Data shows that Proposed Plants Plant Operation Could Be Curtailed or Shut Down Due to High Cooling Water Temperatures

There is a great likelihood that climate change will warm the temperatures of the water supplying Comanche Peak. Water temperatures currently hover close to the unsafe range and only an increase of a few degrees may mean the plant will have to be shut down and significant replacement power costs will be incurred. In the summer months of July and August Lake Granbury water temperatures exceed 95 degrees, which is the temperature that leads to a reduction in generation at the plant. If the temperature exceeds 101 degrees, then the plant ultimately needs to be shut down.
http://www.erm-smg.com/TXU%20Comanche%20Peak.pdf

Likely increase of ambient air temperatures

Using the analysis from The Nature Conservancy based on the IPCC's Fourth Assessment Report at http://www.ClimateWizard.org, we find that likely temperature changes within the expected operating life of the plant to be in excess of 6 degrees (f). Add that to the average current high temperatures on Lake Granbury and the plant will likely have to curtail generation and may not be able to operate without constraint several months each summer.

	Average of all Models (regression)	Emissions Scenarios		
		High	Medium	Low
Mid-century (2050s)	**6 ºF**	6-6.3 ºF	3-5 ºF	3-5 ºF
Late century (2080s)	**4 ºF**	8 -9 ºF	6-7 ºF	4-6 ºF

Here is the raw data based on the specific longitude and latitude of the Comanche Peak region from the various climate models, with B1 a low emissions scenario, AID medium and A2 high emissions. All temperatures are increase temperature in degrees Fahrenheit showing a range of temperature increases by 2050 from a low of 1.5 f to a high of 6.37 f

Mid-century (2050s) **Late century (2080s)**

Model	*B1*	*A1B*	*A2*		*Model*	*B1*	*A1B*	*A2*
bccr_bcm2_0.1	3.85	4.99	4.83		bccr_bcm2_0.1	4.08	6.34	7.12
cccma_cgcm3_1.1	2.96	4.11	4.16		cccma_cgcm3_1.1	3.61	5.05	6.54
cnrm_cm3.1	3.91	5.29	4.71		cnrm_cm3.1	5.09	7.92	8.67
csiro_mk3_0.1	1.84	2.68	2.98		csiro_mk3_0.1	2.32	4.66	5.76
gfdl_cm2_0.1	3.37	5.66	5.57		gfdl_cm2_0.1	5.19	7.58	8.79
gfdl_cm2_1.1	3.05	4.88	4.47		gfdl_cm2_1.1	4.37	6.69	7.76
giss_model_e_r.1	3.26	4.09	4.36		giss_model_e_r.1	4.19	6.28	8.07
inmcm3_0.1	3.61	4.99	5.21		inmcm3_0.1	4.83	6.21	7.54
ispl_cm.41	4.67	6.35	5.53		ispl_cm.41	6.14	8.30	9.85
microc3_2_medres.1	4.44	6.12	6.06		microc3_2_medres.1	6.12	8.82	10.05
miub_echo_g.1	2.84	4.30	4.59		miub_echo_g.1	4.73	6.74	6.99
mpi_echam5.1	4.22	5.07	4.16		mpi_echam5.1	5.14	7.10	8.11
mri_cgcm2_3_2a.1	3.00	4.24	3.61		mri_cgcm2_3_2a.1	4.48	5.74	6.23
ncar_ccsm3_0.1	4.10	5.17	5.26		ncar_ccsm3_0.1	3.49	6.41	8.40
ncar_pcm1.1	1.50	3.29	2.56		ncar_pcm1.1	2.89	4.55	4.34
ukmo_hadcm3.1	5.16	6.37	5.34		ukmo_hadcm3.1	6.61	8.29	9.49

The maps and regression models provided by Climate Wizard are attached at pp.6-7.

Water temperatures at Granbury Lake could exceed operating temperatures

Water coming from Granbury is probable to be at temperatures above safe tolerances.

With additional potential increases in air temperature that might result from global warming, it is likely that the water temperature will also increase, thus making the feed water intake temperature close or above the 101 degrees that resulted in the La Salle Nuclear plant reducing generation in the summer of 2010.

The Lake Granbury Watershed Protection Plan notes how susceptible to the lake temperature is to air temperature:

"Temperature changes are rapid, especially in winter and early spring when cold, dry polar air replaces warm, moist tropical air. Periods of cold weather are short and occur mostly in January; fair, mild weather is frequent. High daytime temperatures prevail for a long period in the summer when the maximum temperature reaches or exceeds 90°F daily. July is the hottest month with an average daily maximum temperature of 95°F.

Watershed Protection Plan

Table 4. Monthly Temperature, Precipitation and Evaporation of the Lake Granbury Watershed

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Temperature Data (1971-2000)													
Mean Minimum Temperature (°F)	29.0	33.9	41.3	49.6	59.5	67.4	71.3	70.1	62.8	51.4	40.4	31.7	50.7
Mean Maximum Temperature (°F)	54.2	59.5	67.8	75.8	82.7	90.1	95.2	95.2	88.0	78.1	65.6	56.9	75.8
Mean Temperature (°F)	41.6	46.7	54.6	62.7	71.1	78.8	83.3	82.7	75.4	64.8	53.0	44.3	63.3

http://www.brazos.org/gbWPP/8-3-2010-2.0-Lake-Granbury-Watershed-Overview.pdf

Lake Granbury Watershed Protection Plan Revision Date: 2010-07-07 2.2.3 Climate, pg 14

There may also be questions about the amount of water available in the Brazos River Basin for recharge of Lake Granbury

Since 1997 the EPA has been warning that;

"A warmer and drier climate would lead to greater evaporation, as much as a 35% decrease in streamflow, and less water for recharging groundwater aquifers"

EPA United States Environmental Protection, Office of Policy, Planning and Evaluation (2111)
EPA 230-F-97-008qq September 1997 Climate Change and Texas

The efficiency of thermal power plants, fossil or nuclear, is sensitive to ambient air and water temperatures; higher temperatures reduce power outputs by affecting the efficiency of cooling.

There is a high likelihood that water shortages will limit power plant electricity production in many regions. Future water constraints on electricity production in thermal power plants are projected for Arizona, Utah, Texas, Louisiana, Georgia, Alabama, Florida, California, Oregon, and Washington state by 2025.

Bull, S.R., D.E. Bilello, J. Ekmann, M.J. Sale, and D.K. Schmalzer, 2007: Effects of climate change on energy production and distribution in the United States. In: *Effects of Climate Change on Energy Production and Use in the United States* [Wilbanks, T.J., V. Bhatt, D.E. Bilello, S.R. Bull, J. Ekmann, W.C. Horak, Y.J. Huang, M.D. Levine, M.J. Sale, D.K. Schmalzer, and M.J. Scott (eds.)]. Synthesis and Assessment Product 4.5. U.S.

http://www.climatescience.gov/Library/sap/sap4-3/final-report/sap4-3-final-water.pdf

A recent report entitled **Impact of Global Warming on Texas** published by the Houston Advanced Research Center found that:

"….(T)he question stated at the outset (is) whether Texas water supply is potentially vulnerable to climate changes on the order of those projected for a greenhouse-warmed scenario. The answer is clearly affirmative. Taking flows to the coast as a measure of river-basin impact, the net effect statewide of the assumed greenhouse climate change, a 3.6°F increase in air temperature and a 5% decrease in precipitation, is to reduce these flows by about 25% under normal conditions and by 42% under drought conditions, relative to the already reduced flows under 2050-projected water-use demands. The 2050 projected flows to the coast are 70% of the 2000 normal values under normal conditions with the effect of a greenhouse climate imposed, and 15% of 2000 normal under drought conditions. In general, the effect of climate on water demands and watershed processing of rainfall is to amplify the changed-climate signal, because the causal connections are nonlinear and reinforcing."

The following charts paint a picture of the impact of drought on the demand for water. Note the 5-24% decrease in precipitation, the 10-32% increase in lake evaporation, and the 280% increase in use of water by steam electric plants. We would question whether this plant is sustainable given the high likelihood of reduced water flows in the central Texas region.

Table 8

Central Region water budget components for various scenarios, as fraction (per cent) of present normal

	Normal climate		*Greenhouse-warmed normal*		*Drought*		*Greenhouse drought*
Precipitation	100		95		80		76
Evapotranspiration	100		96		85		81
Runoff	100		81		42		34
Recharge	100		95		80		76
Lake evaporation	100		120		110		132
	Water-use scenario year						
	2000	2050	2000	2050	2000	2050	2050
Human water uses:							
Surface-water							
M&I	100	193	106	205	101	195	207
agriculture	100	132	134	176	110	145	189
electric	100	274	130	356	107	294	368
Groundwater							
M&I	100	178	106	189	101	179	190
agriculture	100	119	134	159	110	131	171
electric	100	278	130	360	107	297	373
Return flows							
M&I	100	188	106	199	101	190	201
agriculture	100	126	134	168	110	138	181
Steam-electric circulation	100	274	104	286	101	276	288
Downstream flow to:							
Texas coast	100	94	71	64	24	22	26

Impact of Global Warming on Texas Chapter 3 George Ward, University of Texas pg 28

http://www.texasclimate.org/Home/ImpactofGlobalWarmingonTexas/tabid/481/Default. aspx

Nuclear Power has been curtailed worldwide due to high temperatures and it has been costly to replace the power!

France, Germany and Spain were forced to shut down dozens of nuclear plants due to a prolonged heat wave and low water levels. Scientists say climate change was a contributing factor to all of these events, which had far-reaching business impacts. (pg1)

The electric power industry requires a consistent supply of water, and accounts for 39 percent of total freshwater withdrawals in the U.S.65 Fossil fuel plants and nuclear power plants require about 140 liters and 200 liters of water per kilowatt-hour of electricity produced, respectively.66 Water scarcity and uncertainty about the reliability of supply due to climate change may have significant impacts on operations (see Box 10). In summer 2007, prolonged drought conditions forced the Tennessee Valley Authority to partially shut down its Brown Ferry nuclear plant in Alabama due to the high temperature of the cooling water drawn from the Tennessee River. Furthermore, heated discharges from power plants have a harmful effect on water quality and local ecosystems, which is only exacerbated as water levels drop. Electricite de France had to shut down a quarter of its 58 nuclear plants due to water shortages caused by a record setting heat wave. The closures triggered price spikes of 1,300 percent and about €300 million in losses for the French utility. (pg 8)

Nuclear plants in the southeastern U.S. faced a similar threat in 2007 when one nuclear plant was partially closed and several others were threatened by drought-induced water shortages. "Water is the nuclear industry's Achilles heel," says Jim Warren, executive director of the North Carolina Waste Awareness and Reduction Network. Nuclear plant closures in the southeastern U.S. would have adverse impacts on businesses due to the higher cost of replacement power. "Currently, nuclear power costs between $5 to $7 to produce a megawatt hour," says Daniele Seitz, an energy analyst with New York-based Dahlman Rose & Co. "It would cost 10 times that amount if you had to buy replacement power – especially during the summer." (pg9)

Sources: Marc Levinson et al., "Watching water: A guide to evaluating corporate risks in a thirsty world," JPMorgan
Global Equity Research, March 31, 2008.
Mitch Weiss, "Drought Could Force Nuke-Plant Shutdowns," Associated Press, January 24, 2008

Water Scarcity & Climate Change: Growing Risks for Businesses & Investors

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A recent study on Comanche Peak examined the impact of high cooling water temperatures and found when temperature exceed 95 plant production decreased and above 101 F required shut down. Supplemental cooling water systems were not cost effective!

For the simulation year chosen, intake temperatures exceeded 95 F more than 80 days. Plant production decreases once the intake temperature goes above 95 F and ultimately needs to be shut down at 101 F when the condenser pressure reaches 5.0 in. HgA

The supplemental cooling options that were analyzed for the study were: Oriented Spray Cooling Systems (OSCS), Mechanical Draft Cooling Towers (MDCT), and Water Garden Steps (WGS). The option of increasing the SCR surface area by 5% to enhance the surface heat exchange was also considered. These supplemental cooling systems were designed to cool 25% of the intake water. To increase the overall effectiveness of these systems, a dike enclosing the intake was designed to restrict the mixing of the cooled water and the hot reservoir water.

Results
The SCR's response to the designed supplemental cooling system was found to be favorable. On the other hand, the increased surface area did not contribute much to decrease the intake temperature. The supplemental cooling systems lowered the intake temperatures by up to 5 F making the occurrence of the "greater than 95 F" event almost non- existent. While effective, **these supplemental cooling systems increased the house load by a considerable amount. <u>This increased house load alone rendered the MDCT and WGS systems ineffective in terms of capital and operational costs to benefit ratio.</u>** OSCS resulted in an increased power generation but was associated with high capital cost. A minimal return on investment of 2% was not justifiable economically and thus became the basis for subsequent rejection of the OSCS system

http://www.erm-smg.com/TXU%20Comanche%20Peak.pdf

ERM's Surfacewater Modeling Group (SMG) develops and applies multi-dimensional hydrodynamic, transport, and fate models to every type of waterbody. Model applications are made in support of point source discharge permit applications, optimization of cooling water systems, oil spill damage assessments, contaminated sediment management, water quality investigations, water supply development, and TMDL studies. Clients include Federal agencies including the Corps of Engineers, EPA, Bureau of Reclamation, and the USGS and electric utilities (fossil, nuclear and hydropower http://www.erm-smg.com/index.html

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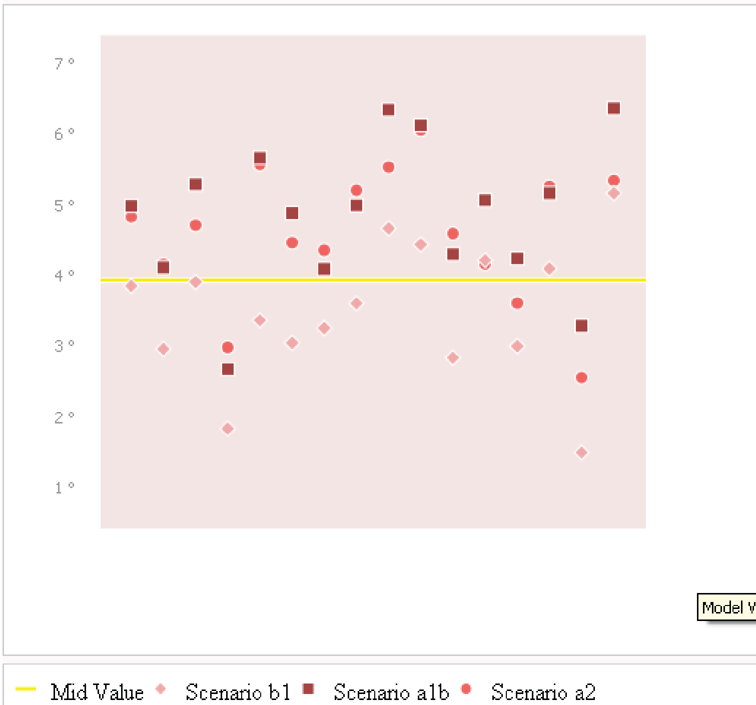
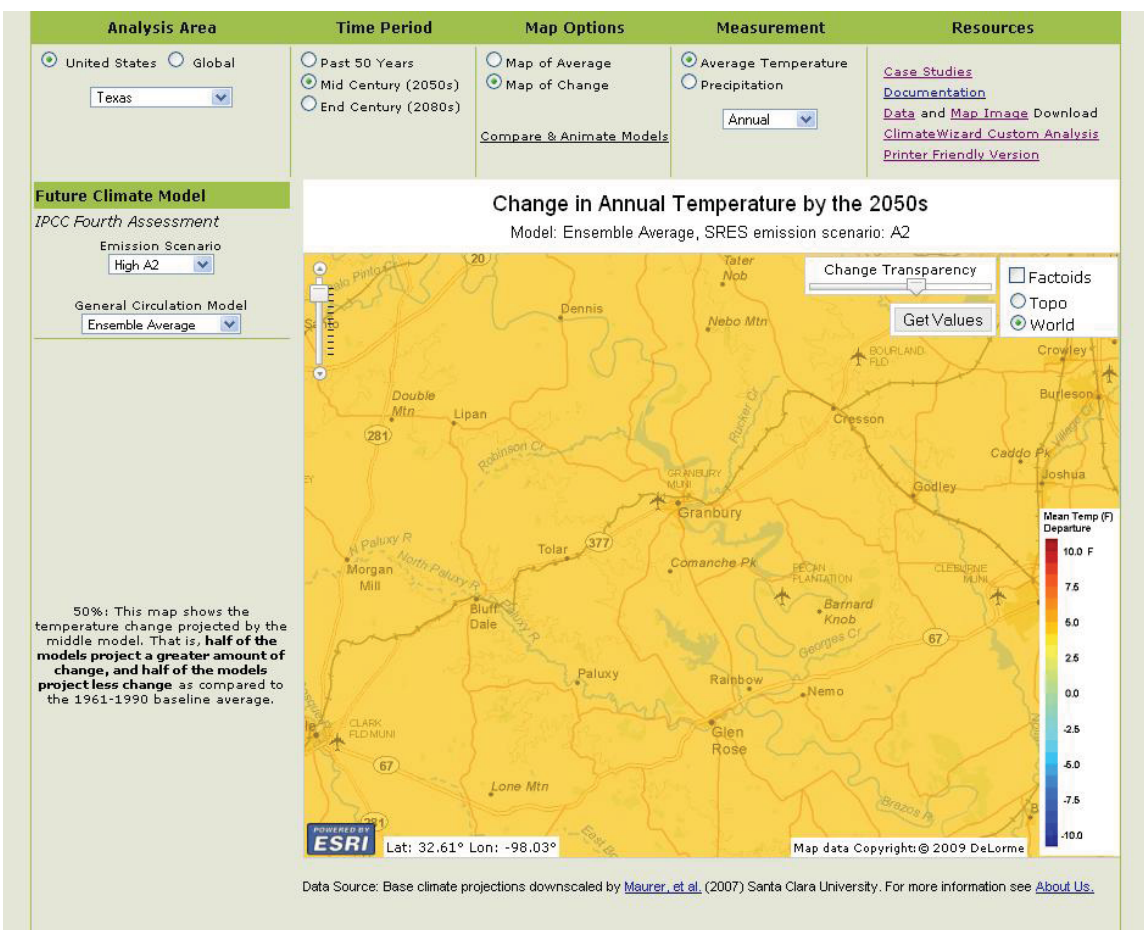
Mid century models (2050s)

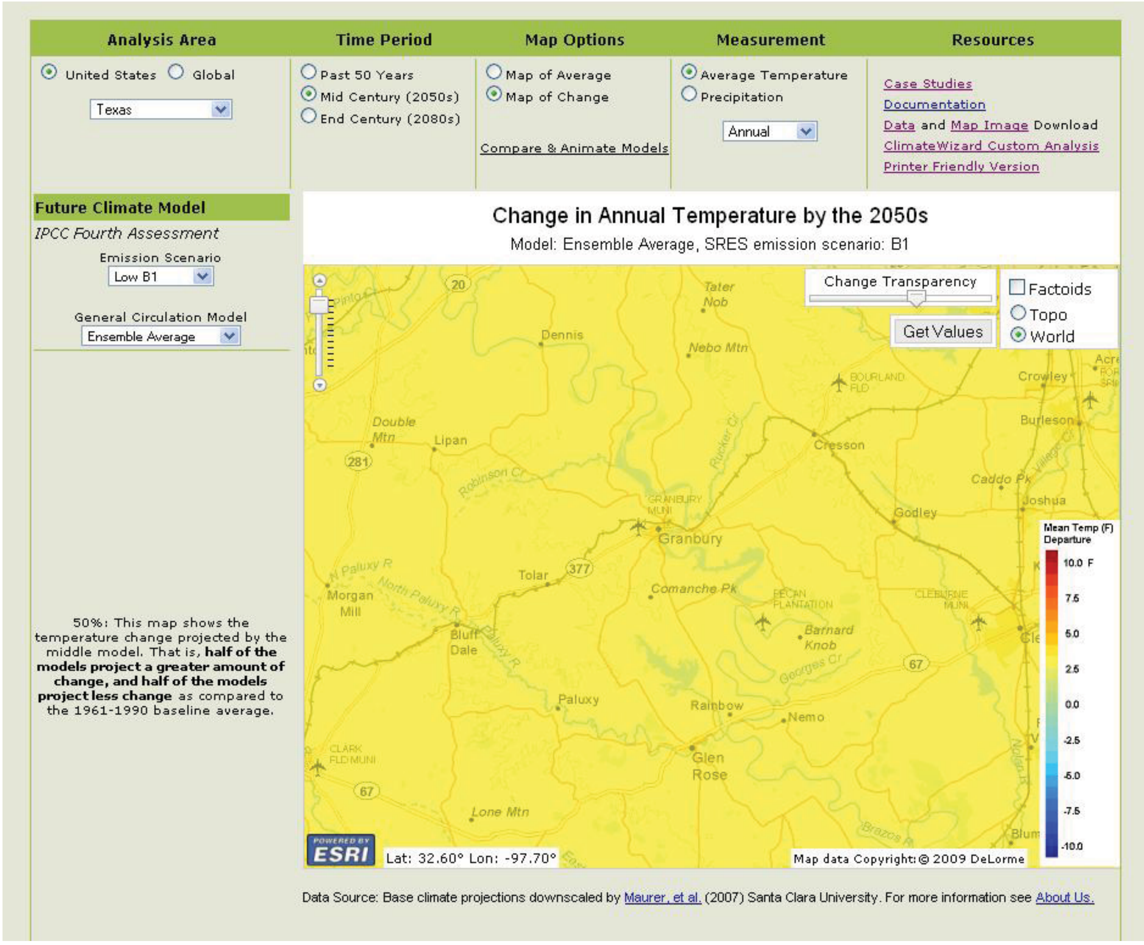
GET ALL MODEL AND SCENARIO VALUES AT INPUT LOCATION

Lon: -97.7826
Lat: 32.2977

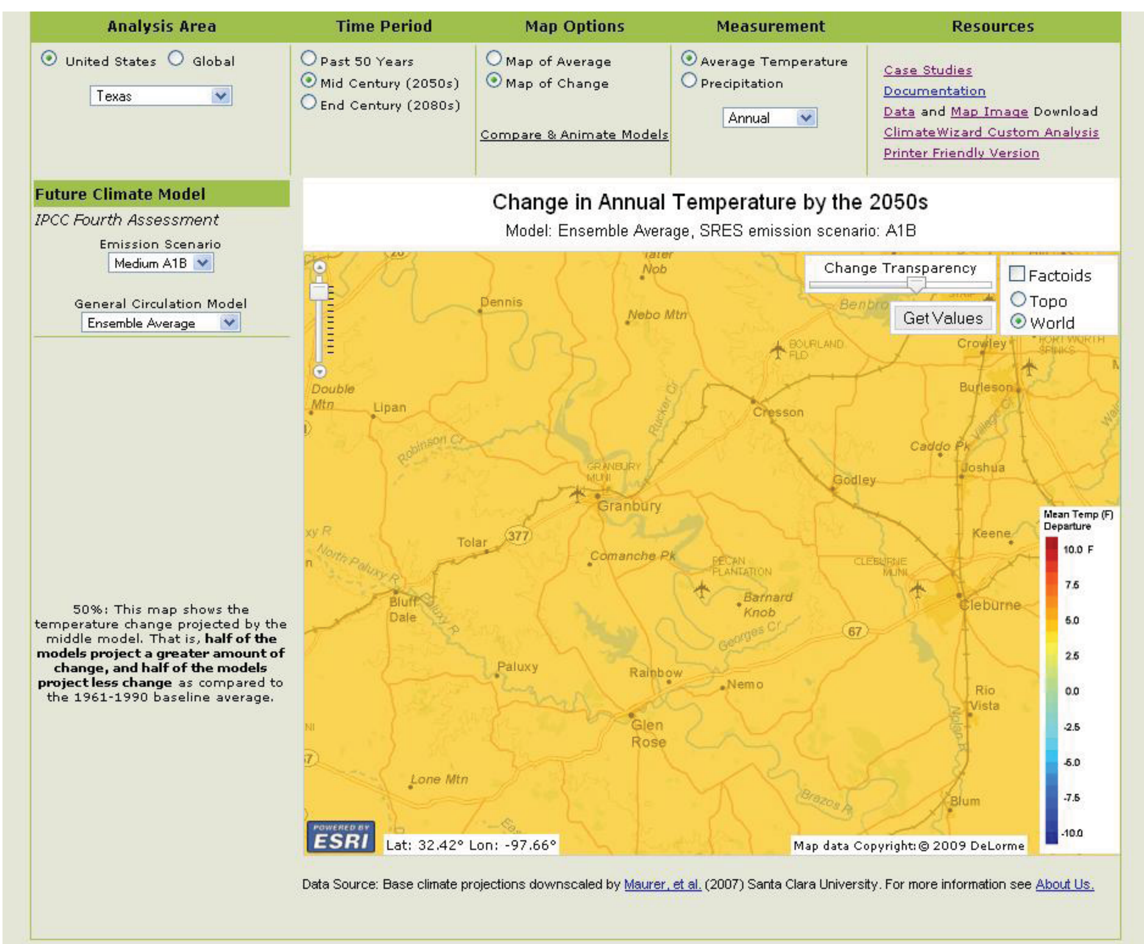


Model	B1	A1B	A2
bccr_bcm2_0.1	3.85	4.99	4.83
cccma_cgcm3_1.1	2.96	4.11	4.16
cnrm_cm3.1	3.91	5.29	4.71
csiro_mk3_0.1	1.84	2.68	2.98
gfdl_cm2_0.1	3.37	5.66	5.57
gfdl_cm2_1.1	3.05	4.88	4.47
giss_model_e_r.1	3.26	4.09	4.36
inmcm3_0.1	3.61	4.99	5.21
ipsl_cm4.1	4.67	6.35	5.53
miroc3_2_medres.1	4.44	6.12	6.06
miub_echo_g.1	2.84	4.30	4.59
mpi_echam5.1	4.22	5.07	4.16
mri_cgcm2_3_2a.1	3.00	4.24	3.61
ncar_ccsm3_0.1	4.10	5.17	5.26
ncar_pcm1.1	1.50	3.29	2.56
ukmo_hadcm3.1	5.16	6.37	5.34





Analysis Area
Time Period
Map Options
Measurement
Resources
United States
Global
Texas
Past 50 Years
Mid Century (2050s)
End Century (2080s)
Map of Average
Map of Change
Compare & Animate Models
Average Temperature
Precipitation
Annual
Case Studies
Documentation
Data and Map Image Download
ClimateWizard Custom Analysis
Printer Friendly Version
Future Climate Model
IPCC Fourth Assessment
Emission Scenario
Low B1
General Circulation Model
Ensemble Average
50%: This map shows the temperature change projected by the middle model. That is, half of the models project a greater amount of change, and half of the models project less change as compared to the 1961-1990 baseline average.
Change in Annual Temperature by the 2050s
Model: Ensemble Average, SRES emission scenario: B1
Change Transparency
Get Values
Factoids
Topo
World
Mean Temp (F) Departure
10.0 F
7.5
5.0
2.5
0.0
-2.5
-5.0
-7.5
-10.0
Dennis
Tater Nob
Nebo Mtn
Crowley
Burleson
Double Mtn
Lipan
Cresson
Caddo Pk
Joshua
Godley
Granbury
Tolar
Morgan Mill
Comanche Pk
Barnard Knob
Bluff Dale
Paluxy
Rainbow
Nemo
Glen Rose
Lone Mtn
Blum
Lat: 32.60° Lon: -97.70°
Map data Copyright: © 2009 DeLorme
Data Source: Base climate projections downscaled by Maurer, et al. (2007) Santa Clara University. For more information see About Us.



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Model: Ensemble Average, SRES emission scenario: A1B
Change Transparency
Get Values
Factoids
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World
Mean Temp (F) Departure
10.0 F
7.5
5.0
2.5
0.0
-2.5
-5.0
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Tolar
Keene
Comanche Pk
Barnard Knob
Cleburne
Bluff Dale
Paluxy
Rainbow
Nemo
Rio Vista
Glen Rose
Lone Mtn
Blum
Lat: 32.42° Lon: -97.66°
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Data Source: Base climate projections downscaled by Maurer, et al. (2007) Santa Clara University. For more information see About Us.