The 5th Symposium

On

Southwest Hydrometeorology

The Albuquerque Marriott Hotel

Albuquerque, New Mexico

September 30th to October 1st, 2009

On behalf of the National Weather Service and The University of New Mexico,
we welcome all attendees to the
5th Symposium on Southwest Hydrometeorology

5th Symposium on Southwest Hydrometeorology

Hosted by:

THE UNIVERSITY of NEW MEXICO *and* National Weather Service, Forecast Office Albuquerque, NM

With generous funding provided by:

COMET 20th Anniversary

Additional funding and support from:

National Weather Service Southern Region Headquarters

Electronic Journal of Severe Storms Meteorology

VAISALA

5th Symposium on Southwest Hydrometeorology

Day One: Wednesday, September 30, 2009

8:00-8:15 Welcome and Introduction to Symposium
Shawn Bennett*, David Gutzler+ and Deirdre Kann*, Symposium Co-Chairs
*NWS Albuquerque and +University of New Mexico

Session I: Short Term Analysis and Forecasting
Session Chair: Shawn Bennett, National Weather Service Albuquerque

8:15-9:00 Invited Presentation: Joseph Galewsky, University of New Mexico
An idealized modeling study of orographic clouds in terrain-blocked flows.

9:00-9:20 An Evaluation of the Relationship Between Cloud to Ground Lightning Events and Precipitation Over Southern Arizona and Northern Sonora. Carlos Manuel Minjarez Sosa, Christopher L. Castro, Kenneth Cummins and Philip Krider, University of Arizona

9:20-9:40 A High-Resolution Simulation of Intensive Observing Period 2 During the North American Monsoon Experiment Using the Weather Research and Forecasting (WRF) Model. William Cassell and Christopher L. Castro, University of Arizona

9:40-10:00 A Study of the Kinematic and Thermodynamic Processes of New Mexico Gap Winds using the Weather Research and Forecasting (WRF) Model. Brian Guyer, NWS WFO ABQ

10:00-10:20 BREAK

10:20-10:40 Unusual Severe Convective Outbreak over South-Central Arizona on 28-29 August 2008. Doug Green, NWS WFO PSR

10:40-11:00 Requirements for developing an adaptive radiosonde network for improved regional weather forecasting over southwestern North America. Michael Douglas, NSSL and John Mejia, CIMMS

Session II: **Climate Change**
Session Chair: Elizabeth Ritchie, University of Arizona

11:00-11:45 Invited Presentation: Brian H. Hurd, New Mexico State University
Impacts and Implications for Managing Water Resources under Climate Change in the Upper Rio Grande Watershed

11:45-1:00 LUNCH (on your own)

1:05-1:25 Climate Change Projections for the Western U.S. with Observation-based Interannual Variability. Tessia Robbins and David Gutzler, University of New Mexico

Session III: **Characterization and Seasonal Prediction of Snowpack and River Flows**
Session Chair: Elizabeth Ritchie, University of Arizona

1:30-2:15 Invited Presentation: Albert Rango, USDA/ARS Jornada Experimental Range
Using New Methods to Improve Snowmelt Runoff Forecasting and Assess Climate Change Impacts on Water Supplies (with Caiti Steele)

2:15-2:35 Utilizing Partnerships to Improve Water Supply Forecasts on the Rio Grande. Paul McKee, NWS WGRFC.

2:35-3:00 BREAK

Session IV: **Climate Variability and Forecasting**
Session Chair: David Gutzler, University of New Mexico

3:00-3:20 The impact of tropical cyclones on the rainfall climatology of the North American Southwest region. Elizabeth Ritchie and Kimberly Wood, University of Arizona, and David Gutzler, University of New Mexico

3:20-3:40 Behavior and rainfall patterns associated with unusual tropical cyclones in the eastern North Pacific during 1992-2005. Kimberly Wood and Elizabeth Ritchie, University of Arizona

3:40-4:20 Long Lead Flood Forecast Application to Benefit Society: Experiences of 2008 Flood Bangladesh Floods. S.H.M. Fakhruddin and A.R. Subbiah, ADPC

Day Two: Thursday, October 1, 2009

Session IV: **Climate Variability and Forecasting (continued)**
Session Chair: David Gutzler, University of New Mexico

8:00-8:45 Invited Presentation: Jae Schemm, Climate Prediction Center, NOAA/NWS/NCEP
The North American Monsoon Forecast Forum at CPC
With Wayne Higgins, Lindsey Long and Wei Shi

8:45-9:05 Can Regional Climate Models Improve Summer Climate Forecasts in North America?
Christopher L. Castro, Francina Dominguez, Hsin-I Chang, University of Arizona

9:05-9:25 Mechanisms Linking Easterly Waves and the North American Monsoon. Simona Olson and Yolande Serra, University of Arizona.

9:25-9:30 Brief Introduction to Posters

Break and Poster Session

9:30-10:40 Scheduled Posters:

Seasonal Snowpack/Streamflow Relationships. Kerry Jones, NWS WFO ABQ and David Gutzler, University of New Mexico

Climatology of High Wind Warning Events for Northern and Central New Mexico. Todd Shoemake, NWS WFO ABQ

An Evaluation of the Flash Flood Predictive Index using Historical Flood Events. Amanda Abeyta and Deirdre Kann, NWS WFO ABQ

Statistics of Multi-Season Drought. David Gutzler, University of New Mexico and Deirdre Kann, NWS WFO ABQ

Use of Tree Ring and Long-Term Precipitation Records to Characterize Warm Season Climate Variability in the Southwest U.S. Brittany Ciancarelli with Christopher L. Castro, Connie Woodhouse, Dave Meko, Ramzi Touchan, Steven W. Levitt, Daniel Griffin, University of Arizona

Session V:	**High Impact Weather** **Session Chair: Deirdre Kann, National Weather Service Albuquerque**
10:45-11:30	Invited Presentation: David Gochis, UCAR Linking weather and climate drivers to understand extreme precipitation variations in the North American Monsoon
11:30-1:00	LUNCH (on your own)
1:00-1:20	The Effects of Prior Rainfall over Northwest Chihuahua Dry Lake Beds on Spring Blowing Dust Frequency and Severity at El Paso International Airport. Mike Hardiman, NWS WFO EPZ
1:20-1:40	Total Lightning, Radar, and Satellite Observations of two Monsoon Thunderstorm events in the Tucson Area, Summer 2007. Erik Pytlak, NWS WFO TWC and Martin Murphy, Vaisala, Inc.
1:40-2:00	Heat Waves in Phoenix: High Impact Events? Doug Green, NWS WFO PSR
2:00-2:20	Temporal Characteristics of Extreme Local Precipitation Events in New Mexico, Colorado and Arizona, John Henz, HDR Engineering
2:20-2:50	BREAK
2:50-3:10	Synoptic Environments Associated withTornadoes in Northern Arizona. David Blanchard, NWS WFO FGZ
3:10-3:30	Tropical Cyclones and the Desert Southwest: Studying and Preparing for a Rare, High Impact Event. Erik Pytlak, NWS WFO TWC
3:30-3:50	Hurricane Dolly: An Examination and Historical Perspective on an Atlantic Basin Tropical Cyclone's Impacts on the Paso del Norte Region. Michael Hardiman, NWS WFO EPZ
3:50-4:10	Vaisala's New Global Lightning Dataset GLD360, Ron Holle and Nich Demetriades, Vaisala, Inc.

End of Symposium

An idealized modeling study of orographic clouds in terrain-blocked flows

Joseph Galewsky
Department of Earth and Planetary Sciences
University of New Mexico

Idealized numerical simulations of moist strongly stratified flow over topography are used to study the processes that control orographic clouds in terrain-blocked flows as a joint function of the nondimensional flow parameter Nh/U, the horizontal topographic aspect ratio Î^2, and the Rossby radius of deformation Nh/f. The simulations show the competition between enhanced upstream condensation in the secondary vertically propagating gravity wave and the reduction of condensation owing to enhanced low-level flow deflection. As Nh/U increases above about 1.5, the tendency for flow to be deflected around the barrier reduces cloud formation in the primary gravity wave over the ridge, while increasing Î^2 expands low-level clouds over a broader upstream area. Ice clouds may form aloft in the secondary vertically propagating gravity wave and extend upstream for several hundred kilometers. In terrain-blocked flows, more than half of the condensate mass develops upstream of the barrier in the secondary gravity wave, while in unblocked flows most of the condensate is downstream of the barrier in the primary lee wave. In 2D, none of the flow can be diverted around the barrier, and it therefore produces a much more vigorous hydrologic cycle than over long (Î^2 = 8) 3D ridges, increasing upstream lifting and cloud water content by at least a factor of 2, and generating primary wave clouds that are not produced in the 3D case. Rotation reduces the upstream extent of condensation in blocked flows to a region on the order of the radius of deformation and in 3D induces a marked asymmetry in the lifting and condensation upstream of the terrain.

An Evaluation of the Relationship Between Cloud to Ground Lightning Events and Precipitation Over Southwest United States and Northwest Mexico

Carlos Manuel Minjarez Sosa*, Kenneth Cummins, Christopher Castro, Phillip Krider
University of Arizona and *Universidad de Sonora

The importance of having an accurate quantitative precipitation estimation (QPE) has been highlighted by a number of authors because of its impact in fields like climatology, hydrology, and weather forecasting among others.

Typically, precipitation is measured and estimated using rain gauges and RADAR, even though, these techniques have their own weaknesses like poor spatial coverage for the former and terrain beam blockage, poor known reflectivity rain rate (Z-R) relationship, etc. for the latter. These problems have motivated researchers to combine both techniques and or seek alternative methods in order to improve QPE.

The relationship between cloud to ground lightning strikes (CG ltg) and convective precipitation has been studied by a number of authors. Its importance rests upon its use as an alternative for QPE. If a region is large enough to be gridded, precipitation per each grid per period of time can be estimated. Hence, we can also count the number of CG ltg strikes per grid and perform a linear regression to obtain the rate of rain per CG ltg occurrence. The accuracy of the estimation may depend on how accurate the precipitation estimation is. Therefore, the weaknesses of conventional precipitation estimation methods should be considered.

Southwest United States and Northwest Mexico is a region characterized because of its complex terrain and its convective precipitation during June, July, and August, due to its location in the region affected by the North American Monsoon. Some authors have highlighted that QPE for this region is affected by RADAR beam terrain blockage and because the dense rain gauge networks are only located in the populated areas (low deserts) and not in the higher and more complex terrain, where most precipitation occurs.

In this presentation we will show our preliminary results in evaluating the relationship between CG lightning occurrences and convective precipitation over Southern Arizona and Northern Sonora. For the summer months of June, July and August of 2005 we will analyze National Lightning Detection network (NLDN) data and NCEP Stage IV precipitation data. We will address the problem of poor rain gauge coverage and radar beam terrain blockage and how these variables conspire in obtaining a poor correlation between both variables. We will try to highlight the importance of CG ltg counts to estimate quantitative precipitation for cases where the mentioned conditions occur.

A High-Resolution Simulation of Intensive Observing Period 2 During the North American Monsoon Experiment Using the Weather Research and Forecasting (WRF) Model

William Cassell and Christopher L. Castro
Department of Atmospheric Sciences
University of Arizona
Tucson, Arizona

The North American Monsoon Experiment (NAME) was a meteorological field campaign in the southwest U.S. and northwest Mexico conducted in summer 2004. Two goals of NAME are to improve the physical understanding of mesoscale meteorological phenomena associated with monsoon precipitation and to improve short-term numerical weather prediction forecasts. Within the campaign there were a series of intensive observing periods (IOPs) that targeted specific meteorological features of importance, mainly related to the development of organized convective thunderstorms. This project uses the Weather Research and Forecasting (WRF) model to retrospectively simulate some of the more important NAME IOPs in a numerical weather prediction mode. WRF simulations dynamically downscale retrospective global meteorological analyses with a multiple grid nesting strategy. The finest nested grid has a grid spacing of 2.5 km, sufficient to resolve individual thunderstorms, and covers the entire NAME core observation region (Tier I domain). The present focus is a preliminary demonstration of the WRF modeling approach using IOP-2. This important IOP was intended to capture the effects of a major gulf surge, or advection of moisture northward through the Gulf of California, and associated development of westward propagating mesoscale convective systems (MCSs) that originate on the Sierra Madres. The gulf surge in IOP-2 was triggered by the passage of tropical storm Blas south of the Gulf of California and caused the formation of a MCS in southern Arizona. Results of the high resolution WRF simulation are analyzed and compared with an existing evaluation of this event from NAME observations, specifically as documented in Rogers and Johnson (2006). Additional later work will evaluate the sensitivity of model simulations of IOPs to the specification of initial conditions and the impact of assimilation of NAME sounding data.

A Study of the Kinematic and Thermodynamic Processes of New Mexico Gap Winds using the Weather Research and Forecasting (WRF) Model

Brian Guyer
NOAA/National Weather Service, WFO Albuquerque, NM

Gap winds have the potential to transport significant low level moisture from the eastern plains of New Mexico into the western half of the state. Repeated events during the early summer season have been partially responsible for the development of the southwest monsoon across New Mexico. Gap winds can also significantly impact operations at both the Albuquerque Sunport and the Santa Fe Municipal airport during moderate to strong events due to their locations within the Rio Grande Valley. Previous studies on gap winds across New Mexico have provided guidance to forecasters on the synoptic regimes leading to the development of these winds. However, no documentation has been provided regarding the kinematic and thermodynamic processes occurring within the cross-canyon environment. This study will provide a more detailed conceptual model of a gap wind within the Rio Grande valley. A simulation of the 15-16 May 2009 gap wind event across the Albuquerque Metro area will be examined using the 7.5km local WRF model.

Unusual Severe Weather Outbreak over the Greater Phoenix Metropolitan Area on 28-29 August 2008

Doug Green
NOAA/National Weather Service, WFO Phoenix, Arizona

During the evening of 28-29 August 2008, an atypical severe weather outbreak occurred over and near Phoenix, Arizona. Between 8 pm MST (0300 UTC) and 1 am MST (0800 UTC), a succession of strong to severe thunderstorms propagated west-southwest across the metropolitan area. The combination of well-above-average storm motion and rapid regeneration of severe convective storms over and northeast of the metropolitan area was an extremely rare occurrence. In terms of impact, damaging straight-line winds, with peak gusts well in excess of 80 mph, resulted in widespread damage, with losses in the tens of millions of dollars, especially over central and south Phoenix, Tempe, and Mesa. Anomalous atmospheric conditions for south-central Arizona, including strong low-mid tropospheric vertical wind shear and high thermodynamic instability, were observed prior to the outbreak, which heightened forecaster situational awareness and allowed WFO Phoenix to effectively convey the increased threat to our customers. This paper will present a review of the circumstances under which this severe weather outbreak occurred, describe and depict convective storm evolution, highlight what went well and what could be improved with respect to outlook, outreach and warning operations, and focus on several 'lessons learned'. Key information gleaned from realtime and post-event local and regional WRF model runs initiated the morning of 28 August 2008 will also be presented.

Requirements for developing an adaptive radiosonde network for improved regional weather forecasting over southwestern North America.

Michael Douglas, NSSL/NOAA
John Mejia, CIMMS, University of Oklahoma

The recent availability of radiosonde systems of relatively low initial cost (~$10K) permits serious consideration of supplementing routine US NWS and Mexican SMN radiosonde observations over southwestern North America for improving short-range weather forecasting. The southwest in particular is likely to benefit from spatially-denser observations because of the extreme topographic variations over the region limit the representativeness of individual soundings, especially in the lower-troposphere. In this talk we summarize the conditions needed to operate a cost-effective adaptive sounding network. The essential requirements include: 1) low initial cost sounding systems 2) an adaptive sounding strategy 3) contract (pay-by-observation) personnel 4) internet connectivity 5) centralized analysis and 6) a decision process for selecting days for making the desired observations. The steps needed to bring such a vision to reality are outlined; these include quantifying the economic benefits that can be expected from forecast improvements using a hierarchy of regional models, defining and convincing key institutions to support the effort, and ensuring the involvement of the US and Mexican NWS's (SOO's and forecasters) in optimizing procedures for selecting observation days.

Impacts and implications for managing water resources under climate change in the Upper Rio Grande watershed

Brian H. Hurd
New Mexico State University

The prospect of climatic changes introduces significant challenges to many vulnerable communities. How these communities choose to prepare depends much on their specific sensitivities, economies, and adaptive capacities. This paper presents an overview of key concepts that underlie the consideration and design of effective climate change adaptation strategies, including issues of the scope of adaptation activities, reactive versus anticipatory adaptation, vulnerability assessment, and adaptation timing. Examples include those related to water resources with a focus on issues relating to the uncertainties involved in designing appropriate climate-wise strategies.

Climate change projections for the western U.S. with observation-based interannual Variability

David Gutzler and Tessia Robbins
Earth & Planetary Sciences Department
University of New Mexico
gutzler@unm.edu

Climate change scenarios on the climate division scale are developed by superimposing a model projected 21st Century linear trend in temperature or precipitation to a repetition of observed 20th Century interannual variability. This procedure allows the projected trends to be placed into context with realistic variability, and facilitates assessment of the projected trend in terms of historical climate fluctuations. Linear trend of temperature and precipitation for climate divisions across the western U.S. for the 21st Century are generated from an average of 18 global models forced by the A1B scenario of greenhouse gas concentration changes, as shown in the IPCC Fourth Assessment report. Historical fluctuations for the same climate divisions are used to generate interannual variability, and superimposed on the 21st Century linear trend to generate the climate change scenario for each Division.

By mid-century, the summer season exhibits a higher average temperature every year than any summer season ever observed in the instrumental record, i.e. summer temperatures quickly rise outside the climatic historical range of variability. Winter temperatures, in contrast, do not fall outside the range of observed 20th Century winters until much later in the 21st Century. This seasonal difference occurs in part because summer trends are larger in magnitude than winter trends. More importantly, however, interannual variability is much larger in winter than in summer so that "cold winters" in the mid-21st Century are comparable to "average" winter temperatures experienced in the current climate.

Using New Methods to Improve Snowmelt Runoff Forecasting and Assess Climate Change Impacts on Water Supplies

Albert Rango and Caiti Steele
USDA-ARS Jornada Experimental Range
New Mexico State University
Las Cruces, NM 88003

In the Southwest US, the southern Rocky Mountains provide a significant orographic barrier to prevailing moisture-laden Westerly winds. In winter and spring, this results in snow accumulation and melt, both vitally important to the region's water resources. Accurate forecasts of both seasonal and short term snowmelt-driven streamflow are essential for effective management of Southwestern water resources but there are challenges in deriving these forecasts. The inherent variability of meteorological conditions in the Southwest, during both snowpack buildup and depletion, requires spatially distributed data. The population of ground-based networks (SNOTEL, SCAN, weather stations) is sparse and does not satisfactorily represent the variability of snow accumulation and melt in our region. Remote sensing can be used to supplement data from ground networks, but the most frequently available remotely sensed product with the highest temporal and spatial resolution, namely snow cover, only provides areal data and not snow volume. Snowmelt runoff models have been and are still being developed for forecasting snowmelt-driven streamflow but these models produce forecasts that are only as reliable as their input data.

With the growing awareness of atmospheric warming and the southerly location of Southwest watersheds, it has become apparent that the effects of climate change will be especially important for Southwestern water users. The NSF-funded EPSCoR project "Climate Change Impacts on New Mexico's Mountain Sources of Water" (started in 2009) has focused on improving ground-based hydrological measurements, developing basin-wide and sub-basin snow cover mapping methods, and generating snowmelt runoff simulations, forecasts, and long-term effects due to climate change. Networks of groundbased measurements are being enhanced. Five new SNOTEL and four new SCAN sites are being installed in 2009-2010 and 12 existing basic SNOTEL sites are being upgraded to enhanced sites. In addition, 30 new automated precipitation gages are being added to New Mexico measurement networks. The first phase of snow mapping and modeling has focused on four sub basins, namely, the Rio Grande near Del Norte, CO and the Rio Hondo, Rio Chama, and Castillo Creek in NM, all tributaries of the Rio Grande basin. An additional 21 sub basins will be added as the method development progresses. High spatial resolution Landsat TM data (30 m) are being used to evaluate estimates of snow cover maps from moderate spatial resolution data from Terra MODIS (500 m). Currently MODIS provides optimal temporal sampling (daily data) but most existing methods for snow cover estimation from MODIS data overestimate snow cover. Therefore we aim to identify the best MODIS snow-mapping algorithm for our area. For the snowmelt modeling, we are using an updated revision of the Snowmelt Runoff Model (SRM).

(Rango and Steele, continued)

SRM directly accepts remote sensing snow cover inputs and can automatically assess the climate change effects of future scenarios. A further aim of our research is to determine the sensitivity of SRM to different spatial aggregations of the remotely sensed data input. The methods under development are intended for operational use by interested water resources agencies. With this end in mind, we will be developing an ArcGIS Toolbox (ESRI) and manual that will incorporate all the tools and instructions necessary for data download, re-projection and formatting, modeling and streamflow estimation.

Utilizing Partnerships to Improve Water Supply Forecasts on the Rio Grande

Paul W. McKee, Senior Hydrologist
NWS West Gulf River Forecast Center
Fort Worth, TX

The NWS West Gulf River Forecast Center (WGRFC) is responsible for providing hydrologic forecast services for the Rio Grande which originates in the Rocky Mountains of southern Colorado, flows through central New Mexico, and demarcates the Texas / Mexico international border. Currently, WGRFC forecasts volumetric water supply for the upper Rio Grande down through central New Mexico utilizing statistical multivariate regression methods. As water availability in the western United States continues becoming more critical, a hydrologic model with probabilistic forecasting capabilities will enhance the ability of WGRFC to provide essential services to water supply stakeholders and provide the framework for enhanced river flow forecasting.

In an effort to enhance the WGRFC's ability to forecast water supply volumes, the State of Colorado's Department of Water Resources (CDWR), in cooperation with the San Luis Valley Irrigation District, funded a project to develop a hydrologic model for four headwater basins in the upper Rio Grande. The hydrologic model includes a continuous, conceptual rainfall–runoff model (Sacramento Soil Moisture Accounting) and an energy balance snowmelt runoff model (SNOW-17) to simulate streamflow and provide volumetric water supply forecasts, and with the addition of Extended Streamflow Prediciton, will provide probabilistic forecasting capabilities. The NWS has continued incremental model development to include the remaining Rio Grande water supply and flood forecast points within the state of Colorado to be completed within FY2010. Similar hydrologic development will be expanded for the Rio Grande through New Mexico to Elephant Butte Reservoir. The NWS has been collaborating with the Upper Rio Grande Basin Water Operations Model (URGWOM), a consortium of Federal agencies with water supply and management responsibilities in New Mexico. This collaboration seeks to accelerate the current development track and directly supports the NWS mission to protect life and property by providing enhanced, more dependable water supply and flood forecasts. For other water resource stakeholders, a primary benefit will be the addition of modeled, physically-based watershed processes, particularly real-time snowmelt and rainfall dynamics, into the basin's broader reservoir management and water accounting activities. The completed model will become a shared resource and tool for many water management activities, as well as provide support for collaborating water supply forecasts with the Natural Resource Conservation Service (NRCS).

This presentation will review the existing state of modeling on the upper Rio Grande. Primary focus will turn to the collaborative efforts to improve and modernize modeling efforts, with a review of the potential products and services that will result.

The impact of tropical cyclones on the rainfall climatology of the North American Southwest region

Elizabeth A. Ritchie*, Kimberly M. Wood*, David S. Gutzler[+]
*University of Arizona and [+]University of New Mexico

During the North American monsoon season, an additional source of tropical moisture is occasionally advected into the U.S. southwest from the eastern North Pacific in the form of tropical cyclone remnants. Although the tropical cyclone-strength winds rapidly diminish upon making landfall, these systems still carry a large quantity of tropical moisture and, upon interaction with mountainous topography, have the potential to drop copious amounts of precipitation. However, these systems are traditionally difficult to forecast accurately due to the nature of their interaction with the midlatitude flow.

Forty-three remnants with varying impact on the U.S. southwest region were investigated from 1992 to 2005 in order to construct paradigms to aid local forecasters. Five categories were determined after examining the rainfall patterns and large-scale features: group 1 cases undergo a more northern extratropical transition (ET) and are thus more likely to bring rainfall to the U.S. southwest; group 2 cases undergo ET farther south bringing rainfall across Northern Mexico and the Gulf Coast region; group 3 cases exhibit largely north and/or northwestern motion and bring rainfall to the west coast of the U.S.; group 4 cases do not interact with a trough but instead are blocked from the southwest by a ridge; and group 5 cases are those cases that are not clearly any of the previous four types.

In this presentation, we will investigate the impact that these groupings of tropical cyclone remnants have on precipitation in the arid North American southwest region. We will study their climatological impact, the preferred rainfall patterns, and the nature of the large-scale circulations that advect them across the southwest U.S. using both observational and model data. The unique behavior and rainfall of a group 5 case, Tropical Storm Ignacio (1997), which brought precipitation to the U.S. southwest as a tropical cyclone and to the northwest U.S. as an extratropical cyclone, will be presented as an illustration of the sometimes bizarre behavior of some of these systems.

Behavior and rainfall patterns associated with unusual tropical cyclones in the eastern North Pacific during 1992-2005.

Kimberly M. Wood and Elizabeth A. Ritchie
University of Arizona

Most Eastern Pacific tropical cyclones (TCs) that impact the southwest United States do so from the influence of or interaction with certain large-scale patterns, with the most common being a mid-latitude trough or cutoff low. However, a few TCs do not fit the patterns explored by Ritchie et al. (2009). Many of these unusual cases bring rainfall to the southwest U.S., yet the mechanisms responsible for the storm motion and moisture transport are often the result of a unique combination of factors rather than the normal large-scale flow.

This talk will focus on three of these unusual TCs: Tropical Storm Ignacio (1997), Tropical Storm Bud (2000), and Hurricane Flossie (2001). Ignacio contributed moisture to the southwest U.S. while remaining at sea, then traveled north along the U.S. west coast, underwent extratropical transition, and brought rain to the Pacific Northwest as an extratropical cyclone. Bud remained off the coast of Mexico for its tropical lifetime, yet favorable winds and the abundant moisture it provided produced a large amount of rainfall across Mexico and the southern U.S., coinciding with the start of the monsoon in Tucson, Arizona. Flossie, a fairly small TC, exhibited unusual motion due in part to a binary interaction with an extratropical low, and the system's remnants brought cloud cover to much of the southwest U.S. as well as significant rainfall to parts of southern California.

Long Lead Flood Forecast Application to Benefit Society: Experiences of 2008 Flood Bangladesh Floods

S.H.M. Fakhruddin and Dr. A.R. Subbiah
Asian Disaster Preparedness Center (ADPC)

It has long been recognized that if society could have advance information on weather, the adverse effects associated with it could be minimized. Prevalence of traditional forecast practices in various parts of the world reflects the demand for long-range forecasts schemes to manage uncertainties associated with it. Recent advancements in long lead flood prediction under the Climate Forecast Applications in Bangladesh (CFAB) program promise huge benefits for society and developed strong interagency cooperation and networking to facilitate the development of flood forecasting schemes and their application at the various levels. During the last monsoon 2007, significant efforts were made to further refine the forecasting scheme and development of institutional networking and coordination mechanisms through series of training at national, district and local levels for interagency collaboration and capacity building at institutional and community level to facilitate generation, interpretation and communication of forecasts at the risk communities. The value of new generation CFAB long lead flood forecast products to reduce disaster risk at the community level has been demonstrated and proven a huge societal benefit and save life and property. This paper describes lessons learned on institutional and community aspects of CFAB in the context of 2007 floods experience.

The North American Monsoon Forecast Forum at CPC

Jae-Kyung E. Schemm, Wayne Higgins, Lindsey Long and Wei Shi
Climate Prediction Center
NOAA/NWS/NCEP

In 2008, CPC introduced a new operational product to provide users a forum to monitor the North American monsoon (NAM). The NAME Forecast Forum (NAME FF) was proposed and endorsed by the North American Monsoon Experiment (NAME) Project Science Working Group as a natural extension to the NAME modeling activities coordinated under the NAME Climate Process Team project. It provided an opportunity to consolidate and assess, in real-time, the skill of intra-seasonal and seasonal monsoon forecasts. The NAME FF has continued in 2009 and three modeling groups collaborate with CPC to provide model simulated seasonal precipitation forecasts in the monsoon region. The website includes spatial maps and accumulated precipitation area-averaged over eight sub-regions of the NAM domain and is updated daily to include the current observed precipitation. A weekly update of the current conditions of the NAM system has been added to CPC's American Monsoons monitoring webpage at:

http://www.cpc.ncep.noaa.gov/products/Global_Monsoons/American_Monsoons/NAME/index.shtml.

A highlight for the 2009 season is the inclusion of the NCEP CFS forecasts in T382 horizontal resolution. These special high-resolution runs were made with initial conditions in mid-April to accommodate the CPC's hurricane season outlook. Some results based on the T382 CFS runs also will be presented at the symposium with emphasis on the prediction of precipitation and accompanying atmospheric circulation over the NAM region.

Can Regional Climate Models Improve Summer Climate Forecasts in North America?

Christopher L. Castro[1], Francina Dominguez[1,2], and Hsin-I Chang[1]
[1]Department of Atmospheric Sciences and [2]Department of Hydrology
University of Arizona
Tucson, Arizona

Official U.S. seasonal climate forecasts by the National Oceanic and Atmospheric Administration (NOAA) are issued by the Climate Prediction Center (CPC), a branch of the National Center for Environmental Prediction (NCEP). CPC currently uses the Climate Forecast System (CFS) global coupled ocean-atmosphere model as the numerical modeling component of these forecasts. Recently, NCEP has produced a comprehensive long-term retrospective ensemble CFS reforecasts for the years 1980-2005. These reforecasts show that CFS model 1) demonstrates an increase in skill when a greater number of ensembles members are used; 2) has an ability to forecast tropical Pacific SSTs and large-scale teleconnection patterns, at least as evaluated for the winter season; and 3) has greater skill in forecasting winter than summer climate. The decrease in CFS skill during the warm season is due to the fact that the physical mechanisms of rainfall at this time are more related to mesoscale processes, such as the diurnal cycle of convection, low-level moisture transport, propagation and organization of convection, and surface moisture recycling. In general, these are poorly represented in global atmospheric models.

Using the Weather Research and Forecasting (WRF) model as a regional climate model (RCM), we are currently dynamically downscaling warm season CFS reforecasts for a contiguous U.S. domain. Data from NCEP reanalysis 2 is also being dynamically downscaled to assess the performance of the RCM assuming “perfect” boundary forcing. We have executed dynamical downscaling tests for several test years with extreme summer climate conditions in the western and central U.S. (specifically 1988 and 1993). Results thus far shows that CFS-WRF simulations can provide a more realistic representation of convective rainfall processes because they better resolve mesoscale circulation features tied to land surface forcing, namely the diurnal cycle of convection. Thus a RCM can potentially add significant value in climate forecasting of the warm season provided the downscaling methodology incorporates the following: 1) spectral nudging to preserve the variability in the large scale circulation while still permitting the development of smaller-scale variability in the RCM; and 2) use of the most realistic soil moisture initial condition, in this case provided by the North American Regional Reanalysis. With these conditions, downscaled CFS-WRF reforecast simulations can produce continental-scale patterns of warm precipitation similar to what actually occurred. This includes a reasonable representation of the North American monsoon in the southwest U.S. and northwest Mexico, which is notoriously difficult to represent in a global atmospheric model. We anticipate that this research will help lead the way toward substantially improved real time operational forecasts of North American summer climate with a RCM.

Mechanisms Linking Easterly Waves and the North American Monsoon

Simona Olson and Yolande Serra
University of Arizona

In northwestern Mexico and southwestern United States, the North American Monsoon System (NAMS) is a major source of precipitation from mid-June through early September. The precipitation from NAMS is associated with a surface low pressure and an upper-level high pressure over the NAMS region, bringing low-level moisture in from the tropical east Pacific, Caribbean, and Gulf of Mexico. NAMS precipitation is also dependent on synoptic events within the NAMS region. Diurnally forced convection due to orographic lifting coupled with low-level moisture fluxes from the tropics forces mesoscale convective systems over the mountains which then move over the lowlands spreading monsoon moisture throughout the Southwest U.S. and northern Mexico.

Easterly waves, which originate in Africa and travel across the Atlantic Ocean to Central America, have been shown to influence both the amount and location of precipitation within the NAMS region, however the physical mechanisms linking the waves to NAMS precipitation events are not well understood. In this study, we investigate links between easterly waves and moisture fluxes up the Gulf of California, as well as interactions of wave troughs with the Sierra Madre Occidental.

Case studies from August 2004 are being examined using the Advanced Research Weather Research and Forecasting (WRF-ARW) regional model. The model setup will be presented. Preliminary results showing easterly wave interaction with the Sierra Madre Occidental and potential moisture fluxes associated with these waves for the August 2004 cases will also be presented.

Poster Session

Relationship between a 700-mb "Dry/Wind" Index and Springtime Precipitation and Streamflow at Select Stations in New Mexico and Southern Colorado.

Kerry Jones[1] and David Gutzler[2]
[1]NOAA/National Weather Service WFO Albuquerque, NM and [2]University of New Mexico

Historical measurements of 1 April snow water equivalent (SWE), cumulative precipitation and mean daily streamflow between 1 April and 30 June, as well as mean 700-mb values of zonal wind and relative humidity within five high elevation watersheds in New Mexico and southern Colorado are analyzed between 1980 and 2005. Simple linear regression techniques are used to relate 1 April SWE and April-June (AMJ) streamflow. This methodology was chosen over a more complex multiple predictor variable regression technique since the primary objective was to analyze "departures" from expected streamflow rather than to minimize the forecast standard error. Precipitation that accumulates after 1 April through the end of the forecast period likely accounts for a significant portion of these departures. However, confidence integrating long-lead precipitation outlooks, which are almost exclusively based on El Niño-Southern Oscillation (ENSO), into 1 April water supply forecasts for northern New Mexico and southern Colorado is low owing to a statistically insignificant relation between tropical ENSO indices (e.g. SOI and Niño 3.4 anomalies) and AMJ precipitation at high elevations in the Southern Rockies. However, generally speaking, dry days are much more common in the spring than are wet ones. Moreover, dry days are often windy, which can accelerate the loss of snowpack through sublimation processes and result in less-than-expected streamflow particularly early in the forecast period. It is therefore instructive to collectively investigate relationships between dry, windy AMJ periods and springtime precipitation, departures from expected seasonal streamflow and ENSO. To accomplish that task, a simple, dual-parameter index (herein referred to as DWND index) to isolate days that were relatively dry and windy was created by dividing the mean 700 mb zonal wind by the mean 700 mb relative humidity. An average DWND index was computed for April, April-May, and April-June for each year. Relationships between the DWND index and AMJ precipitation, seasonal departures from expected streamflow and ENSO were examined. Potentially important links emerged between the DWND index and springtime precipitation. Namely, years that were unusually dry and windy during April and May (average DWND index > 30) recorded below to well below average precipitation if any at all, while years that had a lower average DWND index recorded near normal to much above normal precipitation. More importantly, the relationship between the DWND index and Niño 3.4 anomalies is better defined than is the relationship between AMJ precipitation and Niño 3.4 anomalies. This finding may increase confidence that warm (cold) phase ENSO cycles do in fact result in normal to above normal (below normal) springtime precipitation at high elevations in New Mexico and the Southern Rockies.

Poster Session

Climatology of High Wind Warning Events for Northern and Central New Mexico

Todd Shoemake
NOAA/National Weather Service, WFO Albuquerque, NM

High wind events frequently plague central New Mexico and the greater desert southwest region due to synoptical, seasonal, and diurnal processes. These high wind events pose considerable challenges to forecasters, and they can often have significant effects to life and property within the southwestern United States. Individual National Weather Service offices issue High wind warnings for non-convective wind events reaching specific thresholds for speed. At the Albuquerque Weather Forecast Office these thresholds are defined as winds having sustained speeds of 40 mph or greater and/or instantaneous gusts of 58 mph or higher.

A climatology of high wind events for northern and central New Mexico was established, not only to document the frequency of high wind observations, but also to provide forecasters with a supplemental knowledge of the synoptic regimes associated with these high wind events. This assessment first utilized data from the Albuquerque metropolitan area to document high wind events surrounding the largest population center within central New Mexico. Data for seven additional sites across northern and central New Mexico are also currently being examined.

In the central phase of the study, wind data from hourly surface observations were parsed, and statistical analyses were completed to generate a high wind climatology over a 1976 – 2005 timeframe. Another key objective of this study was to confirm or refute any preconceived forecaster assumptions on high wind scenarios, ultimately guiding future wind forecasts and high wind warning decision-making processes. Also, a few generalized hypotheses will be discussed in anticipation of results of the study, such as the frequency and temporal distribution of high wind events. Temporal distributions of these high wind events will be explored from a yearly, seasonal, and diurnal standpoint. Documented high wind events were also partitioned into subsets to decipher mechanisms that triggered the events. These subsets were then scrutinized thoroughly by looking at associated vertical temperature profiles and ongoing synoptic features that were analyzed at various pressure levels of the atmosphere. Finally, a classification of synoptic settings was applied as composite pressure plots were constructed. These plots were reviewed and will be presented in order to equip forecasters with conceptual models for recognizing such events.

An Evaluation of the Flash Flood Potential Index Using Historical Flood Events

Amanda Abeyta
NOAA/National Weather Service, WFO Albuquerque, NM

Flash flooding is one of the many severe weather events that can put life and property in danger. Flash flooding is a frequent and serious threat in New Mexico due, in part, to diverse topographic features. There are currently several tools available to forecasters that can be used when monitoring potential flooding events, such as Nexrad estimated rainfall rates and amounts, and the Flash Flood Monitoring and Prediction (FFMP) software. Still there is a need for improved systems to support operational forecasters during flood events. Greg Smith, the Senior Hydrologist at the Colorado Basin River Forecast Center, developed a support product called the Flash Flood Potential Index (FFPI). The FFPI ranks the flooding potential of drainage basins and is designed to assist operational forecasters in making the "warn" or "no warn" decision during flash flood situations. The goal of this study was to complete a comparison of FFPI response areas to the locations of documented flooding events in the Albuquerque CWA. Overall, the FFPI constructed by Greg Smith corresponded reasonably well with archived areas. The current focus is to test whether historical data can be used in addition to the original FFPI parameters to more accurately predict dangerous flash floods.

Statistics of multi-season drought

David Gutzler[1] and Deirdre Kann[2]
Earth & Planetary Sciences Department, University of New Mexico
NOAA/National Weather Service, WFO Albuquerque, NM

We develop an extremely simple definition of regional "multi-season drought" based on persistent runs of 3-month precipitation anomalies. This definition is designed so that it is closely related to the set of 3-month running averages of tercile-based precipitation outlooks that form he basis for the NOAA Climate Prediction Center's seasonal forecast. Using this definition, multi-season drought episodes can be defined from 20th Century historical data when a specified number of consecutive 3-month anomalies all lie in the lowest tercile, corresponding to the "below normal" tercile in the CPC's seasonal outlooks.

With drought episodes defined this way, we can then enumerate the characteristics of multiseason drought across the seasonal cycle, for example to explore seasonal tendencies for drought onset or demise, and the relationships between multi-season drought and large-scale climate forcings associated with SST anomalies (such as those related to ENSO). Results are presented for the entire CONUS based on NCDC's multi-state regions. We will emphasize results from the Southwest and West regions for this meeting. The initial set of results is derived using a specified threshold of six consecutive 3-month anomalies as the definition of drought; the sensitivity of the results to this specification is currently being assessed.

Use of Tree Ring and Long-Term Precipitation Records to Characterize Warm Season Climate Variability in the Southwest U.S.

Brittany Ciancarelli[1], Christopher L. Castro[1], Connie Woodhouse[2], Dave Meko[2], Ramzi Touchan[2], Steven W. Levitt[2], and Daniel Griffin[2]

[1]Department of Atmospheric Sciences and [2]Laboratory for Tree Ring Research
University of Arizona
Tucson, Arizona

The Southwest U.S. experiences two distinct periods of precipitation through the year. Cool season precipitation (October to April) is from synoptic-scale mid-latitude cyclones, while warm season precipitation (May to September) is primarily from localized thunderstorms associated with the North American Monsoon. Large-scale forcing factors (e.g. Pacific sea surface temperature) influence the variability of precipitation in contrasting ways between the cool and warm seasons, as determined by the observational record and regional atmospheric modeling studies for the period since the late twentieth century. The goal of this work is to determine if tree-ring records, taken from ponderosa pine and Douglas-fir also record this contrast in interannual variability in climate between these seasons, and how the climate has varied over the past several hundred years. Core samples from trees are currently being collected at sites throughout the region. Partial width indices (early and latewood) from the cores will be analyzed to retrospectively construct winter and summer (monsoon) precipitation back several centuries. The component of the project emphasized here is a preliminary statistical evaluation of existing long-term precipitation records extending back to the late 1800s. Dominant patterns of spatial and temporal variability in these data will then later be compared to precipitation proxy data from the tree rings to assess the reliability of the reconstructions and skill in replicating spatial patterns.

For this portion of the project, we mainly use the standardized precipitation index (SPI) computed from PRISM (Parameter-elevation Regressions on Independent Slopes Model) precipitation data from 1885-2007. As SPI implicitly accounts from the nonnormal distribution of precipitation at a given location, it is very appropriate to investigate climate variability in the western U.S. SPI timescales that isolate the cool and warm season are considered for statistical analysis, for example 3 month SPI from July-September and 6 month SPI from November-April. Empirical orthogonal function (EOF) analysis with and without rotation is applied to determine the dominant spatial patterns of these SPI data. The analysis reveals very different dominant patterns of precipitation variability between the cool and warm seasons. Most important, an out of phase relationship between precipitation in the central U.S. and southwest U.S. is most apparent in the early part of the summer. Principal component time series of the dominant SPI modes are then correlated with indicators of large-scale atmospheric circulation to confirm the linkage of Southwest U.S. climate variability to remote sea surface temperature forcing.

Linking weather and climate drivers to understand extreme precipitation variations in the North American Monsoon

David Gochis
National Center for Atmospheric Research

The past decade (1998-2008) has witnessed one of the lowest precipitation years on record (2002) and the highest precipitation year (2008) on record in terms of all-Mexico summer rainfall. While the steady increase of precipitation values between 2002-08 is indicative of a slow period oscillation, other factors have combined to contribute to such extremes. In this overview talk, several of the mechanisms controlling the occurrence of both high and low seasonal precipitation values will be discussed. These factors include both large-scale influences (i.e. teleconnective patterns) as well as the occurrence of smaller-scale transient disturbances. Emphasis will be placed on understanding how these variations influence wet/dry summers over the core region of the North American Monsoon throughout various regions in western Mexico and the southwestern U.S. The climatic conditions occuring during the 2004 North American Monsoon Experiment (NAME) Enhanced Observing Period will also be highlighted in order to place results from NAME into a broader climate context.

The Effects of Prior Rainfall over Northwest Chihuahua Dry Lake Beds on Spring Blowing Dust Frequency and Severity at El Paso International Airport

Mike Hardiman
NOAA/National Weather Service, WFO El Paso
Santa Teresa, New Mexico
mike.hardiman@noaa.gov

Prior studies have shown a series of seasonally-dry lake beds or playas in Northern Chihuahua, known as the pluvial Lake Palomas System, to be an important point-source region for blowing dust events experienced in the El Paso, Texas metropolitan area. Previous studies have also shown that enhanced blowing dust activity occurs during extended periods of below normal precipitation at El Paso International Airport (ELP). However, rainfall data from one point location approximately 100 km east of the dust source region is not necessarily representative of precipitation over the larger area. This study will compare average Multisensor Precipitation Estimates (MPE) over the dry lake beds and their hydrological basins to blowing dust events at ELP over the past 5-8 years. While this is a small sample size, the years examined encompass both an extended regional rainfall deficit period, and a period of above-normal precipitation in more recent years. Where available, rainfall observations and records from Mexico will also be examined.

Total Lightning, Radar, and Satellite Observations of two Monsoon Thunderstorm Events in the Tucson Area, Summer 2007

Erik Pytlak[1] and Martin Murphy[2]
[1]NOAA/National Weather Service, WFO Tucson, AZ and [2]Vaisala Inc., Tucson, AZ

At the start of the southwest monsoon season of 2007, Vaisala installed an LS8000 total lightning mapping system in southern Arizona. This system maps cloud lightning and the in-cloud components of cloud-to-ground (CG) lightning flashes in two dimensions. Soon after installation, two very different thunderstorm cases in the Tucson metro area were captured by the system, and its observations were compared with radar, satellite and other meteorological information.

On the afternoon of 24 July, a small cluster of thunderstorms moved toward the north-northwest from near the Mexican border and developed what appeared to be an MCS-like stratiform rain area as it matured in a very unstable environment. The most unusual characteristic of this storm system was that 98% of the lightning activity consisted of cloud flashes, and of the few CG flashes detected, many were of positive polarity. This type of lightning activity is apparently rare in southern Arizona, and moreover, storms to the east of the Tucson metro area exhibited much more typical lightning activity for the region: a higher percentage of CG flashes, with most CG flashes being of negative polarity. Another feature of the 24 July storm was the fact that rainfall under the quasi-stratiform region was rather light in the metro area, despite very cold cloud tops and moderate reflectivities aloft.

A very different case occurred on the evening of 10 August. This was a severe convective wind event with much more typical lightning activity, and a spike in CG lightning rate prior to the onset of damaging winds. Yet, in this case, atmospheric instability was not nearly as great as the 24 July event. In this presentation, we analyze the lightning activity, radar and satellite observations of these two storms in more detail.

Excessive Heat Watch/Warning Criteria Employed at WFO Phoenix

Doug Green
NOAA/National Weather Service, WFO Phoenix, Arizona

Hot temperatures are routinely observed over the lower desert of far southeast California and southwest Arizona during the summer: average daytime highs routinely exceed 100 F from early June through mid-September, with warmest average daytime highs (above 105 F) observed during July and early August. Although relative humidity is typically low, apparent temperature often exceeds actual temperature during July and August. Plentiful sunshine and late afternoon breezes exacerbate the heat and its impact, resulting in higher apparent temperature than heat index charts indicate.

Given the typical hot summertime conditions, relatively small difference between average and record temperatures, a trend toward warmer nighttime lows (especially in urban areas), and the less-than-desirable quality/availability of useful heat-health statistics, development of practical excessive heat watch/warning guidance for WFO Phoenix customers has been challenging. Prior to 2000, heat thresholds for the lower desert had been set so high that heat advisories / warnings were never issued. The Kalkstein heat-health model, first applied to the Greater Phoenix area in 2000, was the first serious attempt to address the heat-health issue at WFO Phoenix. WFO Phoenix has modified the heat watch/warning guidance to place more emphasis on the most extreme/unusual heat events, which may or may not be the optimal approach. This talk will focus on describing the current heat watch/warning guidance employed by WFO Phoenix. Persistent excessive heat is a major health concern; to that end, a 'heat wave' definition for the lower desert is proposed, and recent 'heat waves' will be highlighted.

Temporal Characteristics of Extreme Local Precipitation Events in New Mexico, Colorado and Arizona

John F. Henz, Natan Clements, William Badini and Michael McMahon
HDR Engineering, Inc.

The temporal distribution of extreme precipitation events occurring in New Mexico, Colorado and Arizona were accomplished as part of Probable Maximum Precipitation studies in those states. WSR-88D Doppler radar reflectivity observations were augmented by available surface rain gauge networks as available to obtain the most reasonable distributions. Commonalities and notable differences surfaced in each state with distinct topographic influences. The temporal distributions observed were not consistent with HMR-55A and HMR-49 recommended temporal distributions. These differences will be discussed. Initial evaluation of the temporal distributions relative to observed upper air sounding data suggests some predictive value of extreme events may be obtained.

Synoptic Environments Associated With Tornadoes in Northern Arizona

David O. Blanchard
NOAA/National Weather Service, WFO Flagstaff, AZ

Recent tornadic weather events in northern Arizona have exhibited similar synoptic and thermodynamic characteristics suggesting that there may be recurring patterns that can be gleaned from the historical data and which would be beneficial for forecasting future events. A recent event documented by Blanchard (2006) revealed an environment with small buoyant instability, as determined by the convective available potential energy (CAPE), but with both large deep-layer and low-level shear. A second, more recent, event also exhibited large shear and small values of CAPE. Moreover, both events occurred when an upper-level closed low moved across Arizona. The similarities of these two events have motivated this investigation of synoptic environments associated with tornadoes in northern Arizona.

Tropical Cyclones and the Desert Southwest: Studying and Preparing for a Rare, High Impact Event

Erik Pytlak
NOAA/National Weather Service, WFO Tucson, AZ

Although the vast majority of eastern Pacific tropical cyclones dissipate over open waters far away from the United States, several each year interact with the North American Monsoon flow regime and modulate convective rainfall over the southwest U.S. About every two to three years, the remnants of a tropical cyclone are captured by an incoming upper level system and lifted bodily into the southwest U.S. Several of these shearing systems caused serious flash floods in the desert Southwest.

Perhaps a bit more surprising, since 1965 five landfalling, eastern Pacific tropical cyclones have survived long enough to reach the southwest U.S. as a tropical storm with maximum sustained winds over 39 mph. At least six others survived long enough to arrive in the desert Southwest as an intact tropical depression. Recent studies from Australia and Bermuda, and post-mortems on two Arizona tropical storms, suggest that given the right atmospheric conditions, eastern Pacific tropical cyclones can survive surprisingly far inland, and bring not only torrential rains, but also damaging tropical storm force winds to the southwest U.S. This presentation, which will also be presented as a poster at the National Weather Association meeting this October, will outline the basic meteorological patterns that allow eastern Pacific tropical systems to either: interact and enhance the preexisting monsoon circulation; shear into remnants which then traverse the desert Southwest and trigger flash floods; or bodily recurve, survive and arrive in the southwest U.S. as an unusual, but dangerous tropical storm. The presentation will also detail a new tropical cyclone response plan for southwest U.S. NWS forecast offices and the National Centers for Environmental Prediction (NCEP) offices like the National Hurricane Center.

Hurricane Dolly: An Examination and Historical Perspective on an Atlantic Basin Tropical Cyclone's Impacts on the Paso del Norte Region

Mike Hardiman
NOAA/National Weather Service, WFO El Paso, TX
Santa Teresa, New Mexico
mike.hardiman@noaa.gov

Category I Hurricane Dolly made landfall near South Padre Island, TX on 23 July 2009. Despite taking a long track across the high terrain of the Sierra Madre Occidental in Northeastern Mexico, the remnants of Dolly still exhibited a closed surface circulation and as it reached the Paso del Norte Region the morning of 26 July. 24-hour rainfall amounts from Dolly's remnants were as high as 5 inches over parts of the El Paso Metropolitan Area, and widespread flooding was reported across southern New Mexico and Far West Texas. This presentation will examine the pre-storm conditions across the region, as well as synoptic conditions responsible for steering the tropical cyclone into the Paso del Norte region. An historical examination of previous Atlantic Basin tropical cyclone impacts on the area, including Hurricane Allen (1980) and Hurricane Celia (1970), will serve to reinforce the rare nature of the event.

Vaisala's New Global Lightning Dataset GLD360

Ron Holle and Nick Demetriades
Vaisala, Inc.
Tucson, Arizona

Vaisala has installed the new GLD360 network that will detect cloud-to-ground lightning over the globe by January 2010. Coverage of the Atlantic, Caribbean, and Pacific oceans has been completed. The network has a high detection efficiency averaging 70% during both day and night, and a location accuracy of 5 to 10km. Flash polarity and signal strength are also provided. Verification with Vaisala's National Lightning Detection Network, and meteorology applications will also be discussed.