Southern Climate Impacts Planning Program

Annual Report: June 2015 - May 2016

RISA
Regional Integrated Sciences and Assessments

SCIPP
A NOAA RISA TEAM

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The Southern Climate Impacts Planning Program (SCIPP) Phase II was funded on award NA13OAR4310183. For the past two years, our annual performance report has been submitted under the title "Southern Climate Impacts Planning Program (SCIPP) Phase II" and has been accepted. Please accept the annual report entitled "Southern Climate Impacts Planning Program (SCIPP) Phase II for the period 6/1/2015-5/31/2016.

TEAM

SCIPP Team

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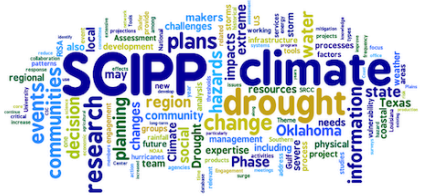
Advisory Committee: David Brown (NOAA); Jeffrey Gaffney (University of Arkansas); Gregg Garfin (University of Arizona); Marilu Hastings (Cynthia and George Mitchell Foundation); Bill Hooke (American Meteorological Society); Rebecca Jennings (Federal Emergency Management Agency); Bill Kiene (NOAA); Victor Murphy (NOAA); Sascha Petersen (Adaptation International); Putnam Reiter (Oklahoma Department of Emergency Management); Bob Rose (Lower Colorado River Authority); David Schlotzhauer (NWS Lower Mississippi River Forecast Center); Melissa Stults (University of Michigan); and Tom Wilbanks (Oak Ridge National Laboratory)

SCIPP Affiliates: Jeff Basara (OU); Jerry Brotzge (OU); Sean Crowell (OU); Scott Greene (OU); Cody Knutson (NDMC); Patrick Marsh (NWS SPC); Heather McCarthy (OU); Mike Richman (OU); Kodi Monroe (OU); John Nielsen-Gammon (TAMU); Cindy Rosenthal (OU); Chie Sakakibara (OU); Theodore Trafalis (OU); and Kai Zhang (UTHealth)



The Southern Climate Impacts Planning Program team consists of the following investigators, core office staff, research & support staff, summer interns, and graduate students from the University of Oklahoma (OU), Louisiana State University (LSU), Texas A&M University (TAMU), and the National Drought Mitigation Center (NDMC). SCIPP's Stakeholder Services Committee (Advisory Committee) is also detailed above. Team personnel are current as of May 31, 2016.

PARTNERSHIPS

New Areas of Focus or Partnerships

Planning for extreme weather and climate events are central to the work of the Southern Climate Impacts Planning Program, though are not our only focus. The following represent the various new areas of focus and partnerships of SCIPP with a brief description of the questions and issues the SCIPP team is working to address.

Planners and the American Planning Association (APA) – One of the goals since SCIPP's inception has been to improve climate hazard preparedness and reduce the impacts that those hazards have on communities and states. Over the years we have engaged with emergency managers and a few planners on a project-by-project basis. More recently we identified the need for planners and emergency managers, who typically work in very separate silos, to collaborate if hazard mitigation planning is to improve. SCIPP has historically been better connected to emergency managers and has a good understanding of their operating context. Within the last few months, however, we have begun to engage with planners through the American Planning Association's national chapter and the state chapters in Arkansas and Oklahoma. The interactions are currently in their infancy, but we are planning more formal interactions and partnerships over the next several months. Furthermore, we are planning more formal interaction with the newly established APA Hazard Mitigation and Disaster Recovery Division.

CHARM (Community Health and Resources Management) Model - One of SCIPP's major efforts for expanding outreach amongst our region included getting involved with the hazard planning process. Initial research revealed various Sea Grants were involved with holding climate adaptation planning workshops and therefore the program was assumed to be a key contact in starting these conversations. Within our region, outreach to the Texas Sea Grant led to an invitation to their CHARM Model workshop in Corpus Christi, TX. Led by the Texas Coastal Watershed Program (TCWP), a partnership between the Texas Sea Grant and the Texas A&M AgriLife Extension, their efforts are supported by FEMA, USACE and various other organizations. As a more technical mapping application aimed at increasing resiliency in planning efforts, CHARM utilizes ArcGIS to incorporate a localized landscape of various cities and "gives local officials, stakeholders, and citizens the power to map and analyze growth with real-time feedback." TCWP spoke with SCIPP about a potential partnership with CHARM, expressing their interest in adding a climate component to the model. Additionally, as supported by FEMA, CHARM is planning on expanding their efforts to all states within the FEMA 6 region, beginning with Oklahoma. SCIPP will potentially become the climate resource within OK, TX and LA, and conversations are continuing with TCWP to explore this partnership.

Arkansas Natural Resources Commission - Beginning in October 2015, SCIPP began working with ANRC to help them develop a drought response and preparedness plan. SCIPP helped develop an agenda and presentation materials for a workshop (held in June 2016 in Little Rock, AR), identify organizations from Arkansas to participate in that workshop, and link to expertise within SCIPP and National Drought Mitigation Center. Arkansas is one of three states that presently does not have or has not been actively developing a drought plan. They have been affected by severe droughts in four of the past five years and recognized the need to better connect to the U.S. Drought Monitor and review agency operations. SCIPP's work with Arkansas will serve as a template for other states, including updating Oklahoma's drought plan in the coming year.

RISA collaboration - SCIPP participated in surge mapping with CISA and CCRUN during the atmospheric river event / Hurricane Joaquin in October 2015. SCIPP applied the tools and mapping capacity built as part of SURGEDAT to another region and a somewhat different type of event.

ENGAGEMENT

Emergency Management - Expanding again on the effort of SCIPP to explore the connection between planning and emergency managers, we have been involved with outreach efforts with the Arkansas Department of Emergency Management (ADEM). Combined with the Professional Association of Emergency Managers, ADEM is holding their annual conference this fall and has offered a session for SCIPP to present. We plan to take this opportunity to explore the emergency management side of the hazard planning process, incorporating a highly interactive discussion focused around their various collaborations, resources used and opinions on working with the planning community.

Architecture - One of the most responsive and prominent sectors from our initial outreach was from architecture. Along with planners, we discovered their heavy presence in a variety of resilience measures including the 100 Resilient Cities. SCIPP is currently building relationships with two different architecture groups: a private company named Perkins and Will, and the national organization, **American Institute of Architects (AIA)**.

* **Perkins and Will** is a global design firm that houses a Resiliency Task Force. This force is currently seeking a network of climate science partners to collaborate with. Initial conversations started at the 100 Resilient Cities meeting in Dallas, however, as the firm is nationwide, it was mutually discovered that efforts should extend across the entire RISA network. SCIPP connected Perkins and Will with Sarah Close and Caitlin Simpson where they discussed the newfound idea of RISA teams working as contractors and quickly shared an introduction to our network of teams. Relationships are moving forward with the SCIPP team about what projects they may need our expertise, and are in the initial stages across the rest of the RISA network.

* **AIA** is a nationwide organization consisting of over 100,000 architects. Upon the discovery of their AIA Resilience firm, informal conversations revealed that their largest climate challenge was relying on climate data for determining baselines, with the need for better historical data of the changing climate. This quickly led into the idea of a pilot project in our SCIPP region, with the potential of expanding to national support. Conversations are currently being discussed around the potential for this pilot, with AIA's suggestion of hosting it in Tulsa, OK. The main reason behind this suggestion is because the city's 100 Resilient Cities Chief Resilience Officer Mary Kell, is a member of AIA. Coincidentally, SCIPP's involvement with Tulsa Partners led to the invitation for Mary Kell to speak at our Annual Committee Meeting in May, and initial conversations are in place between 100 RC, AIA National, AIA Eastern Oklahoma and SCIPP for the coming months.

National Renewable Energy Laboratory (NREL) contacted SCIPP to assist in the development of a Climate Change Risk Assessment (CCRA) for the Strategic Petroleum Reserve's (SPR) sites located in Texas and Louisiana. With SCIPP assistance, the CCRA will build off relevant previous work that has been completed at the SPR and will focus on developing a general understanding of regional climate science for the coastal region of Louisiana and Texas. SCIPP will provide technical assistance and information to help in identifying the SPR's site-specific climate change risks, evaluating the risks to the SPR's operations and mission, and developing strategies to address these risks through the CCRA. To achieve these goals SCIPP will complete the following, 1) Preparation of a regionally-specific, high-level overview of climate projections; 2) An analysis of the likelihood for each potential climate hazard - supporting the risk analysis; and 3) A written climate change summary report for the south-central U.S. region (including Texas and Louisiana) that shall be an addendum to the final climate change risk assessment report and a resource for information incorporated in the report. This report should assist in taking steps sooner rather than later to develop resilience to climate change.

Climate Services

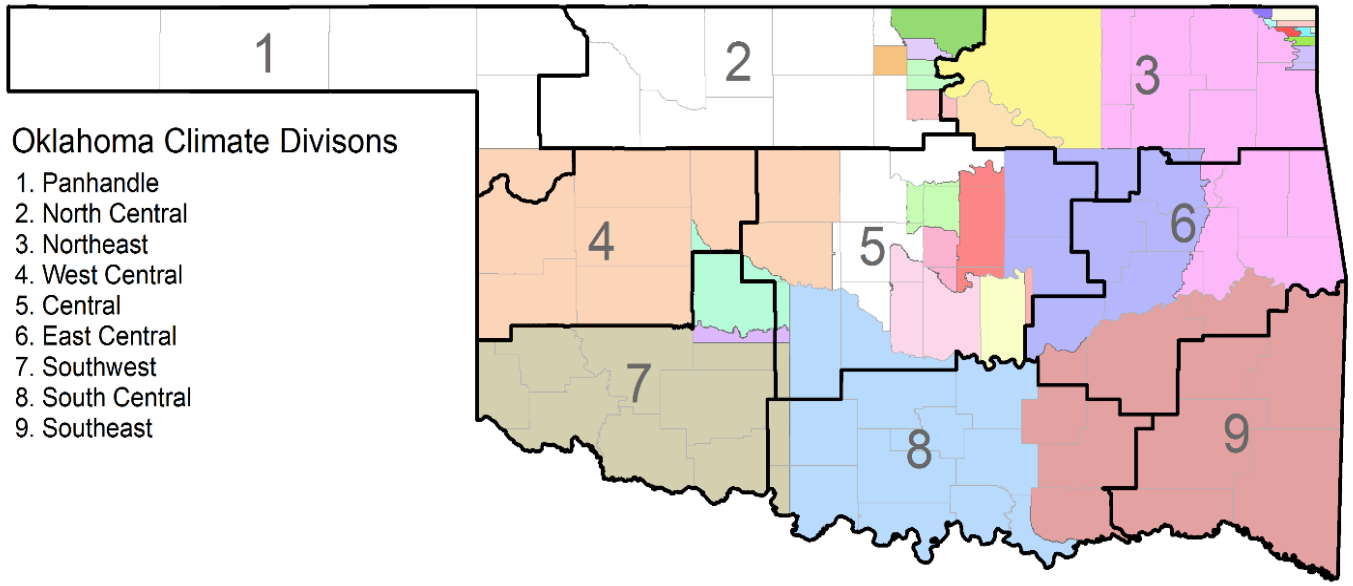
Historical Drought Analysis by Oklahoma Climate Division

Historical drought conditions were analyzed for Oklahoma's nine climate divisions (CDs) between 1895 and 2014. The analyses were produced for Oklahoma tribal nations following a request for more detailed historical drought information for their areas but are also relevant to other local and regional officials. A document was produced for each of the CDs and includes analyses of 1) Average and maximum duration of past drought events, 2) Average and maximum intensity of past drought events, 3) Average month of drought onset and termination, 4) Characteristics of the 10 longest drought events, 5) Climatology of drought events, and 6) Wet periods (i.e. drought breaks). The Modified Palmer Drought Severity Index (PMDI) and precipitation data were used for the analyses. The raw data are available upon request.

Table 1. One example of the analyses produced. Summary table of drought characteristics for Oklahoma climate division 6, which covers portions of the Cherokee, Choctaw and Muscogee Creek Nations.

Climate Division 6 Drought Characteristics			
Averages			
Drought Onset (day-month)	2-Jul	Drought End (day-month)	30-Jun
Drought Event Duration (months)	5.23	Incipient Dry Spell Duration (months)	1.25
Mild Drought Duration (months)	2.11	Moderate Drought Duration (months)	1.15
Severe Drought Duration (months)	0.55	Extreme Drought Duration (months)	0.17
Peak Intensity (0 to -4 scale)	-1.75	Peak Intensity Occurrence (day-months)	9-Jul
Break Between Drought Events (months)	7.34	Average Percent of Normal Precip.	57.48
Maximum			
Drought Event Duration (months)	42	Incipient Dry Spell Duration (months)	5
Mild Drought Duration (months)	13	Moderate Drought Duration (months)	16
Severe Drought Duration (months)	14	Extreme Drought Duration (months)	6
Peak Intensity (0 to -4 scale)	-6.04	Date of Maximum Peak Intensity (mm/yyyy)	08/1936
Break Between Drought Events (months)	44	Maximum Percent of Normal Precip.	89.63
Minimum			
Break Between Drought Events (months)	2	Minimum Percent of Normal Precip.	5.79

Table 2: Tribal jurisdiction map with Oklahoma climate division boundaries overlaid.



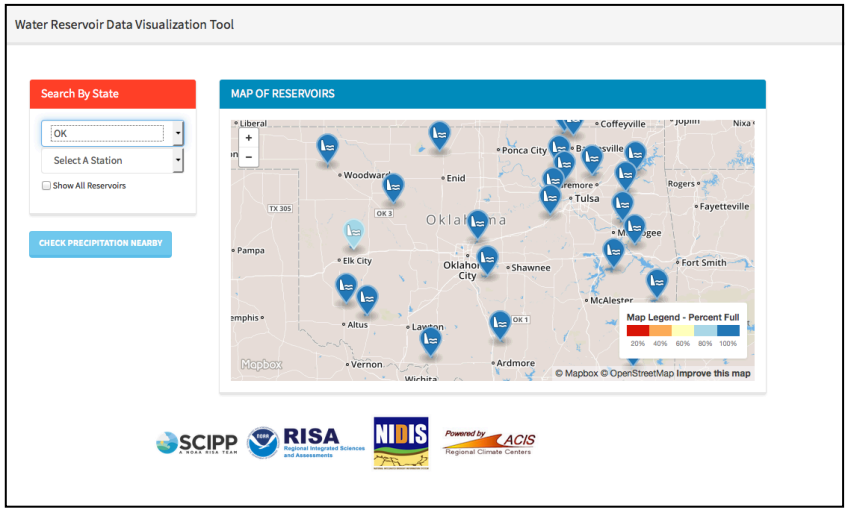
Gulf Coast Joint Venture (Lafayette, LA)

SCIPP provided a summer intern who worked alongside staff at the GCJV during 2015 to conduct an analysis of the effects of drought on habitat suitability for migratory waterfowl. The analysis included the western Gulf Coast (Texas, Louisiana, Mississippi). The outcome of the research was an analysis of multiple drought, temperature, and precipitation variables in relation to the GCJV's satellite-based habitat assessments. The analysis found different variables in each of the regions along the coast as being significant factors in explaining inter-annual variability of suitable habitat (i.e., precipitation appeared a more important predictor in southern areas while temperature was more dominant in northern coastal areas). Although this is not an operational tool, the analysis / technical assistance provides a foundation for building a prediction system.

CLIMATE SERVICES

Water Reservoir Data Visualization Tool

During the Southern Plains drought, meetings with drought managers and planners at regional drought assessment forums and during drought management webinars revealed that numerous user groups desire easily accessible information describing current and historical reservoir levels across the region. Unfortunately, reservoir level information is housed in many disparate places and managed by a number of agencies, including the US Army Corps of Engineers, US Bureau of Reclamation, river basin management authorities, and others. As a result, the region was lacking a unified source of accessible reservoir data. Many websites that provide reservoir status lacked historical data, or at least an easy, visual way to compare across time.



Screen capture of Reservoir Tool homepage.

SCIPP and the Southern Regional Climate Center (SRCC) incorporated suggestions from stakeholders to create a web-based reservoir tool, the Water Reservoir Data Visualization Tool. This tool displays water reservoir data for reservoirs located in Texas, Oklahoma, and Louisiana. Information in the tool includes a reservoir cross-section plot that highlights current elevation, dead-pool, and conservation pool elevations, a summary of physical reservoir information, reservoir levels over time, elevation-area-capacity curves for each reservoir, and precipitation data. Reservoir data sources include the Texas Water Development Board, US Geological Survey, and US Army Corps of Engineers.

Using NWS Cooperative Observer Data via the Applied Climate Information System (ACIS), the SRCC matches nearby precipitation-reporting stations to each reservoir. Users are able to select from nearby sites to examine precipitation in relationship to reservoir response both at the site of the reservoir and also upstream sites important for generating runoff.

As we have seen with the recovery from drought in parts of the region, reservoir response was lagging much longer than drought management experts anticipated. Having real-time information that can be compared spatially across a region and temporally in relationship to previous droughts can help resource managers better anticipate such lagging responses and consequently improve their management decisions related to water availability.

Developing a regionally-complete inventory of surface water conditions was an essential element to being able to understand the relationship between surface and groundwater resources and human and natural consumption. Surface water resources are essential in wildlife management decisions, particularly during times of drought. It is also critical to understanding and anticipating migratory patterns of waterfowl and as an indicator as to whether other unmonitored surface water systems such as wetlands and ponds are stressed. The Water Reservoir Visualization Tool was released on the SCIPP website on October 26, 2015.

PROGRAM IMPACT

Overall Program Impact

Measuring success in any working relationship can be difficult, whether there is an attempt to quantify the success, or prove an action was successful. SCIPP has not conducted a formal evaluation process. Informally, the volume of requests for information and partnerships on projects suggests that SCIPP is a useful contributor toward building resiliency to climate hazards within the region.

Subsequently, one way SCIPP measures success is through our relationships with our stakeholders. SCIPP is currently in Phase II of our proposal. Since the beginning of Phase I in 2008, we have partially measured success by continuing the aforementioned stakeholder relationships. In essence, we measure success by maintaining a working relationship beyond the initial stakeholder contact, whether that was a presentation, phone call, e-mail, etc. We consider a working relationship successful if we are approached with additional questions after this initial correspondence. SCIPP remains flexible to the needs of the stakeholders within our region, and as new opportunities present themselves, we form new partnerships.

Overall program impact also depends on our relationship with the decision maker. Some points are quantitative (how many people attended a webinar or forum, number of people who have accessed our documents, etc.), and some are more qualitative (presenting information). SCIPP has not formally assessed our overall program impact, but rather we use the following as an informal method to measure success, thereby guiding our research and community outreach.

When applicable, we have asked stakeholders to provide us with testimony regarding how our information was used, or how useful our tools have been. Through this avenue, we have learned how our tools are being used beyond our SCIPP region and are having both a national and international impact.

Testimony includes:

"Excellent webinar! I had no idea the situation was so very dire." (From Managing Drought Webinar Series feedback)

"Those [drought webinars] are really great. Thanks to all." (From Managing Drought Webinar Series feedback)

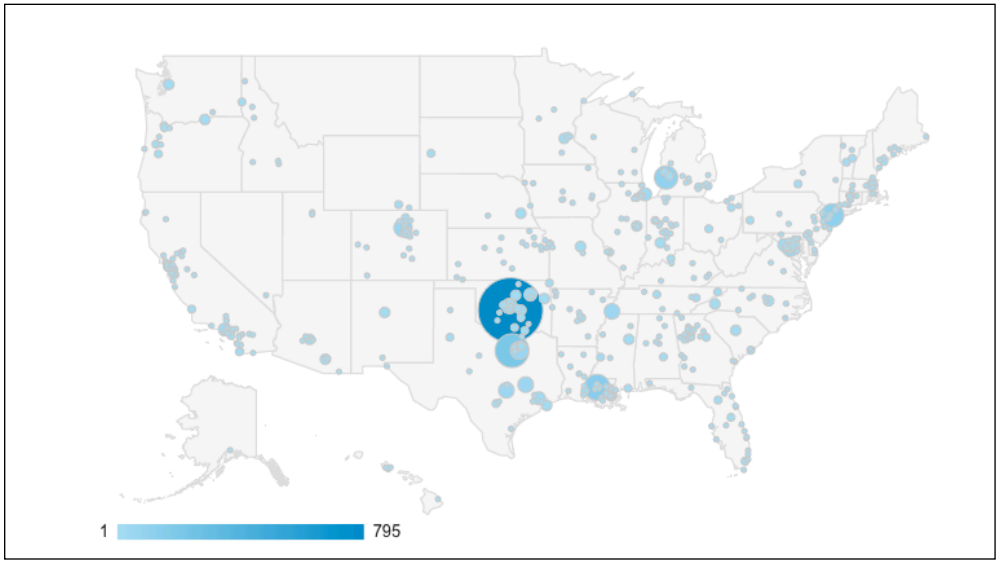
"Thanks for these informative graphic displays." (From e-mail regarding Climograph Tool)

"Every time we speak to a water stakeholder group, the graph is used and generates very positive comments." (From e-mail regarding Historical Trends Tool)

Since November 2015, SCIPP has been utilizing Google Analytics to understand the patterns of those who access our website and social media sites. Using Google Analytics, we can see the number of visits to our website, each page on the website, and how they accessed our website. We are also able to see where people who access this information are located. Most of our website visits come from Norman, OK, followed by Fort Worth, TX and Baton Rouge, LA. Other cities shown on the traffic map below include New York, NY, Holland, MI, Dallas, TX, Boulder, CO, and Oklahoma City, OK.

PROGRAM IMPACT

The return rates of visitors to our website-a way for us to track stakeholders versus spam-is 31.9%, showing that our website is bringing new visitors, but also holds value for deeper connections with about 1/3 returning visitors. Through Google Analytics, we can see that the SCIPP Home Page, Data Tools, and People tabs are our most visited sections of the website.



Google Analytics Map of Locations of SCIPP website users.

Another aspect of Google Analytics is that we can see the referral sites to our website. The majority of referrals come from Carleton College in Minnesota. They have an online EarthLabs course, in which one of their online lessons is on "Climate, Weather, and Trees." They refer to SCIPP, and SCIPP's website, saying "Use the Southern Climate Impacts Planning Program (SCIPP) data products website to research other climate trends, such as precipitation, or climate trends in other regions or states." Other top referral sites include CoCoRaHS, Facebook, Twitter, and Drought.gov. Facebook accounts for 56.5% of our network referrals, and Twitter accounts for 43.4%.

Google Analytics also allows us to annotate various events/news releases/posts and monitor the potential user increase. For example, the 20 May Tornado Assessment was annotated, and we documented an increase of 128 page views on February 15. Similarly, we saw an increase to our website via Facebook that day as well. On March 11, an online EarthLabs course increased our page views by 123.

Separately, SCIPP conducted a user satisfaction survey for the NWS-SRH Southern Plains Drought Outlook Summary in Fall 2015. Survey findings indicated that users were satisfied with the format and characteristics of the outlook. The survey showed some level of value beyond background information, particularly in that 54% of respondents shared it with a colleague and more than 20% used specific products or used a figure or material from the Outlook.

BUILDING EXPERTISE

Building Expertise

Our primary method is to engage organizations **(state agencies, federal partners, non-governmental organizations)** on their needs for climate and weather information. We then work with them iteratively to refine these requests and to identify available sources of information that can meet their needs or to conduct targeted analysis or research to address remaining questions. Each jurisdiction and sector has different processes, documents, procedures, and information sources upon which it relies, so it has been difficult to develop a one-size-fits-all approach to the conversation. Consequently, SCIPP works both at state levels to identify common interests across a sub-region and local communities to identify a more detailed, nuanced understanding of how information is used in decision-making and planning processes.

In 2014 we developed and taught climate training materials to **Native American tribes** in Oklahoma and Texas. This spring, as a result of that and other interactions over the last few years, individuals from the **Delaware Tribe of Indians** in partnership with the **Oklahoma Kansas Tribal Coalition** and the **Quapaw Tribe of Oklahoma** in partnership with several northeast Oklahoma tribes asked us to provide support letters for funding they were seeking through the Bureau of Indian Affairs to expand climate adaptation planning efforts in their tribal nations and several others with whom they were partnering. Last fall, a representative of the **Kiowa Tribe of Oklahoma** approached us for information on climate mitigation strategies for tribes as he was working on a climate mitigation plan for his tribe. We have engaged with this tribe in varying capacities over the last five years.

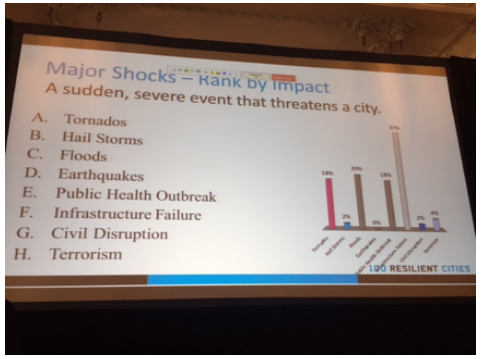
SCIPP acknowledges that there are multiple avenues within the engineering world that are affected by climate and has actively reached out for their engagement over the past few months. From these current efforts, we have made the most engagement with the energy engineer sector. Specifically, the **Oklahoma Chapter of the Association of Energy Engineers (AEE)** requested for SCIPP to present in their monthly Lunch and Learn in May. Pre-meeting conversations led to AEE's request of a "Climate 101" lesson for Oklahoma. Following the presentation, members were actively engaged with questions on historical data and requests for a similar presentation to their various companies. Additionally, an invitation to sit in the proceeding board meeting led to an enthusiastic discussion about a larger one-day workshop. Key insights for this workshop would include a panel of experts ranging from weather and climate to engineering. Topics expressed by both presentations and open discussions will focus on revealing the greater needs of climate information from energy engineers, as well as present on the historical trends related to energy demand and the relevant implications with a changing climate.

NOAA/SARP Thresholds Project, San Angelo: Within the Thresholds project, there were many objectives designed to help build capacity to climate variability and change for local/regional decision-makers. One of the most tangible deliverables this project has brought to light are the development of the "Climate of" documents. Designed to outline the average climate trends of San Angelo as well as a historical climate hazards profile, these documents raise awareness of the city's climate and weather patterns dating back to the 1800's. Having this data written out in an easy to understand, graphical way allows for decision-makers to identify recent life-impacting events and compare them to decades of climate data to understand the true frequency of various events. The final product of this document will combine both the historical analysis with the future projections done by ATMOS Research. With the past, current and future analyses of the regional area of San Angelo combined into one document, this tangible item can serve as a reputable science resource in the various planning and decision-making processes in the city. Discussions from the workshops revealed that various sectors such as planning, parks and recreation, water management and city government would greatly benefit from having a science resource like this document to aid in their ability to understand the climate variability and risk to their city.

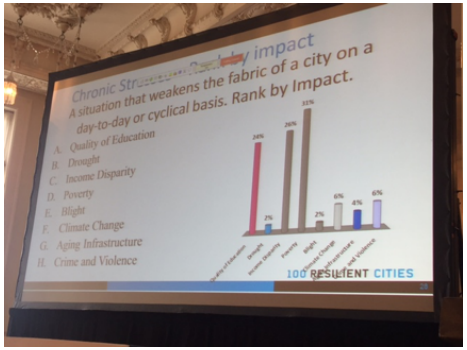
ACCOMPLISHMENT

Accomplishment

Over the past year, SCIPP has increased direct interaction with state and local jurisdictions. Creating these direct connections takes sustained effort. The relationships are difficult to build, but once built they allow research on decision-making processes and an ability to better connect NOAA and partner climate services to meet the needs those stakeholders identify. These relationships are critical for building long-term resilience. Through these types of efforts, SCIPP is facilitating dialog among new partners that have not been well-connected to other NOAA efforts.



As SCIPP was familiarized with the 100 Resilient City Initiative founded by the Rockefeller Foundation, we recognized the potential for engagement when two cities in our region were added in the second round: Tulsa, OK and Dallas, TX. Starting in September 2015, we began our engagement by attending outreach events and developing potential partnerships. Although the cities had similar agendas, the 100 RC process differed for both, and therefore influenced our opportunities for engagement. Our involvement with Dallas was structured through workshops, whereas our advancement with Tulsa (as mentioned on page 5) was helped through our relationship with Tulsa Partners in connecting us with their Chief Resilience Officer. Expanding on the content analyzed through Dallas' workshops, the city has had two workshops so far: an initial "Kick-Off" meeting (October 2015) and a "Stakeholder" workshop (April 2016). From these we learned that the general structure of the initiative is to form a platform of partners who will in return support the resilience initiative for various stakeholders in the city. Workshop exercises focusing on shocks and stressors for Dallas (and similar for Tulsa) revealed that extreme weather events (flooding, hail, ice storms and tornadoes) were amongst the top shocks both in frequency and impact. Additionally, climate change was insinuated by Dallas as a top stressor (not mentioned in Tulsa), however more emphasis was placed on the extreme weather events. The next step for Dallas is to group the stakeholders by area of resilience interest, with "Extreme Weather and Climate Change" as was one of the projected areas. This will be a potential area of involvement for SCIPP as there are limited to no platform partners experienced in weather and climate. Although NOAA is not a listed Platform Partner, they are actively working with El Paso, TX (one of the first round cities) to discuss the implementation of an Early Heat Warning System. Conversations with the El Paso Chief Resilience Officer are planned and will allow SCIPP to learn about the potential involvement of this system for the other cities. Most recently, Nashville, TN was accepted in the third round of cities. SCIPP plans to increase our outreach presence in Tennessee by connecting with their Chief Resilience Officer, as well as potentially convening a workshop with all of the officers within our region. Additionally, SCIPP is continuing to learn from these cities about ways to interact with communities to discuss the topic of resilience and moving forward, we plan to apply the shocks and stressors exercise to states within our region.



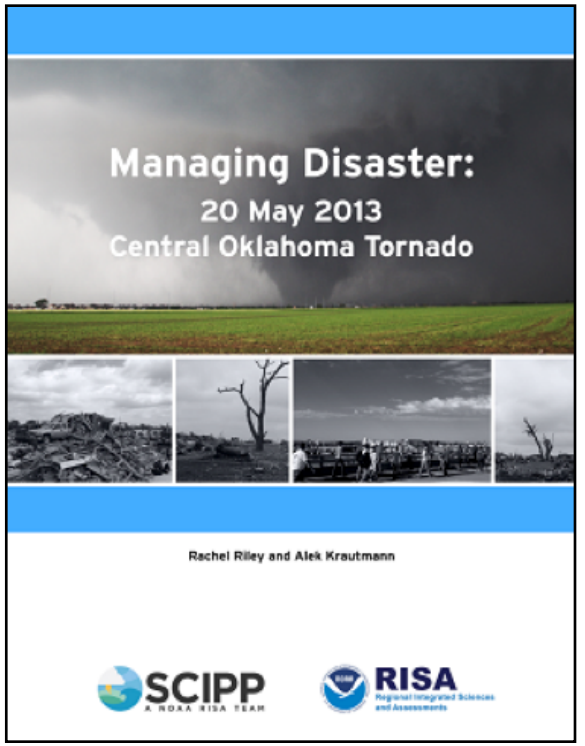
RESEARCH

Research Findings

Relationships and prior planning are key to successful disaster response.

Investigators: Rachel Riley and Alek Krautmann

The EF-5 tornado that struck the central Oklahoma communities of Newcastle, Oklahoma City and Moore on 20 May 2013 required the full engagement of local, state and federal emergency management and captured the attention of the nation and even some parts of the world. Even though the event was exceptionally well-forecasted, 24 people were killed and 387 were treated for injuries at local hospitals. Yet, it provided a unique opportunity to learn how well the planning, preparedness and response efforts that were implemented after previous violent tornadoes struck these communities (e.g., an F-5 on 3 May 1999 and F-4 on 8 May 2003) worked during this disaster and what might be improved should another disaster of this magnitude occur in the area. SCIPP researchers at the University of Oklahoma studied the perspectives of eight city, county and medical emergency management officials and a non-profit organization involved in planning and preparing for and responding to the disaster. All but one of the study participants were involved in managing and responding to previous tornado disasters in the area.



A comparison between the 20 May event to prior plans and experiences revealed that many facets of the response went well. Past experience and planning demonstrated that relationships are a key component to disaster planning and response. Not only are relationships among police, fire, and other emergency personnel important, but relationships with tribal nations, churches, and non-profit organizations are also vital to successfully dealing with a disaster. Many actions taken on 20 May were only possible because of the relationships that had already been formed prior to the event.

Following the event, support to the affected communities poured in through local, national, and even international avenues. While this attention was beneficial, it also created many challenges, most notably the management of a large number of volunteers and a high volume of donations. In fact, donation management almost became a second disaster. Since the event, several of the affected jurisdictions have instituted or are working on instituting a donation management plan, and participants suggested that communities who have not yet experienced a disaster of this magnitude do the same. The donation management planning process should include identifying possible locations such as empty warehouses in advance, making contact with the owners of those empty spaces, determining who will run the warehouse, and communicating to various organizations what items will and will not be accepted at the time the disaster occurs. time the disaster occurs.

RESEARCH

Improved Seasonal Climate/Drought Forecasting in the SCIPP Region

Investigators: Zachary Leasor, Steven M. Quiring

Improved seasonal forecasting could help to mitigate the impacts of extreme heat, a prominent climate hazard in the south-central U.S. Temperature anomalies in this region exhibit temporal autocorrelation from month to month as well as longer time lags, and the magnitude of temperature persistence can provide information that is useful for seasonal climate forecasts. Using high resolution temperature data from 1900-2015, this study has examined the spatiotemporal distribution of temperature persistence. Pearson's pairwise correlation was used to calculate the temporal autocorrelation, which represents the persistence of monthly temperature anomalies at one, three, six, nine, and twelve-month time lags. All autocorrelations can then be tested to verify if the correlation is significantly different than zero. Using this information, a climatology of temperature persistence across the south-central U.S. can be examined.

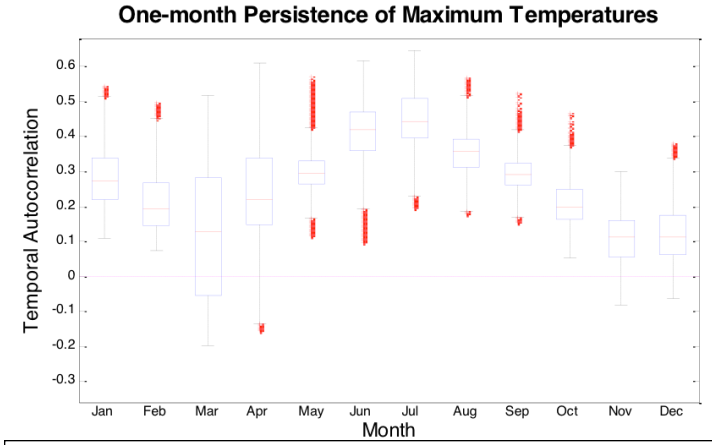
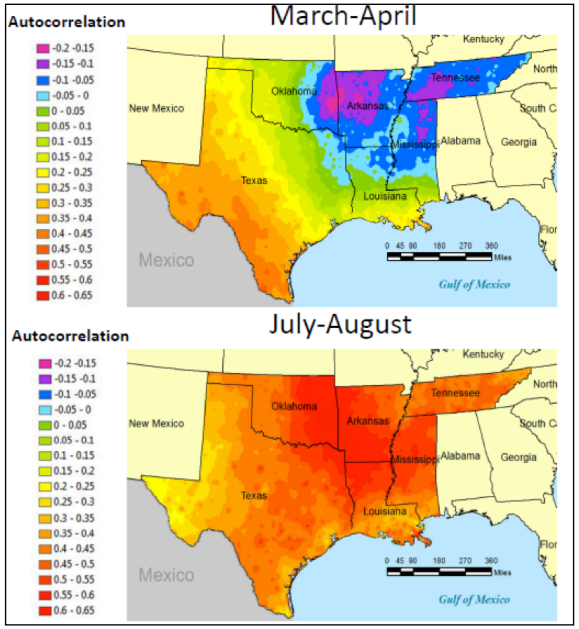


Figure 1. Boxplots displaying distributions of temporal autocorrelations for maximum temperatures at a one-month time lag. The month along the x-axis represents the initial month that the temperature anomaly arises and the autocorrelation reflects the strength with which the initial anomaly persists into the subsequent month.



Initial results suggest that temperature persistence is strongest during the summer months, and that there is a seasonal cycle of temperature persistence. Figure 1 displays the strength of temperature persistence for all locations in the SCIPP region at one-month time lag. The strength of temperature persistence throughout the entire SCIPP region decreases for all months as the lag time increases. Most statistically significant temporal autocorrelations are present at month-to-month timescales, however some locations do see significant temperature persistence at longer lag times. There is characteristic spatial variability in temperature persistence throughout the entire SCIPP region. Figure 2 highlights the difference between two month-to-month pairs with the minimum and maximum extremes of spatial variability. When examining the spatiotemporal distribution of temperature persistence, this information can be utilized in order to determine the locations, seasons, and timescales where it is most appropriate to weigh heavily on persistence in constructing a seasonal temperature forecast. Further research will use the information provided to create a climatology + persistence forecast which can serve as a forecast that can be used as a baseline for comparison with more complex seasonal forecasts.

Figure 2. Maps displaying the magnitude of temperature persistence as expressed by the month-to-month temporal autocorrelations in the SCIPP regions.

RESEARCH

Spatial and Temporal Patterns of In Situ Sea Surface Temperatures within the Gulf of Mexico (GoM), 1901-2010

Investigators: Jason M. Allard, John V. Clarke III, and B.D. Keim

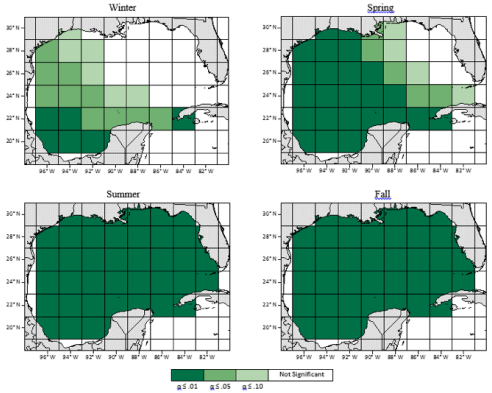


Figure 1. Level of significance for Pearson correlations between yearly time series and their corresponding seasonal sea surface temperature (SST) values over 1901-2010 for each grid cell in the Gulf of Mexico.

This work examines the spatial and temporal patterns of seasonal sea surface temperatures (SSTs) across the Gulf of Mexico (GoM) for the period 1901-2010. The Extended Reconstructed Sea Surface Temperature, version 4 (ERSST.v4), dataset was selected for this study over other reconstructions because of its 2° × 2° grid cell spatial resolution, its recent update to adjust for known biases in SST observations, and its ability to be compared to other in situ studies of GoM SSTs. The monthly ERSST.v4 data were averaged seasonally for each year and grid cell in the GoM. Seasonal SST trends were then calculated for each grid cell with varying start dates (e.g., 1901-2010, 1911-2010) to account for nonlinear SST changes over the study period. Results indicate that the GoM SSTs closely resemble those of global annual temperature trends: SSTs warmed from 1901 to ~1940, followed by a period with little trend or a slight cooling until the mid-1970s, and then a warming afterwards through 2010. The spatial patterns and magnitudes of SST changes, however, varied by season and location within the GoM. The spatial patterns involved gradients with latitudinal and/or longitudinal components: a southwest-northeast (warmer-cooler) gradient in winter, an east-west (warmer-cooler) gradient in spring and fall, and a northwest-southeast (warmer-cooler) gradient in summer. The magnitude of SST changes tended to be largest in summer, followed by spring, fall, and winter. The long-term (1901-2010) SST trends were significant throughout the GoM in summer and fall, but only significant towards the southwestern GoM in winter and spring. These results have implications in discussion of climate change and its impacts on tropical activity in the GoM Basin.

Perceptions of Changing Hurricane Strength Along the U.S. Gulf Coast

Investigators: Wanyun Shao, Siyuan Xian, Barry Keim, Kirby Goidel, Ning Lin

The scientific debate on the impact of climate change on hurricane intensity/strength continues. Regardless of its causes, the consequence of increasing hurricane intensity is undeniably immense among coastal residents. In this study, we investigate how various objective measures of hurricane strength affect people's perception of changing hurricane strength over time. We utilize original survey data to examine the relationship between perceived and actual shift in hurricane strength. In this paper, hurricane strength is indicated as maximum wind speed at landfall, storm surge and economic damage. We find that the characteristics of hurricane strength associated with the most recent landfall are much more closely associated with perceptions of changing hurricane strength than objectively measured trends. This result is consistent with availability bias, suggesting that perceptions are associated with most accessible and retrievable events. We also find that people's belief in climate change play a powerful role in one's perception of changing hurricane strength. Political predispositions are found to affect one's perceptions of changing hurricane strength. Compared to Democrats and Independents, Republicans are far less likely to believe that climate is changing and thus they tend to not believe that hurricanes are becoming stronger. Given that this study focuses on how physical characteristics of past hurricane events influence individual perceptions of hurricane strength shift, future research should focus on how expectations of future climate and weather-related events influence individual attitudes and behaviors.

OUTREACH

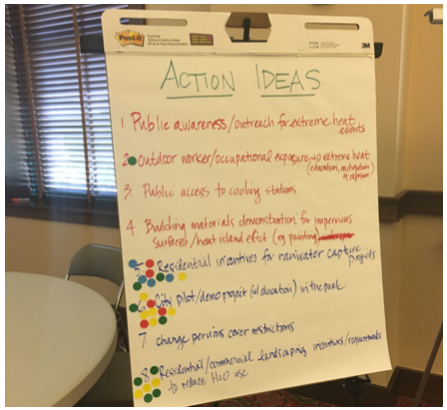
Outreach or Communication Activities

Assessing and Communicating Risk: A Study of Flood Risk Awareness and Resilience in Tulsa, Oklahoma

SCIPP supported an effort by Tulsa Partners to conduct a survey of residents who live in vulnerable areas near an aging levee along the Arkansas River in Tulsa, Oklahoma. SCIPP provided two summer interns who, with Tulsa Partners, the Corps of Engineers, and others, designed and administered a survey to document awareness of levee issues and assess community vulnerability. The findings from the survey supported the city's perceived need to better inform vulnerable residents and to connect them to information and financial assistance programs to reduce their vulnerabilities. The results from this survey are part of a larger Program for Public Information, and will serve as a baseline measurement of how effective future flood-related public information programming is. Also, the interns looked into the effectiveness of this pilot Program for Public Information (PPI) for the City of Tulsa by interviewing and analyzing data from all PPI partners to determine the impact and reach of the program. Analysis of the interviews will lead to recommendations for effective ways of measuring impact and improving the effectiveness of the program. A summer intern in 2016 is building upon this initial work to see how more coordinated information among various agencies in Tulsa are addressing these needs.

Texas and Oklahoma Climate Extremes Workshop: Learning from the Recent Four-Year Drought and Spring Flooding Events: SCIPP served as a presenter, facilitator and notetaker at this event. As a Southern Plains Drought Early Warning System activity with the goal of improving disaster reduction and building capacity for better decision-making relating to drought planning and mitigation, the workshop included presentations and discussions about the shift from extreme drought to floods in 2015 and tactics the participants' agencies used to manage those events. Participants included representatives from the broad areas of water management, public safety, infrastructure, and environment. Discussion topics included monitoring tools, agency coordination, unexpected impacts, successes, and public outreach. Following the workshop, SCIPP produced a summary report that revealed a numerous amount of opportunities suggested based on discussions, such as the increased interest in collaboration across agencies and borders, the establishment of a monthly climate webinar, and the addition of a "train the trainer" workshop geared to assist the participants in bringing the information back to their own agencies.

The NOAA/SARP Thresholds Project: As part of the project's second year, Adaptation International and SCIPP hosted 2 workshops in San Angelo this year (January and April). SCIPP served as the climate resource and during the first workshop we provided the city with a "Climate of San Angelo" document that accompanied an interactive presentation discussing the city's view of these hazards. We then discussed the definition of a threshold and found the quantifiable thresholds for the various stakeholders in the room. The second workshop used the projections of these thresholds (calculated by ATMOS Research) to brainstorm resilience actions for the city. A very engaged and productive session led to the decision to implement a rain water capture system, designed to create public awareness of water conservation and to reduce the City's municipal water use. The lessons from this project are very valuable for SCIPP and the "thresholds" concept is proving to be a hot topic amongst new potential stakeholders. Additionally, the "Climate of" documents are highly valuable in providing a historical context of the hazards in stakeholder's communities and SCIPP plans on developing more throughout our region. Below are pictures from the workshop in San Angelo.



PUBLICATIONS

Key Publications

1) Shafer, M., D. Brown, and C. McNutt, 2016. Managing the 2011 drought: a climate services partnership, in Climate in Context: Science and Society Partnering for Adaptation, A. Parris, G. Garfin, K. Dow, R. Meyer and S.L. Close, eds., American Geophysical Union.

Understanding the long-lasting effects and helping people manage during drought has been a growing area of research and services. Information flow between operational forecasters, the monitoring community, and those affected by drought were studied in the context of an intense multi-year drought across the Southern Plains. The book chapter explores the unique aspects of each partner, why all partners were necessary for effective management, how they informed each other, and what providers and scientists learned from these interactions. These partnerships supported discussions and interactions that helped to build trust and receptivity of drought information and provided multiple points-of-entry into the collective drought monitoring and management system.

2) Simpson, C. F., L. Dilling, K. Dow, K. L. Lackstrom, M. C. Lemos, and R. E. Riley, 2016: Assessing needs and decision contexts: RISA approaches to engagement research. Climate in Context: Science and Society Partnering for Adaptation, A. S. Parris, G. M. Garfin, K. Dow, R. Meyer, and S. L. Close, Eds., Wiley and Sons, 3-26.

In this chapter, we discuss the approaches used by four RISA teams to understand the context within which decision-makers operate and use information. Some of the approaches are formal and are based on social science research methods, and others are more informal based on long-term engagement with stakeholders.

3) Needham, H.F., B.D.Keim, and D. Sathiaraj, 2015: A Review of Tropical Cyclone-Generated Storm Surges: Global Data Sources, Observations and Impacts. Reviews of Geophysics 53(2):545-591.

Tropical cyclone-generated storm surges are among the world's most deadly and destructive natural hazards. This paper provides the first comprehensive global review of tropical storm surge data sources, observations and impacts, while archiving data in SURGEDAT, a global database.

4) Ban, R.J., C.M. Bitz, A. Brown, E. Chassignet, J.A. Dutton, R. Hallberg, A. Kamrath, D. Kleist, P.F.J. Lermusiaux, H. Lin, L. Myeers, J. Pullen, S. Sandgathe, M. Shafer, D. Waliser, C. Zhang, E. Dunlea, C. Mengelt, A. Macaldy, 2016. Next Generation Earth System Prediction: Strategies for Subseasonal to Seasonal Forecasts, Washington DC: National Academies of Sciences

Extending weather and ocean forecasts to predict Earth system conditions weeks to months in advance will help decision makers plan ahead to save lives, protect property, and increase economic vitality. The report presents a research agenda that emphasizes increasing the skill of forecasts; expanding the breadth of forecast model and variables; improving the prediction of extreme and disruptive events; and bringing researchers and decision makers together to develop more actionable forecasts. Decision makers are central to this process, and improving understanding of their decision-making contexts and incorporating social and behavioral science to understand how seasonal to sub seasonal forecasts are being used are an essential element of this research agenda.

5)Trepanier, J.C., M.J. Roberts, and B.D. Keim, 2015: Trends and Spatial Variability in Dry Spells Across the South-Central United States. Journal of Applied Meteorology and Climatology 54:2261-2272. DOI: http://dx.doi.org/10.1175/JAMC-D-14-0319.1

Annual average and maximum spells with no precipitation in the southern United States are analyzed. In this study, dry spells are defined as consecutive days with no measurable rainfall. The strongest geographical indicator for the number of consecutive dry days across this region was longitude. Dry spells tend to have had longer durations at the westernmost stations because of natural climatological controls.

Narrative Examples

Construction of the Ike-Dike in Houston-Galveston

Figure 1. Surge damage in Gilchrist, Texas on the Bolivar Peninsula after Hurricane Ike in 2008. The image was taken by Jocelyn Augusitno of FEMA and is in the public domain. It can be obtained at https://en.wikipedia.org/wiki/Hurricane_Ike#/media/File:Hurricane_Ike_Gilchrist_damage_edit.jpg.

SCIPP personnel are engaged in the research and discussion about the construction of the "Ike Dike," which is a surge barrier that may be constructed to protect the Galveston-Houston region from storm surge. The impetus for the recent discussion to build a surge barrier was the devastating flooding that stemmed from Hurricane Ike in 2008 (Figure 1), along with the long-term history of local catastrophic surge events. Ike produced a 17.5 foot storm surge along the Bolivar Peninsula, which ranks as the 9th largest surge event along the U.S. Gulf Coast since 1880, and the event devastated Galveston and the surrounding region, much like the Galveston Hurricanes of 1900 and 1915, among others. SCIPP is using the SURGEDAT database to assess the range of historical surges in the area and then determine the 500-year, 100-year, and 50-year surge events to be used for assessment and planning. In addition, SCIPP personnel took a team from the SSPEED (Severe Storm Prediction, Education, and Evacuation from Disasters) Center from Rice University - who are also heavily involved in the discussion about the Ike-Dike - on a Katrina tour of New Orleans to assess modern surge mitigation measures that would be relevant to the Ike Dike. Early estimates are that the "Ike-Dike" surge wall will cost between $4-6 billion and will take about 2 years to build. There are competing proposals to the Ike-Dike that would provide a higher level of protection at a lower cost, but would protect a smaller region.

Coping With Drought

Drought has been a predominant theme of SCIPP in recent years, but gave way as attention turned toward floods. The drought of 2011-2015 ended abruptly as record flooding enveloped much of Texas and Oklahoma. This opened up new avenues of discussion and research concerning the nature of hydrologic extremes. This fits well within SCIPP's theme of integrated multi-hazard planning.

Even though attention shifted from drought, drought remained a core strength of SCIPP. Activities undertaken during this past year are detailed according to the working group structure of NIDIS.

Observations and Monitoring

SCIPP contributed to improved monitoring through launching the new Water Reservoir Data Visualization Tool (http://reservoir.srcc.lsu.edu/; see p. 8), conducting three more Field Photos Weekends, and developing new tools for reporting impacts.

The reservoir data tool was the direct result of a need identified in 2011-2012 through interactions with stakeholders in drought forums and webinars. Initial funding for the project was provided by the National Centers for Environmental Information through the Southern Regional Climate Center and NOAA Regional Climate Services Director. SCIPP is now maintaining and expanding the available data as part of its suite of tools.

Field Photos submitted by R Richter Sep 2015

The Field Photos Project was begun in 2012 in partnership with CoCoRaHS and the Earth Observation and Modeling Facility (EOMF; University of Oklahoma). Three times per year – Presidents Day, Memorial Day, and Labor Day, CoCoRaHS observers and other citizen scientists are asked to take photos of their landscape and submit them to the EOMF Field Photos archive. A total of 796 photos were received and uploaded. These photos are being characterized according to drought intensity in another project funded by NOAA Sectoral Applications Research Program (SARP).

SCIPP worked with colleagues at Weather Decisions Technologies (WDT) and the National Drought Mitigation Center on a drought app for mobile phones being developed by WDT, on a separate project funded by NIDIS. In addition to providing access to commonly-used drought products, the app will enable "condition reporting" for different types of impacts (pastures, cropland, lawn & garden, water resources, wildfire, and soil moisture).

Forecasts & Predictions

Predicting summer temperatures are a difficult challenge in the Southern Plains, yet one which is critical to anticipating drought-related impacts. The region is susceptible to flash drought scenarios; consequently being able to anticipate high temperatures in subsequent months could give farmers and ranchers more time to prepare. To address this, Steven Quiring and Zachary Leasor examined spatial and temporal correlations in temperatures between subsequent months (see p. 14). The results did indeed show some level of predictability in the summer months.

It also showed that other seasons which are more dominated by synoptic rather than convective regimes have less predictability. This research could lead to improved predictability of summer drought onset in the Southern Plains.

Interdisciplinary Research and Applications

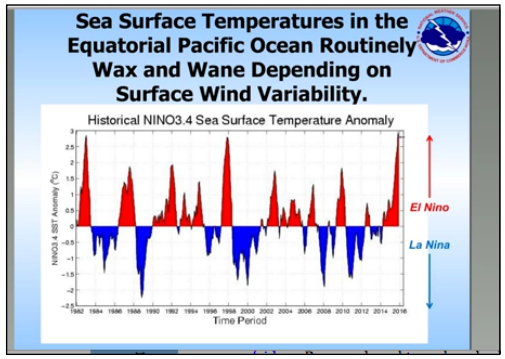
New research included assessing use of various drought indicators, changes in the frequency of precipitation, and comparing planning documents. SCIPP conducted a regional survey of local (county and parish-level offices) on their management of drought, use of various drought indices, perception of the U.S. Drought Monitor, and communications. The survey received 331 responses. A draft summary of the survey has been completed and will be finalized in Summer 2016.

SCIPP worked with Dr. Dawn Jourdan in the University of Oklahoma's Regional and City Planning Department to compare planning documents from three cities in Oklahoma. Cities rarely have stand-alone drought plans; rather response to drought may be scattered across several plans, if it is even featured at all. The research team examined several city plans, including water management, emergency management, and comprehensive plans to see how all types of hazards are portrayed and the relationship between the plans. The data are currently being analyzed.

SCIPP also continued examining ecological impacts of drought (in association with the DOI South Central Climate Science Center) and began developing a wildfire and prescribed burn climatology (funded by a grant from the South Central Climate Science Center). Both of these topics arose from comments made at drought forums and webinars.

Education and Outreach

SCIPP continued providing webinars and briefings on drought. SCIPP conducted a webinar on El Nino transition to La Nina. Several regional National Weather Service Forecast Offices participated in the webinar. In addition, SCIPP produced several 5-minute briefings posted directly to YouTube and the SCIPP videos site, http://www.southernclimate.org/resources/videos. Because drought was largely absent across the region for much of this time, the updates were much less frequent than in previous years. Additional webinar topics are planned, but are waiting until drought is more prominent in order to increase participation.



El Nino to La Nina Drought Webinar: 2/18/16

Other Planning and Engagement

In addition to the focused efforts aligning with NIDIS Working Groups, SCIPP conducted several broad-based activities to promote drought planning. These included a regional workshop and assisting Arkansas with an incipient drought planning effort. The Texas-Oklahoma Climate Extremes workshop is detailed on page 16. The report that was produced from the workshop is one of the key documents that is being used to produce the Southern Plains DEWS strategic plan.

Arkansas Drought Planning Workshop

Appendix: Publications

*Allard, J.M., J.V. Clarke, and **B.D. Keim**, In Press: Spatial and Temporal Patterns of In Situ Sea Surface Temperatures within the Gulf of Mexico (GoM), 1901–2010. American Journal of Climate Change.

*Allard, J.M., C.R. Thompson, and **B.D. Keim**, 2015: How Robust is the Pre-1931 National Climatic Data Center - Climate Divisional Dataset? Examples from Georgia and Louisiana. Theoretical and Applied Climatology 120(1-2):323-330, DOI 10.1007/s007.

*Ford, T. W., D. B. McRoberts, **S. M. Quiring**, and R. Hall, 2015: On the utility of in situ soil moisture observations for flash drought early warning in Oklahoma, USA. Geophysical Research Letters, 42: 9790–9798. doi: 10.1002/2015GL066600

*Ford, T. W., **S. M. Quiring**, O. W. Frauenfeld, and A. D. Rapp, 2015: Synoptic conditions related to land-atmosphere interactions and unorganized convection in Oklahoma. Journal of Geophysical Research-Atmospheres, 120: 11,519–11,535. doi: 10.1002/2015JD023975

*Gustafson, D., **M. Hayes**, E. Janssen, D. Lobell, S. Long, G. Nelson, H. Pakrasi, P. Raven, G. P. Robertson, R. Robertson, and D. Wuebbles, 2015: Pharaoh's dream revisited: an integrated U.S. Midwest field research network for climate adaptation. BioScience, DOI: 10.1093/biosci/biv164.

*Hamilton, L.C, J. Hartter, **B.D. Keim**, A.E. Boag, M.W. Palace, F.R. Stevens, M.J. Ducey, In Press: Wildfire, Climate and Perceptions in Northeast Oregon. Regional Environmental Change.

***Kos, L.**, 2016: Workshop Summary Report for the Texas and Oklahoma Climate Extremes Workshop in October 2015.

*Kuster, E., C. Lunday, and **R. A. McPherson**, 2015: A comparison of North American Regional Climate Change Assessment Program (NARCCAP) output and Oklahoma Mesonet observations. The Geographical Bulletin, 56, 102-106.

*Lewis, A.B., and **B.D. Keim**, 2015: History and Applications of Manual Synoptic Classification. Earth Systems and Environmental Sciences. Reference Module. DOI: http://dx.doi.org/10.1016/B978-0-12-409548-9.09521-X 1

***Quiring S. M.**, Ford T. W., Wang J. K., Khong A., Harris E., Lindgren T., Goldberg D. W., Li Z., In Press:North American Soil Moisture Database: Development and Applications. Bulletin of the American Meteorological Society. doi: 10.1175/BAMS-D-13-00263.1

***Peppler, R. A.**, K. E., Kehoe, J. W. Monroe, A. K. Theisen, and S. T. Moore, 2016: "The ARM Data Quality Program." Chapter 12 in, The Atmospheric Radiation Measurement (ARM) Program. Meteorological Monographs, American Meteorological Society, in press.

*Shankman, D., and **B.D. Keim**, 2016: Flood Risk Forecast for China's Poyang Lake Region. Physical Geography 37(1):88-91.

*Sisterson, D. L., **R. A. Peppler**, T. S. Cress, P. J. Lamb, and D. D. Turner, 2016: "The ARM Southern Great Plains (SGP) Site." Chapter 6 in, The Atmospheric Radiation Measurement (ARM) Program. Meteorological Monographs, American Meteorological Society, in press.

*Shao, W., S. Xian, **B. Keim**, K. Goidel, N. Lin, In Press: Understanding Perceptions of Changing Hurricane Strength Along the U.S. Gulf Coast. International Journal of Climatology.

Appendix: Publications

*Shao, W., J.C. Garand, **B.D. Keim**, and L.C. Hamilton, In Press: Science, Scientists, and Local Weather: Understanding Mass Perceptions of Global Warming. Social Science Quarterly.

*Tonn, G., Guikema, S., Ferreira, C. and **S. M. Quiring**, In Press: A longitudinal analysis of the drivers of power outages during hurricanes: A case study with Hurricane Isaac. Risk Analysis. DOI: 10.1111/risa.12552

*Trepanier, J.C., M.J. Roberts, and **B.D. Keim**, 2015: Trends and Spatial Variability in Dry Spells Across the South-Central United States. Journal of Applied Meteorology and Climatology 54:2261-2272. DOI: http://dx.doi.org/10.1175/JAMC-D-14-0319.1

*Xianwu Xue, Ke Zhang, **Yang Hong**, Jonathan J. Gourley, Wayne Kellogg, **Renee A. McPherson**, Zhanming Wan, Barney N. Austin, 2015: New Multisite Cascading Calibration Approach for Hydrological Models: Case Study in the Red River Basin Using the VIC Model. Journal of Hydrologic Engineering, 05015019. doi: 10.1061/(ASCE)HE.1943-5584.0001282. PDF

*Xue, X., K. Zhang, **Y. Hong**, J. J. Gourley, W. Kellogg, **R. A. McPherson**, Z. Wan and B. N. Austin, 2015: New multisite cascading calibration approach for hydrological models: Case study in the Red River Basin using the VIC model. J. of Hydrol. Eng., 10.1061/(ASCE)HE.1943-5584.0001282, 05015019.

*You, J., K. G. Hubbard, M. Shulski, M. Svoboda, **M. Hayes**, 2015: Development of a long-term (1884-2006) serially complete dataset of U.S. temperatures and precipitation for climate services. Journal Service Climatology, 8(1): https://www.stateclimate.org/sites/default/files/upload/pdf/journal-articles/2015_You_et_al_2015.pdf.

*Zhang, K., J.S. Kimball, R.R. Nemani, S.W. Running, **Y. Hong**, J.J. Gourley, and Z. Yu, 2015: Vegetation Greening and Climate Change Promote Multidecadal Rises of Global Land Evapotranspiration. Nature Scientific Reports, 5, 15956. doi: 10.1038/srep15956.

*Zhanming Wan, Ke Zhang, Xianwu Xue, Zhen Hong, **Yang Hong**, Jonathan Gourley, 2015: Water Balance Based Actual Evapotranspiration Reconstruction from Ground and Satellite Observations Over the Conterminous United States. Water Resources Research, 51, 6485–6499. doi: 10.1002/2015WR017311. PDF.