SOARS is dedicated to broadening participation in the atmospheric and related sciences.

Earth, Wind, Sea, And Sky

Protégé Abstracts

SOARS is dedicated to broadening participation in the atmospheric and related sciences.
“The decisions of
civic life increasingly
involve knowledge
from our science.”

— Rajul E. Pandya
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Geoscientists are increasingly asked to contribute to complex decisions about our interaction with Earth and its resources. The topics dominate the news: oil and its geopolitics, famines, water shortages, spread of new diseases, loss of species, climate change, and air pollution. All of these share a common root: the rising challenge of integrating the wants and needs of a diverse and growing global population into a sustainable future for the planet and ourselves.

The atmospheric sciences, and indeed the geosciences, have an opportunity and obligation to contribute to these decisions. We can make the most of this opportunity with three strategies: striving to have our scientists mirror the diversity of the U.S. population, integrating our research into a multidisciplinary perspective, and reaching out to all the communities affected by and influenced by these decisions. All of these are aspects of making the atmospheric sciences inclusive: inclusive in participation, in issues addressed, and in collaboration with other disciplines.

Starting with the first aspect of inclusivity, we must emphasize the importance of having atmospheric scientists who reflect the diversity of the U.S. population. There are many well-articulated reasons to broaden participation in atmospheric science, including the imperative of fostering creativity, the need to make the U.S. globally competitive, and the necessity of drawing from the entire talent pool to meet future workforce demands. The most compelling reason for broadening participation, however, rises out of the increasing relevance of atmospheric science to our nation's democracy. When the Supreme Court affirmed “participation by members of all racial and ethnic groups in the civic life of our Nation is essential,” they were speaking in support of the diversity of future lawyers. Because the decisions of civic life increasingly involve knowledge from our science—an obvious example is climate change—the Supreme Court could have equally well been speaking about the need to broaden participation in the atmospheric sciences.

In 2005, SOARS celebrated 10 years of work to broaden participation in the atmospheric and related sciences. SOARS is a multi-year undergraduate-to-graduate bridge program that is equal parts learning community, mentoring program, and research internship. A central feature of the SOARS program is a 10-week summer immersion program in which protégés (SOARS participants) conduct scientific research at the National Center for Atmospheric Research (NCAR) or at laboratories of SOARS sponsors. During this summer research experience, SOARS protégés collaborate with up to four mentors to perform original research, prepare a scientific paper, and present their research at an end-of-summer colloquium. All of these activities are designed to engage, encourage, nurture, and prepare our diverse protégés as they pursue a career in atmospheric or related science.

The second aspect of becoming a more inclusive science is to invite collaboration from other disciplines. This collaboration is absolutely essential for the atmospheric sciences as many of the most challenging scientific problems in our science are emerging at the intersection with other disciplines. Interdisciplinary approaches can also help make our work more usable in civic life. For example, an integrated approach to flood risk is more useful than separate meteorological, hydrological, and demographic analyses. Of course, important interdisciplinary problems cannot be addressed effectively without deep wells of disciplinary expertise.

The final aspect of an inclusive science is a science that better reaches out to communities currently underserved by our science. Equity and justice mandate this approach: consider that the communities impacted by a changing climate include those who haven’t benefited as much from the industrialization contributing to the change.

As you look through this volume of *Earth, Wind, Sea, and Sky: Protégé Abstracts*, I hope you will find evidence that atmospheric science is moving towards an inclusive science in all three of the ways described. The individual abstracts reflect interdisciplinary investigations as well as deepened disciplinary understanding. The abstracts themselves chronicle the significant progress of the talented protégés, and the volume as a whole provides a glimpse of the collaborative community that supports these protégés and their continued academic and professional success. Within these pages, there is also a new interdisciplinary collaboration: SOARS partnership with Research Experience in Solid Earth Science for Students (RESESS), which seeks to broaden participation in the solid Earth sciences. Our first shared protégé has an abstract included in this volume. Finally, please notice that many SOARS protégés are doing research that responds to the needs of diverse communities.

To learn more about the work of these capable protégés or the SOARS program, I welcome you to visit our website at www.ucar.edu/soars.
In early 2006, the U.S.-Taiwan joint satellite mission known as the Constellation Observing System for Meteorology, Ionosphere and Climate (COSMIC) will launch six Low Earth Orbit (LEO) satellites. These satellites, each equipped with an advanced Global Positioning System (GPS) receiver, will use radio occultation (RO) limb sounding technology to profile the Earth’s atmosphere with unprecedented accuracy and vertical resolution. The GPS RO soundings available from COSMIC will make significant contributions to global weather prediction, ionospheric research, and climate monitoring. To demonstrate the potential value of GPS RO data in climate research, atmospheric refractivity obtained from GPS RO data in a recent single-satellite German mission, known as the CHAllenging Mini Payload for Geophysical Research and Application (CHAMP), was analyzed. This study examined the refractivity anomalies by altitude and latitude for each season of CHAMP GPS RO data, provided by UCAR’s COSMIC Data Analysis and Archive Center (CDAAC), from May 2001 through present. Refractivity anomalies across the globe were illustrated in color plots that identified any persistent anomaly patterns. A structure was identified over the tropical stratosphere from 20-30 km, which may possibly have a relationship with the Quasi-Biennial Oscillation (QBO). Results indicated that GPS refractivity data could be used to identify specific trends between seasons as well as to identify multi-year phenomenon such as QBO. This study highlights the usefulness of refractivity values from GPS RO data in climate research.
During abrupt climate changes, the climate system is forced across a threshold, causing evolution to a new, persistent state. Studies of abrupt climate changes are necessary to understand how these changes are transferred globally and to gain insight on future climate change. In this research, an abrupt climate change at 8.2 ka (8200 years ago) was simulated using the Community Climate System Model (CCSM) and focusing specifically on the global response of temperature and precipitation. This abrupt change is believed to have been caused by a massive amount of freshwater entering the Labrador Sea from a glacial lake near Hudson Bay. Previous simulations of this event used climate models of intermediate complexity or present-day boundary conditions for greenhouse gases and insolation. In this research, boundary conditions from 8.2 ka and a more comprehensive coupled climate model were used to improve the accuracy of the simulation. Significant global changes, annually and seasonally, were found in temperature and precipitation. The average annual global temperature before the freshwater perturbation was 12.1°C and after the perturbation was 10.7°C, corresponding to a -1.3°C change. Globally, the annual precipitation change was -0.08 mm day⁻¹. T-tests indicated that these changes were statistically significant at the 95 percent confidence level. These changes occurred in part due to a slowdown of the Atlantic meridional overturning (thermohaline) circulation and the resulting increase in the amount of sea ice in the North Atlantic. This, in turn, increased the Earth’s albedo and the Earth absorbed less incoming solar radiation.
Statistical analysis of the weekend effect in the Mexico City Metropolitan Area (MCMA)

Situated in an elevated basin 2240 meters above mean sea level, the Mexico City Metropolitan Area (MCMA) and its 20-25 million inhabitants have grappled with poor air quality for decades. The weekend effect compares values of weekend parameters to those on weekdays. These parameters include carbon monoxide (CO), ozone (O$_3$), oxides of nitrogen (NO$_x$), and temperature. This project utilized the Red Automática de Monitoreo Atmosférico (RAMA) network dataset, which consists of hourly measurements of 10 parameters from 32 sites over 18 years. Our study showed concentrations of CO and NO$_x$ to be higher during the week, except for early morning, 1 a.m. to 6 a.m. local time (LT), when their concentrations were higher on Saturday and Sunday. O$_3$ concentrations were typically higher during the week from 1 to 6 a.m. LT with Sunday concentrations higher until midday, when Saturday concentrations reached a maximum. Temperature showed very little variation throughout the week. In order to determine the significance of these differences, a Student’s t-test was used, which calculated the statistical significance of the difference between two means by comparing the two means to the variation of the data. Three time series for significance were conducted: Saturday versus weekdays, Sunday versus weekdays, and Saturday versus Sunday. The t-test suggested that the weekend effects observed in this study were statistically significant. The significance of the relatively small temperature differences suggested possible boundary layer meteorological conditions influencing the weekend effect. Further study of the weekend effect’s significance and implications is necessary.
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Synoptic analysis of significant snowfall events on Mt. Kilimanjaro

Ice cores recovered from Mt. Kilimanjaro provide evidence of significant climate changes in the East African region over the past 10,000 years. However, the atmospheric processes that lead to snowfall on Kilimanjaro are poorly understood. Earlier studies have suggested that East African climate is dominated by the seasonal shift of the tropical precipitation bands, yet the key factors causing interannual precipitation variability remain unclear, particularly for the long rains season (March-May). To advance the understanding of modern East African climate, this study used data from a new station on top of Mt. Kilimanjaro and put them into a regional atmospheric circulation context. First, the in situ data were compared to global analysis products for testing their representation of the East African region. Overall, these data showed similar activity during corresponding days of snowfall on Kilimanjaro, indicating that snowfall events are likely related to regional precipitation. Second, the use of various global (re-)analysis products allowed the examination of commonalities between individual precipitation events on Kilimanjaro, and helped to identify the key precipitation-causing processes. Results showed distinct seasonality in precipitation, propagating from west to east during the long rains and east to west during the short rains (October-December). In addition, high magnitude snowfall events occurred under the conditions of low wind speed and high humidity. These high magnitude events may be a result of local convection, and may represent certain atmospheric conditions favorable for snowfall accumulation, but their representation of overall regional rainfall totals remains uncertain.
Stratosphere-troposphere exchange via cross-tropopause mixing in the extratropics

Stratosphere-troposphere exchange (STE) is the bi-directional exchange or transfer of mass and chemical species between the stratosphere and troposphere. STE helps determine the chemical composition of the stratosphere and troposphere, and thus affects climate, stratospheric ozone, and oxidation reactions in the troposphere. However, the ways it occurs are poorly understood. STE is expected across the tropopause, located between the troposphere and stratosphere. Data from three observational projects (SUCCESS, TRACE-P, and CRYSTAL-FACE) were studied for evidence of mixing. Aircraft measurements were analyzed to make correlation graphs of ozone versus carbon monoxide concentrations. Mixing, evident in high carbon monoxide (CO) concentrations in the lower stratosphere, was found for each of projects. The TRACE-P measurements showed relatively lower CO concentrations in the lower stratosphere, in spite of the high CO concentrations seen in the upper troposphere due to pollution episodes. CRYSTAL-FACE measured the highest CO concentrations in the stratosphere on 7 and 9 July 2002. During these days, plumes from surface fires reached high into the stratosphere. High CO concentrations were recorded on 3 July 2002 for CRYSTAL-FACE and 2 May 2002 for SUCCESS, although they were not as deep into the stratosphere. Back trajectories indicated possible fire plumes that reached the lower stratosphere on 3 July 2002. Back trajectories also indicated a possible warm conveyor belt in the Eastern Central Pacific that could have lifted polluted air from Asia to the vicinity of the tropopause on 2 May 2002.
Using GPS radio occultation data in the study of tropical cyclogenesis

Numerous studies have examined atmospheric conditions and patterns in tropical cyclogenesis. Although much has been accomplished, a complete understanding of tropical cyclogenesis is hindered by the lack of data in the regions where formation occurs. The GPS (Global Positioning System) radio occultation technique can provide valuable data in key areas. In GPS radio occultation, GPS satellites emit radio signals through the atmosphere that are received by another satellite in a low Earth orbit. Various atmospheric properties are calculated based on the alteration of the signal. This study assessed the value of GPS radio occultation data in the study of tropical cyclogenesis by examining storms of the 2002 Western North Pacific typhoon season. The signature of precursor disturbances to tropical cyclogenesis was determined by analyzing composites of data from the NCEP Aviation (AVN) analysis over four days. Similar composites of GPS radio occultation data were produced. The AVN analysis showed strong signals of precursor disturbances in the low-level wind fields and atmospheric refractivity. The GPS radio occultation data indicated similarly increased refractivity values in corresponding regions, but had sizeable measurement differences with the AVN analysis. These differences were attributed to AVN analysis error due to the lack of input observational data and the high accuracy of GPS radio occultation measurements. Further comparisons showed that with the limited quantity of data currently available, GPS radio occultation by itself was not sufficient to detect precursor disturbances. It can best be used in data assimilation to improve the analysis and forecasts of tropical storms.
A flash flood risk assessment of the Colorado Front Range using GIS

Although significant research has been performed on the impacts and mitigation of flash flood events, the methodology for assessing social vulnerability and regions at risk has not been fully developed. This project explored the environmental-social links of flood hazards and developed a geographic information systems (GIS)-based methodology for flood risk assessment. The assessment was based on a model that risk was a product of exposure to a hazard and societal vulnerability. Vulnerability was represented by population characteristics and distribution of critical facilities. Exposure was estimated by combining the Areal Mean Basin Average Rainfall (AMBER) method with GIS techniques. This method involved relating precipitation accumulation, averaged over a stream basin, to National Weather Service flash flood guidance values to identify basins with flooding potential. The vulnerability and the exposure were integrated in a GIS to estimate the total risk. The 1997 extreme precipitation event in Fort Collins, Colorado was used as a model to assess potential flood risk in two metropolitan areas: Fort Collins and Denver. Results yielded a GIS-based model that combines hydrometeorological information with social data, and allowed for radar-derived precipitation data to be integrated into the GIS to map key areas at risk in Fort Collins and Denver. Early identification of risk areas can assist emergency and floodplain managers in developing response and mitigation measures. The results provide a framework to expand the study of flood risk by introducing near-real-time precipitation data, hydrological models, and detailed socio-economic geographic data.
Enhancing access to climate model metadata via a web-accessible database

The Climate and Global Dynamics Division (CGD) at the National Center for Atmospheric Research (NCAR) wants to provide the greatest possible public access to their climate model metadata. CGD recognized that the information from their climate model runs could be better organized to allow for efficient discovery, analysis, and sharing of the research data. A number of factors were identified, including insufficient information in the data files to adequately describe the data and the difficulty of generating catalogs of the experiments and data. Metadata is information that identifies and describes the contents of the research data. A web-accessible metadata database was developed to enhance climate model metadata organization and accessibility. Using the spiral software development method, database design and creation was done in an iterative process with rapid reviews of each design to test and ensure that the final product satisfied the user’s requirements. The database was designed to meet a specific set of requirements from CGD to store metadata from the Community Climate System Model (CCSM). A web application created a browser-based interface to the database that acts as a catalog for users to locate and sort the metadata in an online browser. Previously, CGD developers manually created a static website containing the metadata that proved to be time consuming and difficult to maintain. This project’s web-accessible database enhances CGD’s ability to share their metadata with the public, making their climate model results accessible to a much wider audience.
Creating a software tool to reuse existing decoders

The Local Data Manager (LDM) was created by Unidata at the University Corporation for Atmospheric Research to relay atmospheric data in near-real time to its community of universities and research facilities. Although the LDM successfully delivers data to its community, Unidata is considering other alternatives with more advanced options for data relay. One alternative to the LDM, the Network News Transfer Protocol-based InterNet News (INN), was shown to successfully deliver data. Because the interface that INN provides to these programs is different from the LDM’s interface, a new piece of software to pass INN articles to existing decoders was required. Decoders are used to transform data into a variety of formats for purposes such as visualization, and input to other programs. This project’s aim was to create a software tool called a decoder wrapper that allows data to be decoded via INN just as it is decoded via LDM. The decoder wrapper was created in C and then upgraded to an object oriented design to facilitate code comprehension and future modification. The created decoder wrapper will facilitate the use of both LDM and INN on the relay network, by putting INN’s data products into a format desired by INN users, and will also facilitate further testing within Unidata of INN’s capabilities for data relay.
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Water vapor estimates using simultaneous S and Ka band radar measurements

Water vapor is a key component defining Earth’s climate and has a vital role in the Earth’s hydrologic cycle. Despite its significance, the water vapor content in the atmosphere has often been difficult to measure with sufficient spatial and temporal resolution. In this experiment, path-integrated water vapor estimates in the boundary layer were retrieved using the ground-based, dual-frequency S-band and Ka-band radars (S-Pol-Ka). The water vapor retrieval method consisted of the following procedures: using quality control criteria to minimize contamination from Mie scattering, estimating the atmospheric attenuation of the Ka-band, and using Hans Liebe’s radiative transfer model to formulate a polynomial equation that computed the water vapor content from the Ka-band attenuation. The data used to obtain the water vapor estimates were collected on 11, 14, 16, and 19 January 2005 during the Rain In Cumulus over the Ocean (RICO) Experiment. On these days, simultaneous measurements were recorded by the S-Pol-Ka radar system and dropsondes were released from research aircraft. Weather echoes in the radar domain offered numerous paths for water vapor retrieval. Dropsonde data provided independent measurements of the water vapor content and were used to validate the results from the retrieval method. For the four days analyzed, water vapor estimates compared favorably with dropsonde measurements along some radar paths while others showed considerable scatter. Based on acceptable trends of the computed estimates, preliminary results suggest that this methodology could successfully retrieve estimates of water vapor content. Additional work is needed to understand the limitations of the technique.
Accurate cloud droplet measurements are important for an increased understanding of cloud microphysical processes, especially the nucleation and growth of cloud particles through condensation and coalescence. In addition, cloud droplets play a significant role in the formation of precipitation; therefore, accurate measurements are important for precipitation forecasting. A Forward Scattering Spectrometer Probe (FSSP) is a cloud droplet-measuring instrument that uses light scattering intensity in determining size distribution and concentration. Some standard FSSPs have been modified structurally to reduce the inaccuracies associated with cloud droplet measurements. The goal of the research was to investigate the effects of changes in droplet velocities and trajectories during measurement using the standard and modified FSSP probes. This investigation will help determine a probe configuration with improved measurement capabilities. Two modeling and simulation packages (Gambit and Fluent) were used. Gambit was used to generate probe prototype models, three-dimensional computational grids and the computational flow domain. Fluent was used for flow simulations under specified boundary and operating conditions. The analysis examined flow fields at various airspeeds (focusing on 145 meters second$^{-1}$ as a case study), angles of attack and trajectories of 20- to 50-micron sized particles passing through the measurement volume. The results obtained showed change in particle velocities within the sampling volume; the change was more pronounced for the standard than for the modified probe. In addition, change in particle trajectories was observed for both probes. Further investigations have to be carried out in order to determine the more suitable probe configuration.
The use and value of climate information in wind power planning

An aging infrastructure, environmental concerns, and growing demand threaten to undermine the reliability and long-term sustainability of the current fossil fuel electricity supply and transmission system. It is widely agreed that renewable energy sources will become increasingly important in the evolution to a next-generation electric grid. In this study the use and value of climate information in determining the location and performance of wind power turbines in the Northern Great Plains of the United States were investigated. Fifty years of hourly wind speed data were used to evaluate the possible influence of seasonal and interannual climate variability on wind power production at four locations in South Dakota. The El Niño Southern Oscillation (ENSO) is a documented source of climate variability in the Northern Great Plains. Our results documented a dominant El Niño/La Niña influence on the probability of lulls in wind speeds, with the stronger influence in the eastern half of the state. Information on wind speed lulls is important to the wind energy industry because these are periods when no energy is being produced. All of the locations also showed a slight decrease in power production potential during El Niño events. Our preliminary results confirmed that information on climate variability and change can be of significant use and value to future wind power planning, siting, and performance.
Characterizing multipath sources at seismic frequencies:  
A case study for the Parkfield GPS array

Multipath, the skewed positions due to signal deflections from surrounding objects, remains one of the limiting sources of error in position measurements determined by 1-Hertz Global Positioning System (GPS) data. There is currently no standard automated technique to remove multipath, consequently affecting the accuracy of any geodetic or seismological application of GPS data. For GPS data to provide sub-centimeter position accuracy, multipath error must first be removed. Characterizing multipath entails identifying sources that contribute to relevant position errors for certain satellite-receiver pairs. In this study, signal-to-noise ratios (SNR) from 1-Hertz receivers were used to make this characterization possible. SNR recorded by the receivers are sensitive to changes in the time-varying GPS environments and are a conduit for revealing multipath. The analysis of SNR power spectra identified receiver-recording characteristics indicative of specular multipath. These included large amplitudes and high frequency or long period interference. With knowledge of the period of observed multipath, a forward model helped in predicting the distance from the theoretical horizontal reflector to the antenna. This prediction was possible because the distance from a horizontal reflector to antenna determines, in part, the phase and frequency of multipath. Preliminary results identified time frames and specific satellite-receiver pairs in which significant multipath occurs. The information, coupled with actual photos of receiver environments, aids in predicting when, where, and why significant multipath will appear. Knowledge gained from multipath characterization can be applied toward the prevention or removal of multipath at other GPS sites with the Parkfield array as a representative model.
The improvement of a carbon monoxide instrument with application to tower measurements of vertical flux

Emissions of carbon monoxide (CO) from anthropogenic sources, in particular automobile exhaust, exceed in quantity the mass of all other man-made source pollutants combined. Because of its photochemical lifetime and insolubility, CO is an exceptional tracer to examine polluted air masses. By measuring CO fluxes, the amount of air pollutants that originate from anthropogenic and biogenic sources can be traced. A commonly used instrument for detecting CO is the vacuum ultra-violet (VUV) fluorescence analyzer. This project focused on modifying and redesigning the NCAR Research Aviation Facility’s (RAF) VUV fluorescence analyzer to improve both its sensitivity to CO and its signal to noise ratio. The RAF VUV fluorescence analyzer has proven sensitive enough to measure CO mixing ratios, however it was not sensitive enough to measure CO fluxes. The instrument’s flow cell and its fluorescence detector, a photomultiplier tube (PMT), were both examined for ways to improve the sensitivity to CO and the signal to noise ratio. The flow cell was modified to reduce photon scattering and then later redesigned to reduce both photon and air molecule leaks. A new PMT was also selected to improve the instrument’s detection limit. Delivery of the new flow cell and the new PMT was delayed past the end of this project. Because of this, new instrument measurements and analysis could not be completed. However, it was expected that these modifications would result in improvements to the instrument’s sensitivity to CO and the signal-to-noise ratio when the parts arrive.
Examining climate influences and economic impacts of harmful algal blooms in Massachusetts: 1993 and 2005

Although the potential causes of harmful algal blooms (HABs), or red tides, have extensively been studied, the relationships between the environmental drivers and economic impacts have not been fully explored. This paper examines the environmental-economic link by investigating the effects of the 1993 and 2005 HABs on shellfish, public health, and the shellfish industry in Massachusetts. This study will be compared to a previous study on the 1993 red tide caused by the Alexandrium species (spp.). Environmental influences including sea surface temperature (SST), salinity, precipitation, streamflow, and shellfish toxicity levels were plotted from 1990 to 2005. Economic impacts on commercial fishery landings in Massachusetts were graphed from 1990 to 2003. These impacts included examining Massachusetts’ blue mussel commercial fishery landings and Gloucester commercial fishery landings. Toxicity levels were found to have positive relationships to both runoff and wind stress in 1993 and 2005. Coincidentally, there was also a significant decrease in commercial fishery landings between 1992 and 1993, resulting in a decrease of millions of dollars of revenue for shellfish fishermen and the state of Massachusetts. Changing fisheries policies affected commercial fishery landings during the same time and were also considered. These results argue for more accurate forecasts of runoff and wind stress to minimize the negative impacts of future HABs.
Examining the processes occurring in thunderstorms that affect soluble, reactive species (chemical reservoir species)

Because many naturally occurring chemical reactions can produce compounds that cause health problems as well as affect global climate, it is important to study the processes that affect the chemical compounds in the atmosphere. One major gap in our knowledge of atmospheric chemistry is the effect of clouds on the chemical environment. A recent intercomparison of convective-scale cloud chemistry models has shown that transport of passive tracers from the boundary layer to the upper troposphere in deep convection is simulated consistently among models, while reactive, soluble species are not. Three chemical species of interest are nitric acid (HNO₃), hydrogen peroxide (H₂O₂), and formaldehyde (CH₂O) because they are important chemical reservoir species for both NOₓ and HOₓ (precursors for ozone) and because they are reactive and soluble in clouds. In this study, possible reasons for the differences in HNO₃, H₂O₂, and CH₂O mixing ratios among the convective-scale cloud chemistry models were examined. By adding a source of NO to represent its production from lightning, by increasing photolysis rate coefficients to account for increased light scatter by the clouds, and by adding adsorption of different chemical species by ice, the importance of each of these processes to HNO₃, H₂O₂, and CH₂O mixing ratios were able to be understood. Preliminary results suggested that lightning plays a key role in HNO₃ production, whereas ice adsorption is an important sink for each of the chemical reservoir species. Increased photolysis rates affect only the production of CH₂O.
Synthetic dual-Doppler analysis of the 11 June 2003 mesoscale convective vortex during BAMEX

Mesoscale convective vortices (MCVs), which form within the stratiform rain of some mesoscale convective systems (MCSs), may persist for days, often regenerating convection daily. Long-lived MCVs can produce as much precipitation as a land-falling hurricane and lead to catastrophic flooding. The theoretical kinematics, or three-dimensional wind structure, of MCVs have rarely been validated using radar observations. A synthetic dual-Doppler analysis was applied to WSR-88D radar data to determine the three-dimensional wind structure of the 11 June 2003 MCV observed during The Bow Echo and MCV Experiment (BAMEX). As in other studies involving MCVs, midlevel cyclonic rotation was observed in the trailing stratiform region of the MCS. This study was unique in the fact that while numerous MCVs have been observed in the stratiform region of MCSs, few have been well resolved. There also appeared to have been a coupling between the middle troposphere and the surface, which may be indicative of cyclonic vorticity growing downward to the surface. Although the technique of synthetic dual-Doppler analysis needs to be verified using a traditional dual-Doppler analysis, the former shows promise as a method for studying other MCVs with readily available operational data.
Characterization of dust storm sources in the southwestern U. S. and northwestern Mexico using remote sensing imagery

Extreme aerosol events, such as dust storms, can produce large quantities of dust and haze dispersed over regional or global scales. Remote sensing data (ground-based and satellite) can be used to assess the frequency and magnitude of these dust events for potential impacts on climate, visibility, and health-related air quality issues. Some of these remote sensing data revealed that the area of the Chihuahuan desert is one of the major dust sources in North America. Different visible and infrared spectral bands from satellite data (NOAA/GOES, GOVAR/Imager, NOAA/POES/AVHRR and NASA/TERRA/MODIS) were examined to locate the origin of dust plumes in the southwestern United States and northwestern Mexico, a region that currently is not well characterized with respect to dust sources. The dust source locations on LANDSAT-7 images were superimposed to identify the surface features associated with these dust sources. This methodology was applied to several dust events, including the dust outbreaks of 15 April 2003 and 15 December 2003, both associated with long-distance aerosol transport, to determine whether these surface features are persistent sources of dust in this region. These findings establish a baseline for continued research in determining potential locations for future dust outbreaks in the southwestern U.S. and northwestern Mexico.
Lower tropospheric analysis of the daily cycle of the wind for the East Coast of the Gulf of California during NAME 2004

The daily cycle of the wind in the lower troposphere is not well known over the Gulf of California and the western coastal plains of Mexico. During the North American Monsoon (NAM) it is thought to be associated with the daily cycle of convective precipitation in this region. For this research project half-hourly lower tropospheric winds from three wind profilers were analyzed. These wind profilers were deployed along the coastal plain of Mexico during the Enhanced Observation Period (EOP) of the North American Monsoon Experiment (NAME 2004). The data from the wind profilers were used to document and understand the daily cycle profile of the winds during the monsoon. Mean profiles and mean daily cycles were computed at Puerto Peñasco (31.34°N, 113.51°W), Bahía Kino (28.81°N, 111.93°W), and Los Mochis (25.69°N, 109.08°W) over the first half of the 2004 NAM. The mean profiles showed shallow southerly winds backing to easterlies; these southerlies deepened with latitude. The mean daily cycles showed land/sea breezes at the most southern sites and a low level jet at the northern site. The directional constancy of these features was high. These results gave an initial look into the structure of the winds in the lower atmosphere in this area and their variability along the Gulf of California, which have not been previously documented. The work has raised additional questions about the wind flow in this region that may facilitate future research of the NAM and be useful for improving models to forecast this phenomenon.
Assessing sand dune mobility from 1980 through 2004 on the Moenkopi Plateau of the Navajo Nation

This study was motivated by concerns about how climate change is affecting Indigenous communities across the globe. Many residents of the Navajo Nation on the southern Colorado Plateau are concerned that the future climate of the region will be warmer and drier than was observed in the 20th century. Droughts during the late 1980s through 2004 over this region have resulted in the decrease of many native plant species and an increase in sand dune mobility causing social harm, including damage to infrastructure and the loss of agricultural productivity. Effectively mitigating sand dune mobility requires understanding the annual and seasonal climate variability, which can affect sand dune development. A climatic sand dune mobility index using wind energy and effective precipitation was calculated to assess seasonal, annual, and decadal trends of potential sand dune mobility over the Moenkopi Plateau on the Navajo Nation from 1980 to 2004. The results demonstrated a large variation in seasonal and annual potential sand dune mobility. For the period from 1980 to 2004, an increasing trend in potential sand dune mobility was observed and appeared correlated with a trend of decreasing effective precipitation. These results provide a better understanding of the climatic conditions over the last 25 years over the Moenkopi Plateau, and show how these conditions relate to increased sand dune mobility. This work shows that the index can be used for other areas on the Navajo Nation, to identify locations at risk and help in planning efforts to mitigate effects from climate change.
Dengue fever affects 50-100 million people worldwide, with symptoms ranging from unaffected to a 50 percent mortality rate. Unfortunately, no specific medical treatment or vaccine is available. Dengue is transmitted in the Caribbean primarily through a mosquito vector called *Aedes aegypti*. Past studies have found that climate factors such as higher temperatures and increased precipitation affect the lifecycle and habitat of these mosquitoes. Likewise, changes in the *Aedes* lifecycle cause changes in dengue transmissions. Therefore, a thorough analysis of those climate factors would aid in understanding dengue transmissions. This study focused on how air temperature, humidity, precipitation, and sea-surface temperature (SST) affected the dengue epidemics of 1994 and 1998. Each climate factor was correlated with dengue outbreaks on a weekly basis. Precipitation, air temperature, and humidity showed weak relationships with dengue outbreaks. SST, however, showed an exponential relationship. A good exponential model was found for 1994, but was not appropriate for 1998. Instead, a regression tree was used to analyze 1998 SST and air temperature thresholds. The thresholds were around 27-30°C, which agreed with past studies. Qualitative analyses of tropical storm systems showed that storms did not have a strong impact on dengue transmissions. In general, the results demonstrated that except for SST, climate factors did not have a large effect on dengue transmissions; rather, key social factors could be at play. Thus, for dengue prevention, the public health infrastructures should focus more on social problems and less on climate factors.
First Row (L to R):
Braxton Edwards, Casey C. Thombrugh, Erick J. Adame, Luna M. Rodriguez Manzanet, Anthony C. Didlake, Jr.,
Stephen Hernandez.

Second Row (L to R):
Amber E. Reynolds, Roberto Cancel III, Rebecca Kit Ying Chan, Julien Wang, Olusegun O. Goyea, Marco Orozco,
Clarence Mann, Melissa A. Burt, Nicole Ngo, Keith E. Goodman, Jr., Shanna-Shaye Forbes, Nancy I. Rivera Rivera,
Alisha Fernandez, Bret Harper, Karen Diaz.
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“SOARS mentor-centered approach, particularly the willingness of the SOARS staff, protégés, and mentors to answer questions and discuss research problems, provided me with much of the information I didn’t know about career options, research interests, and also about communicating my work to the general public.”

— Shanna-Shaye Forbes, second-year protégé
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