

Floridian Heatwaves and Extreme Precipitation: Future Climate Projections

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1 Background and Motivation

- Heatwaves result in more deaths than any other weather events (Borden and Cutter 2008, *Int. J. of Health Geographics*)
 - * **2015 Indian heatwave** claimed upwards of **2,500 lives** (Wehner et al. 2016, *BAMS*)
 - * **1995 U.S. heatwave** showed the effect of urban heat islands (Changnon et al. 1996, *BAMS*)
 - The heatwave claimed **500 lives in Chicago** and over **800 lives nationwide**
- In the United States, Luber et al. (2006, *MMWR*) found that from 1999–2003, excessive heat exposure was a causal/contributing factor to **~700 deaths per year nationwide**. Heatwaves are dubbed “*silent killer*” for reasons such as damaging health impacts after prolonged exposure to daytime heat and/or uncomfortable high nighttime temperatures.
- Adjacent bodies of water moderate Florida's climate, therefore heatwave projections in Florida have largely been understudied.

Objectives

- Compare the **frequency, intensity, and duration** of summer (i.e., June-July-August) **heatwave events over Florida** between the present (i.e., control run or CTL) and the future pseudo global warming (PGW i.e., *same weather but future climate under the high greenhouse gas emissions i.e., RCP 8.5 scenario*) runs of a high-resolution convection allowing modeling experiment (i.e., Liu et al. 2017, *Clim. Dyn.*).
- Investigate whether heavy/extreme precipitation events occur shortly after the passage of a heatwave and document changes in the characteristics of the precipitation between the CTL and PGW runs over Florida.

2 Summary of NCAR's WRF Modeling Experiment (Liu et al. 2017, *Clim. Dyn.*)

- Temperature** and **Precipitation** data was obtained from a WRF model experiment to study the effects of climate change under the RCP8.5 emission scenario for the late 21st century (i.e., 2070–2099)
 - * **1360 × 1016 grid pts** at **4-km** horizontal grid spacing * CONUS and parts of Atlantic/Pacific Oceans, Canada and Mexico
 - Two **13-year climate simulation** experiments from 01 October 2000 to 30 September 2013
 - Control Run (CTL) Forced with 6-h ERA-Interim reanalysis data (Dee et al. 2011, *Q. J. R. Meteorol. Soc.*)
 - PGW run similar to CTL + addition to a climate perturbation given by $WRF_{input} = ERA\text{-interim} + \Delta CMIP5_{RCP8.5}$ where $\Delta CMIP5_{RCP8.5}$ is obtained using the CMIP5 multi-model monthly ensemble-mean change from 1976–2005 to 2070–2099 i.e., $\Delta CMIP5_{RCP8.5} = \Delta CMIP5_{2070-2099} - \Delta CMIP5_{1976-2005}$.

Definition of a Heatwave

- An event is considered a heatwave if the daily mean JJA 2-m air temperature exceeds the 95th percentile for three or more consecutive days (see Perkins and Alexander 2013, *J. Climate*). If the heat wave is interrupted by a brief temperature relapse for less than four days, it will be counted as part of the same heatwave event.
- To be considered a separate heatwave event and to ensure synoptic independence between events, the number of days between heatwave events is required to exceed four or more days.
- The duration of the heatwave is defined as the number of days between the start and end dates of a heatwave event, inclusive.

3 Study Region and Temperature Distribution

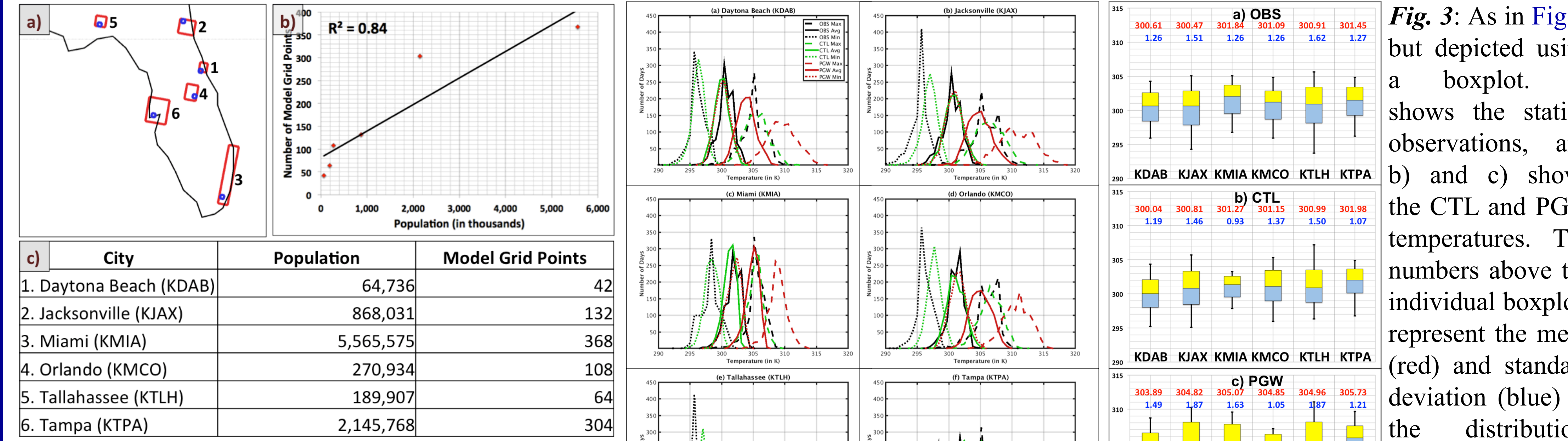


Fig. 1: (a) The location of the six cities over Florida. The numbers next to the red boxes correspond to the name of the city described in Fig. 1c. The blue boxes consisting of nine grid points each represent the location of the airport from which the model OBS was obtained in each city. (b) The population and number of grid points used in defining each city. (c) Table showing the population and number of model grid point for each city (red boxes in Fig. 1a).

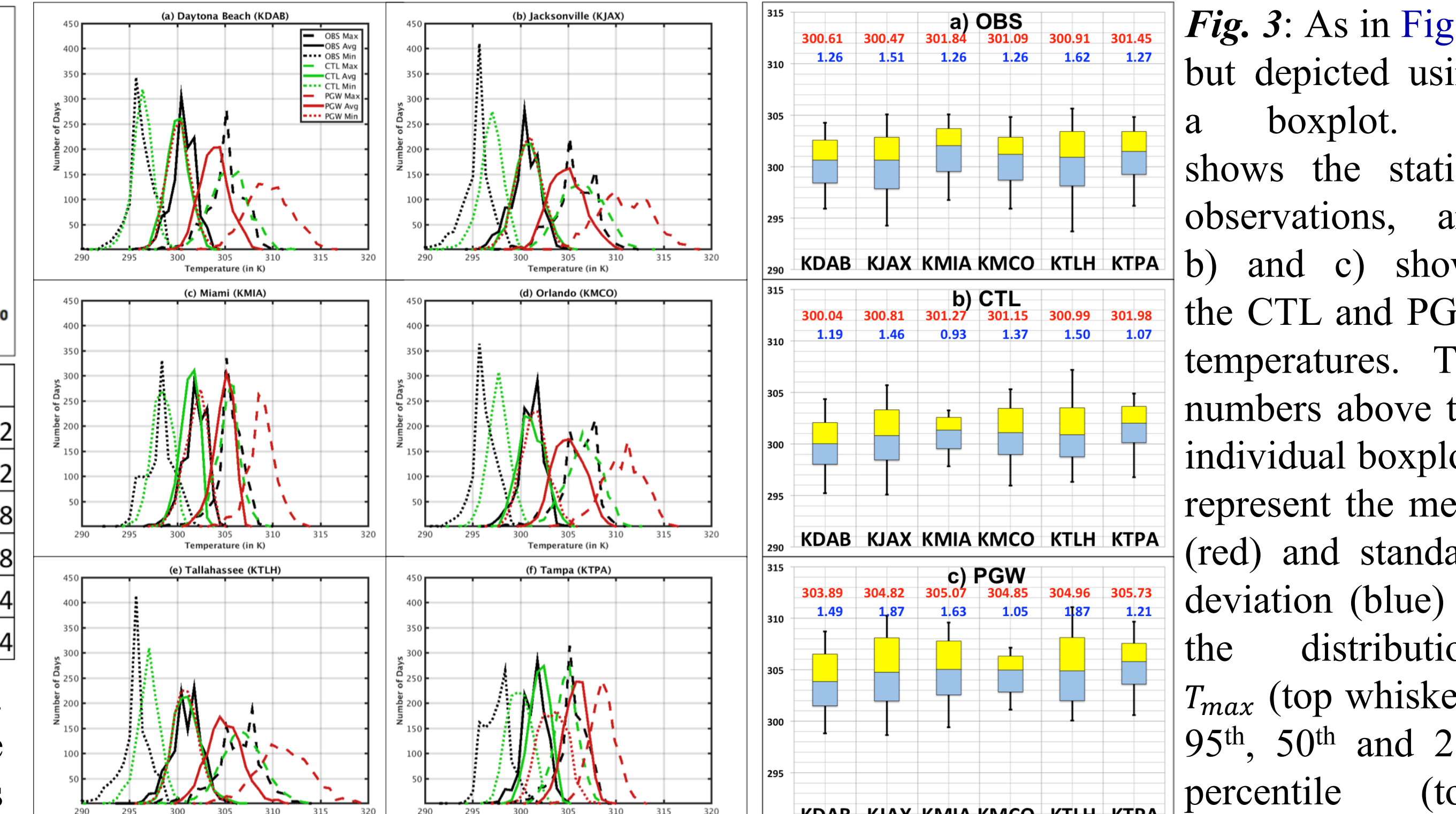


Fig. 2: Distribution of the daily max, mean, and min T for all six cities (blue box in Fig. 1a) for the days corresponding to the 2001–2013 JJA subset. — OBS, — CTL, and — PGW distribution curves illustrates key features such as a shift in the mean temperature in a warmer future climate, and an increase in variance. The plot compares relatively well to the idealized schematic published in IPCC (2012).

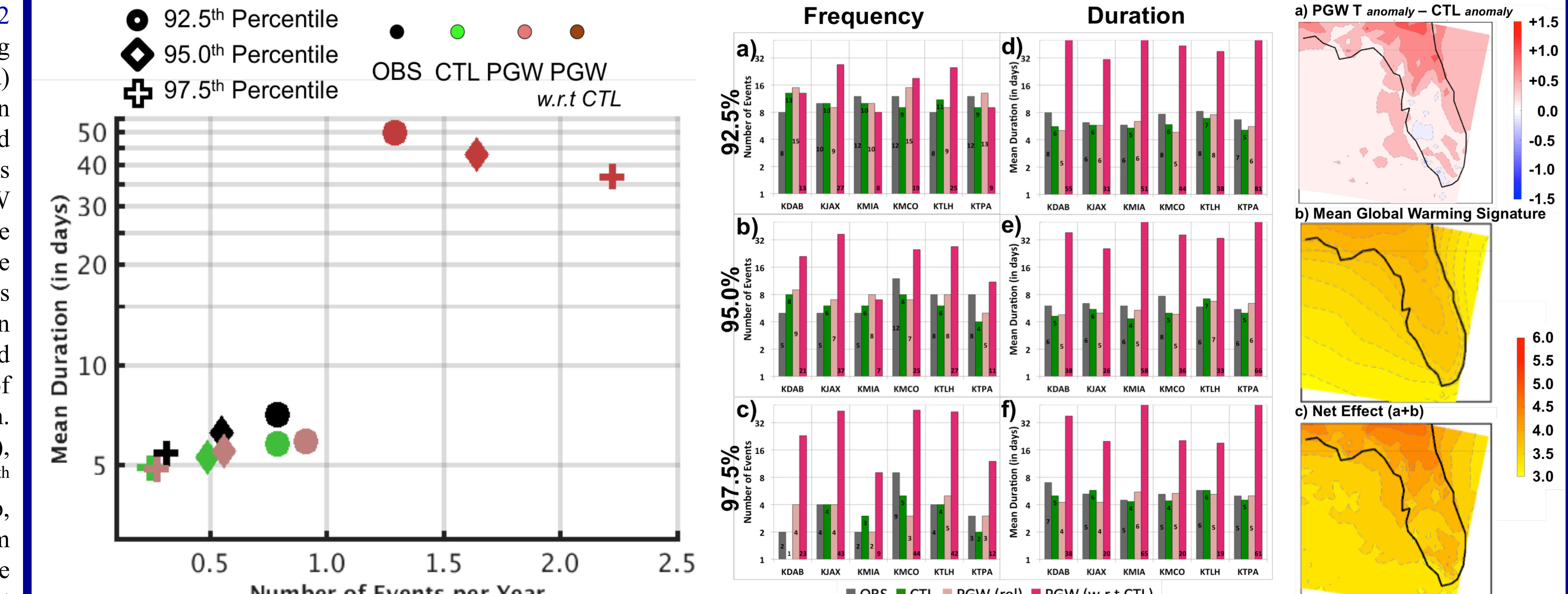


Fig. 3: As in Fig. 2 but depicted using a boxplot. a) shows the station observations, and b) and c) shows the CTL and PGW temperatures. The numbers above the individual boxplots represent the mean (red) and standard deviation (blue) of the distribution. T_{max} (top whisker), 95th, 50th and 25th percentile (top, mid, and bottom parts of the box), and T_{min} (bottom whisker) are represented using the box and whiskers.

Fig. 4: Scatter plot showing the number of JJA heatwave events per year, and the mean duration of the events for three different percentile based temperature thresholds averaged for all six stations from 2001–2013.

5 Precipitation Characteristics During a Heatwave

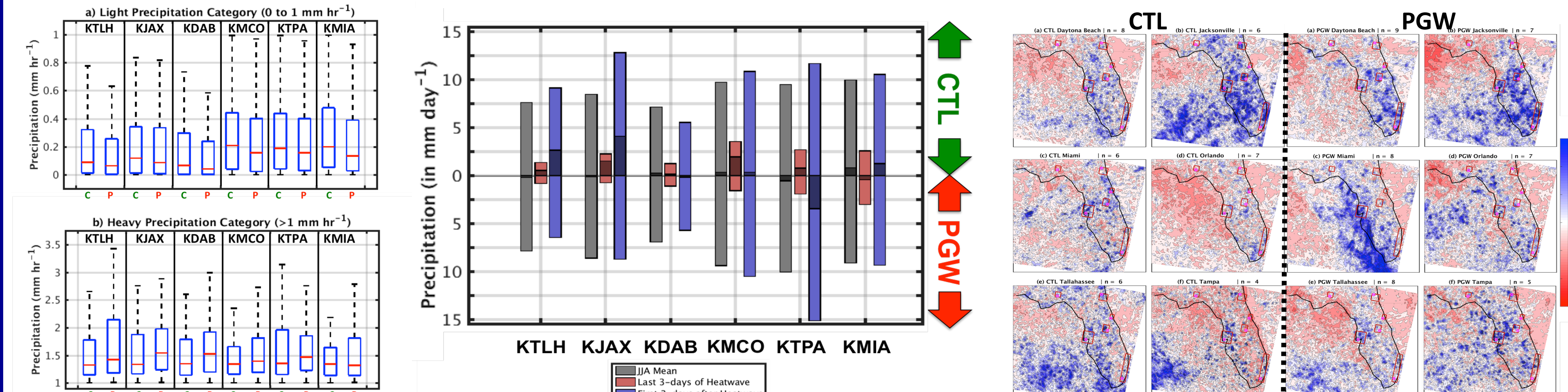


Fig. 7: Distribution of summer (JJA) precipitation obtained for a) light precipitation categories, and b) heavy precipitation categories.

Fig. 8: Mean precipitation rate obtained from the CTL and PGW runs. The difference between the CTL and PGW are highlighted with darker shading on the larger bar.

6 Concluding Remarks

Heatwaves

Precipitation Characteristics

- Under the RCP 8.5 emissions scenario for the late 21st century (2070–2099), we may expect Floridian heatwaves to increase in frequency, intensity, and duration.
- The late 21st-century climate could witness heavier heatwave-associated extreme precipitation events, and a decrease in the frequency of light–moderate precipitation events.

Stay tuned for...

Raghavendra, A., A. Dai, S. M. Milrad, and S. R. Cloutier-Bisbee, 2018: Floridian Heatwaves and Extreme Precipitation: Future Climate Projections, *Climate Dynamics*

Special thanks to...

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