Design and Justification of a Forecasting Network in Equatorial Africa

Kevin Burns Natalie Daab Natalye Lahart
University of Oklahoma School of Meteorology
Mentor: Dr. Michael Douglas, NSSL 2011-2012

http://weather.ou.edu/~africawx/

Summary

The purpose of this research project is to design and justify an effective weather forecasting and climate-monitoring network for the region of equatorial Africa (between 10N and 10S).

The region of study (Figure 1) has roughly the same area size and population as the United States. Therefore, many people are affected by and would benefit from a more effective and updated operational forecasting system. Since weather has both societal and economical effects, it is necessary to measure and predict the most useful weather information for the public at the least cost.

There are several basic concepts that this research will focus on. To begin with, the infrastructure of each of the countries will be studied in order to give some background knowledge. This includes the societal/demographical background, the current forecasting abilities and observation networks, the economics of meteorology (salaries, observation network overhead), and forecast consumers and their applications.

In parallel with building background knowledge about each country, the basic weather and climate variability of each country will also be researched. This includes daily temperatures and variability, precipitation and its space and time variability, important weather events to predict, as well as time and space scales of variation. With this, the skill of the modeling systems to predict such weather events will also be researched.

Thus begins the implementation of a weather forecasting and climate monitoring system for the region of study. The main items that will be focused on for this implementation is the instrumentation (what is needed, cost, quality), the analysis of observed data, how to generate forecasts from analyzed data, and how to effectively distribute forecasts to society. In terms of communicating to the public, we will attempt to figure out if a problem lies with the forecasters themselves disseminating the message, or if there is simply inadequate prediction from the available models since most of the forecasts that are longer than 24 hours do not actually depend on observations over Africa.

Since this is a remote research project most of our research is going to be conducted through the Internet and e-mail. We will evaluate the current national weather services, climatology for each country and decide what improvements and/or additions can be made to each country's and the region's observation and forecasting systems. We will be contacting leaders of the region by e-mail to obtain first-hand information. Overall, our research is going to be conducted nearly exclusively through the online information gathering as opposed to actual on-site observations.

The region that we have selected for study is comprised of diverse countries, large and small, that are affected by a variety of serious weather conditions. It is important that each of these countries has a sufficient forecasting and observing system in place so the people of these countries can be prepared and protected in the event of severe weather. Therefore, we will evaluate the usefulness of forecasts and justify improvement of the forecasting networks.

Introduction

The meteorological problems in Africa are numerous and diverse. Both flash floods and seasonal flooding ravage much of the continent. Strong winds stir up severe dust storms. Beyond the natural hazards, there exist significant societal issues related to weather forecasting. Many observation networks are grounded by lack of funding or dedication. Forecasts are either not communicated to the decision makers effectively or disregarded. Cohesion between countries' networks is often non-existent. The broad range of issues make the problem solving approach difficult, to say the least. Therefore, this research will focus on the region of equatorial Africa, which is shown in Figure 1 below.

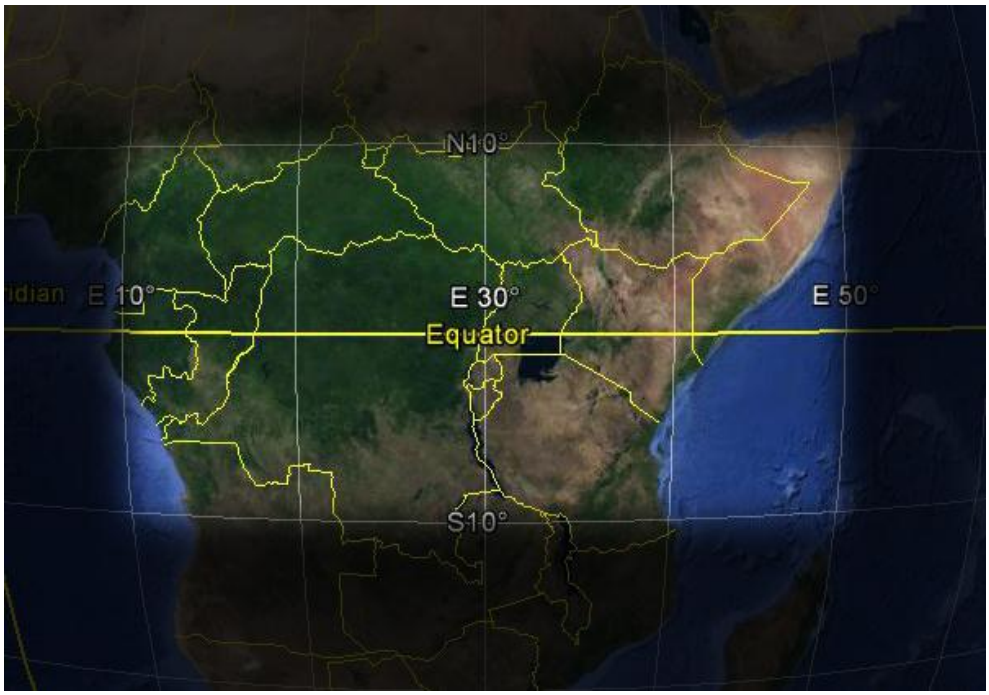

Figure 1. The region of focus- Equatorial Africa from 10N to 10S

The region of equatorial Africa that will be researched consists of 13 different countries. Each of these countries as well as the current state of their development is listed in Table 1.

Table 1. Countries of Interest and Their Current Development

Country	Development
Central African Republic (7)	Least Developed
South Sudan	Least Developed
Ethiopia (15)	Least Developed
Somalia	Least Developed
Kenya (35)	Low Development
Uganda (21)	Least Developed
Democratic Republic of Congo (1)	Least Developed
Congo (63)	Least Developed
Rwanda (18)	Least Developed
Burundi (3)	Least Developed
Tanzania (28)	Least Developed
Gabon (128)	Medium Development
Equatorial Guinea (137)	Least Developed

According to the United Nations, the least developed countries are ones that are the poorest and weakest in the international community (United Nations, 2011). Global Finance magazine also did a study of the world's poorest nations in 2011. The rankings from that list are in parenthesis beside each country in Table 1 (Global Finance, 2011). From all of this information, it is clear that the under development and poor economies of the countries of focus will lead to an added challenge in this research. Although this may make it more difficult to communicate with this countries, it shows that these countries are ones that are in need of help and can greatly benefit from an observation network.

The Observing System Research and Predictability Experiment (THORPEX) Program, initiated in 2008 by the World Meteorological Organization, currently seeks to resolve many of the issues for the continent. THORPEX has released two documents that are critical as the basis for this proposed research. Those two documents are the *WWRP/THORPEX African Science Plan* and the *WWRP/THORPEX African Implementation Plan.*

Of the *WWRP/THORPEX African Science Plan*, there are two main sections and overall goals that will help as the starting point for this research. The first of these two sections is the dynamical and physical processes of eastern Africa. By researching the dynamical and physical processes of the region, their effects on the predictive skill of high impact weather systems in the area can be better understood. Some of the high impact weather events that occur over eastern equatorial Africa are dry spells, flash floods, hail storms, frost, fogs, wind gusts, and torrential rainfall brought on by tropical cyclones and storms. The following figure, Figure 2, from *WWRP/THORPEX African Science Plan* shows the lakes and topography of eastern Africa.

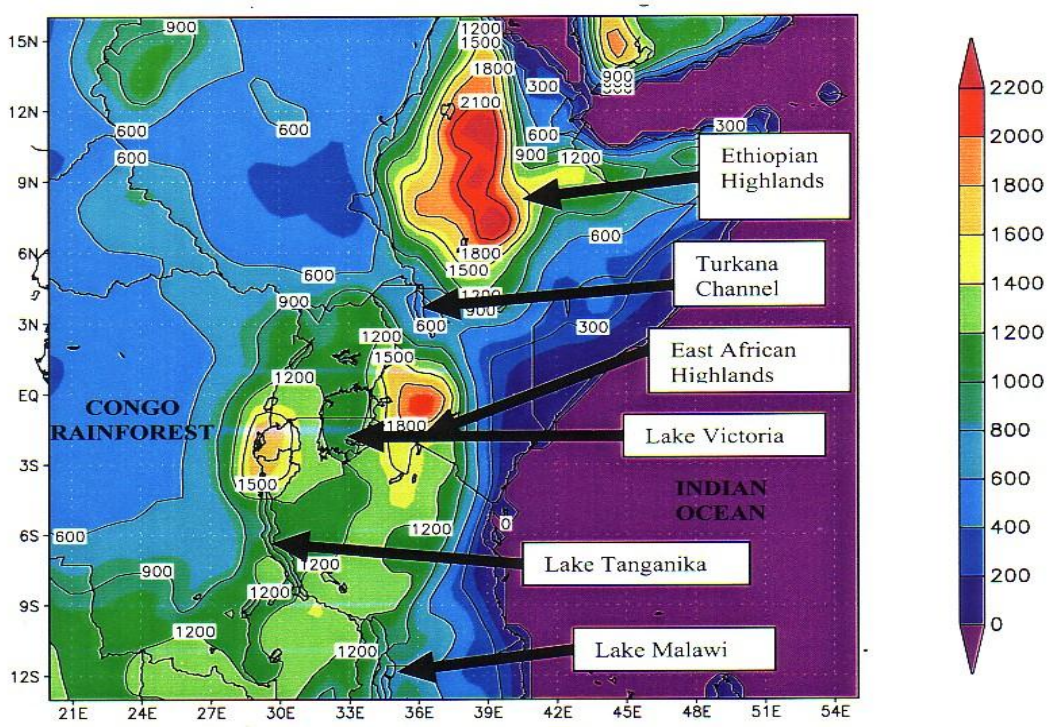

Figure 2. "Topographic map depicting physical features of the Greater Horn of Africa. Elevation is in meters (Bowden 2004)."

Using figures and data like above will lead to more in depth research over the region of equatorial Eastern Africa. Some of the weather features discussed in this section of *WWRP/THORPEX African Science Plan* that can

be studied in more detail are the influence of mesoscale convective systems, easterly waves, tropical cyclones, and dust storms.

The two main questions that the *WWRP/THORPEX African Science Plan* poses in this section are "What is the current knowledge and understanding of the dynamical and physical processes for high impact weather systems in Africa?" and "How can we improve our understanding of dynamical and physical processes and their associated phenomena that cause high impact weather?" These two questions can be applied to this research but to a more narrowed down region of equatorial Africa. The research will attempt to answer these questions by focusing on the most pertinent forecasting problem in equatorial Africa- the basic structure and effectiveness of the national meteorological services.

The second section of the *WWRP/THORPEX African Science Plan* that can be used as a basis for this research is over the observing system itself. As seen in Figure 3 from *WWRP/THORPEX African Science Plan,* Africa is severely lacking in an observation network.

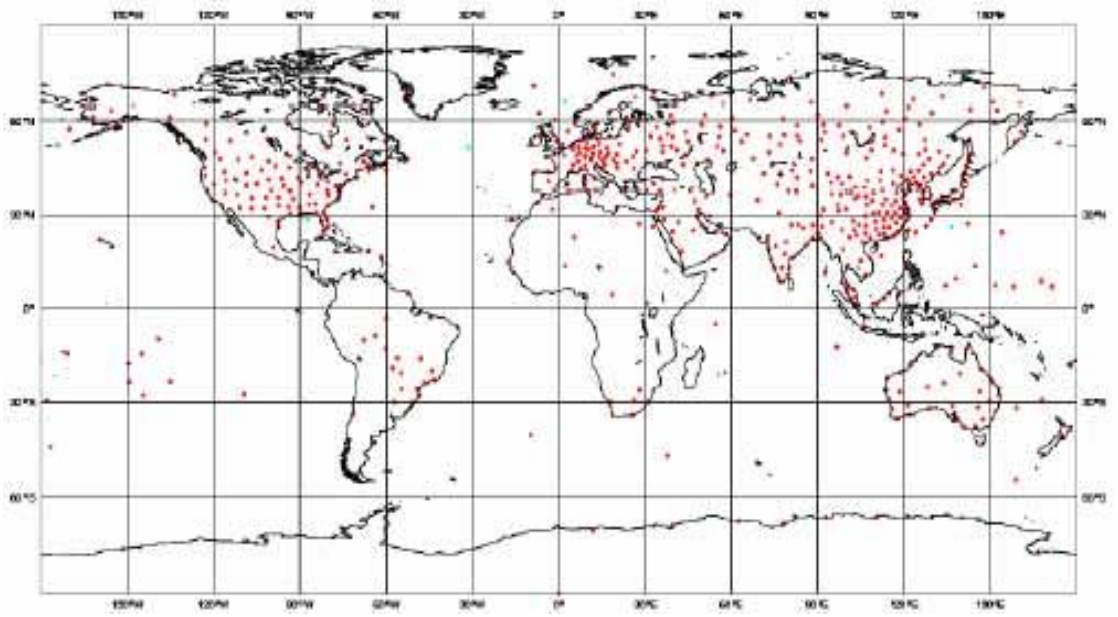

Figure 3. "Temp messages received at ECMWF on May 04, 2005 with very limited observations over Africa"

The East African Community's Five Year Plan, published in 2004, recognized the issues present in its countries (Kenya, Tanzania, and Uganda) in terms of network deficiencies. The study determined that 70% of natural disasters were the result of weather/climate (East African Community, 2011). However, the five year improvement plan laid out by the organization seems to have failed in capturing the attention of government leaders.

The *WWRP/THORPEX African Science Plan* proposes that the problems of observing systems in Africa are "inadequate equipment, inadequate staff and planning, lack of consumables, use of old data formats, inappropriate telecommunications systems for exchange of data and information (often obsolete equipment are used), unable to meet up with rapid technological developments, lack of awareness by stakeholders (governments, institutions, public and private sectors) of the value of meteorological information in socio-economic development and environmental protection, and lack of inventory, coordination, and access to real time meteorological data and information." This research will analyze each of

these components and any others that are presented for equatorial Africa and seek to improve some of these shortcomings.

The combination of understanding what high impact weather events occur in equatorial Africa as well as how the current observing systems can be improved, will allow this research to design and employ the necessary observing systems for these three countries.

The second document that will be very important at the basis of the research is the *WWRP/THORPEX African Implementation Plan*. This document indulges further into what actions can be taken in order to implement an observation network and therefore better forecasting abilities for the entire continent of Africa. This research plans to take some of these suggestions and apply them to the specific region of equatorial Eastern Africa. The *WWRP/THORPEX African Implementation Plan* gives an idea as to some resources that can possibly be contacted for this research including The WMO Disaster Prevention and Mitigation Programme (DPM), WMO Information System (WIS), GEONETCAST, the International Federation of Red Cross and Red Crescent societies, other international disaster relief and recovery organizations, and the meteorological agencies of equatorial Africa. By using the *WWRP/THORPEX African Implementation Plan* as a basis of what can be done in equatorial Africa to create a useful, cost effective observing system that will benefit the countries socially and economically.

The far-reaching efforts of THORPEX include education of forecasters, improving observation systems, and creating better communication channels to disseminate forecasts. The desired end result is a group of forecast providers that can dynamically communicate with a variety of impacted sectors and their respective forecasting needs. The goal of this research is similar to that of THORPEX but to focus more on the equatorial region of Africa that often goes overlooked. (WWRP/THORPEX, 2008)

Prior to THORPEX, the National Severe Storms Laboratory (NSSL) conducted some research in western Africa to attempt determine the state of the region's observational networks. The findings emphasized the need for regional management, staff education, and improved data transmission (including standardized formats). Each of the components are applicable to the entire continent, not restricted to western Africa (AMMA, 2006).

Furthermore, NSSL analysis of the 2006 NAMMA field program yielded more practical solutions for observational networks in Africa and other tropical regions. The pilot balloon launches were determined to be more successful when released at climatologically determined times of decreased cloudiness and locations of minimal cloudy days (for increased visibility). Additionally, the analysis emphasized the need for improved training of observers. The critical point of emphasis was the cost effectiveness of a dynamic radiosonde/pilot balloon network. As radiosondes cost 10 times more to launch than pilot balloons, this design could greatly improve observations in countries with minimal weather service budgets (Douglas, 2011).

In order to best determine what kind of meteorological observations must be made for this region, a significant part of the research will be based on determining what type of basic weather and high impact weather phenomena that these countries face. Journal articles like the one completed by Pierre Camberlin et al. in 2009 about the rainy season variability in equatorial Africa will help to distinguish important meteorological features to the region and how observations can be improved (Camberlin, 2009).

A successful meteorological observation system requires a regional management approach, sufficient personnel training, and flexible, intelligent determination of observing needs. Dynamic launch times and launch types will increase the efficiency of pilot balloon and radiosonde releases. By implementing the suggestions from prior research, the potential for acceptance, and eventual success, will increase. Ultimately, a successful observation network will be beneficial to the weather forecasters of Equatorial Africa.

Objectives

- To determine the societal and demographical background of each country of the region in order to find the current forecasting abilities and economics of each country's meteorology
- To understand the dynamic and physical process behind basic climate and weather variability as well as high impact weather systems in equatorial Africa
- To implement an observation and weather forecasting network based upon the needs of each individual country and the whole region in the most cost effective manner
- To evaluate the usefulness of forecasts through societal impact and ability to distribute forecasts to society

Description

Research will begin with gathering background information about the region and its countries. Each of the 13 countries will be examined to determine the current state of the national weather service (if applicable) and the availability of observational data. The analysis will be initiated by identifying a respective country's national weather service website and evaluating the quality and quantity of data available. If a national weather service is found, it will be tested for data usability because many weather services commercialize observational data making it unfit for regional use. If a national weather service is not found or available for a country, it will be noted and other sources will be sought out to assess the status of that country's meteorological network. Additionally, universities with departments related to weather (atmospheric sciences, physics, climate) will be noted for potential collaboration with the proposed meteorological system. This information gathering will be completed through reliable sources on the Internet.

As adequate information is gathered for each country in the region, it will be assessed based on data availability, data usability, consistency of updates, reliability, and accuracy. Based on the evaluation of each country, certain aspects will be considered for improvement. Recommendations for a newly designed meteorological network will be made based on the needed areas of improvement.

The severe weather events that affect the region are a main target for the proposed meteorological network. To better understand which events are high impacts in the countries of interest, newspapers and other local sources of information will be examined. Any articles that relate to hazardous weather in the region of focus will be noted and analyzed for potential forecasting deficiencies that can be corrected through a regional

network. The inclusion of these societal impacts is vital for the possibility of success. Without a compelling reason to change (safety, industry profits), there will be no improvement.

The focus of the research will hopefully be looking at the current state of equatorial Africa both in a societal sense as well as what affects the area meteorologically and creating a observation network based upon that. However, as the research progresses, the focus may be narrowed down further or even changed depending on the information gathered.

Impact

The region of study for this research has a large population that is affected by an array of serious weather conditions. However, the entire continent of Africa is lacking in an observing system and therefore cannot create accurate forecasts to provide the population. Not only is forecasting needed for a day-to-day basis, but it is also crucial to an area like equatorial Africa that is vulnerable to high impact weather events. The people of this region rely heavily on their natural resources as food, shelter, and other necessities. Successful forecasting and application will help these people in many areas (including agriculture) as well as protecting lives. Proper meteorological networks will affect all aspects of African life. Agriculturally, farmers will be able to use meteorology to more accurately plan for planting seasons and harvesting seasons. Medically, an extensive meteorological network can help diagnose an increased risk of diseases like malaria that control many African lives. It is important that the whole region of equatorial Africa has a sufficient forecasting and observing system in place so that the people of these countries can be prepared and protected in the case of weather danger.

Statement of Work

This research will take place over a six-month period and will be primarily online information gathering via Internet searches, journal and resource databases, and email exchanges. We will begin with an overall evaluation of equatorial Africa. This includes the basic geography, topography, climatology, etc. We will then use this knowledge to figure out what is meteorologically and climatologically important to the region. We will look not only at the daily temperature and precipitation variability, but also severe and unusual weather events that. The high impact events will be researched by looking at things like local newspapers from the countries in the region as well as aid agencies. All of this seemingly background research needs to be completed fairly quickly as the next step of the project will take extensive investigation and time.

Once we have a handle on the basic meteorology of equatorial Africa, we will begin to look into what kind of observation network is already in place. This will consist of looking at papers from the WMO on current observations that are being collected as well as extensive evaluations of websites for each of the countries in the region of equatorial Africa. This evaluation will be looking at the availability of climatological data, finding details of observations, and determining how many and what kind of stations are in place. This will allow us to build a map of where network stations currently are and where they ought to be.

A significant part of the research will come from email exchanges from a multitude of people. Some of the people that we have in mind to email are people that work for each of the national meteorological agencies, science or like-field professors at universities in the each of the countries, people in the military services that utilize meteorological data, aid agencies, local businesses, pilots and other people that work in aviation, emergency management responders, etc. Some of the agencies that THORPEX planned to cooperate with that would be very helpful to our research if we can get in contact with them are "The WMO Disaster prevention and Mitigation Programme (DPM), WMO Information Systems (WIS), GEONETCAST, the International Federation of Red Cross and Red Crescent societies, other international disaster relief and recovery organizations, and excellence centers in computing with experience and networks in Africa (i.e. UNESCO/ICTP)" (THORPEX, 2008). Because we need to have adequate time to hear back responses from these people, we intend to have our emails out explaining who we are and what we intend to do with the information by mid to late January. This will also give us the opportunity to go through all the data that we collect and analyze it for the final stage of our research.

The last part of the research that we hope will be the reason that our research will be effective, is that we want to be able to make suggestions on ways to improve the current observation network. Therefore, we will need to research what tools are available and what would be the most cost effective means of observing. By doing all of this, we will hopefully be able to suggest changes and improvements to the countries of equatorial Africa so that society can benefit from the enhanced forecasts.

As for which team member will be responsible for each of the steps stated above, our team has decided that it is in the best interest and will be most effective for each team member to work equally on each part of the research. However, we will attempt to have one of the team members act as a "team leader" for each of the parts of the research to ensure that everything is completed on time and to the best degree. Natalye Lahart will be the team leader during the initial phase of background research on the demographics of the countries and what high impact events affect equatorial Africa. Then, Natalie Daab will become the team leader during the phase of emailing sources and attempting to create an observation and forecasting network. Finally, Kevin Burns will take over as the team leader for determining the societal impact as well as piecing out research together, especially in terms of the website. But again, it is important to emphasize that since this is a step-by-step type research, each team member will work equally throughout the project.

References

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Natalie DeLana Daab

6 Middletree Lane ● Hawthorn Woods, IL 60047 ● (847) 274-2713 ● Natalie.Daab@ou.edu

University of Oklahoma Student Seeking

BROADCAST METEOROLOGY POSITION

Current University of Oklahoma senior pursuing a broadcast meteorology position upon graduation in May of 2012. Combining a sparkling personality and passion for weather with a strong work ethic and meteorology experience to become an asset to a broadcast television station.

Skills

- Experience with Weather Central: Made weather graphics independently at previous internship
- Excellent Mathematical Cognition: Received A's in 6 university level math courses
- Working Knowledge of TV Station: Interned at News 9 and KSBI-TV in Oklahoma City and WGN in Chicago
- Outgoing Personality: Can easily talk to anyone in any situation
- Quick and Eager Learner: Started making own weather graphics within a week of working at KSBI-TV and News9
- Highly Motivated: Cumulative grade point average of 4.0 at OU
- Diligent Worker: Maintained a job, internship, and full time studies
- Easily Adaptable to New Situations: Studied abroad in England for 6 months
- Passionate about Weather: Loved watching the weather as a child and still have same excitement as an adult

Education

University of Oklahoma, Norman, OK
Expected Graduation: May, 2012
Current GPA: 4.0, President's Honor Roll

Major: Meteorology, Minors: Broadcast Journalism for Meteorology and Mathematics
Undergraduate Academic Achievement Award: Highest GPA of the OU School of Meteorology junior clas

University of Reading, Reading, UK
Study abroad program: January 2011-June 2011
First Class Degree

Studied meteorology with an emphasis on climate change and ocean dynamics in England and traveled to seven different European countries

Lake Zurich Senior High School, Lake Zurich, IL
Graduation: May 31, 2008
GPA: 4.313 on a 4.0 scale

Advanced curriculum with emphasis on math and science
National Honor Society, Eight semesters High Honor Roll

Work Experience

News9, Oklahoma City, OK
August 2011- Present
Weather Intern

Duties: Create and update weather graphics for evening broadcast, analyze surface and upper air maps, Update station website, Write text forecasts, Monitor current and future weather situations, On- camera practice and critique

WGN-TV, Chicago, IL
June 2011-August 2011
Weather Intern

Duties: Analyze weather data and records, Monitor weather conditions and reports for broadcast, Co-editor of Tribune newspaper weather page feature section, Create graphics for Tribune newspaper weather page

National Weather Center: Center for Analysis and Prediction of Storms, Norman, OK
June 2010-November 2010
Undergraduate Research Assistant for PARISE 2010

Duties: Prepare qualitative data for analysis, Transcribe audio and video recordings, Analyze qualitative data

KSBI-TV, Oklahoma City, OK
March 2010-November 2010
Weather Intern

Duties: Prepare weather graphics for evening show using Weather Central, Analyze future weather models, Create time lapse videos from state camera network, Update network website, Write manual for computer programs, Practice and critique on-camera performance

A L'amour Bridal, Barrington, IL
January 2006- August 2011
Sales Associate

Duties: Sell prom dresses, Organize showroom floor, Write descriptions for high school fashion shows, Organize in-store fashion shows, Cash register sales

Activities and Interests

- OU Nightly Weather Producer and Weather Brief Talent
- Oklahoma Weather Lab Forecaster
- Camp Crimson Counselor
- Sooner Orientation Week Volunteer
- School of Meteorology Mentoring Program Mentor
- OU Student Chapter of the American Meteorological Society Member and Speaker
- JourneyChurch Missions Team Member

Kevin C. Burns

2200 Classen Blvd, Apt. 12112
Norman, OK 73071

(501) 574-1144
kevincburns@gmail.com

Objective

Full-time position in a private meteorology company with particular interest in forecasting.

Education

UNIVERSITY OF OKLAHOMA Norman, OK (2008-2012)

- B.S. Meteorology, May 2012 (expected), Minor in Physical Geography
- GPA: 3.61/4.00

Work Experience

University of Oklahoma Athletics Business Office --Student Assistant-- (2009-Present)

- Worked directly with the Assistant Athletic Director (Business) and Director of Business Operations to complete time-sensitive and confidential financial analysis and reporting. Developed Excel macros and streamlined reporting processes.

Student Life --Production Asst. & Video Director-- (Summer 2009 & 2010)

- Directed three camera live video working under the leadership of a production director. Supported co-workers in their responsibilities in a team-like environment.

Walmart, Stores #85 & #5244 -- Cashier/Garden Center Cashier -- (2007-2008)

- Served customers as a cashier. Also operated phones for the department and organized/cleaned the garden center area.

Honors & Professional Affiliations

College of Atmospheric and Geographic Sciences Honor Roll (three semesters)

Recipient of the University of Oklahoma Award of Excellence scholarship

Student Chapter of the American Meteorological Society (Member)

Technical Skill Set

Microsoft Office applications including high proficiency in Microsoft Excel

Windows OS

References

Dr. Kelvin K. Droegemeier University of Oklahoma Vice President for Research Phone: 405-325-6561	**Luther Lee** University of Oklahoma Athletics Assistant A.D./Business Phone: 405-325-1844

NATALYE Y. LAHART

744 Elm Avenue ▪ Norman, OK 73069 ▪ (832) 771-3016 ▪ natalye.lahart@ou.edu

OBJECTIVE

Current senior of the University of Oklahoma seeking to develop my meteorological career and further mature my skills.

EDUCATION

University of Oklahoma, School of Meteorology, Norman, OK — Expected Graduation May 2012
Bachelor of Science, Major: Meteorology
Cumulative GPA: 3.79, Dean's Honor Roll, President's Honor Roll

Universität Hamburg, Hamburg, Germany — January 2011- July 2011
Exchange Student Program
Relevant Coursework: Theoretical Meteorology, Optics, Radiation, and Remote Sensing, and Dynamic Paleoclimatology

EXPERIENCE

Camp Ozark, Mt. Ida, Arkansas — May 2009-August 2010
Camp Counselor and Lifeguard
- Responsible for 10 young campers for 9 weeks in the summer
- Acting as a positive role model and a responsible lifeguard
- Providing an upbeat experience for the campers during their 2 week terms

Texas 400 Group, Houston, TX — May 2008-March 2010
Private Law Firm Intern
- Assisting the owner of the firm in entering data and client information into the system
- Developing new ideas for prospective future interns

ACTIVITIES

Oklahoma Weather Lab — September 2008-Present
Member
- A student-run organization that enhances the studies of meteorology while forecasting for Oklahoma regions
- Devote up to 2 hours per week to the club

Meteorology Peer Mentoring Program — August 2010-December 2010
Mentor
- Responsible for introducing new students to the Department of Meteorology at OU
- Participate in monthly meetings and constant communication with mentees

Vice President: Social Standards — January 2010-December 2010
Delta Gamma Fraternity
Chairman of Honor Board
- Able to develop and advance the organization through service, leadership, mentoring, and friendship
- Responsible for maintaining chapter morale, recommending programming based on behavioral trends, supervising and planning social events, presenting risk and crisis management policies
- Receive opportunities to network with alumnae

Director of New Members August 2011-Present

Delta Gamma Fraternity

- Create and coordinate the New Member Pursuit program for 77 new members
- Plan, teach, and present during the 10-week new member process
- Responsible for creating a sense of welcome and security to new members

Director of Intramurals January 2009-December 2009

Delta Gamma Fraternity

- Responsible for creating intramural teams for Delta Gamma
- Communicate ideas, schedules, and gather support for teams
- Participate in activities that foster the growth in the university

University of Oklahoma Mentoring Program August 2008-May 2009

Participant

- Selected to receive opportunities to communicate with faculty members of the University and gain insights into the activities and complexities of the meteorology program
- Gained access to professional knowledge and practical career insight

Alpha Lambda Delta February 2009- Present

Member

- A selective honor society for freshman at the University of Oklahoma
- Extends many opportunities for service and scholarship

Rambling Oaks Nursing Home January 2009 - Present

Volunteer

- Spending time with the elderly in their retirement home
- Organized and participated in different activities throughout the year with the residents

TECHNICAL & LANGUAGE SKILLS

- Proficient use of MS Word, Excel, and PowerPoint
- Exposure to C+ programming
- German: level A2
- Intermediate Spanish (speaking, reading, writing, comprehension)

HONORS & AWARDS

- OU Honor's College August 2008
- Dean's Honor Roll Fall 2008, Fall 2009, Fall 2010
- Alpha Lambda Delta Honor Society February 2009
- Department of Meteorology Scholarship Spring 2009
- President's Honor Roll Spring 2009, Spring 2010
- Lloyd Noble Family Scholarship Nominee Fall 2010

REFERENCES

Dr. Fred Carr
Past Director for OU School of Meteorology
(405)325-2990
fcarr@ou.edu

Kim Rieger
Advisory Team Chairman
(785)845- 6768
kim_rieger@okwp.uscourts.gov

Debby Priddy
AssociateDirectoratCamp Ozark
(870)867-4131
debbie@campozark.com