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# Texas PanHandle Climate Change Interactive GIS Web Application

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**Abstract**

A geographic information system (GIS) web application was developed to show the temporal and spatial variability of bias corrected historic and future climate change across the Texas PanHandle region. Spatially downscaled (50 $km^2$) global climate model (GCM) simulated precipitation, maximum temperature, and minimum temperature for the years 1971-2000 and 2041-2070 have been downloaded from North American Regional Climate Change Assessment Program (NARCCAP). Climate variables simulated by CRCM-CCSM, RCM3-GFDL, RCM3-CGCM3 regional climate models (RCMs) have been used for this study. Most of these model predictions are incorporated with bias due to scaling issues and immature/incomplete concepts. Typical biases include over estimation of rainfall events with low intensities and incorrect estimation of extreme temperatures. Removal of bias is important for reasonable predictions of future climate data. The bias from the historic and future climate datasets have been removed using distribution mapping technique. Bias in temperature and precipitation was removed using gaussian and gamma distribution mapping techniques respectively. This web application can be easily accessed and used by farmers, water managers, agri based industries, policy and decision makers, and other researchers to study the climate change trends across the region and plan accordingly. The web application provides the mean annual and mean monthly values of historic and future precipitation, maximum and minimum temperatures for each of the sixty seven counties in the region.

*Keywords*: climate change, NARRCAP, GIS, bias correction, distribution mapping technique, Texas PanHandle.

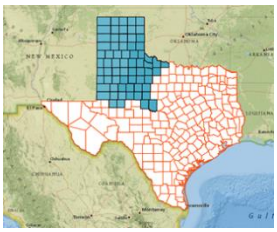
## 1 Introduction

The overall objective of my research was to study the impacts of future climate change on cotton lint yields in Texas PanHandle region and suggest mitigation strategies to prevent the losses due to climate change. Accessing and understanding the future climate datasets for a non-technical background people like farmers, policy decision makers from current available sources are quite challenging. The main idea of creating the interactive GIS web application was developed to provide the climate information that can be easily viewed and accessed by a common man.

Changing climate patterns will have a considerable effect on the agriculture sector, food security, water resources, and every other sector dependent on them thus affecting the regional economy. It is essential to know ahead how the climate might be changing in the region and plan accordingly to mitigate those losses.

Texas PanHandle region is the northern region of Texas encompassing 67 counties (Fig. 1). The region is a major producer of cotton and depends on precipitation and ground water pumping for its irrigation needs. This region has one of the heavily restricted ground water pumping regulations due to increasing droughts and declining ground water levels.

Figure 1: Texas PanHandle region (blue counties).




## 2 Methodology

Creation of the web application was a two-step process. The first step involved bias correction of the climate datasets and second step is a creation of the web application.

Three RCM simulated climate datasets were downloaded from NARCCAP. The data has a daily temporal resolution and a spatial resolution of 50 $km^2$. Distribution mapping technique [1] also known as statistical downscaling or quantile - quantile mapping was used to remove the bias from the climate variables. This method involves creation of a transfer function to correct the distribution function of the simulated values to match the distribution function of the observed values. This method has been successfully used in previous studies ([1]; [2]; [3])

Precipitation datasets were bias corrected using Gamma distribution mapping technique (Fig. 2) and the temperature datasets using Gaussian distribution mapping technique (Fig.

3). Before bias correcting precipitation datasets, a method has been employed to match the total number of rainfall events simulated by the RCMs with the observed data.

Figure 2: Bias correction of precipitation data using Gamma distribution mapping technique.

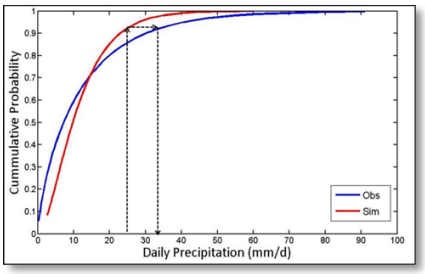
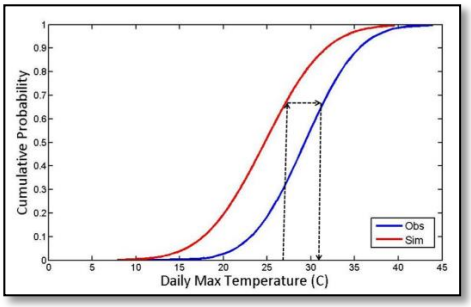



Figure 3: Bias correction of temperature data using Gaussian distribution mapping technique.




The scaling parameters that were obtained during the bias correction of model simulated historical precipitation and temperature were used to bias correct the future climate datasets.

The GIS interactive web application was developed on ESRI ArcGIS Explorer platform. All the datasets for the web application were developed on ArcGIS desktop 10.1 and then uploaded them on to ArcGIS explorer online. The images generated during the bias correction process were hosted on Flickr server and then linked them to the pop-up window boxes on ArcGIS explorer online. The dashboard feature on the explorer provided a visually appealing platform to generate the statistical and summary of the climate parameters for each county. Figure 4 gives the diagrammatic representation of the methodology involved in web app development.

## 3 Results

Bias corrected historical precipitation and temperature data matched well with the observed data. All the models predicted an increase in temperature ranging from $2^{O}$c to $4^{o}$c and decrease in precipitation by 1% to 10% by 2070 for most of the counties. These changes are not uniform across the region. Only three counties showed an increase in precipitation when compared to historic data.

A web application has been developed showing the temporal and spatial variability of historic and future climate change across the region (Fig. 5). It provides a county summary climate values for the time frame of 2041-2070 at a monthly and annual scales.

Figure 5: Texas PanHandle Climate Change interactive GIS web application

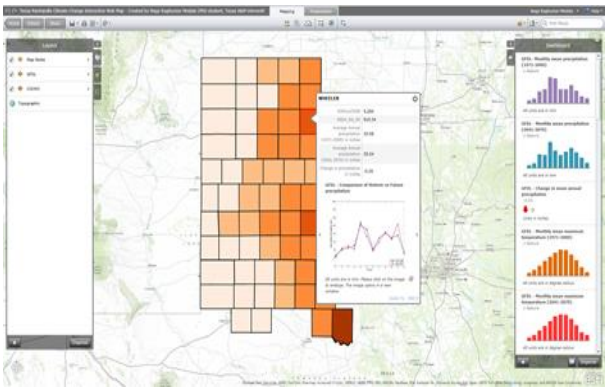


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Figure 4. Diagrammatic representation of methodology and tools involved in creating this web application