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Processing and Monthly Summaries of Downscaled Climate Data for Knoxville, Tennessee and Surrounding Region

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September 2016

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OAK RIDGE NATIONAL LABORATORY
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Computational Sciences and Engineering Division
Geographic Information Science and Technology Group

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ABSTRACT

Oak Ridge National Laboratory (ORNL) and the City of Knoxville, Tennessee have partnered to work on a Laboratory Directed Research and Development (LDRD) project towards investigating climate change, mitigation, and adaptation measures in mid-sized cities. ORNL has statistically and dynamically downscaled ten Global Climate Models (GCMs) to both 1 km and 4 km resolutions. The processing and summary of those ten gridded datasets for use in a web-based tool is described. The summaries of each model are shown individually to assist in determining the similarities and differences between the model scenarios. The variables of minimum and maximum daily temperature and total monthly precipitation are summarized for the area of Knoxville, Tennessee for the periods of 1980-2005 and 2025-2050.

1. BACKGROUND

Oak Ridge National Laboratory (ORNL) and the City of Knoxville, Tennessee have partnered to work on a Laboratory Directed Research and Development (LDRD) project towards investigating climate change, mitigation, and adaptation measures in mid-sized cities. Knoxville is particularly interested in knowing future flooding possibilities and the best placement for green infrastructure. Outputs from Global Climate Models (GCMs) are often at a resolution that is too coarse for decision makers to use at a local level. Downscaling the data and the use of bias-correction allow for the information to be scaled to a finer resolution that is more relevant for managing and allocating local resources. ORNL has statistically and dynamically downscaled ten GCMs to both 1 km and 4 km resolutions[1]. The processing of those ten gridded datasets for use in a web-based tool, and for general use in GIS platforms, is described in this document. Specifically, the creation of data that are location specific and summarized for use in the area of Knoxville, Tennessee.

The ten climate models (Table 1) were selected based on data availability and to represent one model from each of the Coupled Model Intercomparison Project phase 5 (CMIP5)[2]. The GCM outputs were dynamically downscaled, using Regional Climate Model version 4 (RegCM4), to 18 km. These outputs of daily precipitation and minimum/maximum temperatures were then statistically bias-corrected to 4 km grid cells using PRISM data[3]. The 18 km climate data was also re-gridded and bias-corrected using Daymet data[4] to create the 1 km data. Netcdf files of the 1 km and 4 km datasets were obtained for daily minimum temperature (Tmin), daily maximum temperature (Tmax), and daily precipitation values for the years 1980-2005 and 2025-2050. The 1 km climate model data was used for creating the monthly summaries for the area surrounding Knoxville, Tennessee.

The original area the acquired netcdf files covered was an area larger than necessary for the purpose of the analysis (Figure 1). Had the initial area been used, the results would have been skewed by the Smoky Mountains to the east and other areas surrounding the actual area of interest for this study. The climate pattern of local information would have been obscured by this extra information. The area of interest is defined not just as the county which the city of Knoxville resides but, more importantly, includes the

[1] Methodology described in Ashfaq, M., Bowling, L. C., Cherkauer, K., Pal, J. S., & Diffenbaugh, N. S. (2010). Influence of climate model biases and daily-scale temperature and precipitation events on hydrological impacts assessment: A case study of the United States. Journal of Geophysical Research, 115(D14). http://doi.org/10.1029/2009JD012965

[2] Further information can be found in Naz, B. S., Kao, S.-C., Ashfaq, M., Rastogi, D., Mei, R., & Bowling, L. C. (2016). Regional hydrologic response to climate change in the conterminous United States using high-resolution hydroclimate simulations. Global and Planetary Change, 143, 100–117. http://doi.org/10.1016/j.gloplacha.2016.06.003

[3] http://prism.oregonstate.edu/

[4] https://daymet.ornl.gov/

HUC 12 watersheds (representing the hydrologic unit code of 12 digits) that cover Knox County, Tennessee. By using the watersheds as a boundary, the precipitation that falls within the watersheds affecting Knox County will be accounted for in the climate summary.

Table 1: Brief summary of ten downscaled climate models used to summarize data for the area surrounding Knoxville, Tennessee.

Model	Center	Model Components							Atmospheric Resolution (degrees) One degree ~ 111 km at the equator	Vertical levels in atmosphere
		Atmos.	Aerosol	Atmos. Chem.	Land Surface	Ocean	Ocean.Bio Geo-Chem	Sea Ice		
ACCESS	Commonwealth Scientific and Industrial Research Organization and Bureau of Meteorology, Australia	•	•		•	•		•	1.25x1.88	38
BCC-CSM	Beijing Climate Center, China Meteorological Administration	•	•		•	•	•	•	2.79x2.81	26
CCSM4	National Center for Atmospheric Research, USA	•	•		•	•		•	0.94x1.25	26
CMCC-CM	Centro Euro-Mediterraneo per I Cambiamenti Climatici	•	•			•		•	0.75x0.75	31
FGOALS	LASG, Institute of Atmospheric Physics, Chinese Academy of Sciences	•	•		•	•	•	•	1.66x2.81	26
GFDL-ESM2M	NOAA Geophysical Fluid Dynamics Laboratory, USA	•	•		•	•	•	•	2.02x2.5	48
IPSL-CM5A-LR	Institut Pierre Simon Laplace, France	•	•		•	•	•	•	1.89x3.75	39
MPI-ESM-MR	Max Planck Institute for Meteorology, Germany	•	•		•	•	•	•	1.87x1.88	95
MRI-CGCM3	Meteorological Research Institute, Japan	•	•		•	•		•	1.12x1.13	48
NorESM1-M	Norwegian Climate Center, Norway	•	•	•	•	•		•	1.89x2.5	26

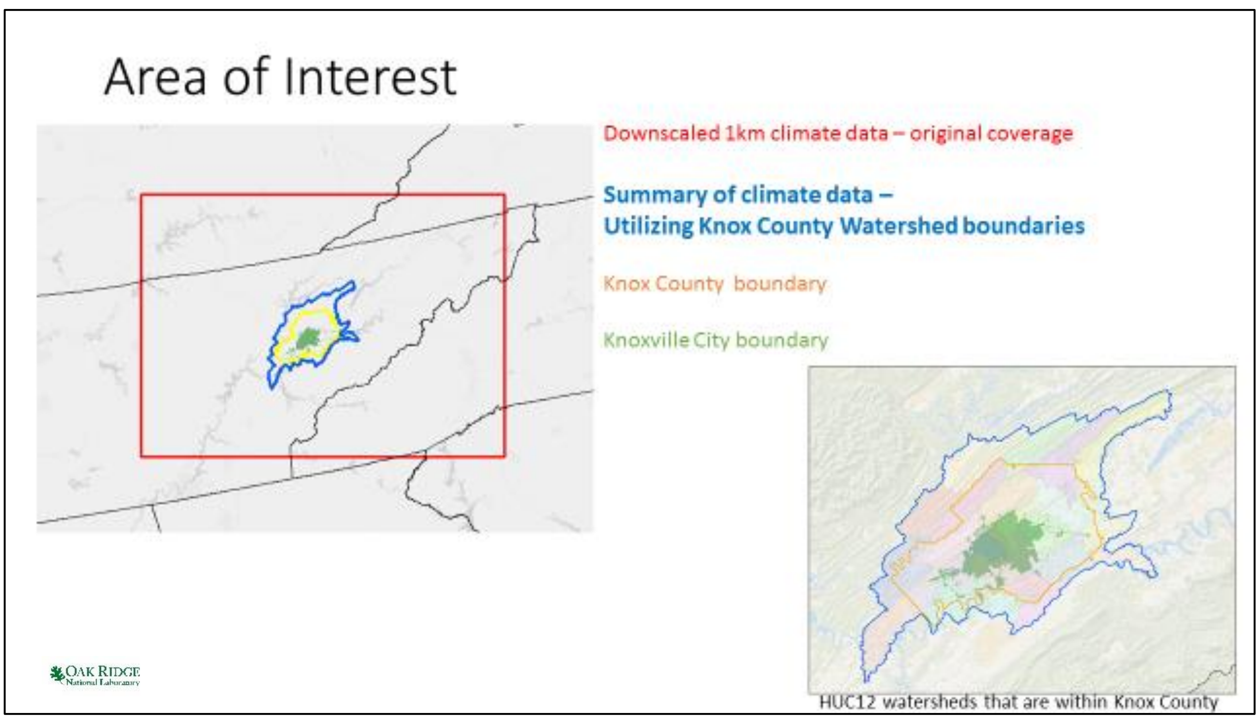

Figure 1: Area of interest for climate model processing for the area surrounding the city of Knoxville, Tennessee.

2. METHODOLOGY

The daily netcdf files, of the original area of coverage, were averaged across each month for each year (1980-2005; 2025-2050) by using cdo commands in a Linux environment. This created a netcdf file for the entire area of coverage that held a monthly average within each grid cell for both past and future time periods of interest. For example, a gridded file for January 1980, February 1980, March 1980…November 2005, December 2005 were created for monthly precipitation totals, precipitation average, Tmin average, and Tmax average. These average monthly netcdf files were projected from Geographic Coordinate System NAD83 to Lambert Conformal Conic WGS84. The resulting geotiffs were clipped to the area of interest, which in this instance, consists of the watersheds that cross the Knox County, Tennessee boundary (Figure 1). RStudio was used to create summaries and graphs from these clipped geotiffs for the specific study area.

3. RESULTS

The monthly summary results for both time periods, past (1980-2005) and future (2025-2050), and each of the ten climate models, are summarized and plotted to show the similarities and differences between the models and time periods for each of the climate variables (Tmin, Tmax, and precipitation). Boxplots were created for each of the variables to show the differences between the modeled information in each time period (Figures 2-7). Graphs were also created for each model to show the modeled shift between past and future variables (Figure 8). The information for the summaries is all pertaining to the 1 km climate data. The monthly summary values for each model, time period, and variable are listed in Appendix A.

3.1 MINIMUM TEMPERATURES

The 1980-2005 downscaled modeled data was bias-corrected, with Daymet, to match historical observations so there will not be much variation. Boxplots of the past average monthly minimum temperature values indicate this (Figure 2), as all the points are clustered on top of one another and the box plot is shown as a single line. There are no outliers.

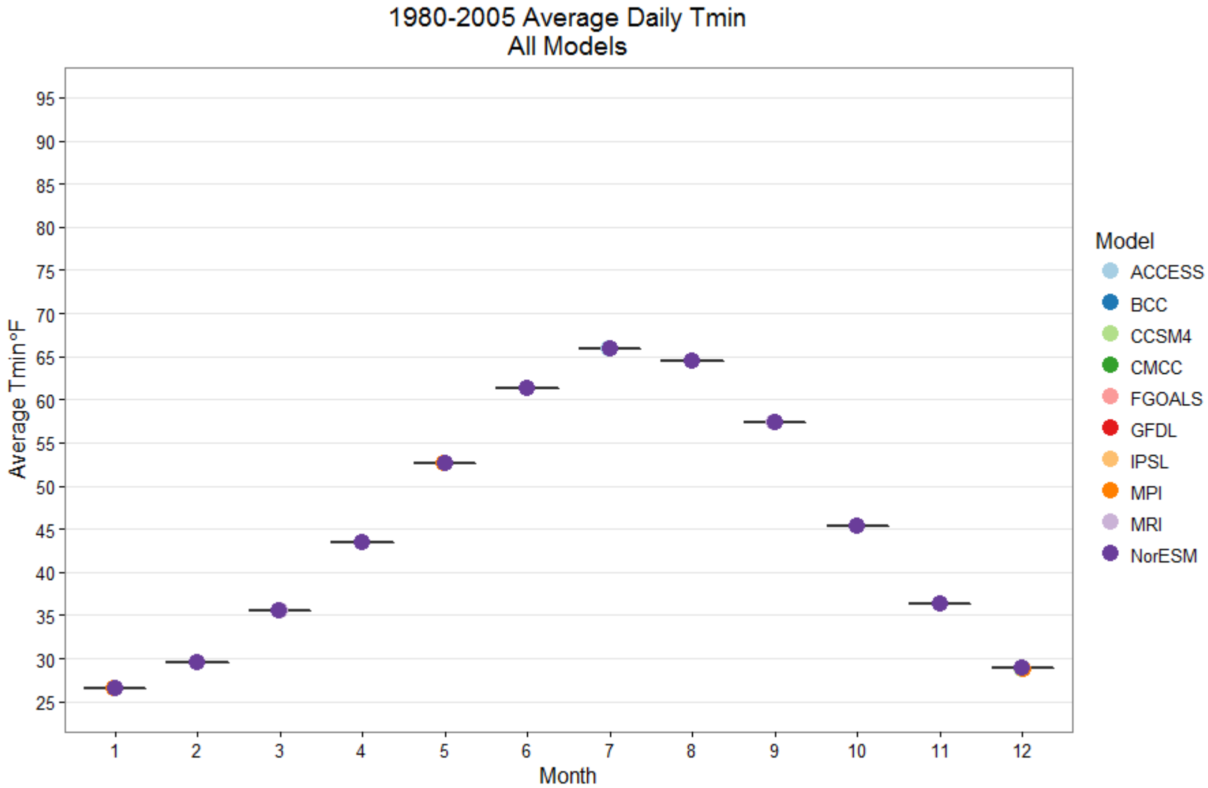

Figure 2: Monthly boxplot summaries of the average daily minimum temperature for ten climate models for the period 1980-2005 for Knoxville, Tennessee area.

The climate models all begin at the same point for the future time period (2025-2050) but allow for non-stationarity as they calculate possible future scenarios. The future Tmin boxplots (Figure 3) show variation among the average model values. Outliers are labeled with the model name in the month they occur.

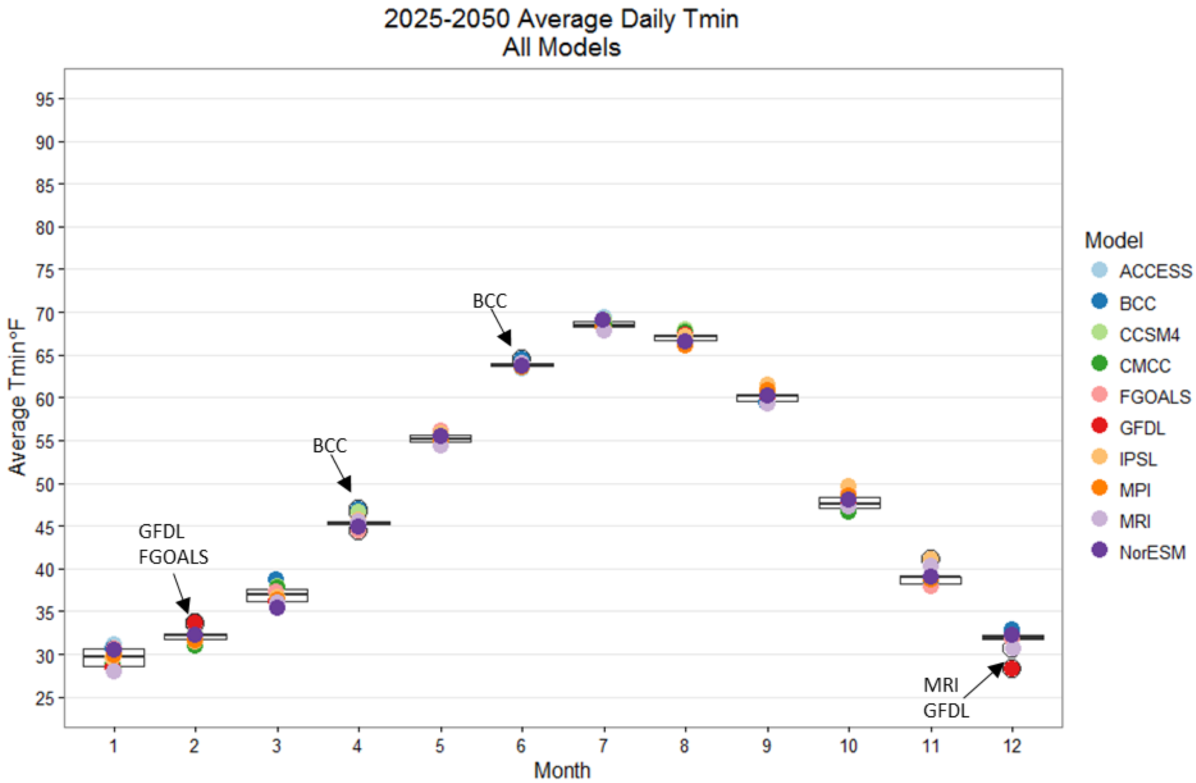

Figure 3: Monthly boxplot summaries of the average daily minimum temperature for the period 2025-2050 for Knoxville, Tennessee area.

3.2 MAXIMUM TEMPERATURES

The 1980-2005 downscaled modeled data was bias-corrected, with Daymet, to match historical observations so there will not be much variation. Boxplots (Figure 4) of the past average monthly maximum temperature values indicate this, as all the points are clustered on top of one another and the box plot is shown as a single line. There are no outliers.

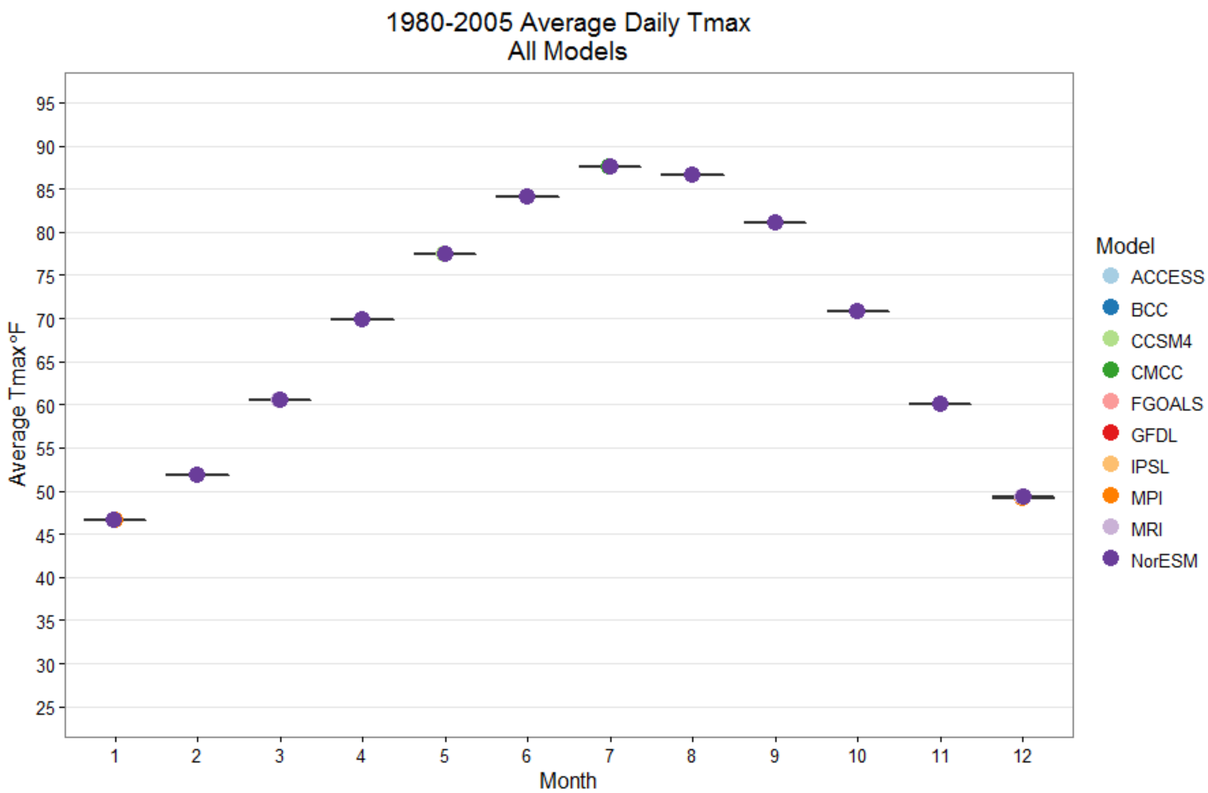

Figure 4: Monthly boxplot summaries of the average daily maximum temperature for ten climate models for the period 1980-2005 for Knoxville, Tennessee area.

The models all begin at the same point but allow for non-stationarity as they calculate possible future scenarios. The future Tmax boxplot (Figure 5) indicate there is some variation between the models. Outliers are labeled with the model name in the month they occur.

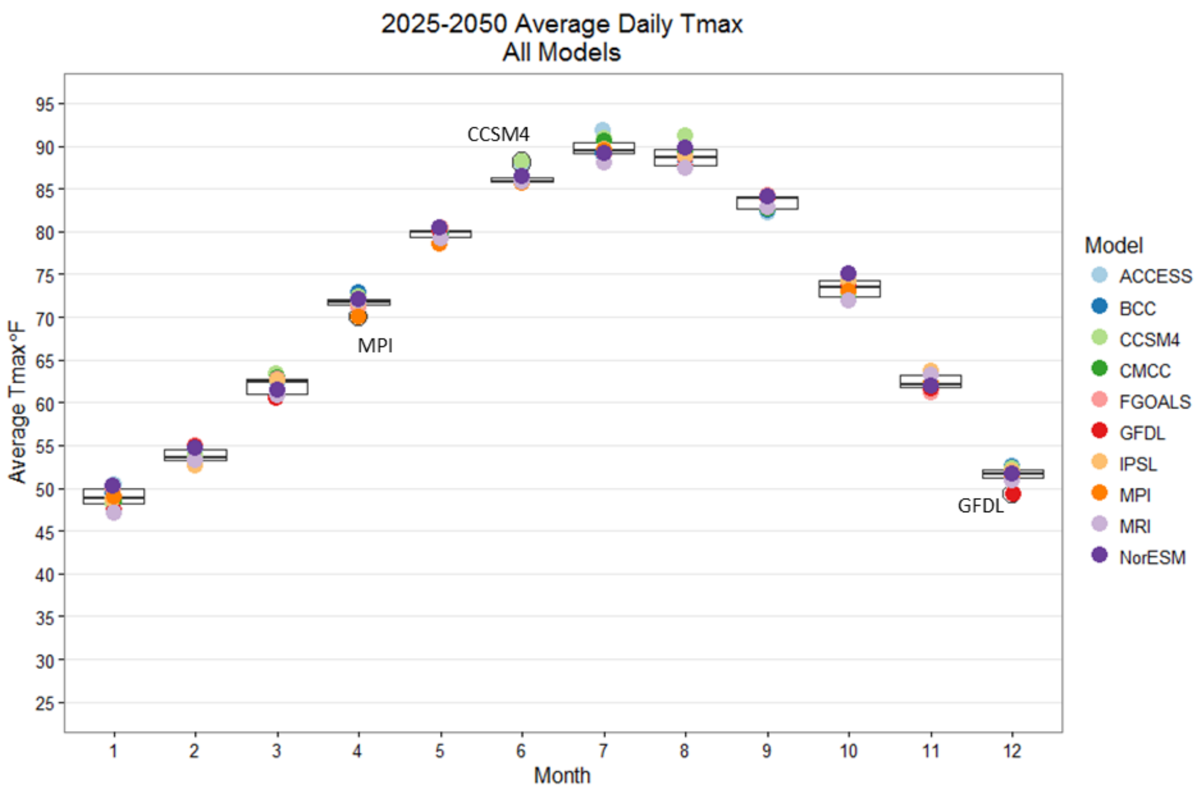

Figure 5: Monthly boxplot summaries of the average daily maximum temperature for ten climate models for the period 2025-2050 for Knoxville, Tennessee area.

3.3 PRECIPTATION

The 1980-2005 downscaled modeled data was bias-corrected, with Daymet, to match historical observations so there will not be much variation. For the precipitation boxplot (Figure 6), the models agree on past monthly precipitation totals, with only December showing some variation among the average monthly totals. There are no outliers.

Figure 6: Monthly boxplot summaries of the average monthly precipitation for ten climate models for the period 1980-2005 for Knoxville, Tennessee area.

The future precipitation models all begin at the same point but allow for non-stationarity as they calculate possible future scenarios. The future precipitation boxplots show variation in the model values with December, again, showing the most variation. Outliers are labeled and indicate which models project higher precipitation values than the other models for that month.

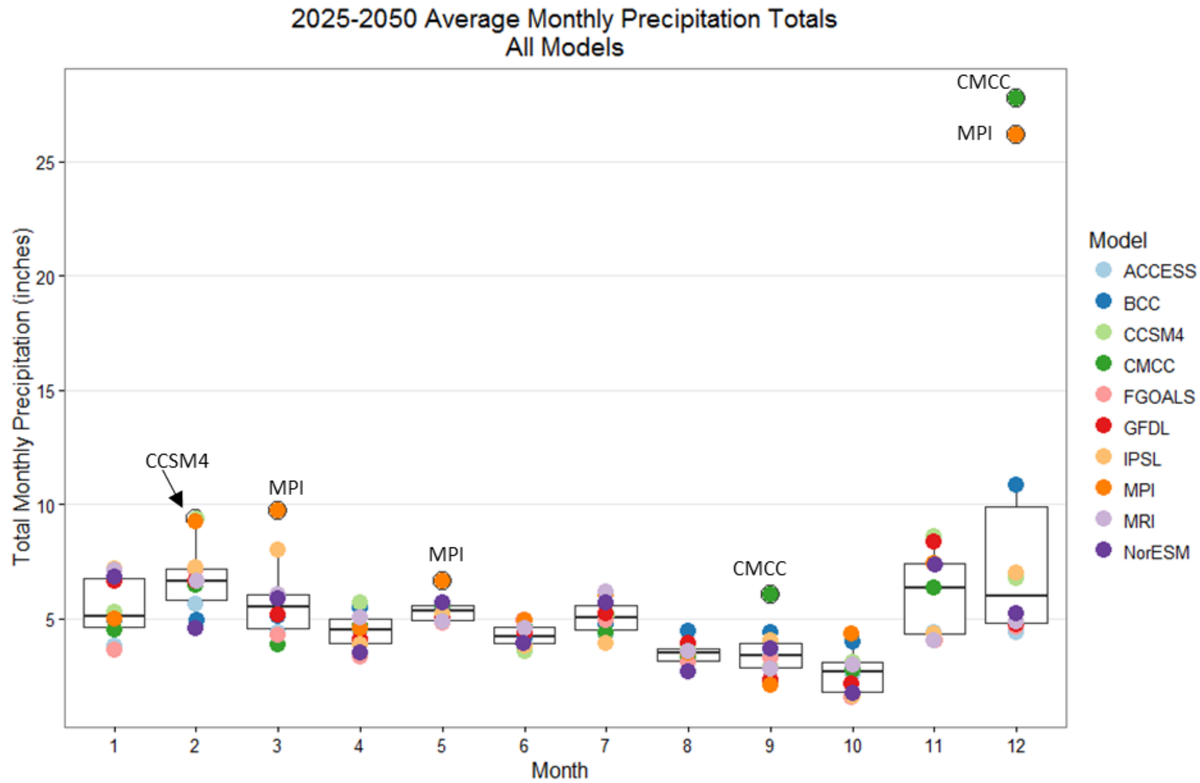

Figure 7: Monthly boxplot summaries of the average monthly precipitation for ten climate models for the period 2025-2050 for Knoxville, Tennessee area.

3.4 PAST (1980-2005) VS FUTURE (2025-2050) CLIMATE VARIABLES

The three climate variables for both past and future periods are shown together to observe shifts in average daily temperatures and average total monthly precipitation (Figure 8). All ten models show an increase in minimum and maximum temperature between the past and future periods. The total monthly precipitation is variable as to whether there is an increase or decrease between the periods with the notable exceptions of the CMCC and MPI models. The future total precipitation values are projected for these models as a very high increase in the amount of December precipitation.

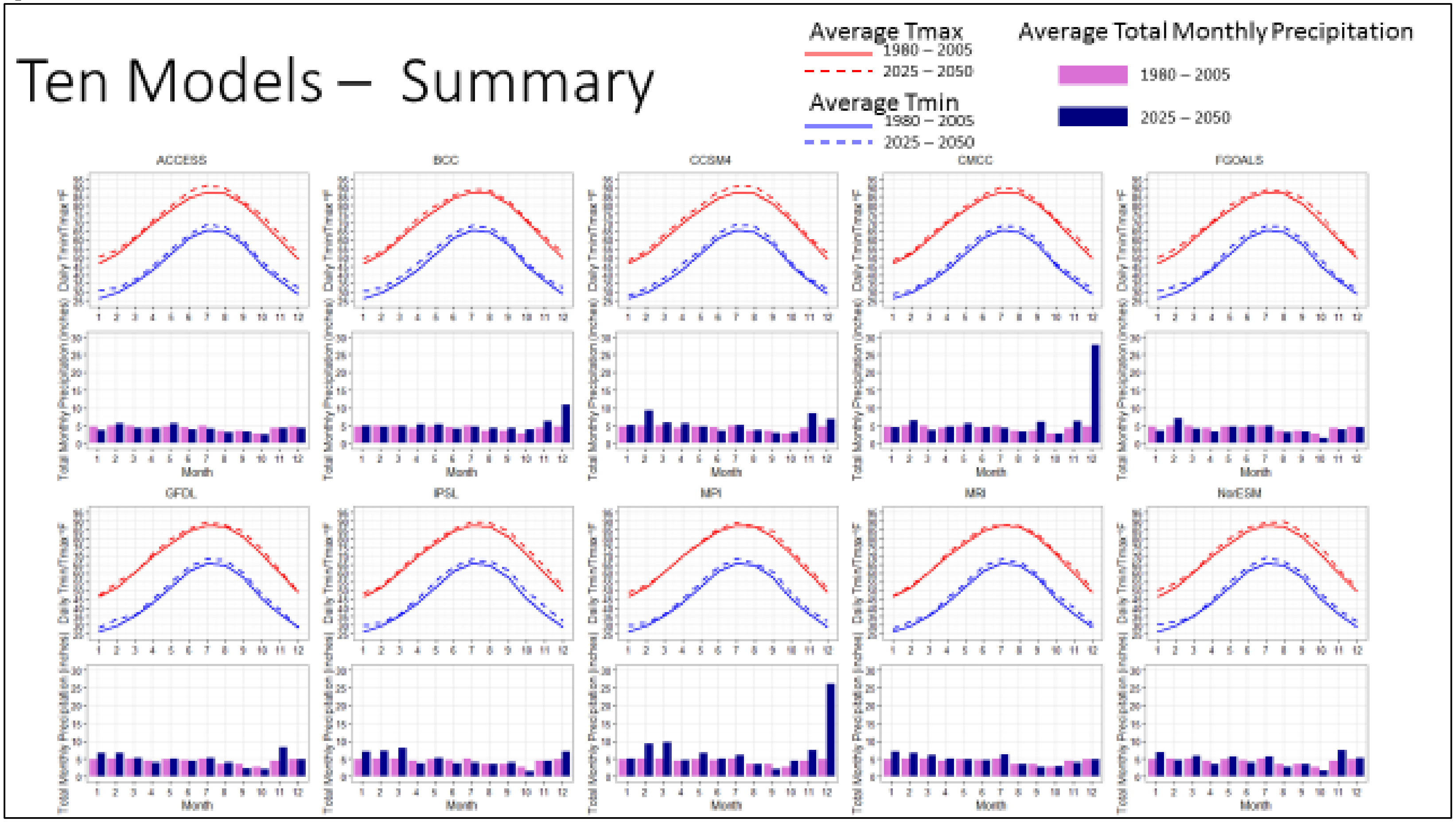

Figure 8: Charts for all ten climate models showing the difference between past (1980-2005) and future (2025-2050) climate variables for the area surrounding Knoxville, Tennessee.

4. CONCLUSION

The ten downscaled GCMs, at the 1 km grid cell resolution, are processed and summarized for the watersheds that affect Knox County, Tennessee. The overall change in maximum daily temperature is +2.14 °F, minimum daily temperature is +2.51°F, and change in precipitation is +0.88 inches. Seasonally, the precipitation pattern suggests wetter winters and drier summers. The ten climate model results are shown individually to assist in determining the differences between each of the model scenarios.

APPENDIX A. Monthly Summary Data Values for Each Model, Time Period, and Variable

APPENDIX A. Monthly Summary Values for Each Model, Time Period, and Variable

The values for each month in the periods 1980-2005 and 2025-2050 are listed below. The values are the results of averaging all cells within each geotiff for the study area.

Model	Month	Total monthly precip in inches (present)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (present)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (present)	Tmax in deg F (future)	Change in Tmax (deg F)
ACCESS	January	4.73	3.80	-0.93	26.54	31.17	4.63	46.65	50.34	3.69
ACCESS	February	4.95	5.63	0.68	29.56	32.21	2.65	51.87	54.00	2.13
ACCESS	March	5.01	4.42	-0.60	35.48	37.25	1.77	60.58	62.18	1.60
ACCESS	April	4.46	4.47	0.01	43.37	45.12	1.74	69.81	71.66	1.85
ACCESS	May	4.90	5.58	0.68	52.59	54.89	2.30	77.46	79.90	2.43
ACCESS	June	4.53	4.00	-0.53	61.36	63.40	2.04	84.15	87.85	3.70
ACCESS	July	5.06	4.25	-0.81	65.90	69.35	3.45	87.54	91.88	4.34
ACCESS	August	3.57	3.14	-0.43	64.50	67.39	2.90	86.61	89.74	3.13
ACCESS	September	3.57	3.44	-0.13	57.40	59.32	1.92	81.10	82.12	1.02
ACCESS	October	2.71	2.55	-0.16	45.34	47.55	2.21	70.85	74.34	3.48
ACCESS	November	4.43	4.42	-0.01	36.28	38.97	2.68	60.09	63.18	3.09
ACCESS	December	4.81	4.40	-0.41	28.84	32.63	3.80	49.13	52.58	3.46

Model	Month	Total monthly precip in inches (past)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (past)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (past)	Tmax in deg F (future)	Change in Tmax (deg F)
BCC	January	4.73	4.94	0.21	26.54	30.62	4.08	46.65	49.47	2.83
BCC	February	4.95	4.90	-0.05	29.56	32.32	2.76	51.87	53.28	1.41
BCC	March	5.01	5.10	0.09	35.48	38.66	3.18	60.58	62.62	2.04
BCC	April	4.46	5.43	0.97	43.37	46.92	3.55	69.81	72.78	2.97
BCC	May	4.90	5.50	0.60	52.59	55.86	3.27	77.46	80.00	2.54
BCC	June	4.53	4.15	-0.38	61.36	64.50	3.14	84.15	85.96	1.81
BCC	July	5.06	4.75	-0.31	65.90	68.43	2.53	87.54	89.14	1.61
BCC	August	3.57	4.43	0.86	64.50	67.01	2.51	86.61	88.31	1.70
BCC	September	3.57	4.41	0.83	57.40	59.39	1.99	81.10	82.48	1.39
BCC	October	2.71	3.98	1.26	45.34	46.81	1.46	70.85	72.15	1.29
BCC	November	4.43	6.35	1.91	36.28	38.15	1.87	60.09	62.07	1.98
BCC	December	4.86	10.86	6.01	28.88	32.85	3.98	49.29	52.42	3.13

Model	Month	Total monthly precip in inches (past)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (past)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (past)	Tmax in deg F (future)	Change in Tmax (deg F)
CCSM4	January	4.73	5.27	0.54	26.54	28.09	1.55	46.65	48.20	1.55
CCSM4	February	4.95	9.38	4.43	29.56	32.33	2.77	51.87	53.81	1.94
CCSM4	March	5.01	5.87	0.86	35.48	37.95	2.48	60.58	63.44	2.86
CCSM4	April	4.46	5.68	1.22	43.37	46.56	3.19	69.81	72.33	2.51
CCSM4	May	4.90	4.88	-0.02	52.59	54.42	1.83	77.46	80.21	2.75
CCSM4	June	4.53	3.56	-0.98	61.36	63.97	2.61	84.15	88.13	3.97
CCSM4	July	5.06	5.19	0.13	65.90	69.08	3.17	87.54	90.94	3.40
CCSM4	August	3.57	3.72	0.15	64.50	67.90	3.40	86.61	91.13	4.52
CCSM4	September	3.57	2.92	-0.66	57.40	60.10	2.70	81.10	83.93	2.83
CCSM4	October	2.71	3.11	0.40	45.34	47.06	1.72	70.85	72.75	1.90
CCSM4	November	4.43	8.59	4.15	36.28	37.85	1.57	60.09	61.69	1.60
CCSM4	December	4.82	6.77	1.95	28.81	31.69	2.88	49.18	52.27	3.09

Model	Month	Total monthly precip in inches (past)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (past)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (past)	Tmax in deg F (future)	Change in Tmax (deg F)
CMCC	January	4.73	4.53	-0.20	26.54	28.75	2.21	46.65	48.34	1.69
CMCC	February	4.95	6.46	1.51	29.56	31.03	1.47	51.87	52.80	0.93
CMCC	March	5.01	3.86	-1.15	35.48	37.73	2.25	60.58	62.85	2.26
CMCC	April	4.46	4.72	0.26	43.37	45.41	2.04	69.81	71.33	1.52
CMCC	May	4.90	5.57	0.66	52.59	55.17	2.57	77.46	79.46	2.00
CMCC	June	4.53	4.63	0.09	61.36	63.60	2.24	84.15	85.79	1.64
CMCC	July	5.06	4.41	-0.64	65.90	68.39	2.49	87.54	90.57	3.03
CMCC	August	3.57	3.28	-0.28	64.50	67.56	3.07	86.61	89.26	2.65
CMCC	September	3.57	6.03	2.46	57.40	60.42	3.03	81.10	82.68	1.58
CMCC	October	2.71	2.75	0.03	45.34	46.56	1.22	70.85	72.01	1.16
CMCC	November	4.43	6.34	1.91	36.28	39.09	2.81	60.09	63.49	3.40
CMCC	December	4.85	27.78	22.93	28.84	31.78	2.95	49.27	51.57	2.30

Model	Month	Total monthly precip in inches (past)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (past)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (past)	Tmax in deg F (future)	Change in Tmax (deg F)
FGOALS	January	4.73	3.64	-1.09	26.54	30.67	4.13	46.65	49.97	3.32
FGOALS	February	4.95	7.11	2.16	29.56	33.48	3.92	51.87	54.92	3.04
FGOALS	March	5.01	4.25	-0.76	35.48	37.28	1.81	60.58	62.73	2.15
FGOALS	April	4.46	3.31	-1.15	43.37	44.47	1.10	69.81	71.04	1.23
FGOALS	May	4.90	4.79	-0.11	52.59	56.07	3.47	77.46	80.49	3.03
FGOALS	June	4.53	4.92	0.39	61.36	63.89	2.53	84.15	86.04	1.89
FGOALS	July	5.06	4.94	-0.12	65.90	68.34	2.43	87.54	89.04	1.50
FGOALS	August	3.57	3.08	-0.49	64.50	67.35	2.85	86.61	88.48	1.87
FGOALS	September	3.57	3.29	-0.28	57.40	60.25	2.85	81.10	84.27	3.17
FGOALS	October	2.71	1.57	-1.14	45.34	48.75	3.41	70.85	74.98	4.13
FGOALS	November	4.43	4.03	-0.40	36.28	37.87	1.59	60.09	61.20	1.10
FGOALS	December	4.84	4.65	-0.19	28.88	31.74	2.86	49.26	51.16	1.90

Model	Month	Total monthly precip in inches (past)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (past)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (past)	Tmax in deg F (future)	Change in Tmax (deg F)
GFDL	January	4.73	6.64	1.91	26.54	28.50	1.96	46.65	47.41	0.76
GFDL	February	4.95	6.65	1.70	29.56	33.65	4.09	51.87	54.81	2.94
GFDL	March	5.01	5.17	0.16	35.48	36.13	0.65	60.58	60.46	-0.12
GFDL	April	4.46	4.08	-0.38	43.37	45.21	1.84	69.81	71.74	1.92
GFDL	May	4.90	4.99	0.09	52.59	55.03	2.44	77.46	80.06	2.59
GFDL	June	4.53	4.32	-0.22	61.36	63.79	2.43	84.15	85.58	1.43
GFDL	July	5.06	5.20	0.14	65.90	68.19	2.29	87.54	89.60	2.07
GFDL	August	3.57	3.92	0.35	64.50	67.30	2.80	86.61	87.61	1.00
GFDL	September	3.57	2.33	-1.25	57.40	59.99	2.59	81.10	83.97	2.88
GFDL	October	2.71	2.14	-0.58	45.34	47.57	2.23	70.85	73.76	2.91
GFDL	November	4.43	8.36	3.93	36.28	38.94	2.65	60.09	61.60	1.50
GFDL	December	4.84	4.74	-0.10	28.83	28.33	-0.50	49.20	49.30	0.09

Model	Month	Total monthly precip in inches (past)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (past)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (past)	Tmax in deg F (future)	Change in Tmax (deg F)
IPSL	January	4.73	7.16	2.43	26.54	29.60	3.06	46.65	48.64	1.99
IPSL	February	4.95	7.23	2.28	29.56	31.36	1.80	51.87	52.59	0.72
IPSL	March	5.01	7.99	2.98	35.48	36.61	1.14	60.58	62.50	1.92
IPSL	April	4.46	3.85	-0.61	43.37	45.60	2.23	69.81	71.77	1.96
IPSL	May	4.90	5.21	0.31	52.59	55.71	3.12	77.46	79.15	1.69
IPSL	June	4.53	3.78	-0.75	61.36	63.73	2.37	84.15	85.74	1.58
IPSL	July	5.06	3.90	-1.16	65.90	67.96	2.06	87.54	89.62	2.08
IPSL	August	3.57	3.50	-0.07	64.50	67.16	2.67	86.61	88.88	2.27
IPSL	September	3.57	4.03	0.46	57.40	61.54	4.14	81.10	84.10	3.00
IPSL	October	2.71	1.60	-1.11	45.34	49.59	4.25	70.85	74.15	3.29
IPSL	November	4.43	4.32	-0.11	36.28	41.10	4.82	60.09	63.65	3.56
IPSL	December	4.87	7.01	2.14	28.88	32.18	3.31	49.26	51.95	2.69

Model	Month	Total monthly precip in inches (past)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (past)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (past)	Tmax in deg F (future)	Change in Tmax (deg F)
MPI	January	4.73	4.97	0.25	26.54	29.84	3.30	46.65	48.95	2.30
MPI	February	4.95	9.22	4.28	29.56	31.54	1.98	51.87	53.20	1.33
MPI	March	5.01	9.72	4.70	35.48	36.38	0.90	60.58	60.78	0.20
MPI	April	4.46	4.56	0.10	43.37	45.39	2.02	69.81	70.04	0.23
MPI	May	4.90	6.65	1.74	52.59	54.84	2.25	77.46	78.55	1.09
MPI	June	4.53	4.95	0.42	61.36	63.59	2.23	84.15	85.73	1.58
MPI	July	5.06	6.04	0.98	65.90	68.26	2.36	87.54	89.45	1.92
MPI	August	3.57	3.49	-0.07	64.50	65.99	1.49	86.61	87.36	0.75
MPI	September	3.57	2.08	-1.49	57.40	60.83	3.43	81.10	84.12	3.02
MPI	October	2.71	4.32	1.61	45.34	48.54	3.20	70.85	73.07	2.22
MPI	November	4.43	7.41	2.98	36.28	38.67	2.38	60.09	62.27	2.17
MPI	December	4.82	26.18	21.36	28.81	32.17	3.36	49.18	51.17	1.99

Model	Month	Total monthly precip in inches (past)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (past)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (past)	Tmax in deg F (future)	Change in Tmax (deg F)
MRI	January	4.73	7.12	2.39	26.54	27.92	1.38	46.65	47.14	0.50
MRI	February	4.95	6.67	1.72	29.56	32.16	2.60	51.87	53.27	1.40
MRI	March	5.01	6.07	1.06	35.48	36.08	0.61	60.58	60.81	0.23
MRI	April	4.46	5.04	0.58	43.37	45.49	2.12	69.81	71.83	2.01
MRI	May	4.90	4.86	-0.04	52.59	54.28	1.69	77.46	79.19	1.73
MRI	June	4.53	4.55	0.02	61.36	63.94	2.58	84.15	85.79	1.63
MRI	July	5.06	6.17	1.12	65.90	67.74	1.84	87.54	88.05	0.52
MRI	August	3.57	3.56	-0.01	64.50	66.51	2.02	86.61	87.33	0.73
MRI	September	3.57	2.82	-0.75	57.40	59.22	1.82	81.10	82.79	1.70
MRI	October	2.71	2.98	0.26	45.34	47.22	1.88	70.85	71.96	1.11
MRI	November	4.43	4.06	-0.37	36.28	40.24	3.96	60.09	63.25	3.16
MRI	December	4.84	4.89	0.05	28.86	30.67	1.81	49.22	50.90	1.68

Model	Month	Total monthly precip in inches (past)	Total monthly precip in inches (future)	Change in total monthly precip (inches)	Tmin in deg F (past)	Tmin in deg F (future)	Change in Tmin (deg F)	Tmax in deg F (past)	Tmax in deg F (future)	Change in Tmax (deg F)
NorESM	January	4.73	6.84	2.11	26.54	30.42	3.88	46.65	50.18	3.53
NorESM	February	4.95	4.59	-0.36	29.56	32.24	2.68	51.87	54.66	2.78
NorESM	March	5.01	5.89	0.87	35.48	35.41	-0.07	60.58	61.40	0.82
NorESM	April	4.46	3.50	-0.96	43.37	44.90	1.53	69.81	72.06	2.25
NorESM	May	4.90	5.67	0.77	52.59	55.44	2.85	77.46	80.46	3.00
NorESM	June	4.53	3.90	-0.64	61.36	63.75	2.39	84.15	86.45	2.30
NorESM	July	5.06	5.70	0.64	65.90	69.04	3.13	87.54	89.20	1.66
NorESM	August	3.57	2.67	-0.90	64.50	66.57	2.07	86.61	89.77	3.16
NorESM	September	3.57	3.66	0.09	57.40	60.20	2.80	81.10	84.00	2.90
NorESM	October	2.71	1.71	-1.00	45.34	48.04	2.70	70.85	75.01	4.15
NorESM	November	4.43	7.38	2.94	36.28	39.07	2.79	60.09	61.94	1.85
NorESM	December	4.85	5.20	0.34	28.84	32.25	3.41	49.27	51.64	2.37