and were further discussed. The charts, graphs and statistics produced will be a useful tool for scientists, enabling them to critically evaluate hypothesized mechanisms of Antarctic climate change.



The standardized annual anomalies of the Marshall Southern Annular Mode index, zonal wind stress for 50°S-65°S, and lower tropospheric temperature during the summer (DJF). Temperature data is from Remote Sensing Systems (RSS) and the zonal wind stress came from the ERA-Interim Reanalysis dataset (ERA-I). The baseline period is 1979-2010. The original anomalies were computed by subtracting the monthly means computed over the entire time series from each month and averaging by season.

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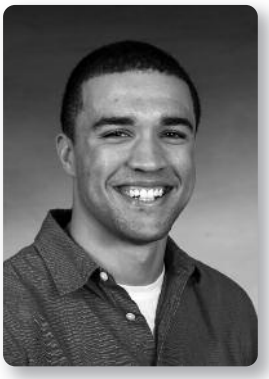
Methane emission resolving power of the proposed GEO-CAPE satellite



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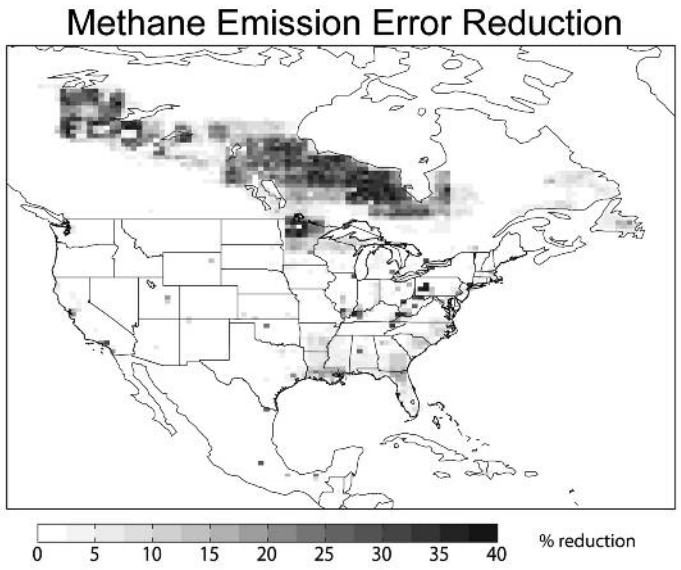
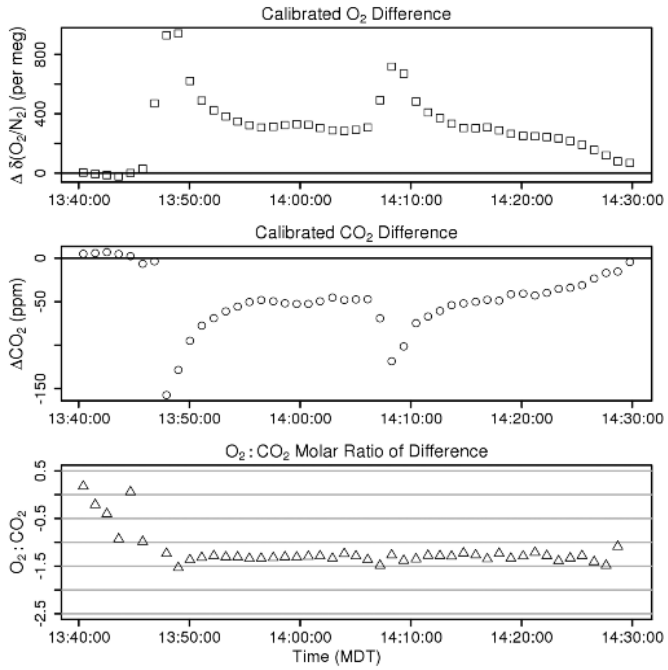
Methane is an important greenhouse gas in the atmosphere, ranked second behind carbon dioxide in total preindustrial to present radiative forcing. Despite a well-constrained global methane budget, there are still large uncertainties regarding the magnitude and trend of emissions at regional scales. Recent studies of methane emissions from the U.S. natural gas industry have found discrepancies between reported emission inventories and values observed in field studies. The observed differences increase the net climate impact of natural gas usage and exemplify the need for improved, broad-coverage monitoring of methane. The proposed Geostationary Coastal and Air Pollution Events (GEO-CAPE) satellite mission plans to put an instrument into orbit capable of providing methane observations over North America. In this study, we examined the potential methane emission resolving ability of the GEO-CAPE instrument using a Monte-Carlo approach to approximate the posterior error. To do this, an ensemble of 50 simulations was performed where initial emissions and simulated satellite observations were randomly perturbed. Afterwards, the difference between the true emissions and estimated emissions were averaged to retrieve posterior error values. Initial results show that inversions using GEO-CAPE observations reduced the absolute emission error 20-40% in regions with moderate to high methane emissions. With near 100% relative error reduction in some instances, the ability to constrain emissions in North America with the GEO-CAPE instrument is promising. While further experiments are needed, initial results indicate that this instrument can provide the methane data necessary to further constrain methane emissions, which is crucial for investigating methane's climate impacts.



The average methane emission error reduction using simulated GEO-CAPE observations over North America. The percent reduction is the difference between the prior and posterior methane emission error averaged over 50 ensemble members.

A mobile oxygen versus carbon dioxide gradient sampler: An analyzer on the move

We have designed a compact oxygen (O_2) and carbon dioxide (CO_2) gradient sampler to investigate the relationships between exchanges of oxygen and carbon dioxide in a variety of locations. Measurements of local O_2:CO_2 flux ratios can help us better understand carbon and nutrient cycling by trees and soils. Microorganisms use organic carbon as food, consuming O_2 and producing CO_2 through respiration. Nitrifying bacteria acquire their energy by oxidizing ammonium (NH_4+) to nitrate (NO_3-). Because one C atom is oxidized by one O_2 molecule, CO_2 and O_2 soil flux ratios are expected to be close to -1 unless N (nitrogen) is undergoing nitrification. If the process of nitrification is occurring, then the ratio between CO_2 and O_2 should be shifted toward up to 30% more O_2 consumption by the soil, which will affect near-soil atmospheric O_2:CO_2 gradients. The mobility of this sampler instrument will allow us to collect local data about respiration and photosynthesis from different parts of an ecosystem in both natural and agricultural settings. The sampler uses infrared CO_2 and fuel-cell O_2 analyzers, each equipped with two detector cells. We have minimized measurement drift by rapid switching of two inlet gas streams between the two sample cells on the O_2 sensor, and by occasionally measuring air from two compressed air cylinders with known CO_2 and O_2 differences. Our laboratory tests have shown that this system can resolve O_2:CO_2 ratios over a 100 ppm CO_2 gradient to 0.005 mol O_2 per mol CO_2 precision (1σ) in one minute. The data acquired by this instrument will aid future analyses and contribute to testing models of CO_2, O_2, and N cycling.



The above figure depicts two measurements of diluted exhalations from human lungs. At 13:45, 13 cc of exhaled air was injected into a 5 l sample mixing volume, followed by a second 13 cc of breath from the same person at 14:07. The top chart shows the change in calibrated oxygen concentrations in per meg (1 per meg is equal to 4.8 ppm) over time. The middle chart shows the change in calibrated CO_2 concentrations in ppm over time and the bottom chart shows the ratio between the O_2 and CO_2 differences (O_2:CO_2 molar ratio) over time, which holds steady at 1.3 ±0.05 mol O_2 / mol CO_2.

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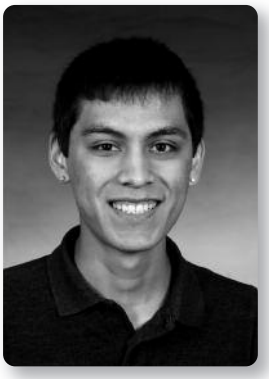
Automated source parameter and low level wind estimation for atmospheric transport and dispersion applications



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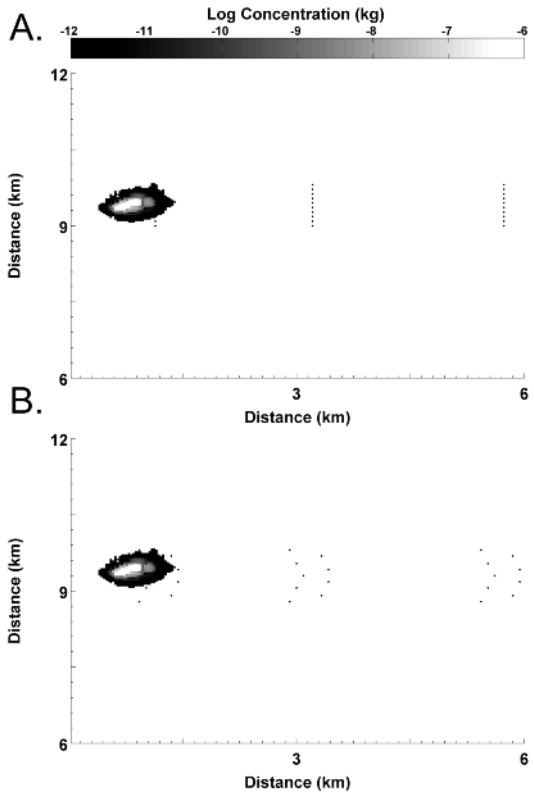
In the event of a chemical, biological, or radiological agent release into the atmosphere, forecasting the agent's transport and dispersion is key for safety and defense purposes. Atmospheric transport and dispersion (AT&D) models are capable of producing such forecasts, however, their solutions are sensitive to source characteristics and meteorological parameters such as release location, the amount of agent released, wind speed and direction. Many times these characteristics and parameters are unknown. Yet, determining such source terms has the potential to produce improved AT&D forecasts. There are many different approaches for determining these source terms, but what is needed in a real-world scenario is both speed and accuracy. One operational model developed by scientists at the National Center for Atmospheric Research is capable of both estimating the source terms and generating an AT&D forecast based on these terms. Until now, the model has been tested against a very limited set of plume dispersion scenarios; therefore we have conducted a more rigorous examination that includes a broader variety of plume dispersion scenarios with varying travel distances, sensor configurations, and plume detection methods. In addition, the limits of the model's performance were evaluated. This was done by feeding the model erroneous wind data and determining where forecasts were accurate (successful) and where they were not (failure). Preliminary results have shown that the source estimates from the straight-line layout are better than the source estimates from the two-row layout.



Agent plume traveling across a straight-line sensor layout (a) and a two-row sensor layout (b) in a 6 x 6 km close up.

SOARS GRADUATE PROTÉGÉ RESEARCH

SOARS helps students to bridge the transition from undergraduate institutions to graduate school. The ability for protégés to come back for summer research internships after beginning graduate school provides them with the opportunity to collaborate with NCAR scientists on what will, in many cases, become their graduate research theses. Over the years a number of SOARS mentors have served on protégés' graduate committees, and have often continued to collaborate and publish with their protégés long after they graduate from SOARS. This summer, several protégés came to SOARS with the support of their graduate advisors to work on graduate research. SOARS appreciates this collaboration between protégés, university faculty, SOARS, NCAR scientists and the wider UCAR community. The following abstracts reflect the research carried out by these graduate protégés during the summer, with the summer research serving as only a small piece of a much larger project.

Vulnerability to tropical cyclone flooding

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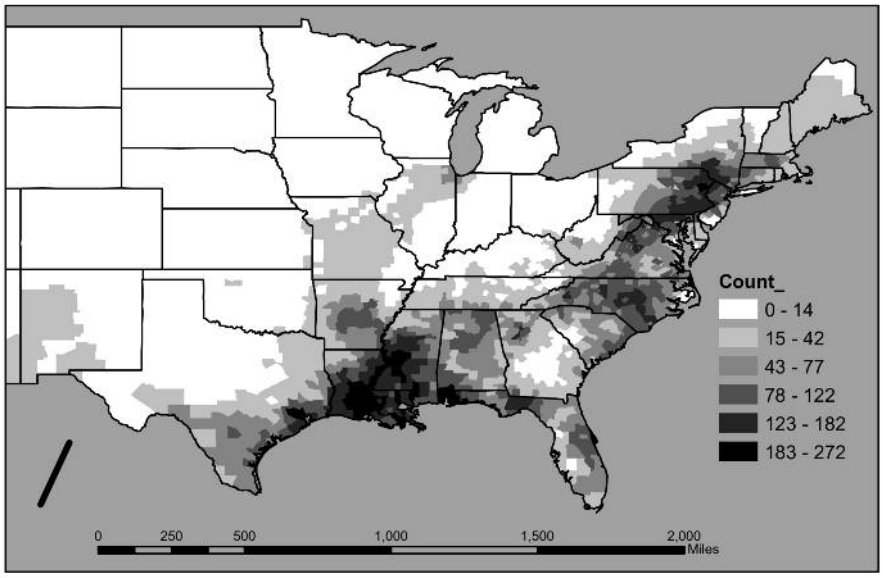
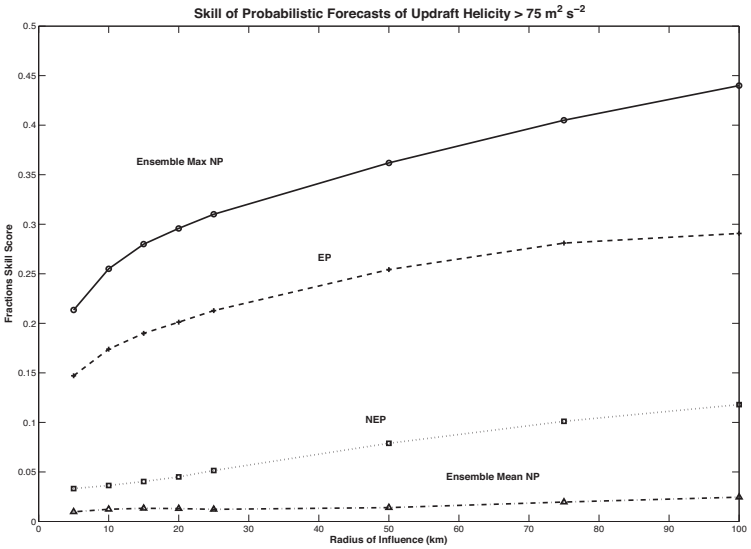
Flooding is the second leading cause of fatalities due to weather related disasters in the United States. Previous work assessing flood fatalities from 1959-2005 revealed a fifth of all flood related fatalities were a result of tropical systems. A recent study of tropical cyclone (TC) related fatalities unveiled 82% of deaths between 1970 and 1999 were a result of drowning. More specifically, 59% of all TC related deaths were due to freshwater flooding. Other studies have also shown a growing trend in flood devastation on the economic and loss of life scale. In an effort to reduce TC flood impacts this study develops a risk index for tropical cyclone-related flooding. Previous flood vulnerability research used stream data and rainfall to assess the likelihood of flooding. Our study differs by using historical TC rainfall data together with TC-related flash flood warnings to develop a climatology of TC flood potential. Results show a far richer spatial structure to the flash flood warnings compared to the smoother TC rainfall climatology, with high flood potential extending far inland in some regions. This index will be incorporated in an overall hurricane disaster risk assessment that will include inland and coastal hazards.



Climatology of flash flood warnings resulting from 85 U.S. landfalling Atlantic Basin tropical cyclones from 1988-2012.

Verifying WRF ensemble forecasts of updraft helicity

Increased computational power has allowed for numerical weather prediction models to be run with horizontal grid spacings of a few kilometers. Such convection-permitting forecasts are capable of producing reasonable representations of convective development without using a cumulus parameterization scheme. Nevertheless, these forecasts cannot fully resolve localized severe weather phenomena, such as large hail, strong winds, and tornadoes that occur on horizontal scales of hundreds of meters to a few kilometers. Thus, in order to predict these phenomena, proxies for these hazards must be generated from model-simulated fields. The proxy used in this study was updraft helicity (UH), which predicts updraft rotation that occurs in the mesocyclones of supercell thunderstorms. This study focused on the predictability of mesocyclones because supercell thunderstorms commonly produce severe weather. Forecasts of UH for one severe weather case were generated from a five-member, convection-permitting Weather Research and Forecasting (WRF) ensemble and were verified against a rotation tracks product developed at the National Severe Storms Laboratory. The rotation tracks product is a measure of azimuthal shear derived from the radar radial velocity field. Neighborhood probabilities of the forecast and observed fields exceeding specified thresholds were computed and used to calculate fractions skill score, probability of detection, and probability of false detection. Results showed useful guidance in predicting areas of rotation, particularly when using the ensemble maximum neighborhood probability of UH. Considering the ensemble maximum increased the probability of detection relative to that of any individual forecast.



Fractions skill score plotted as a function of radius of influence for four methods of calculating ensemble probabilities of updraft helicity greater than 75 m2s-2: the traditional ensemble probability (EP), the neighborhood ensemble probability (NEP), ensemble maximum neighborhood probability (NP), and the ensemble mean NP. Skill scores shown for forecast probabilities computed during an 8-hr time window and verified against the NP of rotation track magnitude greater than 50 s-1.

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Vanishing Points™ in South Terrebonne Parish: An assessment of technology's future role on climate change adaptation

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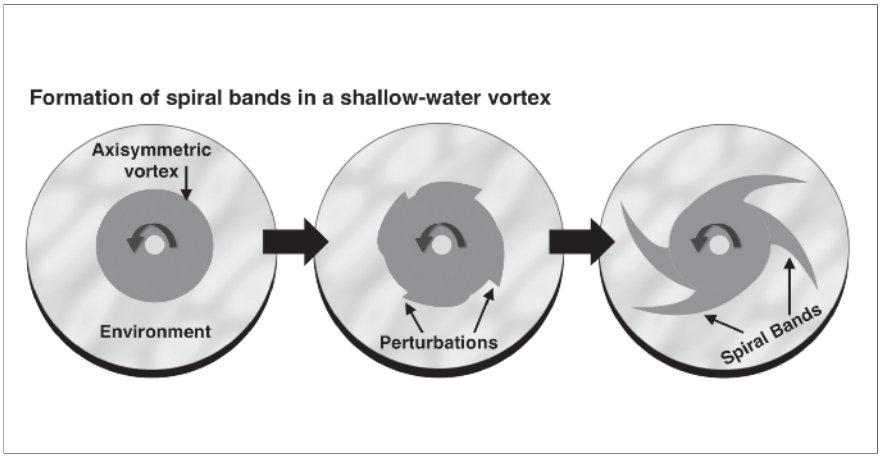
Currently, southern Louisiana is undergoing extreme land loss at an alarming rate of about 16.6 square miles annually, which is equivalent to losing one football-sized swath of land every hour. The combined deleterious effect of land subsidence, sea level rise, salt water intrusion, and various other processes threaten the culture and livelihood of the residents living in this region. This study uses participatory techniques to highlight the need for collaborating with community members for future climate change adaptation decision-making and planning. Traditionally, research into environmental disasters, such as land loss, has been attributed to physical sciences. This approach, however, does not address the human elements such as risk perception and attachment to place. To address this limitation, this study investigates the use of an interdisciplinary approach by collaborating with the residents of South Terrebonne Parish to develop the mobile application Vanishing Points™. The application serves as an educational tool that provides awareness of the culture being threatened by land loss in this region. Vanishing Points™ showcases locations and the history of cultural significance attained through participatory action research (PAR) methodology. Additionally, surveys completed by 200 residents provide insights to their attachment to place as well as their understanding and/or concerns about coastal land loss, wetland restoration, and climate change. It is expected that these survey results will support PAR projects such as Vanishing Points™ for use in disaster and climate change adaptation, planning, and mitigation.

Screenshots of the mobile application Vanishing Points™.

Investigating the stability of a balanced shallow-water vortex: A first step towards better understanding the formation of tropical cyclone spiral rainbands

Spiral rainbands are curved patterns of clouds and precipitation outside of the inner-core region of tropical cyclones (TCs). These features are often the source of various TC-related threats, such as flash flooding, landslides, and tornadoes. Their appearance in satellite imagery is often used to estimate TC intensity. Moreover, previous studies suggest that examining spiral rainbands can help understand changes in TC intensity.

Numerous ideas have been proposed to explain the formation of TC rainbands. Two of these hypotheses have been extensively investigated. The first characterizes rainbands as manifestations of inertia-gravity waves. The second describes rainbands as propagating Rossby waves on a circular vortex, called vortex-Rossby waves. Despite these and many other efforts, there is still no widespread agreement in the literature about how TC spiral rainbands form. This study approached the problem by analyzing the stability of an idealized vortex in a shallow-water system. The purpose was to understand the characteristics of perturbations to a simple flow that grow as spiral bands. Insights from this analysis will be applied to three-dimensional simulations of TCs produced by the System for Atmospheric Modeling (SAM). SAM represents the state of the art in numerical simulation of clouds and thus offers a promising tool to clarify the formation of TC spiral rainbands.



Schematic diagram showing a balanced axisymmetric shallow-water vortex that develops spiral bands. This study examined the stability of such a vortex to perturbations as a first step towards better understanding the formation of tropical cyclone spiral rainbands.

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Assessing the impact of initial condition errors on intensity forecasts of Hurricane Katia (2011)

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WRITING & COMMUNICATION
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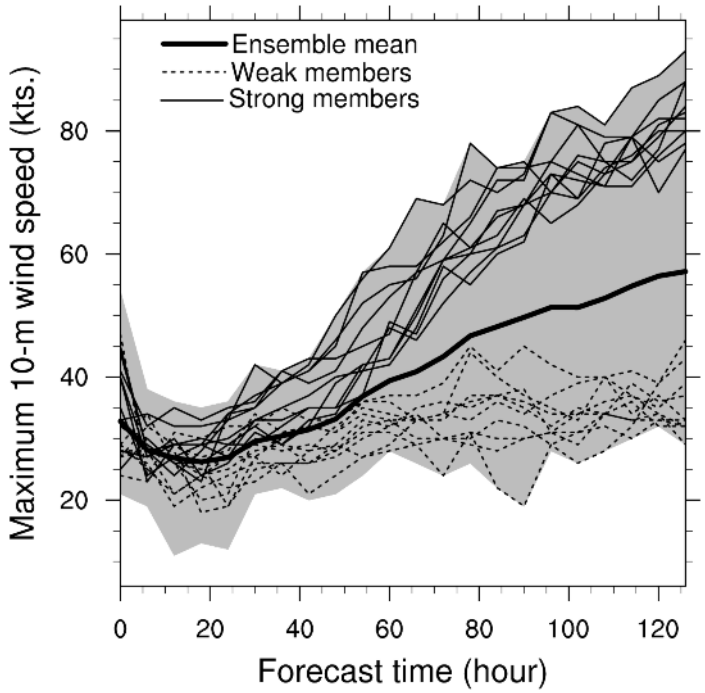
Why is predicting the strongest winds within tropical cyclones (TCs) such a challenging task? One possible reason is the uncertainty in the forecasts that originates from poor representations of TC structure in the initial conditions of numerical models. To understand how initial-time errors can lead to large intensity forecast uncertainty, this study examined ensemble forecasts from the Advanced Hurricane Weather Research and Forecasting (AHW) model. Specifically, the research efforts were focused on the poorly forecasted Hurricane Katia (2011) by using 96 ensemble forecasts from the AHW model. Two distinct subgroups were identified and extensively studied: 1) 10 members that predicted a strong hurricane (named strongest members) and 2) 10 members that predicted a weak storm (named weakest members). Composites of these two subgroups were created to diagnose how differences in the initial conditions of these members resulted in substantially different forecast scenarios. Results indicated that both subsets were initialized with a relatively strong vertical wind shear, but the strongest members had more water vapor in the downshear and right-of-shear quadrants. The moist environment in these quadrants aided TC intensification by maintaining and enhancing the shear-organized convection. Initial vorticity asymmetries were also substantially different. In the strongest members, a cyclonic vorticity feature located downshear seemed to have played an important role in strengthening the TC vortex. These findings suggest that sampling and assimilating observations from the downshear and right-of-shear flanks of TCs could help reduce the uncertainty in the initial conditions, thus increasing the accuracy of numerical TC intensity forecasts.



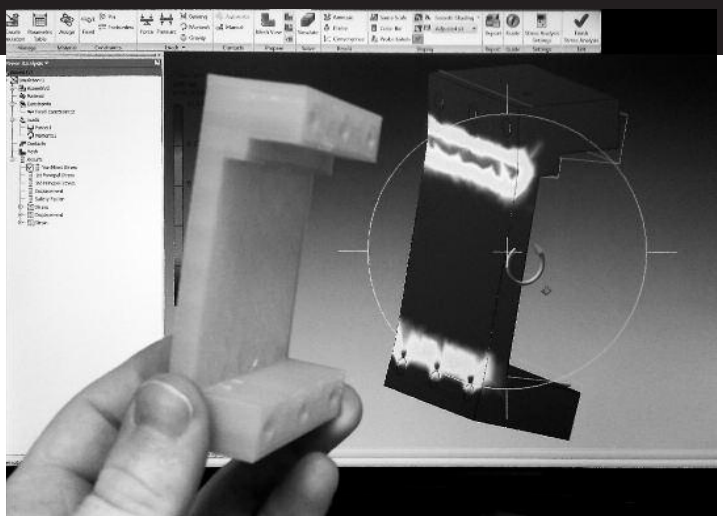
Five-day intensity forecasts for Hurricane Katia obtained from the Advanced Hurricane Weather Research and Forecasting (AHW) ensemble forecasting system. The gray shading denotes the maximum 10-m wind speed spanned by all ensemble members at each hour. The thin, dashed lines depict the 10 weakest members, while the thin, solid lines depict the 10 strongest members. The mean of all the ensemble members is represented by the thick solid line.

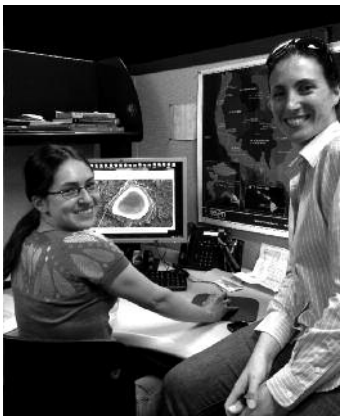
NEON INTERNS

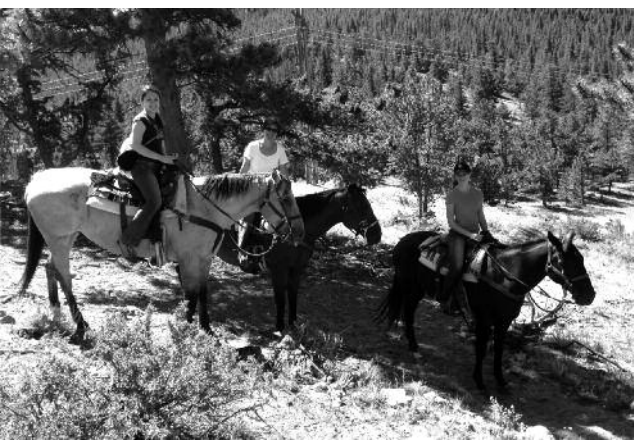
National Ecological Observatory Network

NEON's Internship Program is designed to help undergraduate students in science, engineering, and environmental communications build successful work experiences and prepare for future STEM careers. ❖ Intern projects span the breadth of NEON's endeavors — from engineering instruments for long-term field deployment to analyzing complex data sets for signals indicating environmental change and communicating NEON's mission and results to public audiences. A cornerstone of our program is mentoring. Each intern receives support from his/her own team of mentors who guides their work and provides insights on career options and career paths. NEON interns receive training in scientific communications, an important skill for STEM professionals, and are given multiple opportunities to practice sharing their work in a variety of formats including scientific or technical papers, posters and oral presentations. Our goal is for interns to leave NEON with completed projects they are proud to include on their resume along with workplace skills that position them as future leaders in their field. ❖ Because NEON is committed to broadening participation in science and engineering fields, and this is reflected in the mission of the internship program, we are particularly interested in working with students from historically underrepresented groups in science and engineering. From early in the design process, NEON consulted with SOARS to ensure our program used best practices for recruitment and intern support. We also collaborated with SOARS on cross-program student activities such as leadership training and scientific communications workshops that strengthened all students' experiences. ❖ NEON is proud of its first cohort of interns, and of their significant contributions towards building our national ecological observatory from the ground up.

Interns are pictured left to right:
Adrienne Rodriguez, Abigail Oakes, Nicole Dear, William Ennis

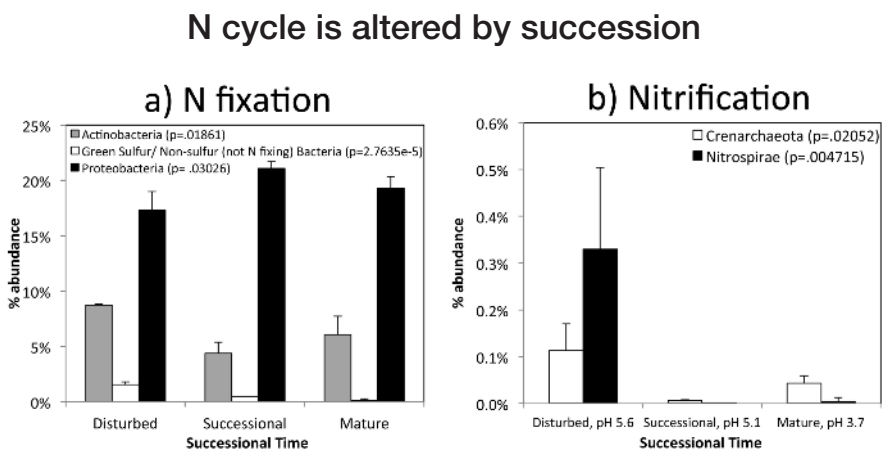






Successional changes in soil microbial communities in a Northeastern U.S. hardwood forest

Soil microbial communities are important components of terrestrial ecosystems, driving many key processes such as nitrogen (N) fixation and carbon (C) sequestration. Despite the importance of soil microbial communities, little is known about how they respond to disturbance and change with succession. The National Ecological Observatory Network (NEON) monitors causes and responses of changing ecosystems on a continental scale and provides a platform to address these concerns. Soil microbial community samples were collected from ten plots at three successional stages (disturbed, successional, mature) from a mixed northern hardwood site at Harvard Forest. Samples were processed for 16S rRNA and mRNA sequence information and compared to determine if succession significantly impacted community structure and function. Statistical and trend analyses provided insight into how soil microbial communities respond to forest disturbance, and ultimately how these responses influence the ecosystem processes they drive. It was observed that N fixation and nitrification were altered by succession. Nitrogen fixation by free living N-fixing bacteria (Actinobacteria, Chlorobi) was highest in the disturbed stage while activity by plant associated N-fixing bacteria (Proteobacteria) was highest in the mature stage. Low soil pH in the mature successional stage correlated to a decreased abundance of nitrifying bacteria and archaea and an accumulation of C, likely caused by nitrification inhibition in these acidic soils. This study also helped validate the NEON sampling design and ability of data collected to address biologically meaningful questions.



Abundance of bacteria with succession. Figure **a**) shows the change in abundance of free living (Actinobacteria and Green Sulfur Bacteria) and plant associated (Proteobacteria) N-fixing bacteria, while **b**) demonstrates the change in abundance of nitrifying bacteria and archaea that accompany an increase in soil acidity associated with succession.

Nicole Dear

Senior
University of Michigan
Microbiology

MENTORS

PROJECT
Jacob Parnell

WRITING & COMMUNICATION
Liz Goehring

COMMUNITY
Michael SanClements

Design and prototype of STREON aquatic organism exclosure

William G. Ennis

Junior
University of Alabama
at Tuscaloosa
Mechanical Engineering

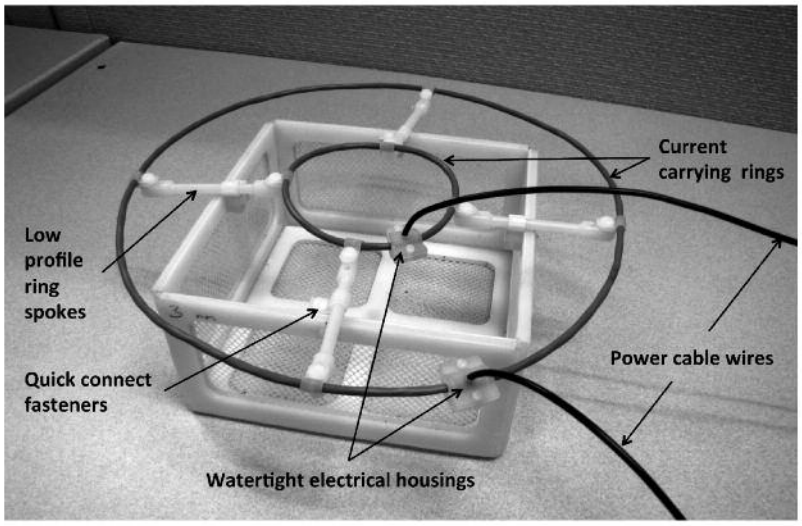
MENTORS

PROJECT
Susan Tower, Andrew Sparks,
Ryan Utz

WRITING & COMMUNICATION
Liz Goehring

COMMUNITY
Nicholas Applegate

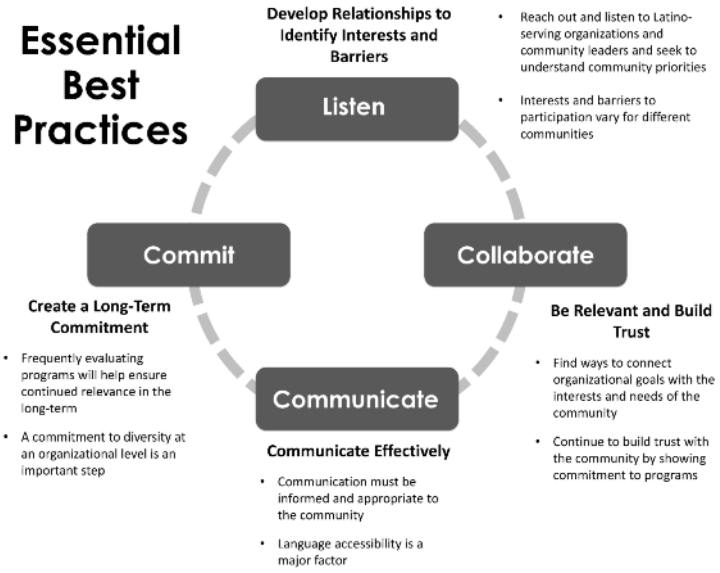
The STReam Experimental Observatory Network (STREON) is an ecological experiment supported by the National Ecological Observatory Network (NEON) to experimentally stimulate environmental stressors to observe changes in aquatic ecosystems. One primary STREON treatment involves a patch-scale elimination of top consumers (i.e., fish) from food webs. The treatment will be accomplished by creating an underwater electrical field around patches of stream bottom. The field is generated by passing electric current through two concentric metal rings. This project involved the design and preliminary test of the STREON rings and components and presented the following engineering challenges: creating a watertight connection between the rings and the power source cables, anchoring the rings to the STREON underwater apparatus (a basket filled with sediment), and ensuring rigidity and strength of the ring assembly. The final product met the following design criteria: it used non-conductive materials, minimized resistance to water flow, was easy to assembly and disassemble in the field, and had a low manufacturing cost. STREON sites are located throughout the United States in environmentally heterogeneous environments; therefore all materials used in the final product were chosen to withstand variable temperatures, water conductivities, depths, and flow rates. Preliminary trials have shown that all components met or exceeded engineering requirements. The STREON exclusion experiment is planned to begin real-world trials in the next few years and achieve full-scale operation by 2017.



The STREON Aquatic Organism Exclosure consists of two components: the sediment basket and ring assembly (i.e., current-carrying metal rings, watertight electrical housings, and low-profile ring spokes). The rings are connected to opposite terminals of a power source, which induces a current that takes the shape of a dome surrounding the rings.

Inclusive environments: Developing outreach for Latino communities

According to the United States census, more than half of the growth in the total population of the United States between 2000 and 2010 was due to an increase in the Hispanic/Latino population, which represented 16% of the 2010 United States total population. Despite this increase, the National Science Foundation reported that Hispanics made up only 6% of the science and engineering workforce in 2010. Because Latinos are a growing portion of the United States population and have been historically underrepresented in the scientific community, many scientific organizations are searching for effective ways to engage these communities. In an effort to foster both awareness of and involvement in science, technology, engineering and mathematics (STEM) fields among Latinos, this study reviewed best practices for outreach to Latino communities. Best practices were summarized by the following concepts: develop relationships to identify interests and barriers, remain relevant and build trust, communicate effectively and create a long-term commitment. To begin applying these best practices at the National Ecological Observatory Network (NEON), situational analyses were conducted at two NEON sites that exist near large Latino communities. The analyses revealed that possible barriers including language, low socioeconomic status, and limited access to higher education should frame future NEON outreach efforts at these and other sites. These frames, in combination with the reviewed best practices, served as the basis for further recommendations for developing a NEON outreach program for Latino communities across the country.



Best Practices for Outreach to Latino Communities
The core best practices for outreach to Latino communities include listening to the community, collaborating with community groups, communicating effectively with community members, and committing to serving the community long-term. These best practices were derived from studies conducted by the Nature Conservancy, Environment for the Americas, and the Center for Diversity and the Environment.

Abigail Oakes

Junior
New College of Florida
Natural Sciences

MENTORS

PROJECT
Jennifer Walton, Liz Goehring

COMMUNICATION
Sandra Chung

COMMUNITY
Claire Lunch

Revealing lake ecosystem function from bathymetric, hydrologic, and land use modeling in ArcGIS

Adrienne Rodriguez

Junior
North Carolina State University
Environmental Technology
and Management

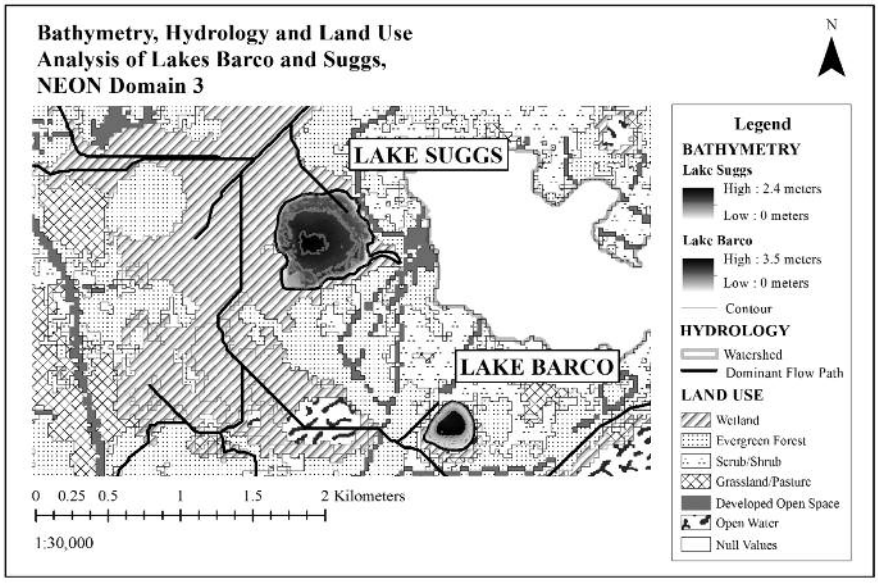
MENTORS

PROJECT
Charlotte Roehm, Melissa Slater

WRITING & COMMUNICATION
Liz Goehring

COMMUNITY
Jennifer Everhart

Lake ecosystem function can be assessed in part by measuring its bathymetry, watershed hydrology, and surrounding land use. For the next thirty years, the National Ecological Observatory Network (NEON) plans to provide data following standardized methods that undergo rigorous quality assurance. Raw L0 data will be converted to higher level data products using algorithms denoted in Algorithm Theoretical Based Documents (ATBDs). When rectified, the ATBDs and associated data products will be freely available for scientific, educational, and public policy use. For my project, ATBDs were created and tested for lake bathymetry, as well as watershed hydrology and land use. Included was development of the methodology for transforming L1 quality assured data into either L3 spatially rectified data, or L4 algorithmic models using ArcGIS. Analyses of two lakes (Barco and Suggs in central Florida) illustrate the ATBDs' product outcome and potential for deriving ecological information. For example, the bathymetric data show that both lakes are shallow, suggesting minimal lake stratification. The derived hydrologic and land use data show Barco is less influenced by external surface water inputs and wetlands than Suggs, thus increasing the likelihood for Suggs to experience higher nutrient and organic matter loading than Barco. Using ArcGIS enabled the potential detection of trends in lake ecosystem structure and function over time. The creation of each ATBD demonstrates the application, transparency and standardization NEON data can provide.



Bathymetry, Hydrology and Land Use Analysis of Lake Barco and Suggs, NEON Domain 3
Multi-layer data set representation of NEON Domain 3 watershed in central Florida. At the top of the map is Suggs Lake; while at the bottom is Barco Lake. Land use data provided by 2006 National Land Cover Database (NLCD). Bathymetric data provided by NEON, Inc. Hydrologic data is a 10 meter resolution Digital Elevation Model provided by USGS National Elevation Dataset.

SPARK–NCAR
PRE-COLLEGE INTERNSHIP

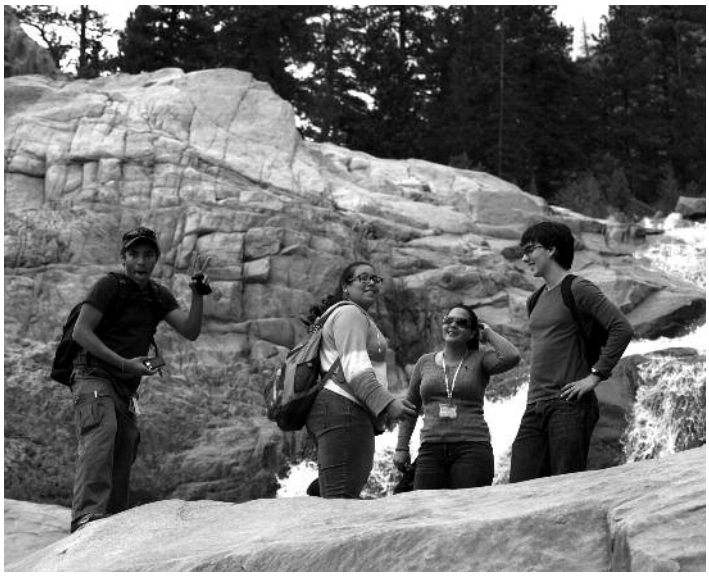
The SPARK-NCAR Pre-College Internship program is designed to provide high school and early college students with an opportunity to gain experience with real-world scientific research, computing challenges and engineering projects. Now in its fourth year, the program welcomed students from Puerto Rico. The Puerto Rican students attended the program through a partnership with the Anna Mendez University System's Pre-College Summer Research Internship Program. For eight weeks, all eight students worked with engineers, scientists and software engineers on projects ranging from development of web displays for certain aircraft in-flight icing tools to correcting precipitation gauge measurements for wind-based undercatch during snowfall. Students participated in seminars during the course of the eight weeks and several writing workshops, all of which helped to enhance their scientific writing skills and expose them to different topics within atmospheric science. They presented posters on their research at the conclusion of the summer program during a formal poster session open to all NCAR scientists and engineers. The Pre-College Internship Program is proud of their current and past students, almost all of whom have gone on to pursue college degrees in STEM-related fields.

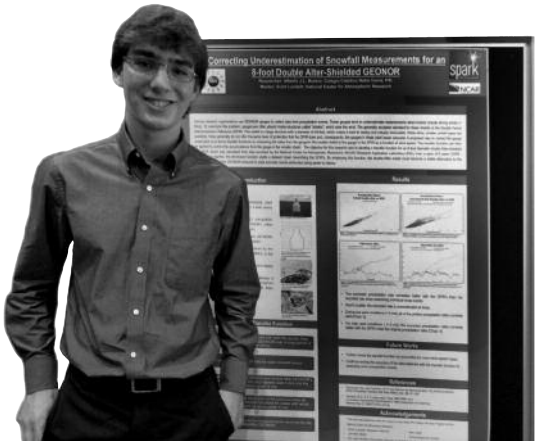
spark Pre-College Internship
UCAR science education

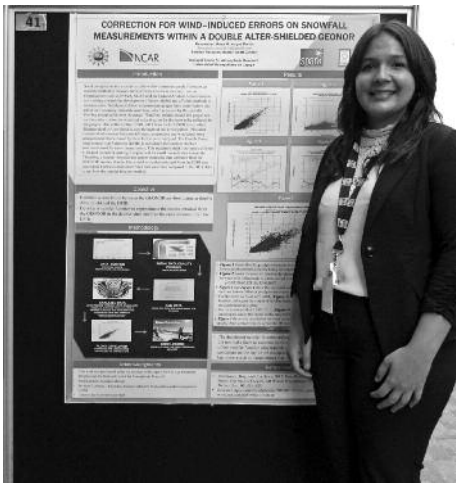
NCAR

Interns are pictured left to right:

Ricardo Tardí Hernández, Alejandro Aponte Lugo, Rosa Vargas Martes, Alberto Mulero Fernández, Normarie Román Roque, Emery Price Cancel, Gabriela Talavera-Santiago, Joseph Colon Villers, Stacey Wheeler (STAR-program Intern)




Correcting Underestimation of Snowfall Measurements for an
8-Foot Double Alter-Shielded GEONOR
spark
NCAR


41
CORRECTION FOR WIND-INDUCED ERRORS ON SNOWFALL
MEASUREMENTS WITHIN A DOUBLE ALTER-SHIELDED GEONOR
NCAR

Evaluating the accuracy of the OTT Parsivel to determine snowfall amounts

Over the years, various types of precipitation gauges have been developed to accurately measure snowfall intensities. Some of the most widely used gauges for snowfall measurement are the weighing gauges, but new optical-based sensors also have the ability to measure snowfall amounts. In this investigation, three gauges were compared: the OTT Particle Size and Velocity Disdrometer (Parsivel), the T-200b 1000 mm capacity GEONOR, and the ETI NOAH II gauge. Data collected from the OTT Parsivel were compared to those of the GEONOR and ETI and the differences were analyzed. Events with total accumulations lower than 2 mm were not used. Initial results showed scatter in the data when comparing rates from the Parsivel to the GEONOR and the NOAH II gauges. Some events showed good agreement between all three, while others did not. Additional research is ongoing to determine if other variables (temperature, wind speed, etc.) may be contributing to the scatter in the data.

Joseph Colón Villers

Chaperone
Spark-NCAR Pre-College Internship

Junior
Universidad Metropolitana, Recinto de Cupey
Mathematics

MENTORS

RESEARCH
Scott Landolt, NCAR and Stacey Wheeler, STAR

Effects of temperature changes and calibration drifting on the NOAH II All-Weather Precipitation Gauge

In atmospheric research, precipitation is one of the most essential variables. Presently, there are multiple instruments, called precipitation gauges, which are used to obtain the measurements of snow and rain precipitation. During the collection of data, these gauges are exposed to harsh and hostile environments, such as snow, water, winds, temperature changes and structural damage. These conditions not only affect the instrument's collection of precipitation, but also, the functionality of the instrument and the accuracy of the measurements. The purpose of this project was to analyze the effects of temperature on the equipment and determine if the calibration coefficients have drifted during use in the field. For this research, the model NOAH II All-Weather Precipitation Gauge was used. This gauge uses the load cell method for measuring precipitation. Various load cells from different NOAH II gauges were tested at room temperature and temperatures below zero Celsius. The results from these tests were compared to the previous calibration coefficients, showing that all of them had drifted from their original coefficients, affecting the accuracy of the readings. Some of them showed a parallel error, while others showed complete damage to the load cell. The temperature results were compared with the new room temperature results from the same load cell, also showing a change in the readings of the load cells. Consequently, maintaining the equipment in optimal conditions and understanding the instrumentation's behavior during different weather environments is vital for an improvement in the measurement's accuracy when reading precipitation.

Alejandro Aponte Lugo

Freshman
University of Puerto Rico, Mayagüez
Mechanical Engineering

MENTORS

RESEARCH
John Mickey, NCAR

Alberto J. L. Mulero

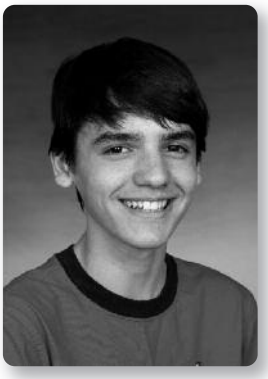
Colegio Catolico Notre Dame

MENTORS

RESEARCH
Scott Landolt, NCAR

Correcting underestimation of snowfall measurements for an 8-foot diameter double Alter-shielded GEONOR

Various research organizations use GEONOR gauges to collect data from precipitation events. These gauges tend to underestimate readings when events include strong winds (> 5ms^{-1}). To overcome this problem, gauges are often placed inside structures called "shields," which slow the wind. The generally accepted standard for these shields is the Double Fence Intercomparison Reference (DFIR). This shield is a large structure with a diameter of 40-feet, which makes it hard to deploy and virtually immovable. While other, smaller, shield types are available, these generally do not offer the same level of wind protection that the DFIR does and, consequently, the gauges in these tend to underestimate precipitation. A proposed way to correct the gauge undercatch is to derive transfer functions by comparing the rates from the gauge in the smaller shield to the gauge in the DFIR as a function of wind speed. The transfer function can then be applied to correct the accumulations from the gauge in the smaller shield. The objective for this research was to develop a transfer function for an 8-foot diameter double Alter shielded GEONOR, which was calculated from data recorded by the National Center for Atmospheric Research's (NCAR) Research Application Laboratory (RAL) over a span of 6 years (2008-2013). When applied, the developed function yielded a data set more closely resembling the DFIR's. By employing this function, the double Alter shield could become a viable alternative to the DFIR by correcting the GEONOR amounts to yield accurate results while also being easier to deploy.



Emery G. Price Cancel

Senior
Academia Bautista de Puerto Nuevo

MENTORS

RESEARCH
Scott Landolt, NCAR and
Stacey Wheeler, STAR

Wind bias correction of snowfall measurements for the single Alter-shielded GEONOR

The Double Fence Intercomparison Reference (DFIR)-shielded GEONOR is the reference shield for solid precipitation. However, a DFIR has a 40-foot diameter outer shield, which makes its use inconvenient for small weather stations and impossible for field meteorologists who have to be mobile. A single Alter-shielded GEONOR is more convenient to use because of its smaller size, but it suffers from the effects of undercatch. This is because the smaller shields can't efficiently slow the wind from passing over the GEONOR's orifice and carrying the precipitation with it. The main objective of this research was to correct a single Alter-shielded GEONOR's snowfall measurements to obtain results more similar to those of a DFIR. For the purpose of this study, the data used was collected from a GEONOR with a 4-foot diameter single Alter shield with 18-inch laths, as well as data from a DFIR-shielded GEONOR. Data from both gauges were matched and a transfer function was developed, which approximates the data measured by the gauge in the single Alter to that of the gauge in the DFIR and adjusting for wind undercatch. To test the transfer function, a scatter plot, which included both corrected and uncorrected single Alter GEONOR rates and the rates of the DFIR, was created. After applying the derived transfer function, it was concluded that there was a significant increase in accuracy of the single Alter-shielded GEONOR rates as compared to the DFIR-shielded GEONOR rates.

Field installation of 3D sonic anemometers for measuring wind velocity around a DFIR shield

The NCAR Marshall Field site is a site specialized for winter weather measurements. They primarily focus their research on the effect of wind shields around precipitation gauges. Most precipitation gauges are equipped with a wind shield to help slow the wind blowing past the gauge. A wind shield is a barrier made of wood and/or metal strips that prevents wind from blowing the precipitation over the top of the gauge. The standard wind shield is the Double Fence Intercomparison Reference (DFIR) which is an octagonal fence with an outside diameter of 40 feet and an inner fence that is 12 feet in diameter. In this research, we installed 3-Dimensional Sonic Anemometers in one DFIR for the study of the turbulent effects of wind. The 3D sonic anemometers can measure three orthogonal wind components based on the speed of sound. These anemometers were positioned strategically inside and out of the DFIR. Each anemometer collected data to be compared with one another to determine the turbulent flow of wind as it moves past the DFIR. Studying and analyzing the turbulent effects of wind will help understand how solid precipitation, carried along by the wind, falls into gauges.

Normarie Román Roque

Educación Bilingüe de Cidra, Certenejas II

MENTORS

RESEARCH
Albert Jachcik, NCAR

Suitability of containers as breeding habitats for the dengue vector mosquito aedes aegypti: experiments and model validation

Dengue is the most widespread arthropod-borne virus in the world, being endemic to tropical regions and causing an estimated 390 million infections per year. The primary dengue vector mosquito Aedes (Ae.) aegypti spends its life cycle exclusively near human habitation, and female mosquitoes preferentially bite humans for blood meals. Ae. aegypti utilizes a wide range of artificial containers as breeding sites, ranging in size from small trash items, to medium-sized buckets and tires, to large water storage containers. The development of immature Ae. aegypti to adulthood is strongly dependent upon availability of water and the container's water temperature. In this study, the environmental factors affecting representative mosquito breeding containers were assessed to determine their impact on water conditions. An experiment was conducted where containers of different size and color were placed outdoors in close proximity to one another, but sets of containers were placed in different shading conditions. Water temperature in each container was measured automatically every 15 minutes and evaporation was recorded daily for 28 consecutive days. Experimental data were analyzed and compared to output from the Water Height And Temperature in Container Habitats Energy Model (WHATCH'EM), which estimates water temperature and height for user-defined containers by solving for the energy balance. Results from the container experiments showed that there is a larger daily temperature range for smaller containers, and that shading largely drives daily average temperature, with container size and color being secondary. Comparison of observations with WHATCH'EM showed that the model successfully simulates day-to-day variations in temperature, but overall has a cold bias and underestimates evaporation.

Gabriela D. Talavera-Santiago

Colegio Noviciando Santa María del Camino

MENTORS

RESEARCH
Daniel Steinhoff and Andrew Monaghan, NCAR

Ricardo M. Tardí Hernández

Senior
High School
Homeschooling

MENTORS

RESEARCH
Andy Gaydos, NCAR and
George McCabe, NCAR

Developing a prototype of a Java-based display for icing hazard risk level

Ice accumulation on aircraft is one of the most life-threatening natural hazards that affect the safe operations of aircraft in the Northern Hemisphere. NASA is working on the development of remote-sensing technologies for the detection and measurement of icing conditions aloft, to eventually provide an icing hazard product for pilots' operational use. As part of that effort, NASA has partnered with NCAR to create software that fuses data from multiple ground-based instruments into a single detected icing condition product. Currently, the NASA Icing Remote Sensing System (NIRSS) provides a Java-based display with a resultant vertical profile of the icing environment directly above an airport, but future plans include a volumetric product to include the entire airport terminal area. This project expands the existing display to include an indication of icing hazard risk in the vicinity of the airport, including the corridors along major landing and takeoff trajectories, where the icing risk to aircraft is the greatest. The project consisted of various phases, including understanding the existing NIRSS display, the preparation of a layout for the new display window, the testing of different drawing methods and calculation of the trigonometric functions to draw the required shapes in the proper locations on the display. A prototype display was developed and integrated into the existing NIRSS display application. It was tested with a simulated dataset and is ready to display the actual data product as it is developed.

Rosa M. Vargas Martes

Freshman
Universidad de Puerto Rico,
Mayagüez Campus
Physics

MENTORS

RESEARCH
Scott Landolt, NCAR

Correction for wind–induced errors on snowfall measurements within a double Alter-shielded GEONOR

Solid precipitation is a crucial variable within climate research. However, an accurate method to measure snow remains uncertain for many reasons. Organizations such as NOAA, NCAR and the Federal Aviation Administration are working towards the development of more reliable and efficient methods to measure snow. Solid precipitation measurement gauges have many factors that affect their accuracy, primarily wind bias, which is caused by the updrafts blowing precipitation over the gauge. Therefore, shields around the gauges are used in order to slow the wind and make it easier for the snow to be collected by the instruments. Data collected from 2004-2013 from the GEONOR six-foot diameter double Alter shield was used throughout this investigation. Plots that contained information like snowfall rates, temperature and wind speed were analyzed and errors caused by these factors were recorded. The Double Fence Intercomparison Reference (DFIR) is considered the standard shielded instrument used for snow measurement. This standard shield is not space-efficient (~40-foot diameter), making it impractical for small research sites to operate. Therefore, a transfer function that approximates the data collected from the GEONOR six-foot double Alter shield to the data obtained from the DFIR was developed. Corrected and uncorrected data were then compared to the DFIR data. The transfer function was shown to approximate the events from the double Alter to the events from the DFIR, allowing the smaller shield instrument to have more accurate readings.

Key to Mentors' Affiliations

AGMUS	Ana G. Mendez University System
CIRES	Cooperative Institute for Research in Environmental Sciences
CU	University of Colorado at Boulder
ESRL	Earth System Research Laboratory
FIU	Florida International University
MIT	Massachusetts Institute of Technology
NCAR	National Center for Atmospheric Research
NEON	National Ecological Observatory Network
NOAA	National Oceanic and Atmospheric Administration
PU	Purdue University
SLWDC	South Louisiana Wetlands Discovery Center
SOARS	Significant Opportunities in Atmospheric Research and Sciences
STAR	Summer program for STEM teachers in training
STEM	Science, Technology, Engineering and Math
SUNY	State University of New York
UCAR	University Corporation for Atmospheric Research
UCP	UCAR Community Programs
WHOI	Woods Hole Oceanographic Institution

SOARS protégé Jenine McKoy in Rocky Mountain National Park.

2013 SPONSORS AND ACKNOWLEDGEMENTS

NEON Undergraduate Internship Program

National Science Foundation

SOARS

National Science Foundation,
Directorate for Geosciences, Atmospheric Sciences

National Center for Atmospheric Research

Center for Multi-scale Modeling of Atmospheric Processes
at Colorado State University

University of Colorado at Boulder

University Corporation for Atmospheric Research

Woods Hole Oceanographic Institute

Spark-NCAR Pre-College Internship

National Center for Atmospheric Research

National Science Foundation

Sistema Universitario Ana G. Méndez

University Corporation for Atmospheric Research

The material is based upon work supported by the National Science Foundation under Grants No. ATM-0618847 (SOARS), and Grant No. EF-1029808 (NEON).

This publication has been printed on recycled-content paper by an environmentally-friendly printer.

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Review Editors: Rebecca Batchelor, Scott Landolt, Liz Goehring

Photography: UCAR, NCAR, NEON

Design: Eugene Malowany, Malowany Associates

Printing: B&B Printers

On the cover: A supercell thunderstorm produces a funnel cloud over the plains of the Oklahoma Panhandle on May 31, 2007. Scott Landolt, NCAR.


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Undergraduate Internship Program
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www.neoninc.org/education/internship

Spark-NCAR Pre-College Internship
National Center for Atmospheric Research (NCAR)
www.spark.ucar.edu/programs/spark-pre-college-internship