APPENDIX B:
CLIMATE ANALYSIS RESULTS

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TABLES

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ACRONYMS

CCSM	Community Climate System Model
IPCC	Intergovernmental Panel on Climate Change
ISI-MIP	Inter-Sectoral Impact Model Intercomparison Project
NCAR	National Center for Atmospheric Research
PRECIP	Average annual precipitation
RCP	Representative Concentration Pathway
TAVE	Annual average temperature
TAFB	Tinker Air Force Base
TMAX	Annual average maximum temperature
TMIN	Annual average minimum temperature

B.1. CLIMATE ANALYSIS

The climate associated with Tinker Air Force Base (TAFB) is consistent with what is referred to as a humid subtropical climate (Köppen, 1884). It is characterized by hot humid summers, and cool winters. The average annual temperature is 64.6 °F (15.9 °C) with annual precipitation of 39.4 inches (1001 mm) per year with a dryer winter season.

The climate projections for TAFB represent a moderate emission scenario (RCP 4.5) and a high emission scenario (RCP 8.5) based on National Center for Atmospheric Research (NCAR) Community Climate System Model (CCSM) prepared for the IPCC-AR5 (Gent & Danabasoglu, 2011; Hurrell et al., 2013; Moss et al., 2008, 2010). Climate projections do not predict extreme weather events, which are short-term events that are significantly different from the usual weather pattern (hurricanes, flash floods, heat waves). Climate describes trends in temperature and precipitation over a long period of time (usually thirty years) for a given location.

Climate information for historical data are downscaled to approximately 1 km grid resolution and provide daily climate information from 1980 to 2009. Climate model simulations were downscaled to 6 km grid resolution and data from 2026 to 2035 were extracted to represent the decadal average for 2030 and extracted data from 2046 to 2055 represent the decadal average for 2050.

Climate projections (Table B-1) indicate that minimum and maximum temperatures will increase over time under both emissions scenarios. For the decade centered around 2030, both scenarios project a similar degree of increase in average annual temperature (TAVE) of between 2.6 °F (1.4 °C) and 3.9 °F (2.2 °C) over the historic average. The two emission scenario projections show higher warming by 2050, with RCP 4.5 expressing a warming of 3.6 °F (2.0 °C). RCP 8.5 expresses a slightly greater warming of 5.1 °F (2.8°C) for this period.

Average annual precipitation (PRECIP) varies between emission scenarios and over time due to larger interconnected ocean-atmosphere dynamics associated with the NCAR CCSM model. For 2030, RCP 4.5 scenario projects an increase in PRECIP of 11% while RCP 8.5 shows a small increase of 1%. For 2050 RCP 4.5 projects a moderate increase in PRECIP of 14% while RCP 8.5 shows a smaller increase of 5%.

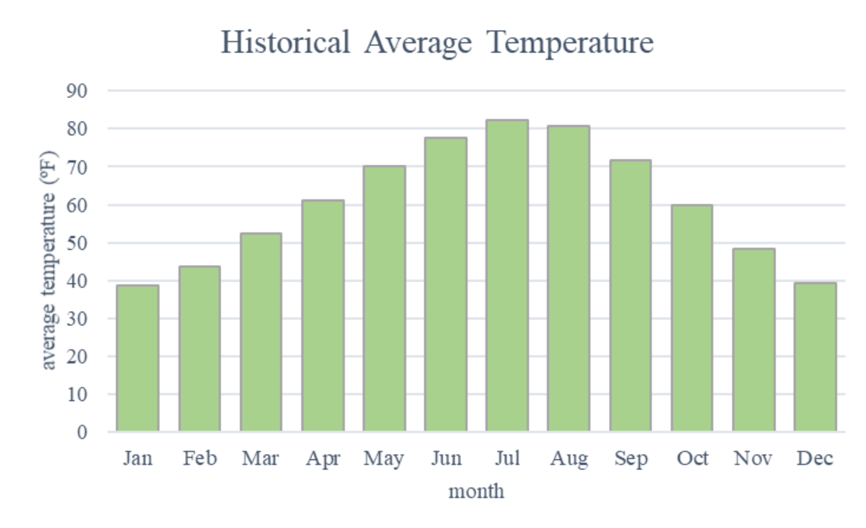
Table B-1. Summary climate data.

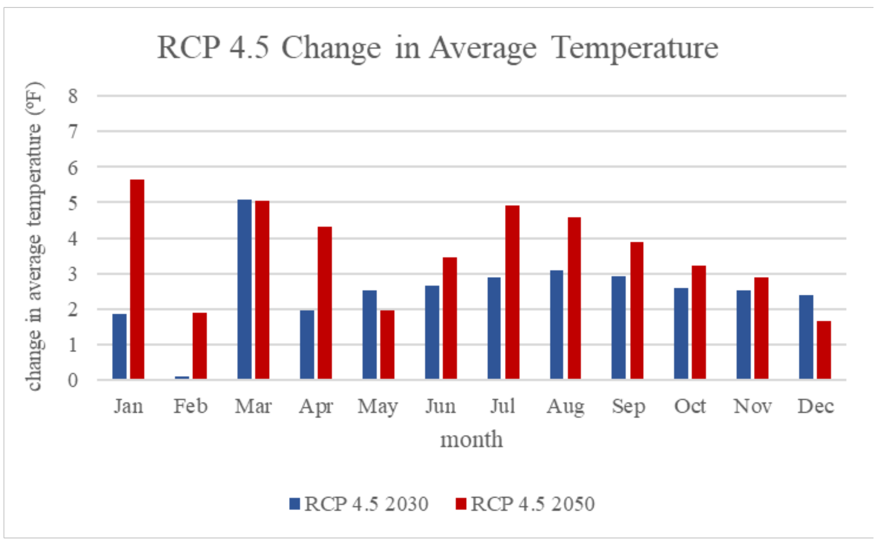
Variable	Historical	RCP 4.5		RCP 8.5	
		2030	2050	2030	2050
PRECIP (inches)	39.4	43.6	44.9	39.9	41.5
TMIN (°F)	49.2	51.6	52.5	53.1	53.9
TMAX (°F)	72.0	74.7	76.0	75.9	77.5
TAVE (°F)	60.4	63.1	64.2	64.4	65.7
GDD (°F)	5367	5973	6148	6214	6490
HOTDAYS	64.1	91.0	102.0	100.7	113.4
WETDAYS	1.3	0.4	1.2	0.1	0.4

Notes: TAVE °F = annual average temperature; TMAX °F = annual average maximum temperature; TMIN °F = annual average minimum temperatures; PRECIP (inches) = average annual precipitation; GDD °F = Average annual accumulated growing degree days with a base temperature of 50 °F; HOTDAYS (average # of days per year) = average number of hot days exceeding 90 °F; WETDAYS (average # of days per year) = annual number of days with precipitation exceeding 2 inches in a day.

B.1.1. Temperature and precipitation

Monthly climate analysis comparing historical averages with changes in each scenario is provided in Figure B-1 through Figure B-4. The historical time period represents a 30-year historical base period. The projected time periods represent decadal averages centered around 2030 (i.e., 2026-2035) and 2050 (i.e., 2046-2055).





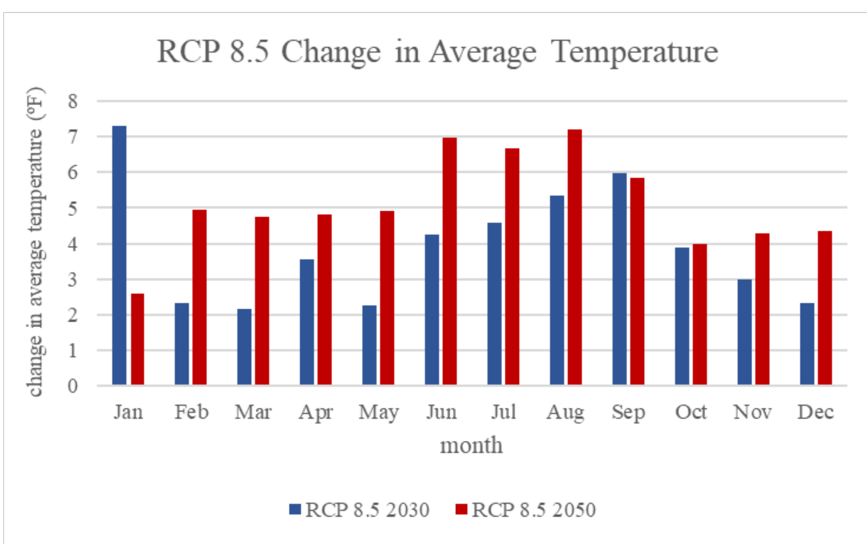
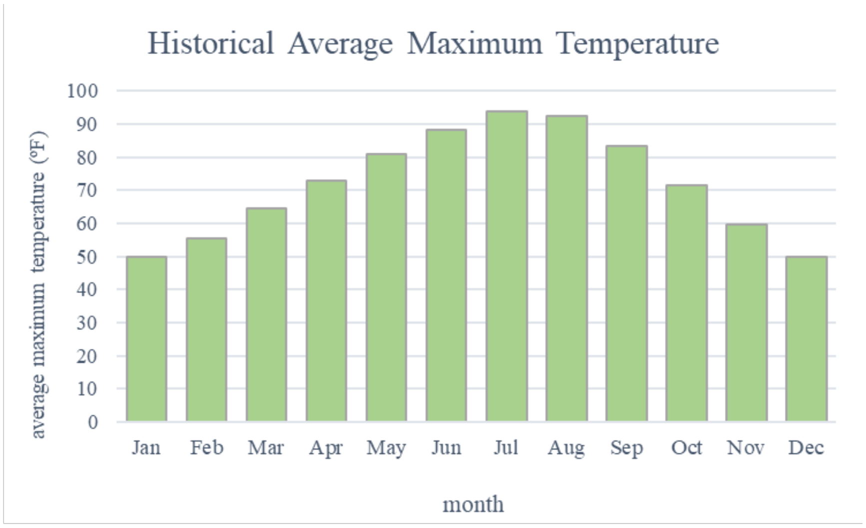
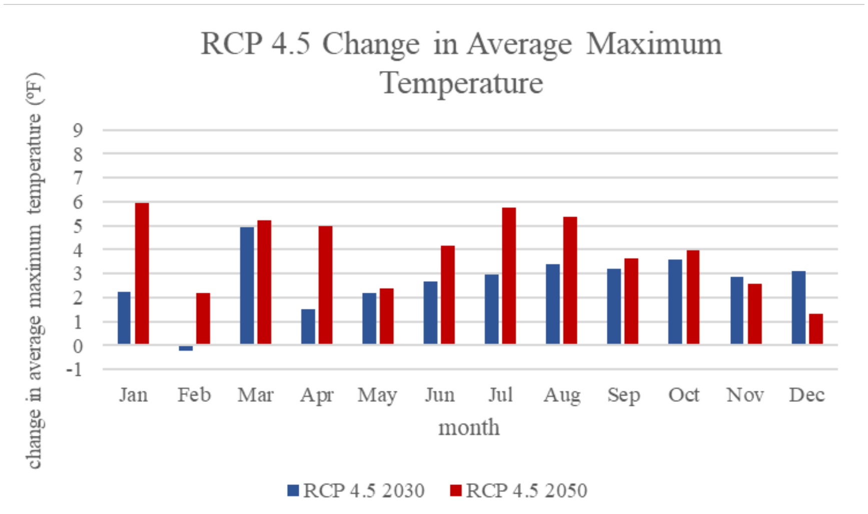


Figure B-1. Monthly average temperature.





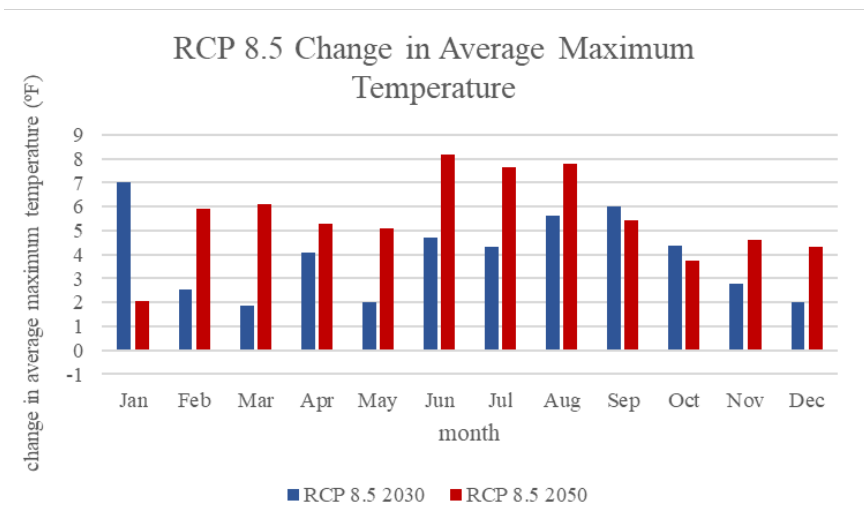
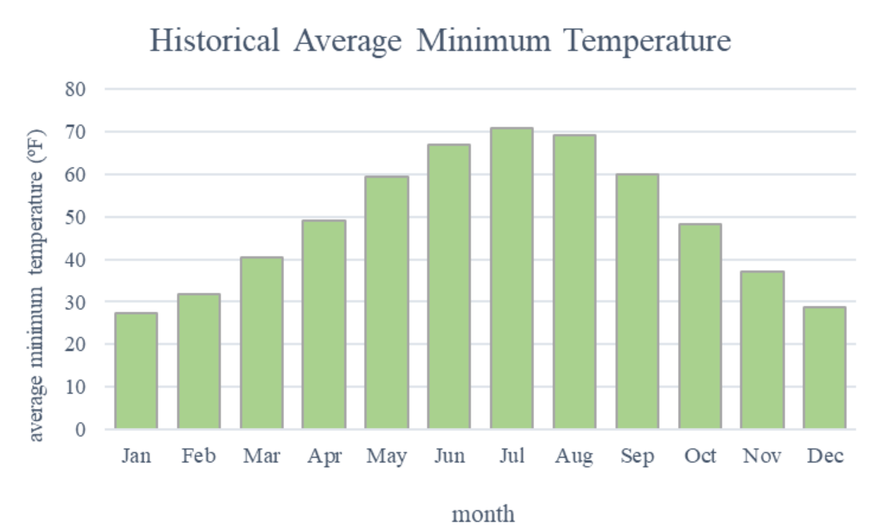
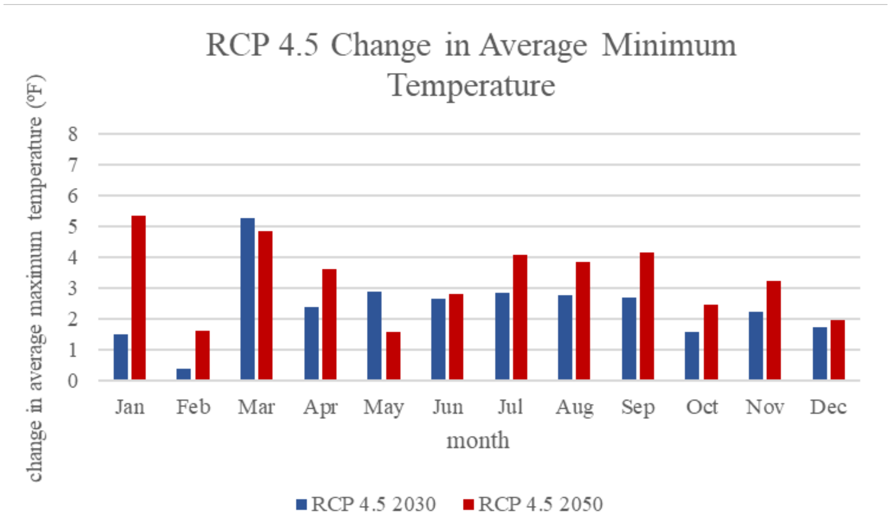


Figure B-2. Monthly average maximum temperatures.





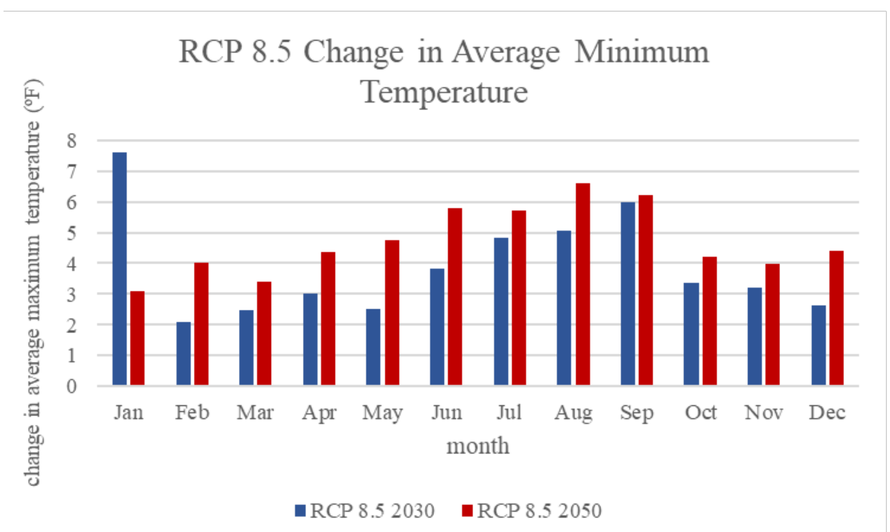
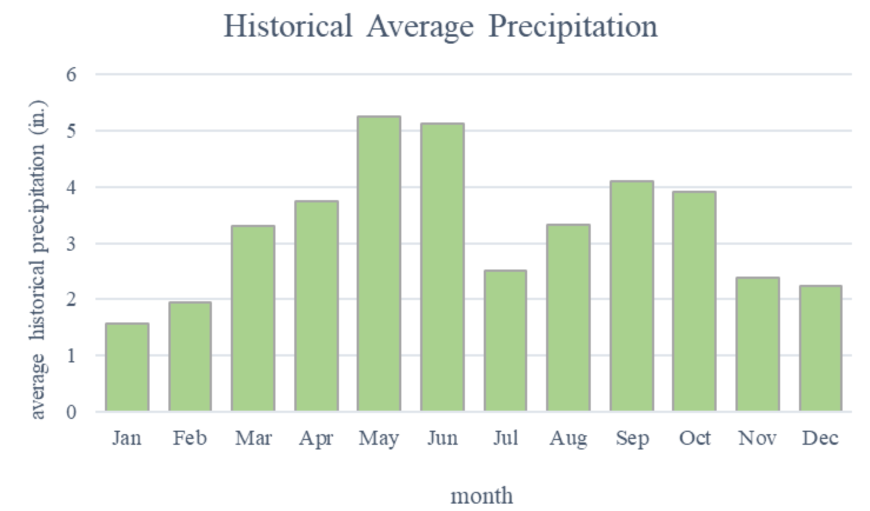
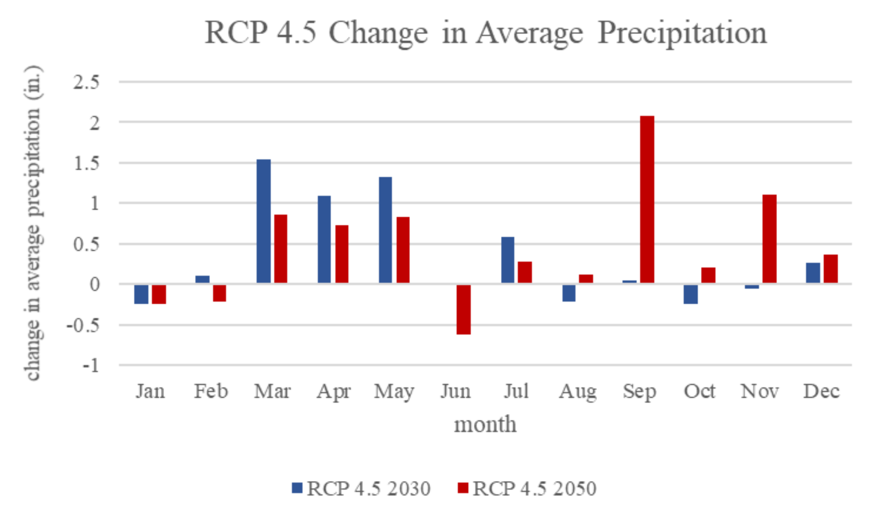


Figure B-3. Monthly average minimum temperatures.





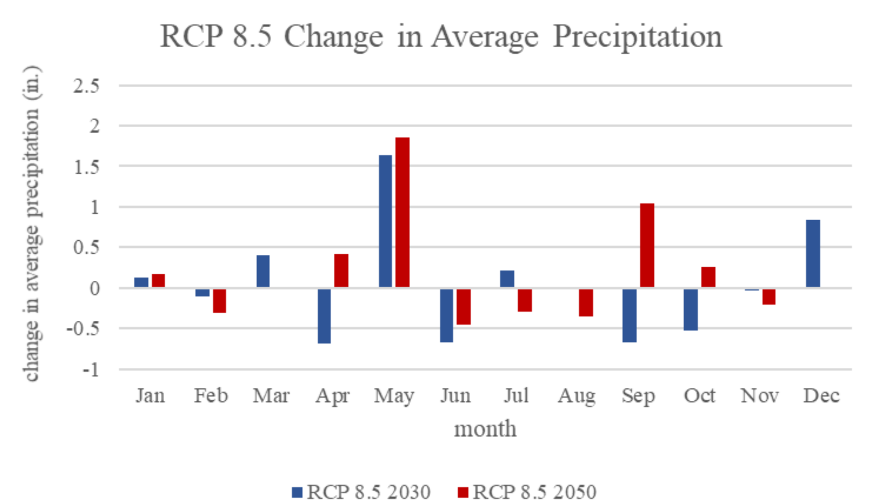


Figure B-4. Monthly average precipitation.

Walter and Lieth climate diagrams (Walter & Lieth, 1960) showing monthly temperatures overlaid with precipitation are shown for historical and each projected scenario in Figure B-5 through Figure B-9. Walter and Lieth climate diagrams show precipitation and temperature interactions for the year modeled. The red line displays monthly temperature averages (degrees Fahrenheit) measured on the left axis. The blue line shows precipitation (inches) measured on the right axis. The bar along the x-axis defines predicted months with likely (dark blue) or possible (light blue) frost. Values at the top of the panel are mean annual temperature and mean total precipitation. Black numbers beside the axis are the mean maximum and mean minimum temperature of the warmest and coldest months, respectively. The diagrams show seasonal changes in precipitation and temperature that may impact survival of flora and fauna on the installation.

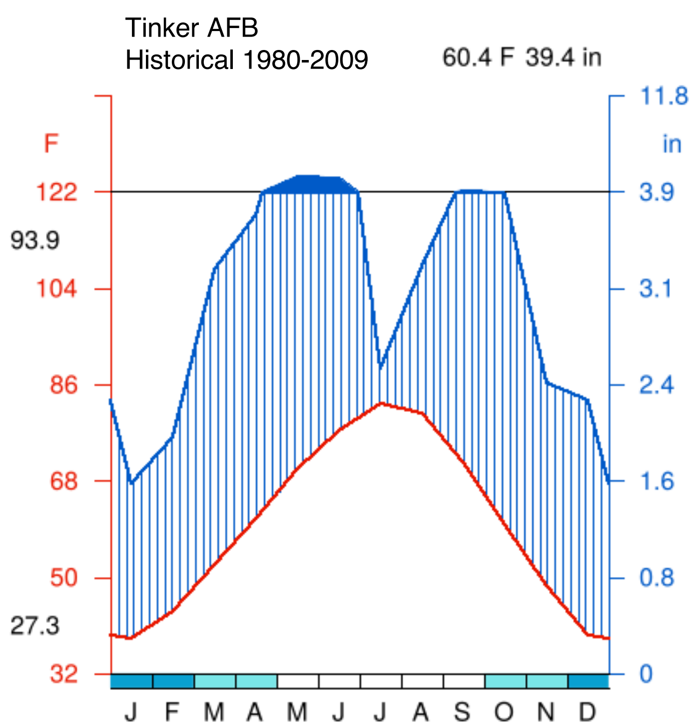


Figure B-5. Walter and Lieth climate diagram over the 30-year historical period.

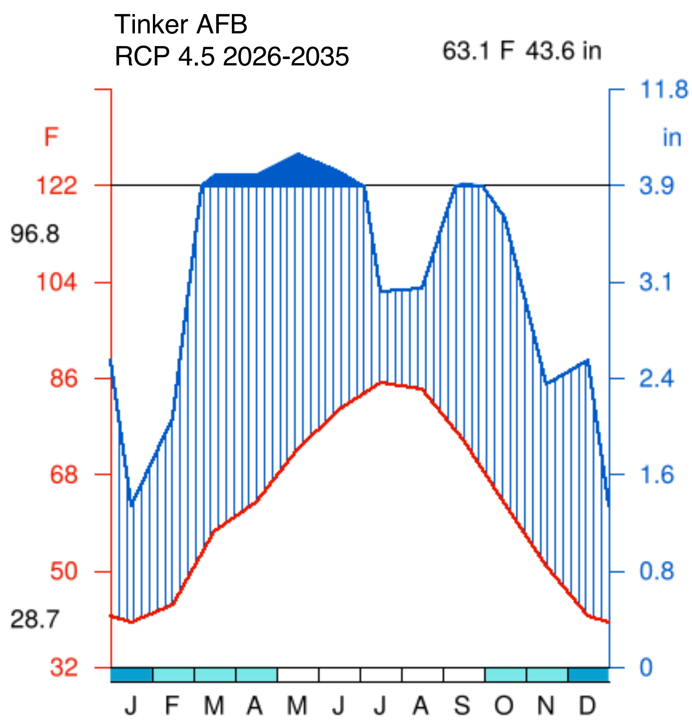


Figure B-6. Walter and Lieth climate diagram for the RCP 4.5 2030 scenario.

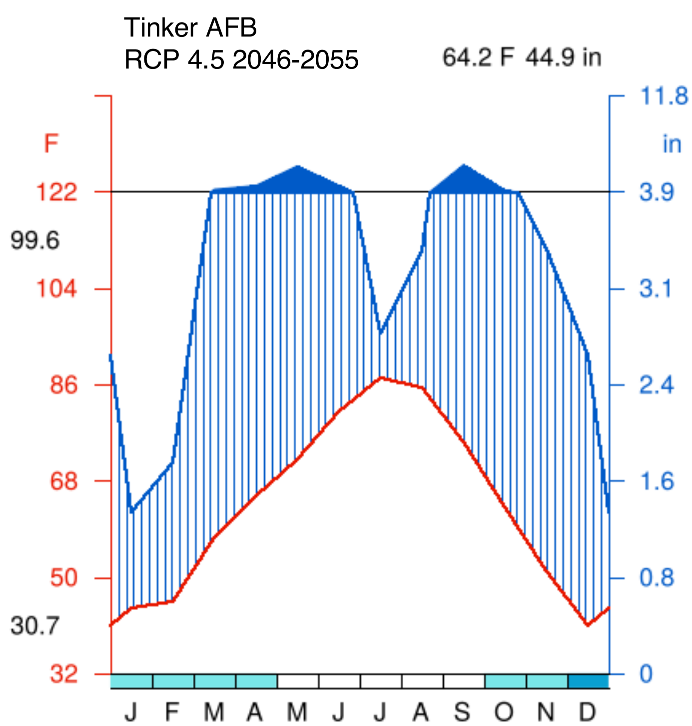


Figure B-7. Walter and Lieth climate diagram for the RCP 4.5 2050 scenario.

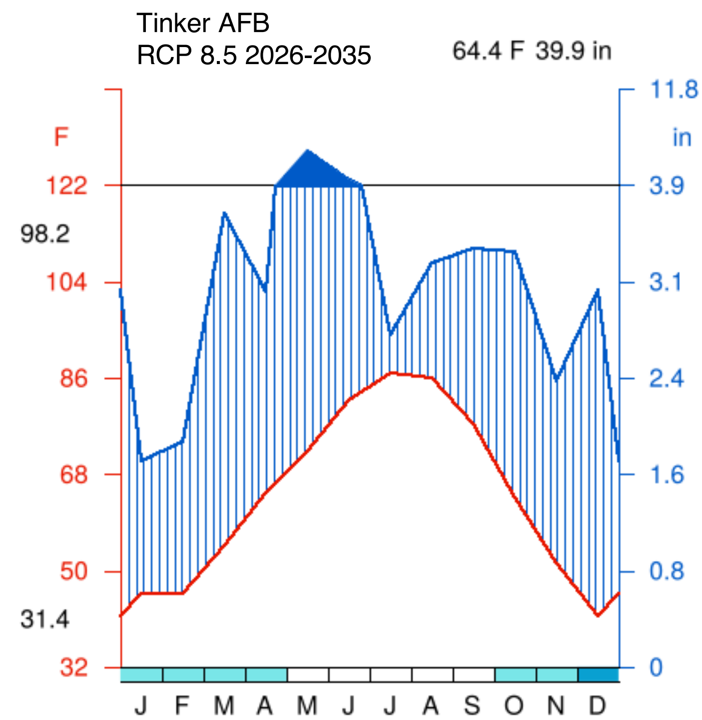


Figure B-8. Walter and Lieth climate diagram for the RCP 8.5 2030 scenario.

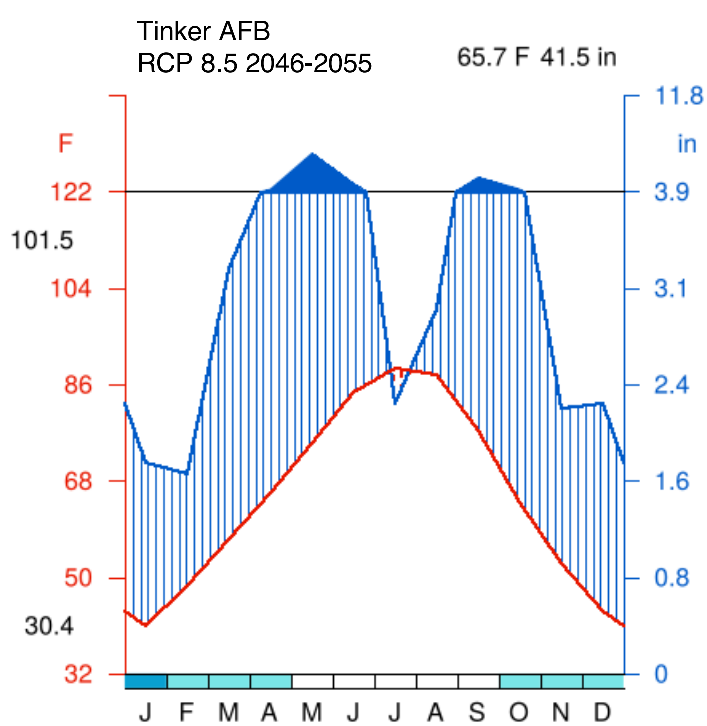


Figure B-9. Walter and Lieth climate diagram for the RCP 8.5 2050 scenario.

B.2. CLIMATE DISCUSSION

Temperature and precipitation changes under a single emissions scenario are not linear. In other words, the trends projected in the 2050 timeframe are not simply more extreme versions of the changes projected for 2030. The projections for RCP 4.5 are not simply a less-intense pattern than RCP 8.5.

There is a general trend of increasing TAVE and PRECIP, but these increases do not happen uniformly throughout the year in any scenario. Under the RCP 4.5 scenarios, temperature increases are greatest in the early part of the year suggesting that spring warms more quickly than other seasons. The greatest temperature increases during the 2050 timeframe are expected to occur during the months of June through September, which have historically been the hottest months (Figure B-1).

PRECIP will increase under all scenarios. RCP 4.5 precipitation increase are mainly projected for spring and summer months (Figure B-6 and Figure B-7). PRECIP increases for the RCP 8.5 scenario are small and are projected to increase spring precipitation. RCP 8.5 2050 projects a brief arid period in July (Figure B-9).

The humid subtropical climate that observes hot, humid summers and cool winters will continue with warmer winters and hotter summers. The trend of higher TAVE and PRECIP will ultimately result in less freeze thaw days and dry days but more growing degree days and hot days. The system-wide impacts of these changes are highly dependent on the ability of the flora and fauna to adapt to changing seasons, temperate extremes and more rapid temperature variation.

B.3. ABOUT THE CLIMATE DATA

The climate data sources as well as the North Central Climate Adaptation Science Center should be cited or acknowledged in any publications using these graphics.

B.3.1. ISI-MIP

Historical data used is the historical ½ degree global dataset provided by the Inter-Sectoral Impact Model Intercomparison Project (ISI-MIP) at the Max Planck Institute for Meteorology (Hempel, Frieler, Warszawski, Schewe, & Piontek, 2013). Climate projections used data from HadGEM2-ES dataset, also provided by the ISI-MIP project. The temporal frequency of data records is daily. The time origin is 1860-1-1 00:00:00 UTC and the time increment is days. Dataset variables are maximum temperature = ‘TMAX’; minimum temperature = ‘TMIN’; average annual precipitation = ‘PRECIP’.

B.4. LITERATURE

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