Spreadsheet exercise on uncertainty in climate projections

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Workshop on Downscaling and Analysis of Uncertainty
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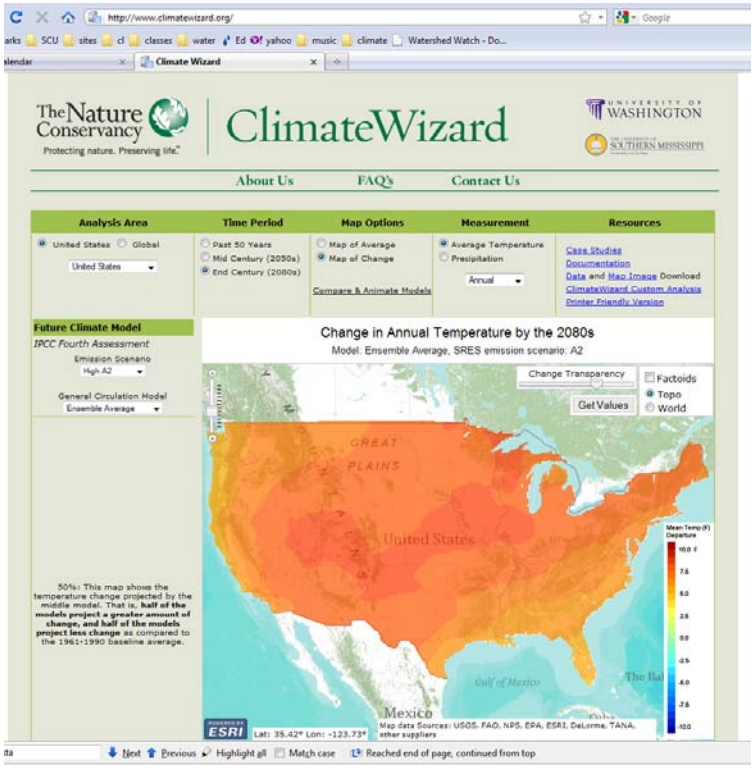
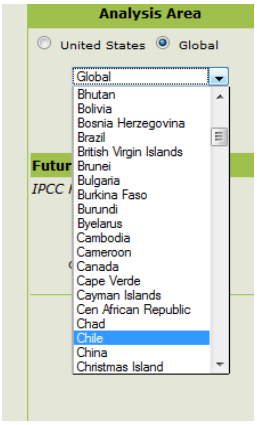
Pontificia Universidad Católica de Chile, Santiago, Chile.

a) Using data from the **climatewizard**.

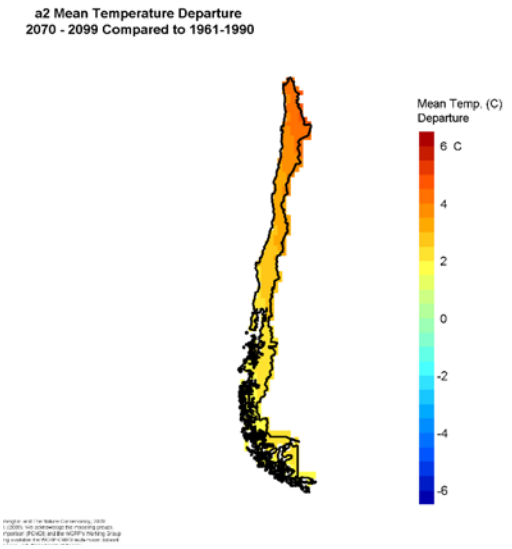
The climate wizard (www.climatewizard.org) provides downscaled climate projection data in a summary format. Data can be freely obtained from that web site.

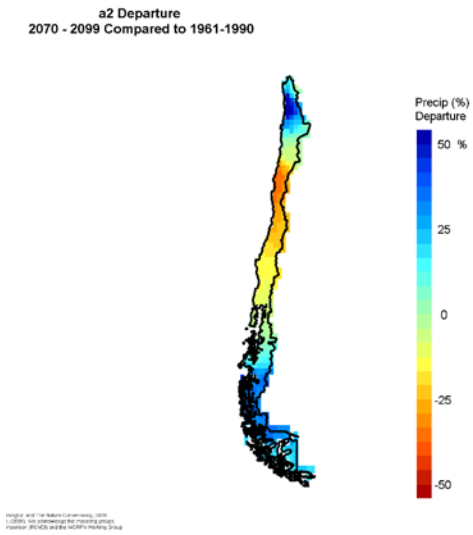


By selecting "global" data you can zoom to any country of interest:

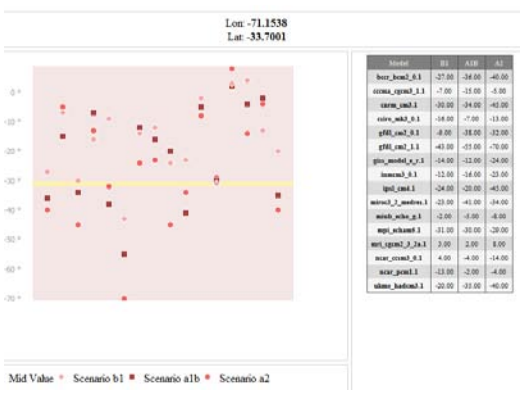


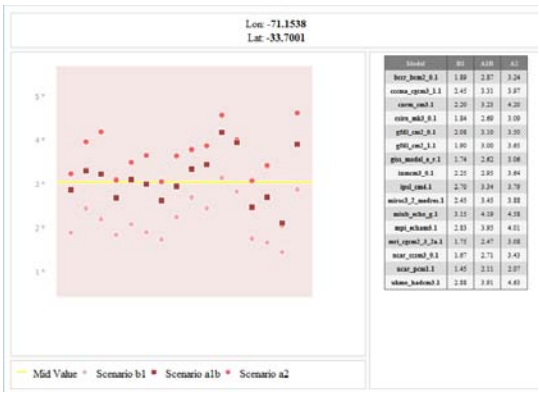
Maps can be directly downloaded for the Country, showing the projected change in December-February temperature and June-August precipitation. These maps show the **ensemble average** (of 16 separate GCM projections) differences between 2070-2099 and 1961-1990.





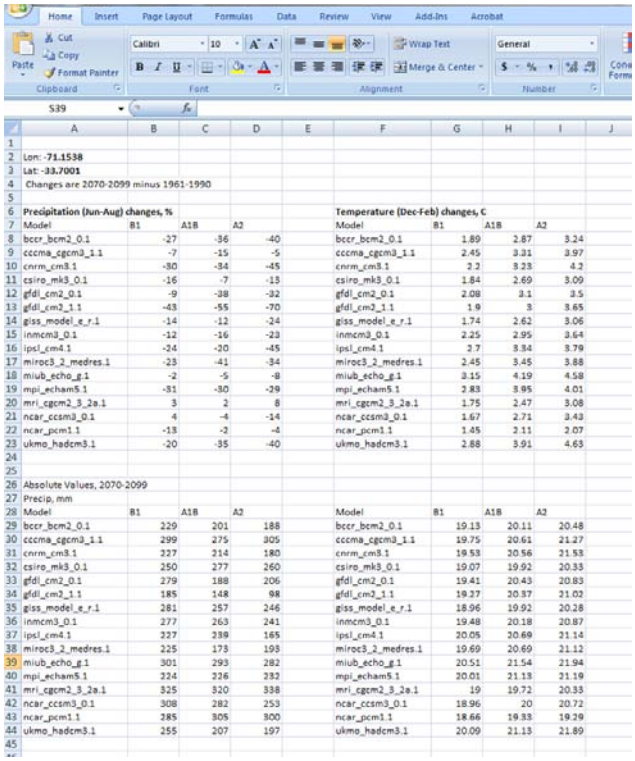
By clicking "Get Values" and then clicking on the map, all 48 projections for that point (in this case at latitude -33.7001; longitude -71.1538) are shown in a table:





These 48 values (for both precipitation and temperature changes) can be copied into a spreadsheet for analysis.

In Excel, open these two sets of tables:

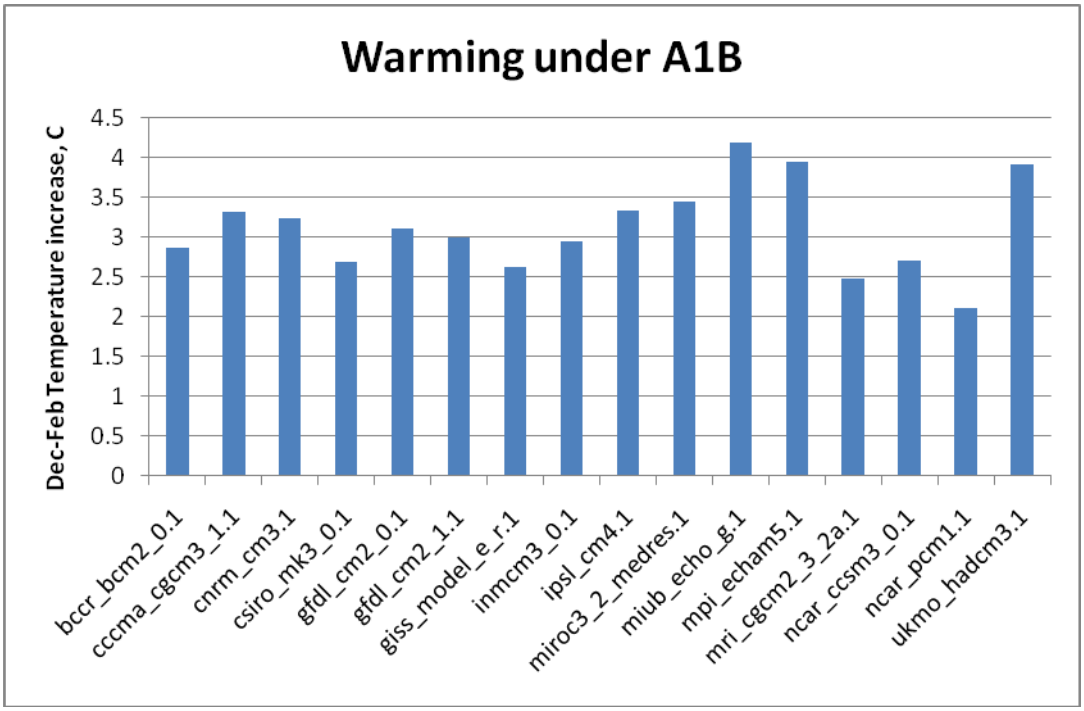


	A	B	C	D	E	F	G	H	I	J
1										
2	Lon: -71.1538									
3	Lat: -33.7001									
4	Changes are 2070-2099 minus 1961-1990									
5										
6	Precipitation (Jun-Aug) changes, %					Temperature (Dec-Feb) changes, C				
7	Model	B1	A1B	A2		Model	B1	A1B	A2	
8	bccr_bcm2_0.1	-27	-36	-40		bccr_bcm2_0.1	1.89	2.87	3.24	
9	cccma_cgcm3_1.1	-7	-15	-5		cccma_cgcm3_1.1	2.45	3.31	3.97	
10	cnrm_cm3.1	-30	-34	-45		cnrm_cm3.1	2.2	3.23	4.2	
11	csiro_mk3_0.1	-16	-7	-13		csiro_mk3_0.1	1.84	2.69	3.09	
12	gfdl_cm2_0.1	-9	-38	-32		gfdl_cm2_0.1	2.08	3.1	3.5	
13	gfdl_cm2_1.1	-43	-55	-70		gfdl_cm2_1.1	1.9	3	3.65	
14	giss_model_e_r.1	-14	-12	-24		giss_model_e_r.1	1.74	2.62	3.06	
15	inmcm3_0.1	-12	-16	-23		inmcm3_0.1	2.25	2.95	3.64	
16	ipsl_cm4.1	-24	-20	-45		ipsl_cm4.1	2.7	3.34	3.79	
17	miroc3_2_medres.1	-23	-41	-34		miroc3_2_medres.1	2.45	3.45	3.88	
18	miub_echo_g.1	-2	-5	-8		miub_echo_g.1	3.15	4.19	4.58	
19	mpi_echam5.1	-31	-30	-29		mpi_echam5.1	2.83	3.95	4.01	
20	mri_cgcm2_3_2a.1	3	2	8		mri_cgcm2_3_2a.1	1.75	2.47	3.08	
21	ncar_ccsm3_0.1	4	-4	-14		ncar_ccsm3_0.1	1.67	2.71	3.43	
22	ncar_pcm1.1	-13	-2	-4		ncar_pcm1.1	1.45	2.11	2.07	
23	ukmo_hadcm3.1	-20	-35	-40		ukmo_hadcm3.1	2.88	3.91	4.63	
24										
25										
26	Absolute Values, 2070-2099									
27	Precip, mm									
28	Model	B1	A1B	A2		Model	B1	A1B	A2	
29	bccr_bcm2_0.1	229	201	188		bccr_bcm2_0.1	19.13	20.11	20.48	
30	cccma_cgcm3_1.1	299	275	305		cccma_cgcm3_1.1	19.75	20.61	21.27	
31	cnrm_cm3.1	227	214	180		cnrm_cm3.1	19.53	20.56	21.53	
32	csiro_mk3_0.1	250	277	260		csiro_mk3_0.1	19.07	19.92	20.33	
33	gfdl_cm2_0.1	279	188	206		gfdl_cm2_0.1	19.41	20.43	20.83	
34	gfdl_cm2_1.1	185	148	98		gfdl_cm2_1.1	19.37	20.37	21.02	
35	giss_model_e_r.1	281	257	246		giss_model_e_r.1	18.96	19.92	20.28	
36	inmcm3_0.1	277	263	241		inmcm3_0.1	19.48	20.18	20.87	
37	ipsl_cm4.1	227	239	165		ipsl_cm4.1	20.05	20.69	21.14	
38	miroc3_2_medres.1	225	173	193		miroc3_2_medres.1	19.69	20.69	21.12	
39	miub_echo_g.1	301	293	282		miub_echo_g.1	20.51	21.54	21.94	
40	mpi_echam5.1	224	226	232		mpi_echam5.1	20.01	21.13	21.19	
41	mri_cgcm2_3_2a.1	325	320	338		mri_cgcm2_3_2a.1	19	19.72	20.33	
42	ncar_ccsm3_0.1	308	282	253		ncar_ccsm3_0.1	18.96	20	20.72	
43	ncar_pcm1.1	285	305	300		ncar_pcm1.1	18.66	19.33	19.29	
44	ukmo_hadcm3.1	255	207	197		ukmo_hadcm3.1	20.09	21.13	21.89	
45										

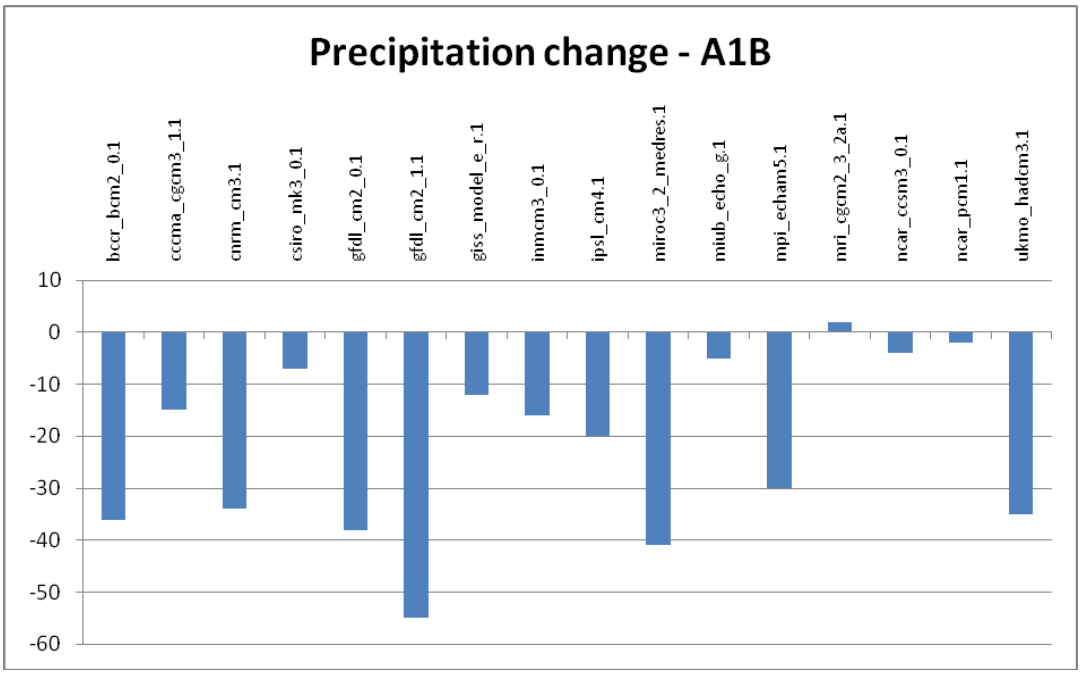
Now let's test this data to see what it says.

Q1: How much warmer is the future period (2070-2099) projected to be relative to 1961-1990?

A1: That depends on future emissions. For example, if future emissions look like A1B:



The minimum is 2.1°C and the maximum is 4.2°C, and the average is 3.1°C. We could do a lot more with this, but let's look at precipitation changes.



We see 15 of 16 models project drier conditions. But how much drying should one plan for? That depends on risk (or probability) level.

Q2: What is the probability of seeing drier conditions?

Calculate the mean and standard deviation of the set of projected changes (in this case, precipitation changes, as %, for scenario A1B:

$$\bar{x} = -21.75\,(\%) \qquad s_x = -16.9\,(\%)$$

calculate the t statistic, comparing the calculated mean to zero, the case for no change:

$$t = \frac{\bar{x} - 0}{s_x / \sqrt{n}} = 5.15$$

use Excel's TDIST function to find the probability of the change being zero:

=TDIST(t,n-1,1) = TDIST(5.15,15,1)

which produces a value of 6 x 10^{-5}. This means there is virtually no chance that no change will be experienced. thus, based on this data set, drier conditions are nearly certain. This assumes that these 16 projections are equally likely and that they encompass the uncertainty in future projections.

Q3: Are warmer projections typically drier?

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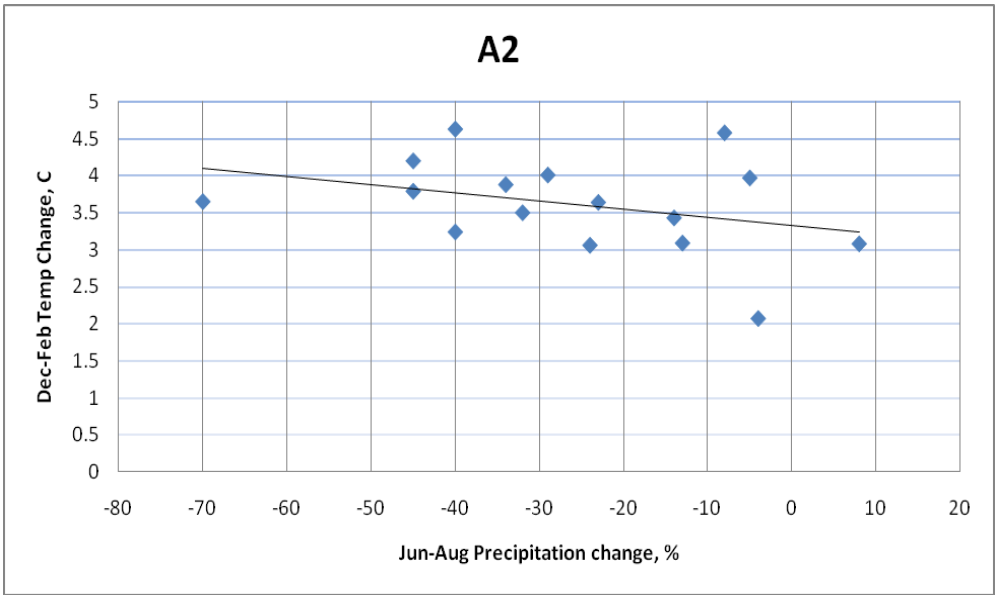
22	ncar_pcm1.1	-13	-2	-4		ncar_pcm1.1	1.45	2.11	2.07	
23	ukmo_hadcm3.1	-20	-35	-40		ukmo_hadcm3.1	2.88	3.91	4.63	
24										
25										

Using scenario A2, start by plotting models predictions of ΔT vs. ΔP, and add a trend line:



Using Data Analysis → Regression, ANOVA statistics can be computed:

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.341951925
R Square	0.116931119
Adjusted R Square	0.05385477
Standard Error	0.621989469
Observations	16

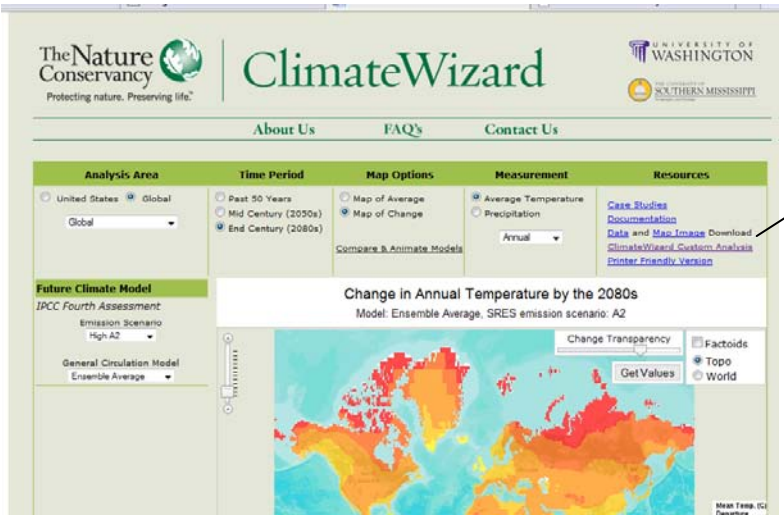
ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0.7171824	0.7171824	1.85380292	0.194852283
Residual	14	5.4161926	0.3868709		
Total	15	6.133375			

This indicates that there is a 19.4% chance that the apparent relationship could have occurred by chance. This is a relatively weak case for significance of the relationship. This means we cannot claim warmer projections are drier, at least for this point, and the Scenario A2.

Basin-wide changes - expanding analysis beyond a point

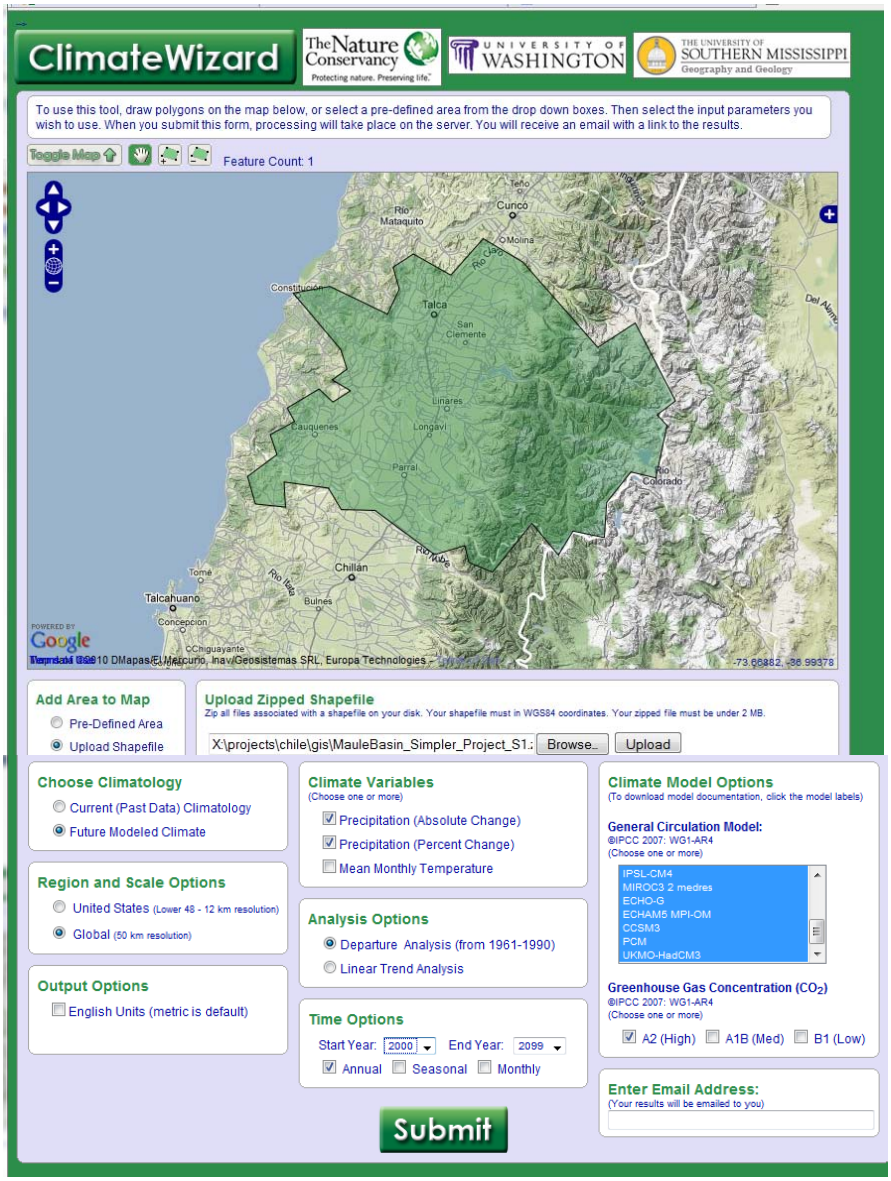
The Climate Wizard allows you to upload a shapefile defining an area of interest to focus analysis on a particular county, watershed, or other area. Here I show an analysis using the Maule Basin

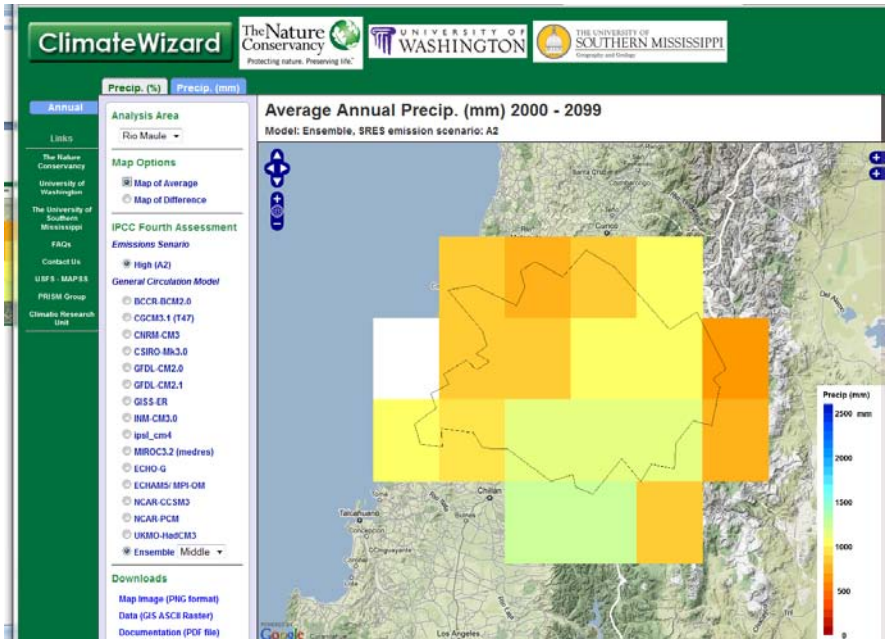


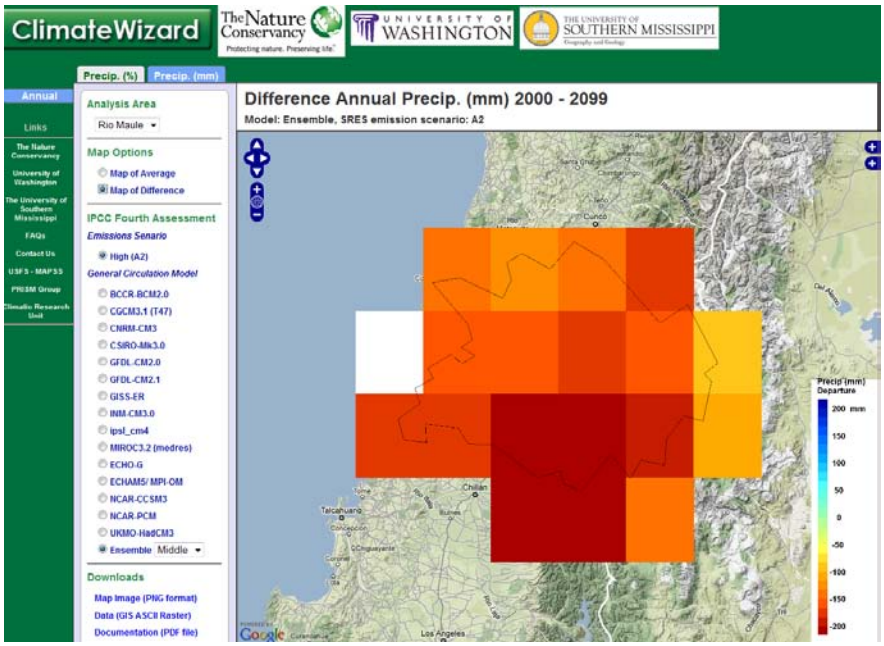
Select "Custom Analysis"

after logging in, you arrive at this window:

And the shapefile is uploaded here.


ClimateWizard
The Nature Conservancy
Protecting nature. Preserving life.
UNIVERSITY OF WASHINGTON
THE UNIVERSITY OF SOUTHERN MISSISSIPPI
Geography and Geology
To use this tool, draw polygons on the map below, or select a pre-defined area from the drop down boxes. Then select the input parameters you wish to use. When you submit this form, processing will take place on the server. You will receive an email with a link to the results.
Toggle Map
Feature Count: 1
Teno
Cunco
Rio Mataquito
Molina
Rio Claro
Constitución
Talca
San Clemente
Del Alamo
Linares
Cauquenes
Longavi
Parral
Rio Colorado
Rio Nuble
Chillan
Tomé
Rio Itata
Talcahuano
Bulnes
Concepcion
Chiguayante
Google
©2010 DMapas/El Mercurio, Inav/Geosistemas SRL, Europa Technologies
-73.66882, -36.99378
Add Area to Map
Pre-Defined Area
Upload Shapefile
Upload Zipped Shapefile
Zip all files associated with a shapefile on your disk. Your shapefile must in WGS84 coordinates. Your zipped file must be under 2 MB.
X:\projects\chile\gis\MauleBasin_Simpler_Project_S1.:
Browse...
Upload
Choose Climatology
Current (Past Data) Climatology
Future Modeled Climate
Region and Scale Options
United States (Lower 48 - 12 km resolution)
Global (50 km resolution)
Output Options
English Units (metric is default)
Climate Variables
(Choose one or more)
Precipitation (Absolute Change)
Precipitation (Percent Change)
Mean Monthly Temperature
Analysis Options
Departure Analysis (from 1961-1990)
Linear Trend Analysis
Time Options
Start Year: 2000
End Year: 2099
Annual
Seasonal
Monthly
Climate Model Options
(To download model documentation, click the model labels)
General Circulation Model:
©IPCC 2007: WG1-AR4
(Choose one or more)
IPSL-CM4
MIROC3 2 medres
ECHO-G
ECHAM5 MPI-OM
CCSM3
PCM
UKMO-HadCM3
Greenhouse Gas Concentration (CO_2)
©IPCC 2007: WG1-AR4
(Choose one or more)
A2 (High)
A1B (Med)
B1 (Low)
Enter Email Address:
(Your results will be emailed to you)
Submit





Data can be downloaded in GIS format for further processing, or images can be downloaded.