Regional Climate Model Superensemble Simulations of Recent trends in Extreme events for the Western US

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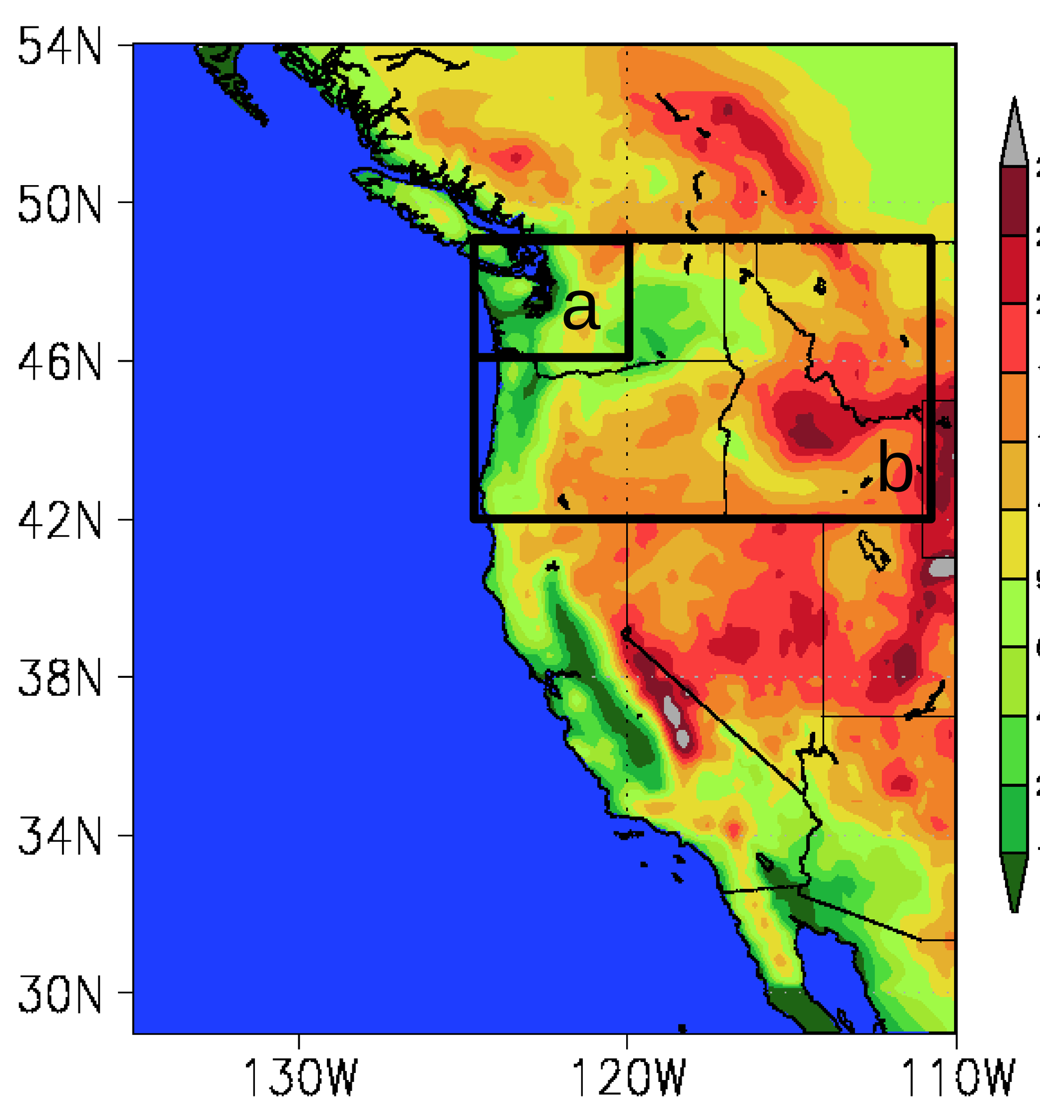
Introduction: One of the most prominent impacts of climate change over the western United States is the potential for an elevated number of extreme events over the region. Recent events such as the 2011 Texas drought and heat wave have been shown to be more likely due to anthropogenic climate change. Another projected impact of global climate change is an increase in extreme rainfall episodes. Over the Pacific Northwest, recent years have seen an upswing in heavy precipitation events such as the Chehalis River floodplain floods of 2007 and 2009 in western Washington state. This study analyzes climate model output derived from the climateprediction.net (CPDN) Weather*at*Home (WAH) regional climate model superensemble project, with greenhouse gas concentrations and other climate forcings representative of the 1960s and present day.

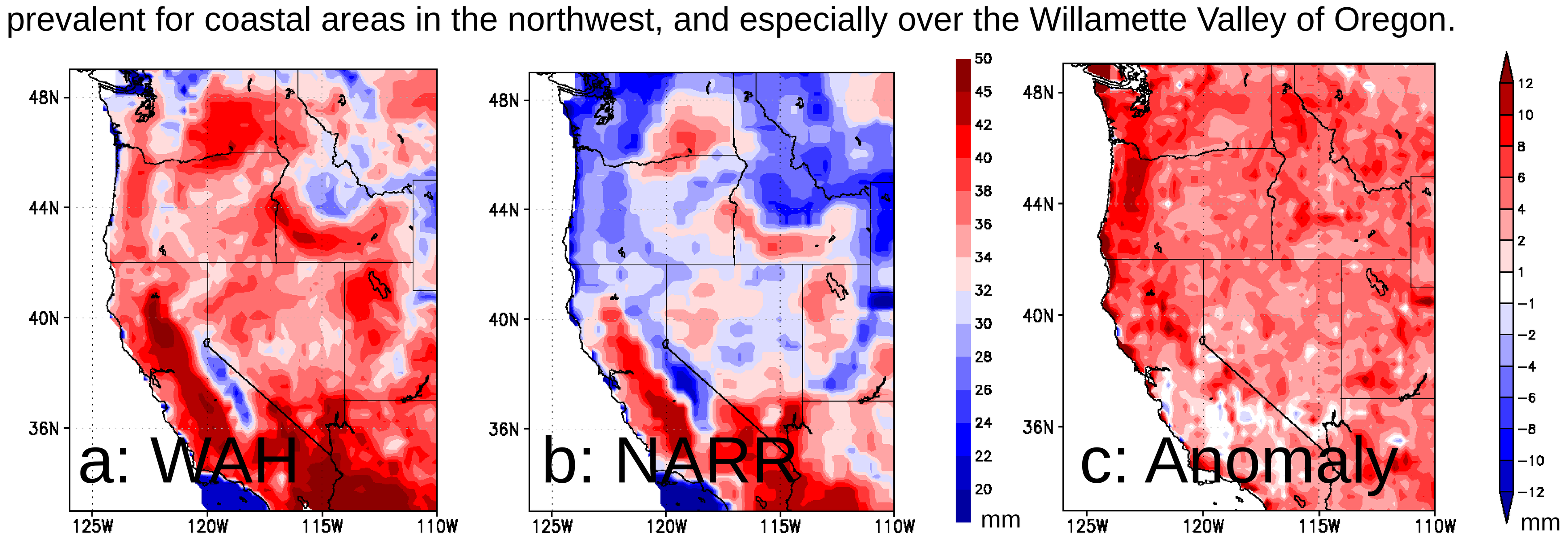
Objectives: (1) Analyze the spatial and temporal distribution of extreme weather events in the western United States, (2) explore biases in model data compared to observations, and (3) elucidate recent trends in extreme events by comparing the decade of the 2000s and one in which global climate change had not influenced (1960s).

Model Data Description: CPDN utilizes volunteer computers from users worldwide to perform hundreds of thousands of simulations of the Earth's climate from 1950 to 2050. WAH nests the Hadley Regional Model (HadRM3P) at 25 km spatial resolution over the western US within the global model HadAM3, run at a spatial resolution of 1.25˚ x 1.875° and 19 levels with 15 minutes time step for dynamics. Direct extreme event outputs utilized in the present study include: Maximum daily temperature (°C) for the month (**Tmax1**), highest daily precipitation (mm) event in a month (**Pmax1**), number of days with precipitation higher than 40 mm (**Pge40**), and number of days with temperature exceeding 30°C (**TT30**). Two subdomains are utilized for data averages to construct return periods in the linear trends section. The subdomains are for (a) western Washington state and (b) Pacific Northwest.

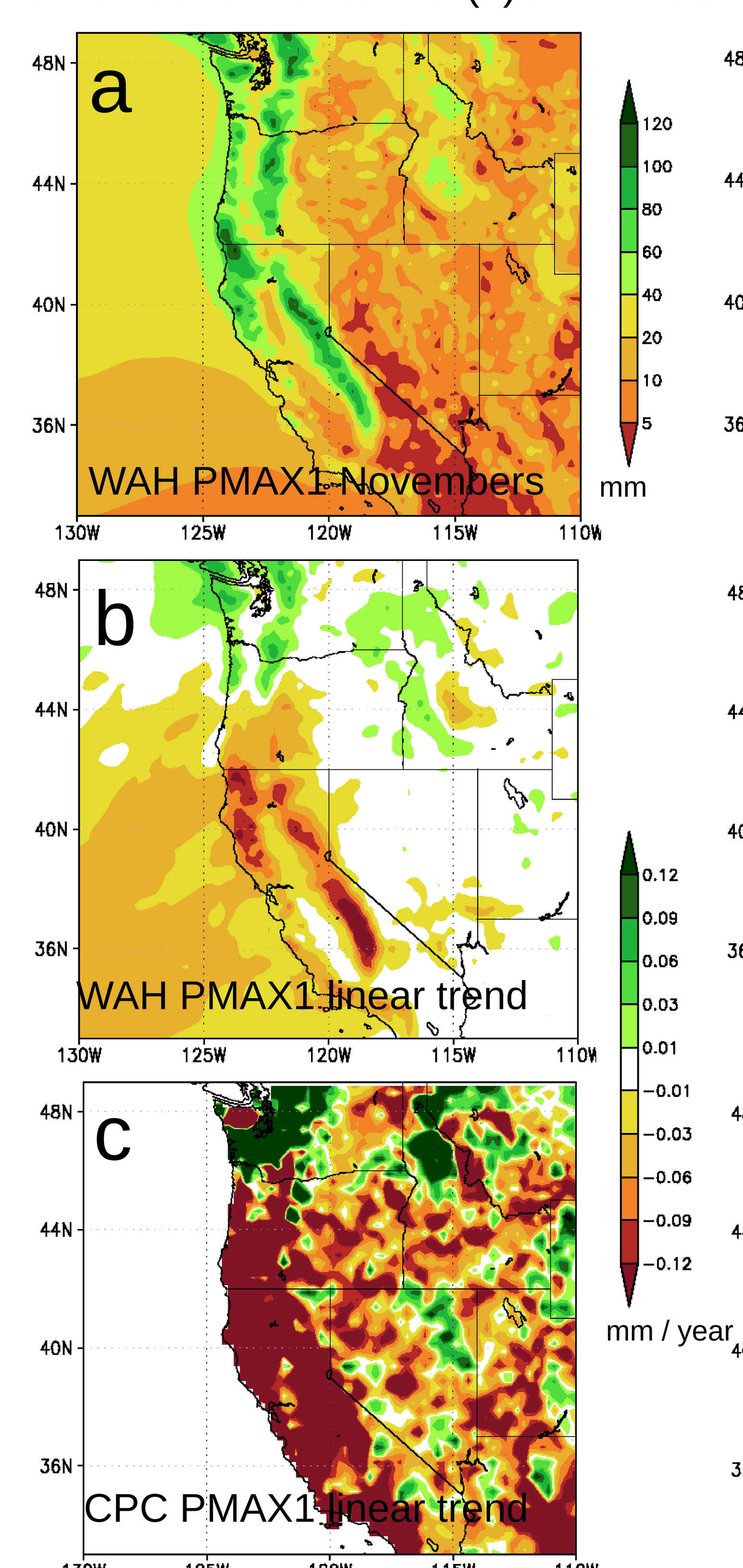


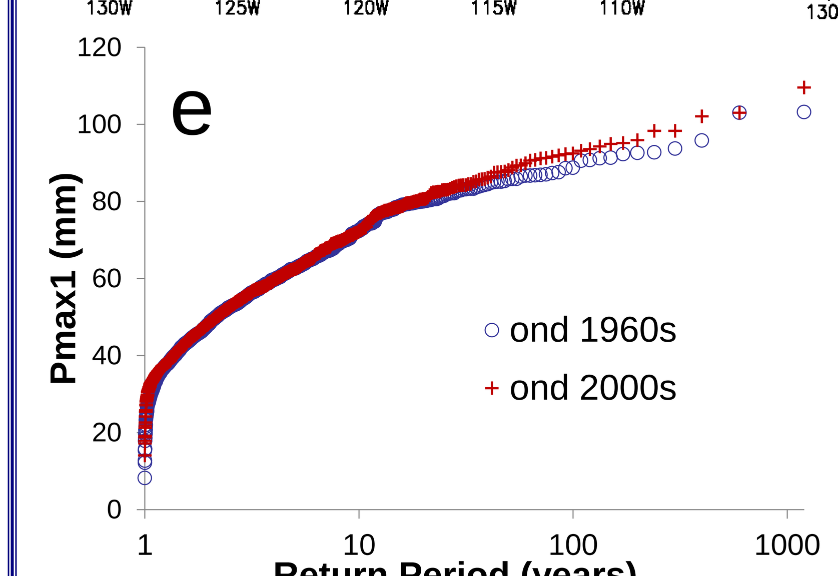
Model domain and topography

Methodology and Validation of Extreme Events: The average of 500 model runs is compared against the North American Regional Reanalysis (NARR) for temperature extremes. The Climate Prediction Center's (CPC) High resolution, station data, gridded precipitation is utilized for due to the longer temporal range (1948). The analysis used perturbed physics model runs for Tmax1 and standard physics for Pmax1. An example of model bias is shown below for June-July-August Tmax1 for WAH (a), NARR (b) and the calculated anomaly (c). There is an overall positive bias and it is most prevalent for coastal areas in the northwest, and especially over the Willamette Valley of Oregon.



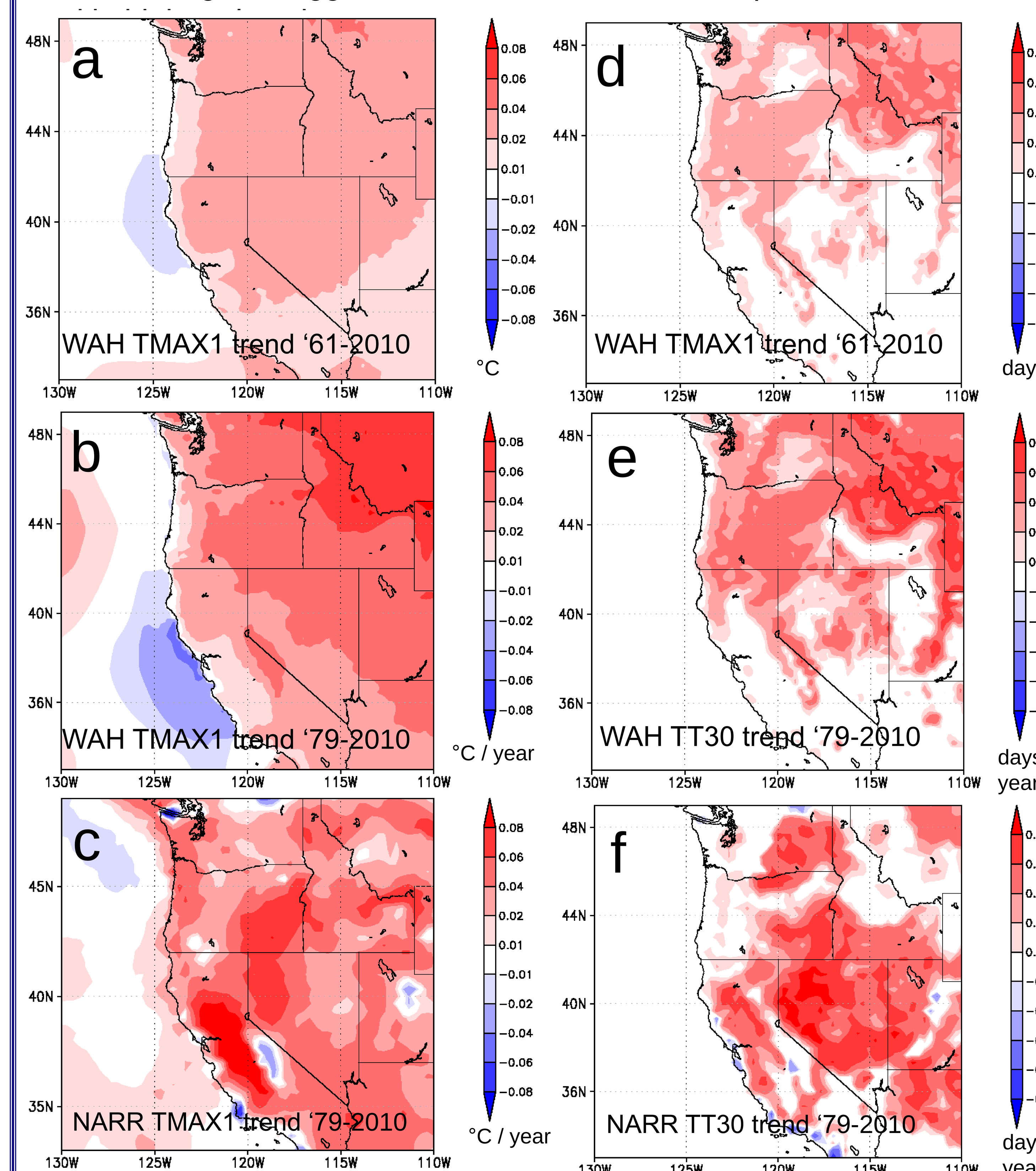
Trends in precipitation: A least-squares regression was performed on the Pmax1 and Tmax1 (next panel) data to acquire linear, temporal trends for the month of November 1961-2009. The trend for Pmax1 shows a marked increase over the Pacific Northwest for points north of 44°N in the model (b) as well as CPC (c). The number with precipitation totals above 40 mm (Pge40) also displays an upward trend in the model (e) and CPC (f). Note that the trends in CPC are a magnitude of order higher than those in the model. Total amounts for November are shown in (a) for Pmax1 and (d) Pge40 for context.

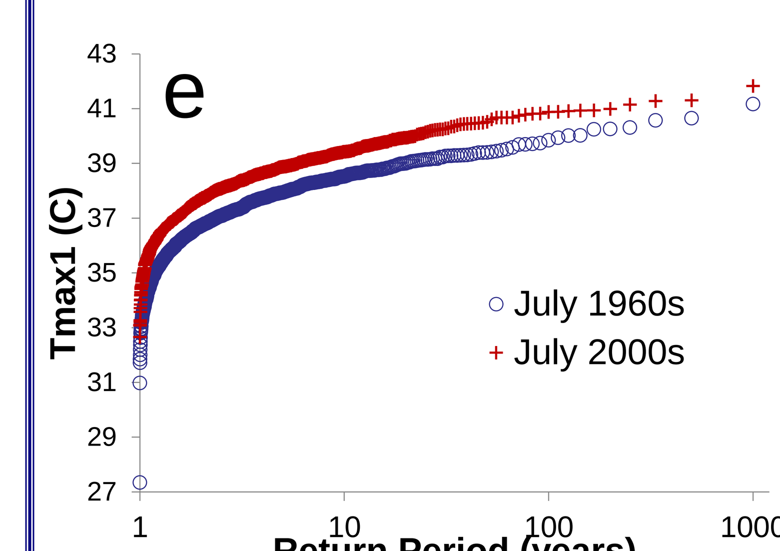




Analysis of return periods (e) over western Washington state for Pmax1 shows that, for the October-November-December (OND) season, the 2000s consistently **surpass the 1960s by 5%** for events with return periods higher than 60 years.

Trends in Temperature: The trend in Tmax1 in July shows an overall positive trend for much of the domain in the model for the 1961-2010 (a) and 1979-2010 (b) periods, with the higher trends away from the Pacific in WAH. The same is found in NARR for 1979-2010 (c), although the highest trend over the northern Central Valley is not captured by the model. The TT30 variable also displays general upward trends (figures d-f). The NARR data does deviate in the location of highest trends and the model misses larger changes in California and Nevada, while concentrating the bigger trends in the northeastern portion of the domain





The return period for the average July Tmax1 (e) for the Pacific Northwest domain is also shown to be warmer and with higher frequency in the 2000s compared to the 1960s. Further, the data suggests that a **100-year event was 7 times more likely** in the 2000s than in the 1960s.

Concluding Remarks and Future Work: The WAH model data has shown its capability to capture important regional trends in extreme events, such as those that led to floods in western Washington state in 2007 and 2009. Although the mean of the simulations over a given location may act to lessen the magnitude of trends in precipitation and temperature, the inherent statistics of a large sample size allows for more specialized analyses such as return period calculations, which measure the trends in likelihood of an event. The changes in precipitation extremes along the west coast are especially well-captured by WAH, in spite of the difference in magnitude. The biases in location of temperature extremes will be scrutinized further in future work. In the coming months, data from future climate years (2030-2050) will become available for analysis through experiment 2 of the project. This will enable the study of potential changes in frequency and intensity of high-precipitation events such as the Washington floods in the 21st century.

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