University: University of South Florida

Name of University Researcher Preparing Report: Dr. Jennifer Collins

NWS Office: Tampa Bay Area (Ruskin)

Name of NWS Researcher Preparing Report: Charles Paxton

Type of Project (Partners or Cooperative): Partners

Project Title: Meteorological Conditions Influencing Sea Breeze Convergence and Resulting Rainfall Patterns and Hazards in Pinellas County, FL

UCAR Award No.: Z10-83394

Date: 2/2/2012

Section 1: Summary of Project Objectives

Using the knowledge of local experts (operational meteorologists and researchers), our primary objectives are to:

1. **Determine the spatial distribution of rainfall patterns in Pinellas County which result from the varying wind regimes to improve forecasting local mesoscale phenomena.**
2. **To predict convective hazards over Pinellas County and surrounding area, including but not limited to flash floods, hail, downbursts and tornadic events which affect marine and aviation operations and the vulnerable Pinellas County population.**

Section 2: Project Accomplishments and Findings

The results of this study provide significant findings for the localized area of Pinellas County and give meteorologists local knowledge for support when making forecasts. From this study, generalizations can be made about precipitation and severe weather patterns in the Pinellas County area. The basic findings of this study are as follows:

The first part of the project involved identifying the dominant surface wind directions in Pinellas County for June, July, and August from 1995 through 2009 using the 1200 UTC sounding data from Ruskin, FL. This study revealed that an easterly wind flow dominated the Pinellas County area. However, even though there were significantly more days with an easterly wind flow, the south and west wind flow days brought the most rain to the Pinellas peninsula. This information can be useful especially for QPF forecasts.

Secondly, we determined the spatial distribution, timing and amounts of rainfall in Pinellas County associated with the dominant wind regimes. From this study, it appears that

the greatest chances for summer rain in Pinellas County are associated with westerly winds. An examination of ArcGIS shapefiles reveals that in all wind direction categories except for the 241-300° wind direction, the largest amounts of rainfall occur in two maxima within the center of the Pinellas peninsula. Examination of Nexrad Level II radar files in Gr2Analyst reveals that rain can be expected later in the day when winds are out of the east compared to days when rain is associated with a westerly flow. This information is useful for local short-term forecasts by providing generalizations that can be made of what to expect for each wind category. For example, on a day with a wind direction in the 181-240° category, it appears likely that rain will occur in the eastern center of the peninsula over the St. Petersburg-Clearwater International Airport. This information is especially beneficial because of the possible impact on airport operations.

Thirdly, we determined the correlations between atmospheric parameters and precipitation amounts during June, July and August from 1995-2009. Wind speed is positively and statistically significantly correlated with precipitation in two wind direction categories (121-180° and 181-240°). Precipitable water is positively and statistically significantly correlated with precipitation in almost every wind direction category. This information about precipitable water and wind speeds is helpful when making short-term forecasts as well. For example, on a day with a southerly wind direction between 121-240°, higher wind speeds could bring more precipitation. A day with higher precipitable water most likely means that more precipitation will fall. Even though one might assume that CAPE would be positively correlated with precipitation in all wind directions, a positive correlation existed between CAPE/CAPEV and rainfall only when winds came from between 1° and 120°. However, due to the lack of significance at the 5% level, more research is needed to confirm whether CAPE has a significant relationship with precipitation, especially at wind directions greater than 120°.

Fourthly, we examined the effect of wind flows on severe weather events in Pinellas County. This study demonstrates that most severe weather occurs on days with a south-easterly wind flow (61-180°). Hail was associated with a southeast wind regime; tornadoes with an east and southeast flow; strong wind with an east, southeast and southerly flow; and floods were associated with a flow from the southeast and southwest. This information is useful to forecasters by providing case studies of severe weather and providing additional support to the severe weather alert decision making processes.

Lastly, we determined which atmospheric parameters and indices were associated with severe weather events. Days with hail occurrences had the lowest average wind speed, a moderate average CAPE value, and the lowest precipitable water average of the severe events studied. Days with tornado occurrences had moderate to higher average wind speed, a higher precipitable water value, a higher SWEAT value and the lowest average CAPE value of the severe events studied. Strong wind events had moderate values for all variables. Of the severe weather events considered in this study, flooding reports had the highest average values of wind speed (2.8 ms^{-1}), CAPE (1437 J kg^{-1}), precipitable water (51 mm), and SWEAT (198). From this study, more information is provided about what values of certain atmospheric parameters and indices are more often associated with different forms of severe weather. For example, on a day with high wind speed, CAPE, precipitable water and SWEAT, forecasters might issue flood warnings for Pinellas County.

Section 3: Benefits and Lessons Learned: Operational Partner Perspective

As the results of the study of "Meteorological Conditions Influencing Sea Breeze Convergence and Resulting Rainfall Patterns and Hazards in Pinellas County, Florida" between the University of South Florida and the Tampa Bay Weather Forecast Office were being processed by Cristina Mazza last summer, the forecasters were using the data to improve forecasting. The research examined the effect of wind regimes, stability, moisture, and mesoscale interactions on precipitation patterns and potential for severe weather. The information was used in several different ways and in several different products. The results improve the public, aviation, marine, and severe weather programs for a geographically unique area along Florida's west coast. The rainfall information from the study was used to provide better predictions on where the heaviest rainfall would occur particularly toward the end of last year's rainy season. The study allowed forecasters to foresee where the greatest rainfall might be and include verbiage in statements. The study also shows severe weather and relationships to sounding parameters. This will be very helpful in Hazardous Weather Outlook products in upcoming summer regimes. Pinellas County is the most densely populated county in Florida, so these improvements to the warning and forecast program will affect a large number of people and have significant economic impacts. No major problems were encountered through the course of study.

Section 4: Benefits and Lessons Learned: University Partner Perspective

Benefits are broader than initial scope of project. Collaborating on this project has resulted in NWS and USF discussion on other topics. Such discussion has resulted in

- The development of a grant proposal to COMET Partners which was submitted in January 2012, titled, "Long Range prediction of atmosphere and ocean conditions associated with rip current drownings in the United States"
- The student has been able to present at their first local chapter and national AMS meeting. The student also participated in NWS webinars and other presentations at the University and elsewhere.
- At the NWA conference, the student met with Dr. Louis Uccellini, Director of the National Centers for Environmental Prediction (NCEP). His interest in her work motivated her to continue this study further and produce a MS thesis on the topic. The student was further motivated to see her results being used by the NWS forecasters.

Section 5: Publications and Presentations

Publication (peer-reviewed) – status: not yet submitted:

- Mazza, C.A., J.M. Collins, C.H. Paxton, 2012: The Influence of Meteorological Parameters on Rainfall and Severe Weather in Pinellas County, FL. Applied Geography (to submit March/April, 2012).

Poster Presentations:

- Mazza, C.A., J.M. Collins, and C.H. Paxton, 2010: Sea breeze and associated wind regimes affecting rainfall and severe weather in Pinellas County, Fl. National Weather Association Conference. October 2010. Tucson, AZ.

- Mazza, C.A., J.M. Collins, 2010: Sea breeze and associated wind regimes affecting rainfall in Pinellas County, FL . USF's Graduate Student Research Symposium. October 2010. Tampa, FL.
- Paxton, C.H., C.A. Mazza, J.M. Collins, 2011: Interrelationships among wind direction, atmospheric moisture content and stability with the spatial distribution of rainfall and the occurrence of severe weather in Pinellas County, FL. American Meteorological Society Conference. January 2011. Seattle, WA. (4 page paper submitted).

Oral Presentations:

- Mazza, C.A., J.M. Collins, C.H. Paxton, 2011: Sea Breeze and Associated Wind Regimes Affecting Rainfall Patterns and Severe Weather in Pinellas County, FL. Florida Society of Geographers Conference. February 2011. Gainesville, FL.
- Mazza, C.A., J.M. Collins, C.H. Paxton, 2011: Sea Breezes and Associated Wind Regimes Affecting Rainfall Patterns and Severe Weather in Pinellas County, FL During the Months of June-August 1995-2009. National Weather Service Webinar Presentation. March 2011. Ruskin, FL.
- Mazza, C.A., J.M. Collins, C.H. Paxton, 2011: Sea Breeze and Associated Wind Regimes Affecting Rainfall Patterns and Severe Weather in Pinellas County, FL. Association of American Geographers Conference. April 2011. Seattle, WA.
- Mazza, C.A., J.M. Collins, C.H. Paxton, 2011: Interrelationships among wind direction, atmospheric moisture content and stability with the spatial distribution of rainfall and the occurrence of severe weather in Pinellas County, FL. National Weather Service Presentation. May 2011. Ruskin, FL.
- Mazza, C.A., 2011: Interrelationships among wind direction, atmospheric moisture content and stability with the spatial distribution of rainfall and the occurrence of severe weather in Pinellas County, FL. University of South Florida Thesis Defense. September 2011. Tampa, FL
- Mazza, C.A, 2012: The Influence of Meteorological Parameters on Rainfall and Severe Weather in Pinellas County, FL. West Central Florida American Meteorological society Meeting. January 2012. St. Petersburg, FL.

Section 6: Summary of University/Operational Partner Interactions and Roles

Describe the responsibilities of the various project participants over the course of the entire project.

The student was given training by both PIs on the software (GR2 Analyst) to analyze radar data. She was also given instruction on soundings which we would later analyze. The team was involved in all parts of the project. During the early stage, the student was tasked with preparing GIS shapefiles. The whole team analyzed these together. Dr. Collins worked with the student on the correlations and an expert was brought in to confirm an appropriate test used – the Bonferroni. During this time we submitted an abstract (and conference paper) for NWS SOO Charles Paxton to present at the national AMS meeting (2011). We were all involved with the writing of this. The team are currently expanding the conference paper into a submission to Applied Geography (First draft has been completed). The work was presented at other conferences in geography and meteorological fields and the feedback provided at the conferences were included in the final results.