Analysis of 3, 6, 12, and 24 Hour Precipitation Frequencies Over the Southern United States

Final Report

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1. PROJECT OBJECTIVES

The idea for this project came from Mr. Dan Smith, former SSD Chief for the National Weather Service (NWS) Southern Region. Specifically, forecasters soon may be asked to prepare 3 hourly probability of precipitation forecasts at high horizontal resolution using the Interactive Forecast Preparation System (IFPS). Climatology is an excellent starting point for preparing these forecasts. This collaborative research is developing that climatological guidance for the National Weather Service (NWS) Southern Region.

The objective of this project was to prepare climatological values of precipitation for as many stations as possible within the National Weather Service Southern Region. The frequencies were prepared separately for each month. Then, for each month the frequencies were calculated over 24 hour intervals (00-24 UTC), 12 hour intervals (00-12 UTC, 12-00 UTC), 6 hour intervals (00-06 UTC, 06-12 UTC, etc.), and 3 hour intervals (00-03 UTC, 03-06 UTC, etc.).

2. PROJECT ACCOMPLISHMENTS

The first phase of the research was conducted by Mr. Matt Sitkowski, an undergraduate meteorology major at Florida State University (FSU) who graduated in May 2004. Since then, the research was continued by Mr. John Sullivan, also an undergraduate meteorology major. Prof. Henry Fuelberg (FSU) and Mr. Irv Watson (NWS-TLH) supervised the project.

The precipitation frequencies were derived from observed hourly surface (HPD) data obtained from the Forecast Systems Laboratory.

Mr. Sitkowski computed probabilities for the entire NWS Southern Region based on the 30 year period from 1968 – 1997. For each month, he produced probabilities for eight 3-h intervals (00-03 UTC, etc). Thus, 96 different sets of computations were made (12 months times 8 periods per month) for 308 stations in the Southern Region. He also calculated the frequencies for 6, 12, and 24 h periods. We required that 85% of the hourly data be available (not missing) for a given 3 h interval before proceeding. Thus, there typically were about 275 stations for a given interval. We have achieved relatively uniformly spaced coverage within each County Warning Area. Various other depictions also were prepared, e.g., time plots of probability at individual sites. Mr. Sitkowski documented the results in a Senior Honors Thesis at FSU.

The original results were based on two types of rain gauges—those reporting to 0.01 in., and those reporting only at 0.10 in. intervals. Data from both types of gauges were used interchangeably in the first set of calculations. That combination of gauges was not appropriate; so we re-calculated the frequencies, this time using only those gauges reporting at 0.01 in. intervals. Although a majority of the original gauges were not used, results derived from only the higher resolution gauges are consistent with the NWS definition of precipitation (0.01 in. or greater).

All of the results are available on our web site at:

http://bertha.met.fsu.edu/research/cometPrecipFreqs

That site also contains a more complete description of how the calculations were performed. A few highlights and conclusions are given below.

Figures 1 and 2 show three hourly climatological precipitation frequencies (in percent) for the month of July for the periods 06-09 UTC and 21-24 UTC, respectively. One should note the large differences between the two time periods that show the diurnal character of the precipitation during the warm season. Using Tallahassee, FL as an example, the frequency of precipitation between 06-09 UTC is 3 %, while during 21-24 UTC it has increased six fold to 19 % as a result of afternoon heating and sea-breeze induced convection. During the cold season (not shown), the diurnal differences are much smaller.

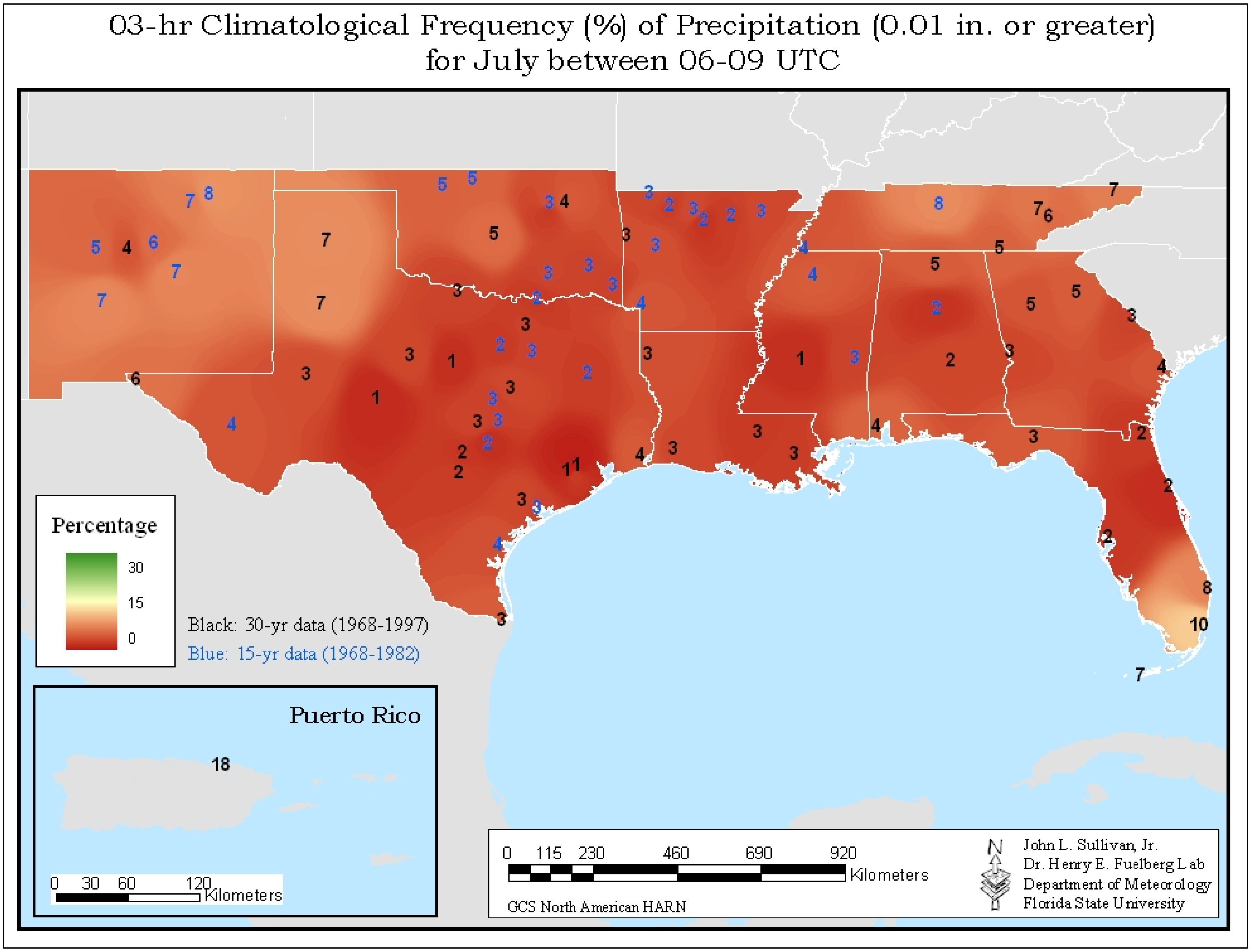

Fig. 1. Climatological rainfall frequencies for July for the 3-h period 06-09 UTC.

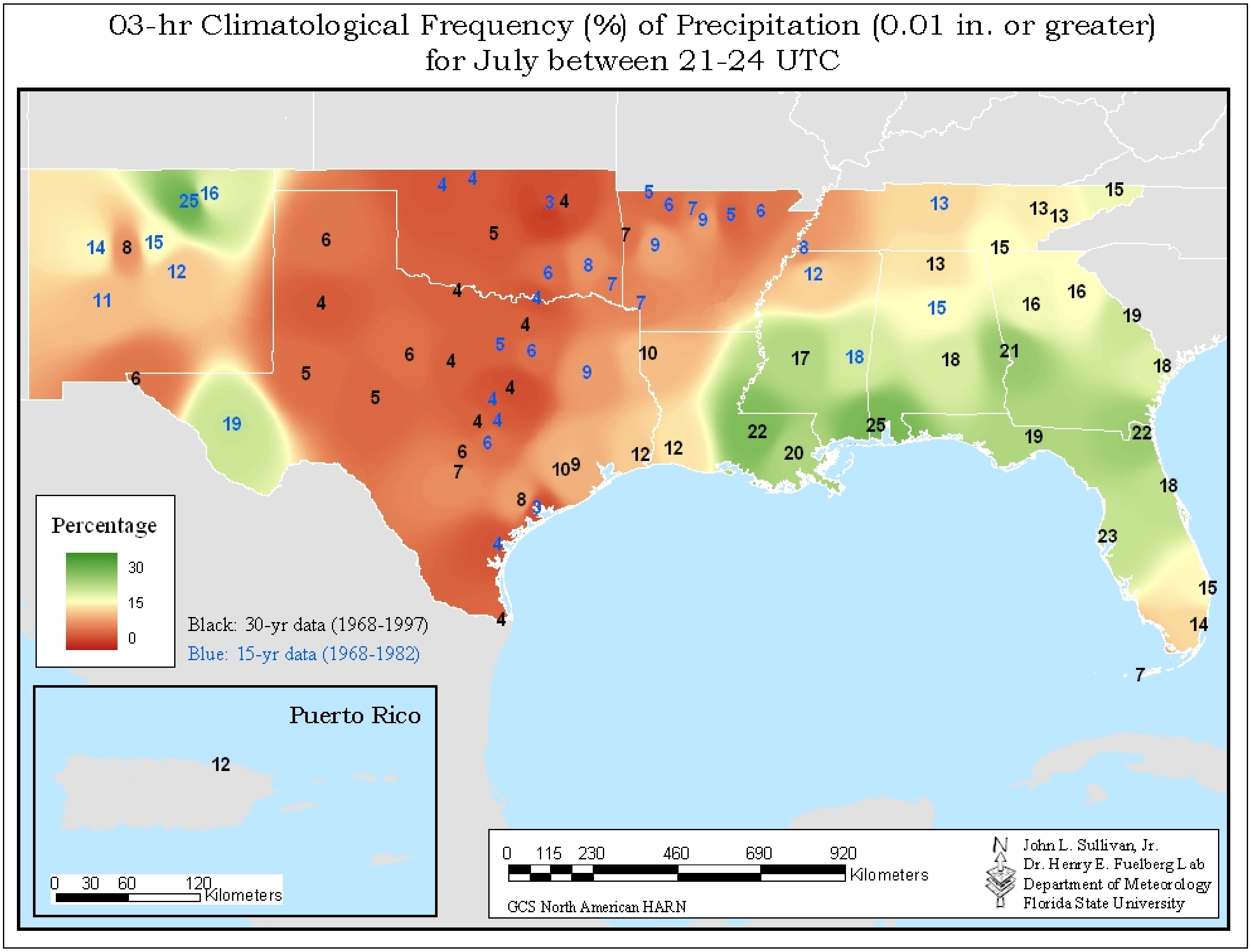

Fig. 2. Climatological rainfall frequencies for July for the 3-h period 21-24 UTC.

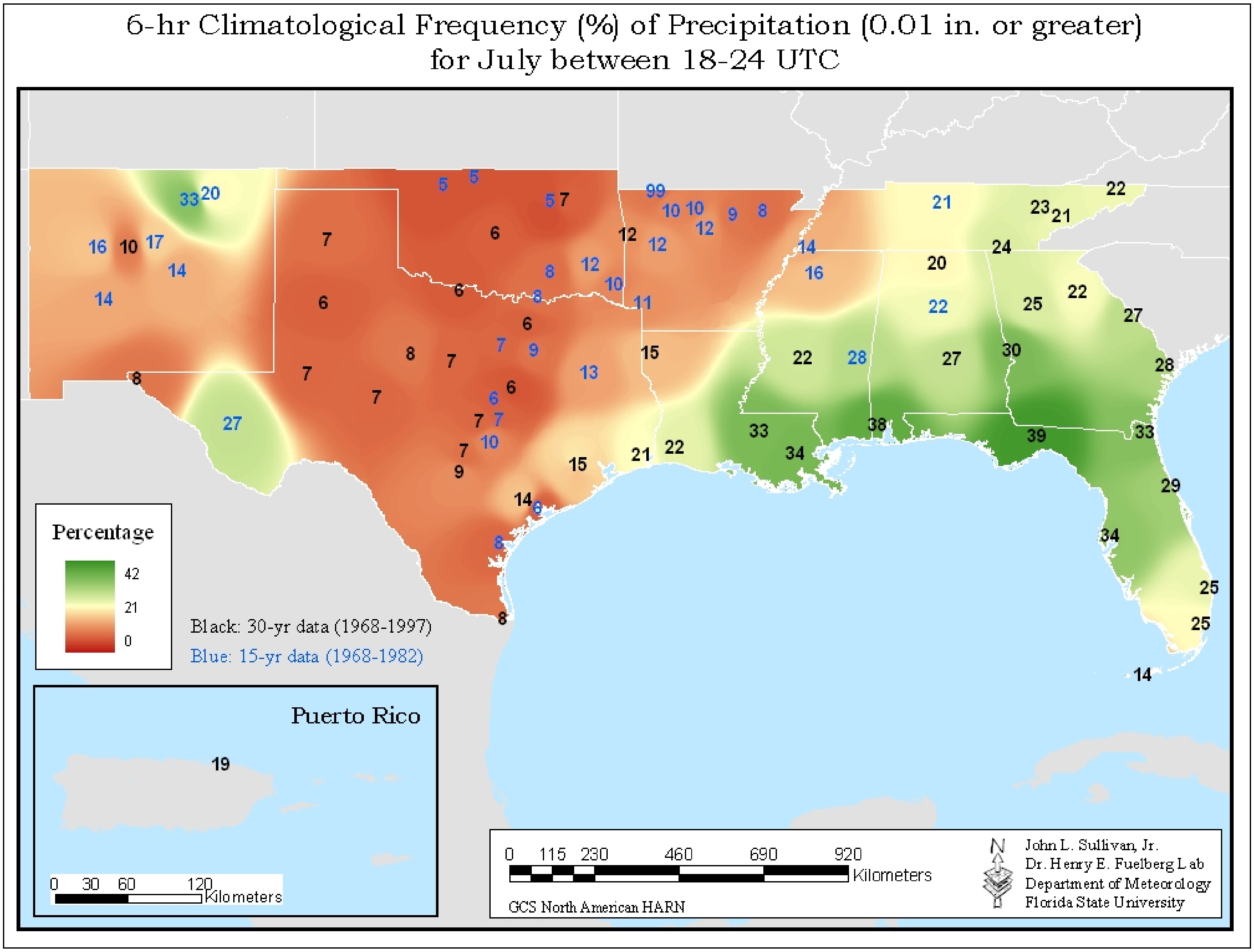

Fig. 3. Climatological rainfall frequencies for July for the 6-h period 18-24 UTC.

Figures 3-5 show how precipitation frequencies vary depending on the time interval being considered. Again using Tallahassee as the example, the frequencies increase from 39% for the 6-h period between 18-24 UTC, to 46% for the 12-h period between 12-24 UTC, to 53% for the 24-h period between 00-24 UTC. Similar changes in frequency can be found for virtually every location in the region. Forecasters who are aware of these frequency changes over different time intervals and different times of the day can better prepare forecasts that are not inconsistent with climatology.

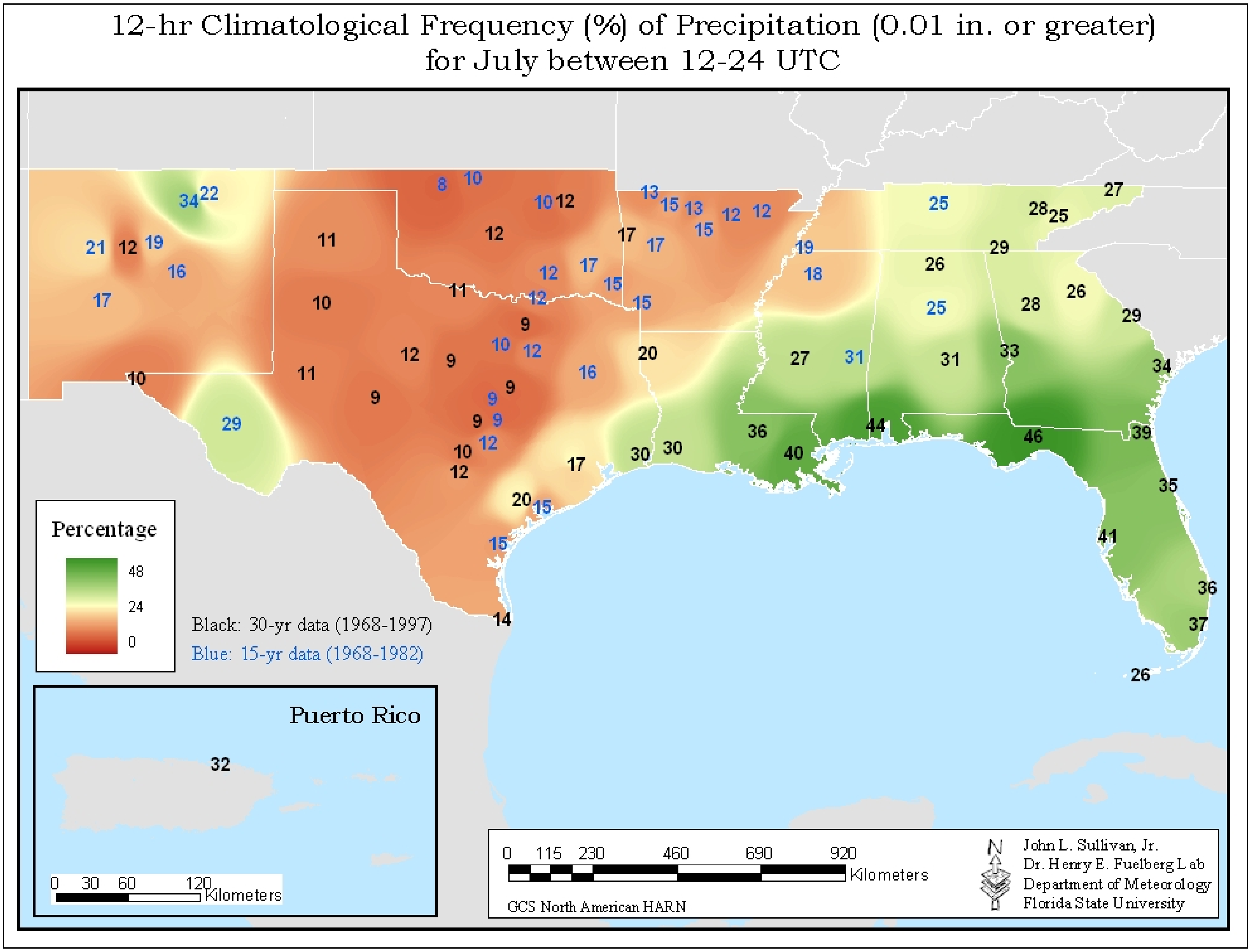

Fig. 4. Climatological rainfall frequencies for July for the 12-h period 12-24 UTC.

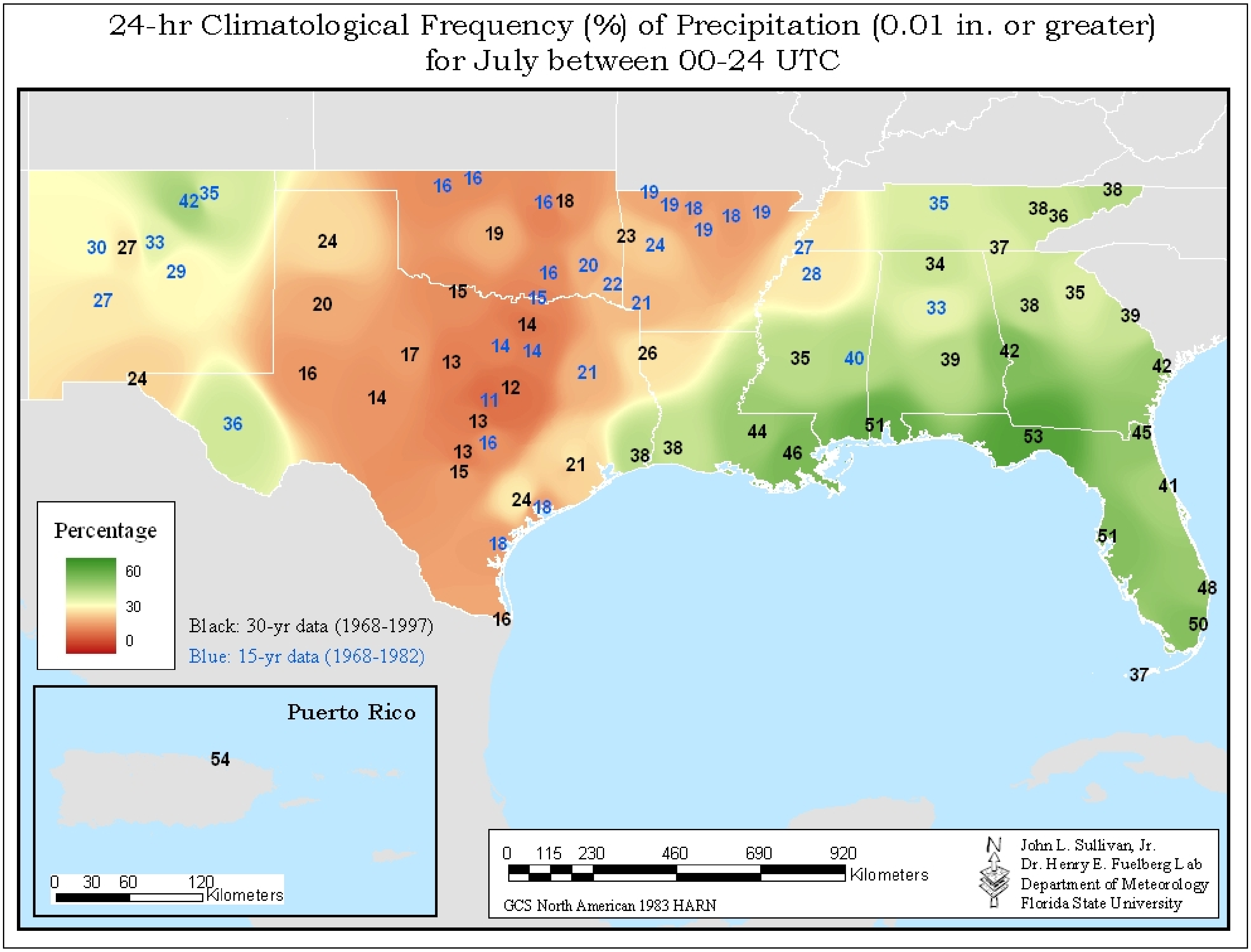

Fig. 5. Climatological rainfall frequencies for July for the 24-h period 00-24 UTC.

3. BENEFITS AND LESSONS LEARNED—OPERATIONAL PERSEPCTIVE

The analysis of precipitation data to obtain frequencies for 3-, 6-, 12-, and 24-h intervals provides valuable information to forecasters, allowing them to understand the use of probability of precipitation (PoP) at smaller temporal resolutions than 12 h. Forecasters soon may be asked to issue PoP forecasts for 3-hourly time periods in the form of high resolution gridded fields in the Interactive Forecast Preparation System (IFPS). Knowledge of the climatological likelihood of an event is an excellent starting point for a forecast. These climatological frequencies also will provide a basis for assessing forecast skill.

4. BENEFITS AND LESSONS LEARNED—UNIVERSITY PERSEPCTIVE

This COMET partners project has fostered collaborations between Florida State University and NWS-TLH and provided students and faculty an opportunity to address forecast problems. As a result, the participants have learned a great deal about IFPS, i.e., how the NWS is preparing forecasts in this "new era". Insights can be passed along to students in our various classes. Matt Sitkowski and John Sullivan, the undergraduates performing the study, have learned much about NWS operations and research methodology.

5. PRESENTATIONS AND PUBLICATIONS

Sitkowski, Matthew, 2004: Analysis of 3, 6, 12, and 24 hour precipitation frequencies over the southern United States. Honors thesis submitted to the Department of Meteorology at Florida State University, 23 pp. [Available from Prof. Fuelberg.]

Smith, D., 2003: Climatological probabilities of precipitation for 3-, 6-, 12-, and 24-hr periods. NWS Southern Topics, Nov. 2003 issue.

Smith, D., 2004: 3-hourly precipitation frequencies. NWS Southern Topics, Feb. 2004 issue.

Sullivan, John, 2005: Web site containing results of precipitation frequencies for the NWS Southern Region, http://bertha.met.fsu.edu/research/cometPrecipFreqs

6. UNIVERSITY/OPERATIONAL PARTNER INTERACTIONS AND ROLES

Dan Smith, formerly head of Scientific Services for the National Weather Service Southern Region, was the prime motivator for this research. Mr. Smith has a long standing interest in probability of precipitation forecasting. We had numerous e-mail exchanges and telephone conference calls while the research was being conducted to make sure that our product would meet his needs.

Andrew I. (Irv) Watson, SOO at National Weather Service—Tallahassee, was the local operational partner. Mr. Watson facilitated data acquisition, assisted with computer programming, and answered many questions about the applicability of the precipitation frequencies to operational forecasting.

Matt Sitkowski and John Sullivan, undergraduate meteorology majors at Florida State University, performed all of the calculations and prepared all of the graphics for the web site. Both of them did outstanding jobs.

Henry Fuelberg, professor of meteorology at Florida State University, supervised the two students and collaborated with Mr. Smith and Mr. Watson.

The interactions between Florida State University and the National Weather Service were very beneficial to both groups. The role of each group and person was ideally suited to his background and the needs of the project.