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Future Regional Climate Change in Bear River Basin: Concepts and Scenarios

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National Center for Atmospheric Research

TNC Workshop
Bear River Basin
Salt Lake City, Utah
May 26, 2010

National Center for Atmospheric Research

Outline

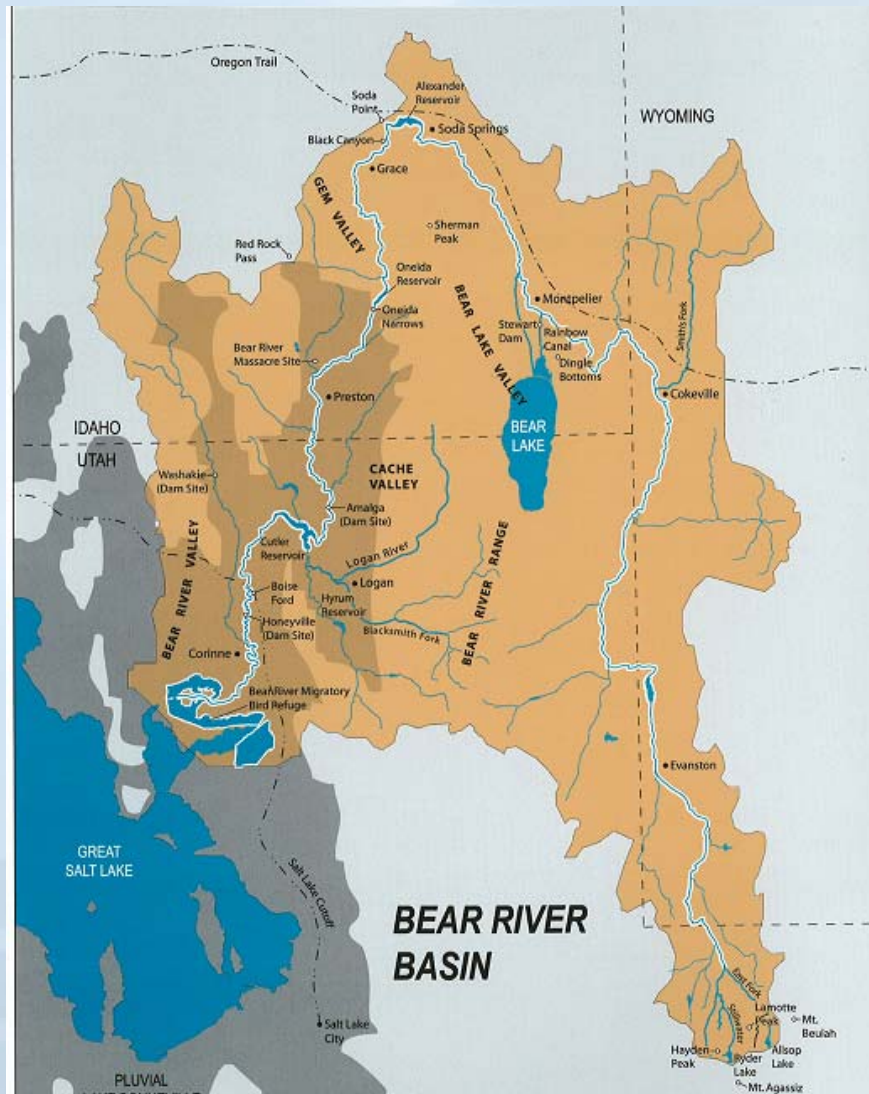


- Different perspectives on future climate
 - What we know about future climate change
- Main Scenario for this Workshop
- Higher Resolution Scenarios
 - Alternative scenario

Bear River Basin



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Bear River Basin



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The Nature Conservancy
Protecting nature. Partnering with people.

Bear River System -- UT, WY, ID

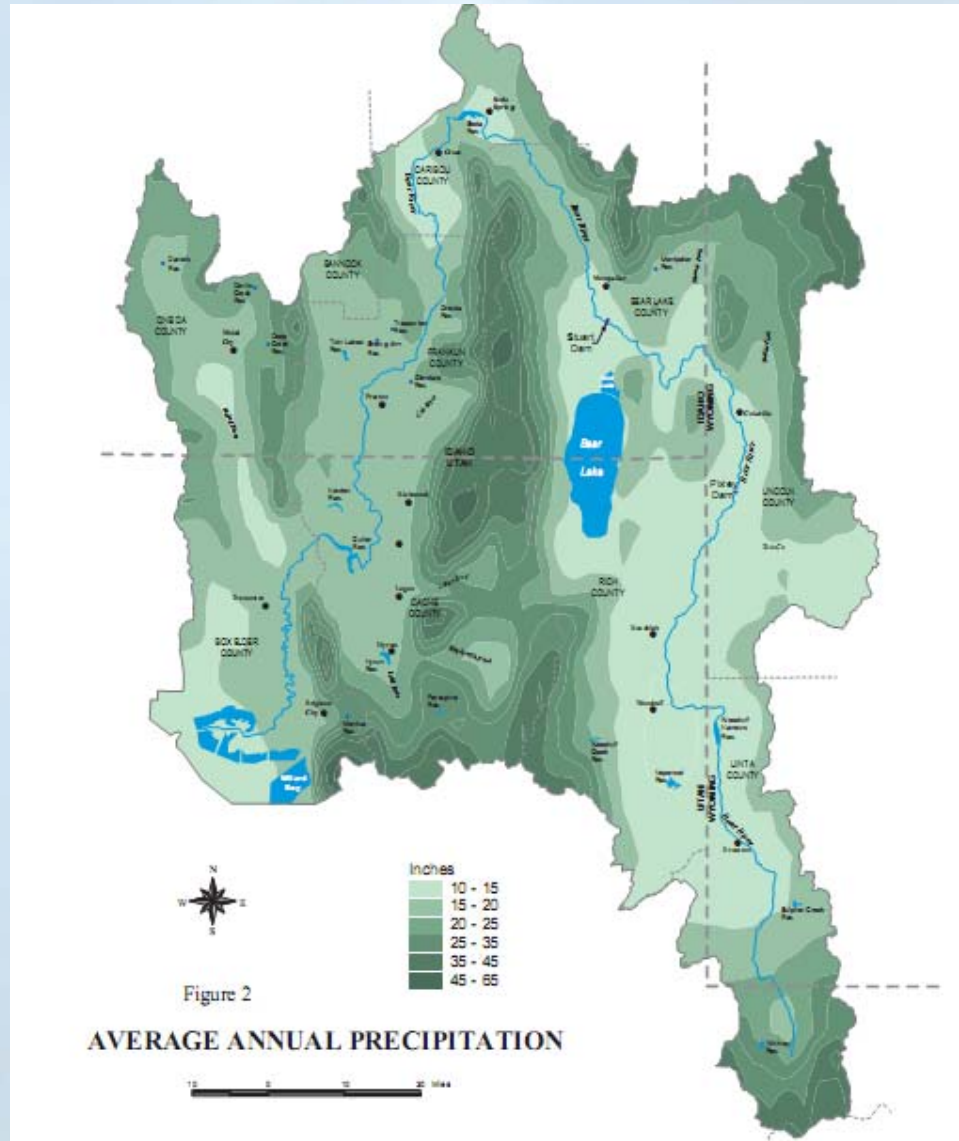


Prepared by The Nature Conservancy, (TNC). For more information contact: 801.531.0999.

Annual Precipitation



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The Future

North American Projections

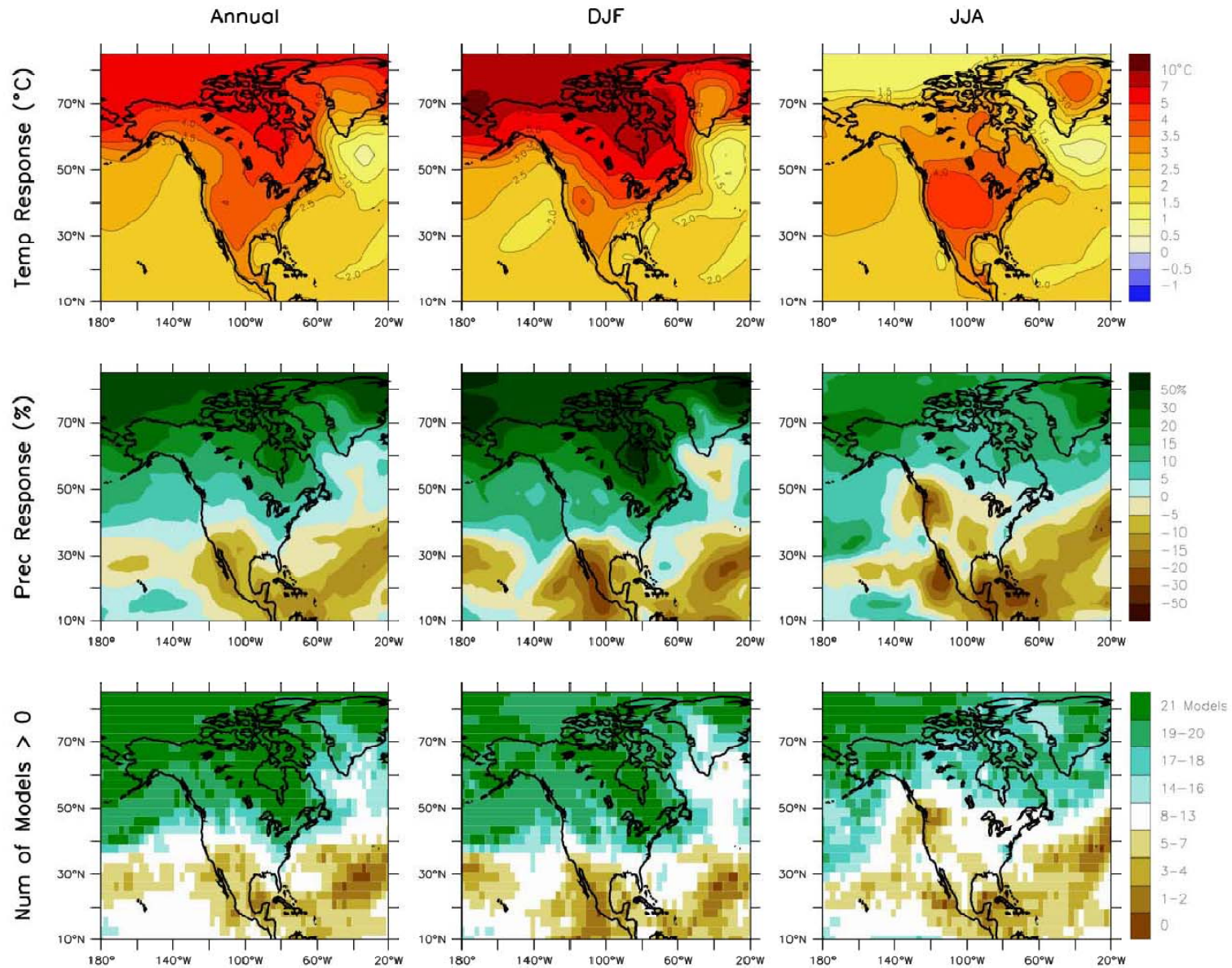
(end of 21st century,
assuming A1B scenario)

- Based on 21 global climate model results
– expert judgment of model results
- Always note model limitations (e.g., coarse spatial resolution of models, ~ 2 deg.)

Temperature and precipitation changes with model agreement (2080-2099 minus 1980-1999) A1B Scenario



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Summary of Change in Precipitation

Regional Likelihood Statements (VL and L)

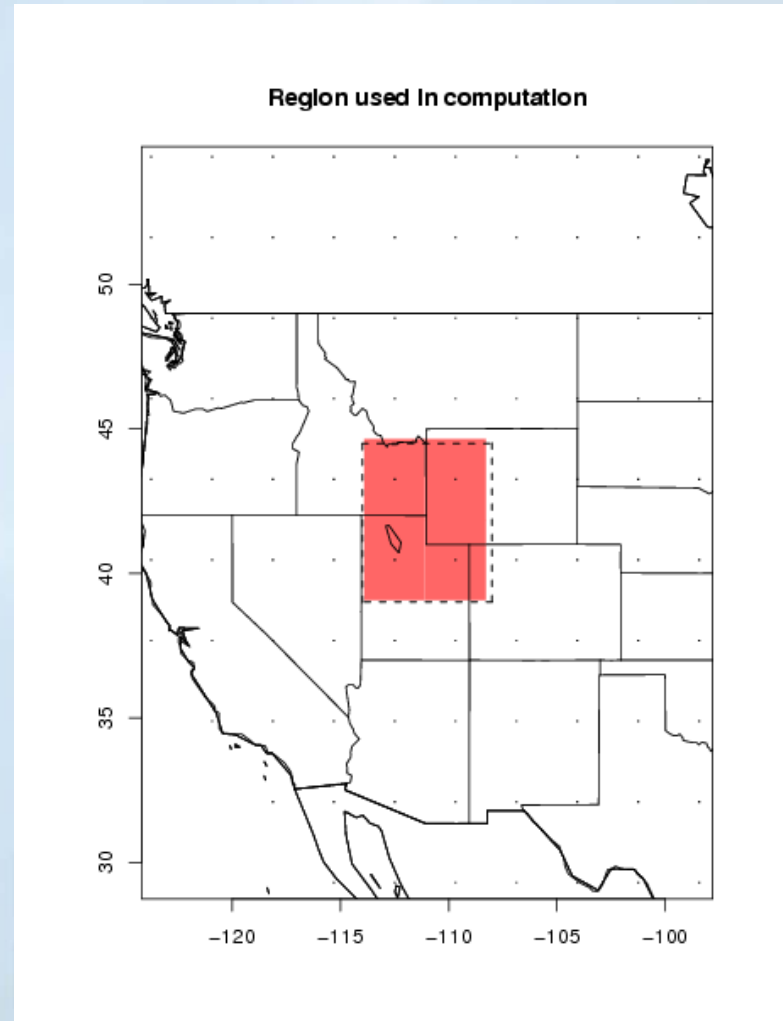
for North America

- (1) Very likely annual mean **increase** in precipitation in most of northern Europe and the Arctic (largest in cold season), Canada, and the **North-East USA**
- (2) Likely annual mean **decrease** in North Africa, northern Sahara, Central America (and in the vicinity of the Greater Antilles in JJA) and in **South-West USA**.
- (3) Likely summer (JJA) mean decrease in central Asia, central Europe and *southern Canada*.
- (4) Likely winter (DJF) mean increase in central Europe, and *southern Canada*
- (5) Very likely **decrease in snow** season length and likely to very likely decrease in snow depth in most of Europe and **North America**.



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Area for Global Model Analysis



Global Model Scenarios



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Quantiles	25 th	75 th
Annual changes:		
Temperature °C (°F):	2.3 (4.1)	3.0 (5.4)
Precipitation (% change)	- 5	+8
Winter		
Temperature	1.9 (3.4)	2.8 (5.0)
Precipitation	+ 3	+20
Spring		
Temperature	2.0 (3.6)	3.0 (5.4)
Precipitation	- 4	+7
Summer		
Temperature	2.7 (4.9)	3.7 (6.7)
Precipitation	-25	+2
Fall		
Temperature	2.4 (4.3)	3.0 (5.4)
Precipitation	- 4	+13



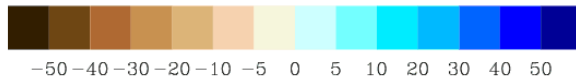
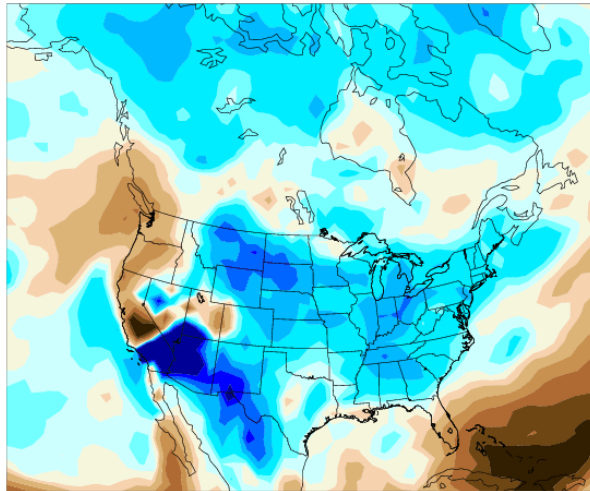
Main Scenario

	Temperature Change °C	Precipitation % Change
Annual	3.5	2
Winter	2.5	13
Spring	3.5	-6
Summer	4.5	-15
Fall	3.5	0

Global Model Change in Precipitation - Summer

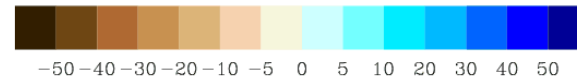
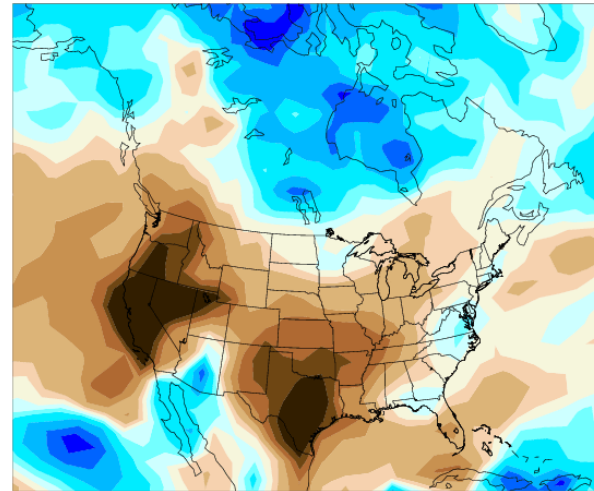
CCSM Change In Seasonal Avg Precip

JJA 2041-2070 minus 1971-2000 %



GFDL Change In Seasonal Avg Precip

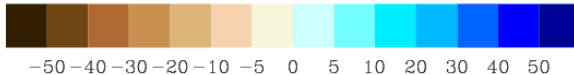
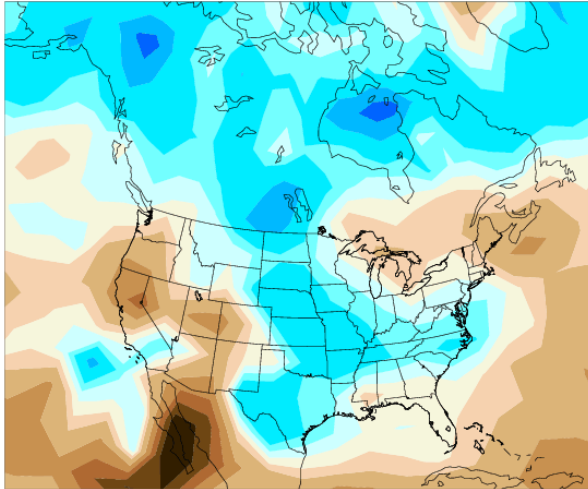
JJA 2041-2070 minus 1971-2000 %



Global Model Change in Precipitation - Summer

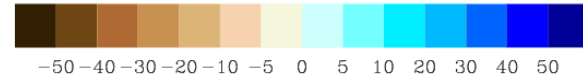
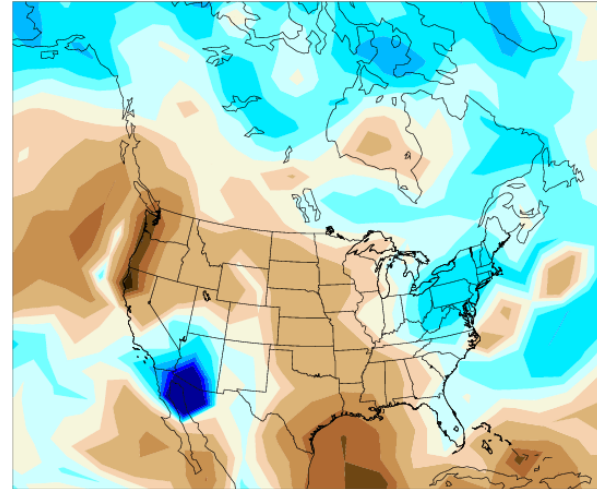
CGCM3 Change In Seasonal Avg Precip

JJA 2041-2070 minus 1971-2000 %



HadCM3 Change In Seasonal Avg Precip

JJA 2041-2070 minus 1971-2000 %





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Higher Resolution Climate Simulations

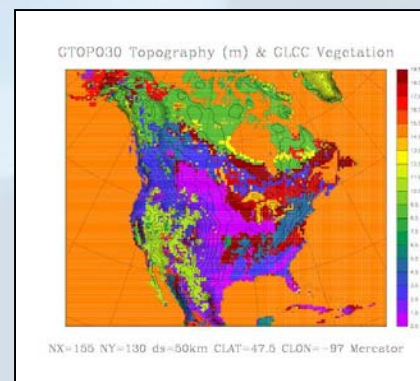
Dynamical Downscaling

The North American Regional Climate Change Assessment Program (NARCCAP)



www.narccap.ucar.edu

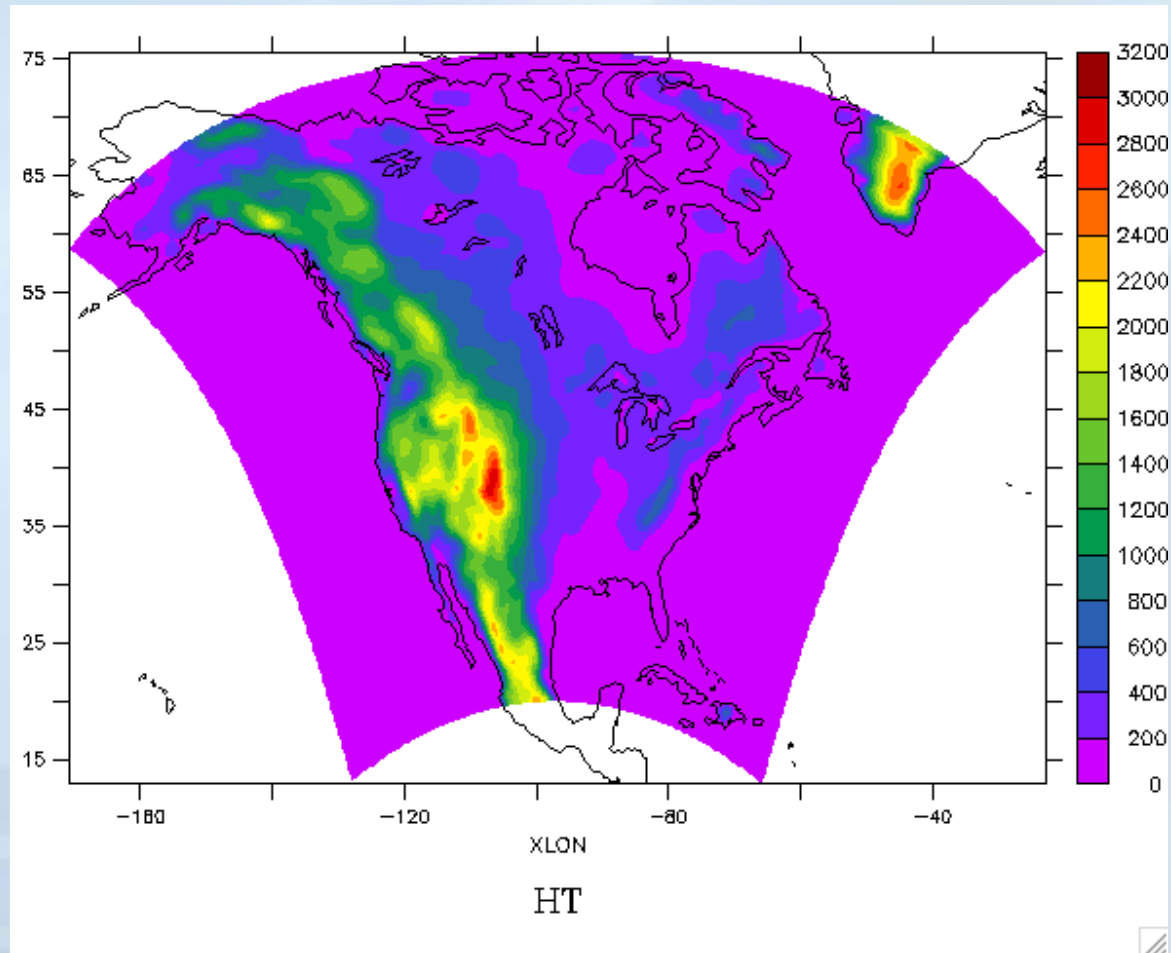
- Explores multiple uncertainties in regional and global climate model projections
 - 4 global climate models x 6 regional climate models
- Develops multiple high resolution regional (50 km, 30 miles) climate scenarios for use in impacts and adaptation assessments
- Evaluates regional model performance to establish credibility of individual simulations for the future
- Participants: Iowa State, PNNL, LNNL, UC Santa Cruz, Ouranos (Canada), UK Hadley Centre, NCAR
- Initiated in 2006, funded by NOAA-OGP, NSF, DOE, USEPA-ORD – 4-year program



NARCCAP Domain



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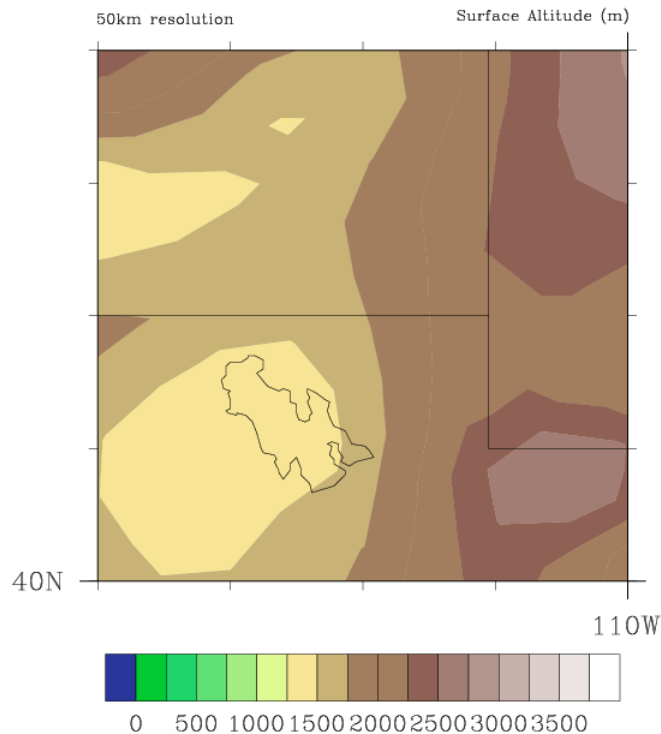
Orography – Bear River

2 different spatial resolutions



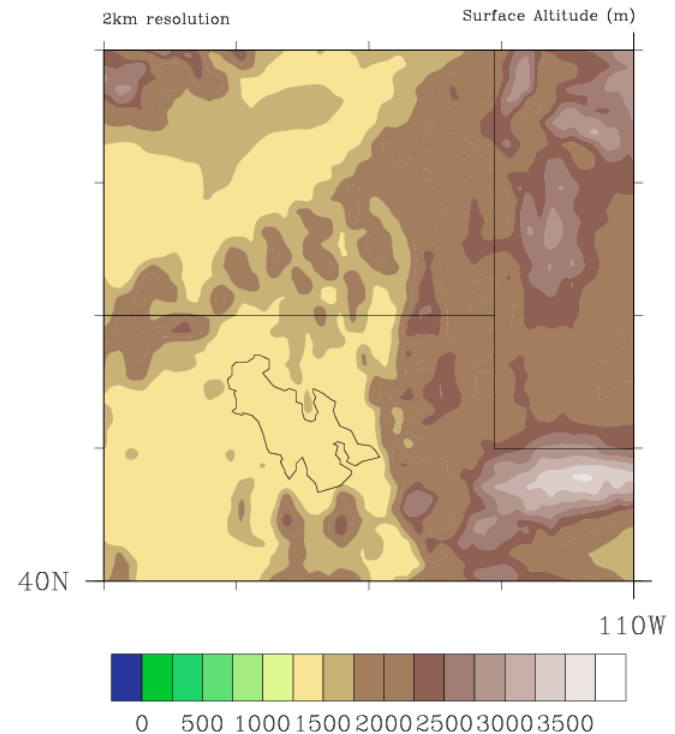
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CRCM Elevations



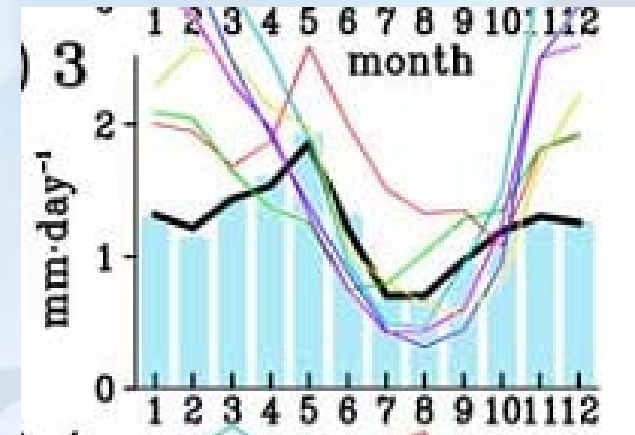
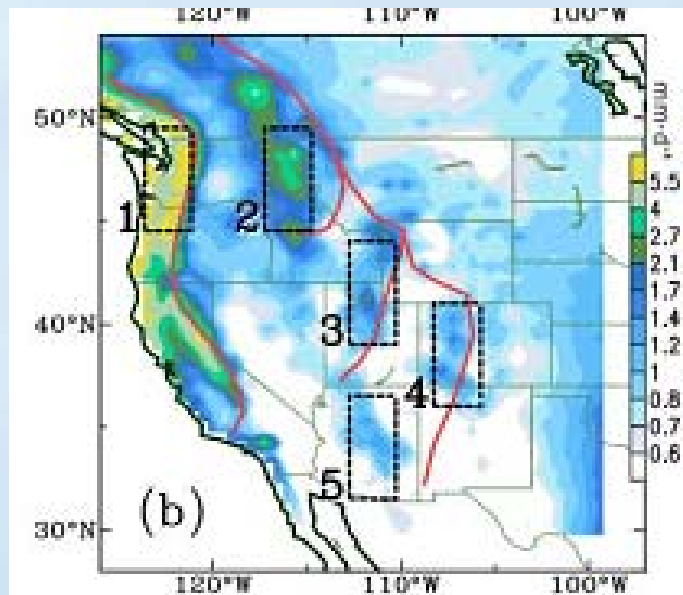
50 km (30 miles)

WRF Elevations



2 km (1.2 miles)

RCM Precipitation



- North American Regional Reanalysis (NARR) — black line
- Canadian Regional Climate Model (CRCM) — red line
- Exp. CPC Regional Spectral Model (ECPC) — green line
- MMS-PSU/NCAR mesoscale model (MM5i) — blue line
- Regional Climate Model version 3 (RCM3) — cyan line
- Weather Research & Forecasting model (WRF) — purple line
- Hadley Center Regional Model v.3 (HRM3) — yellow line

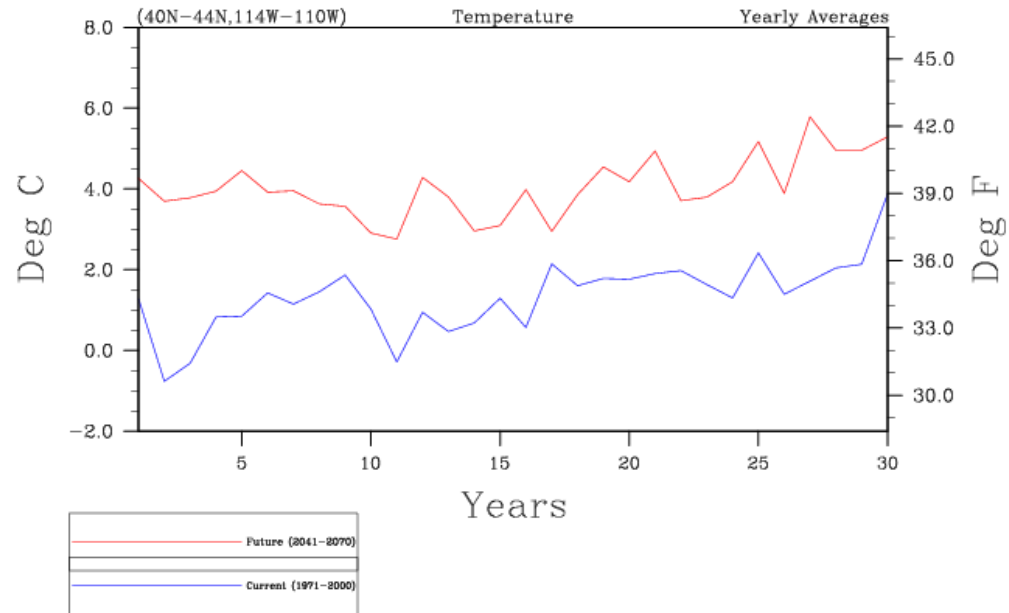
Wang et al., 2009

Sample scenario from one RCM (Canadian model)

Temperature Current and Future



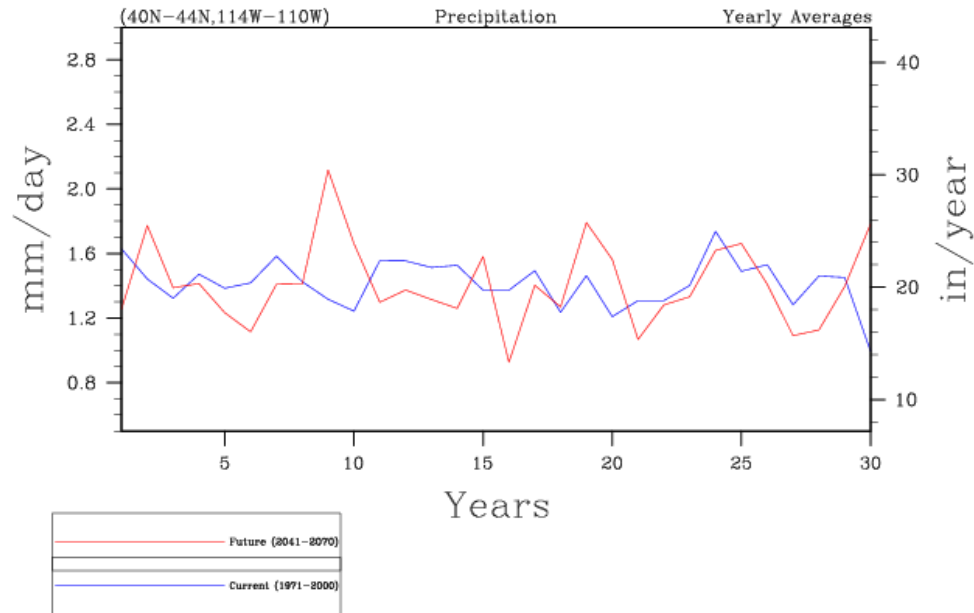
CRCM+cgcm3 Spatial Avg Bear River Region



Mean Change = 2.7 Deg C (4.9 Deg F)

Annual Precipitation Current and Future

CRCM+cgcm3 Spatial Avg Bear River Region



Mean Change = -0.4%

Change in Winter Precipitation



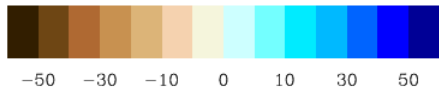
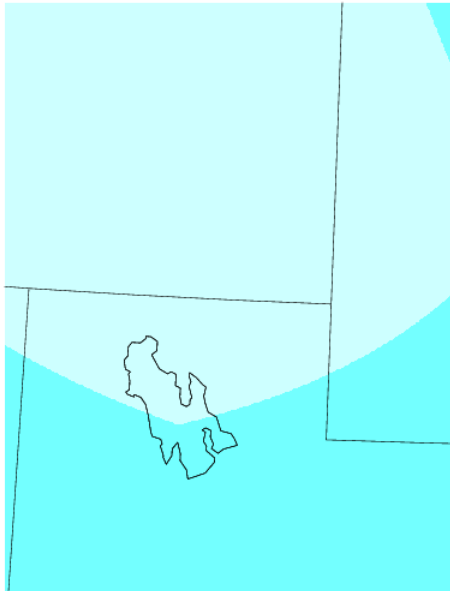
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Global Model

Regional Model

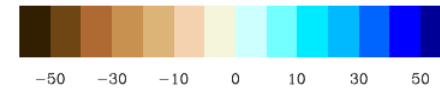
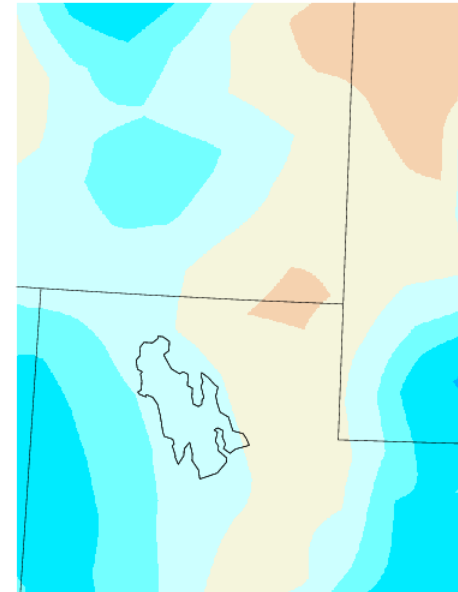
cgcm3 Change In Seasonal Avg Precip

DJF 2041-2070 minus 1971-2000 %



CRCM+cgcm3 Change In Seasonal Avg Precip

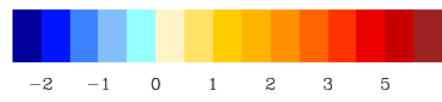
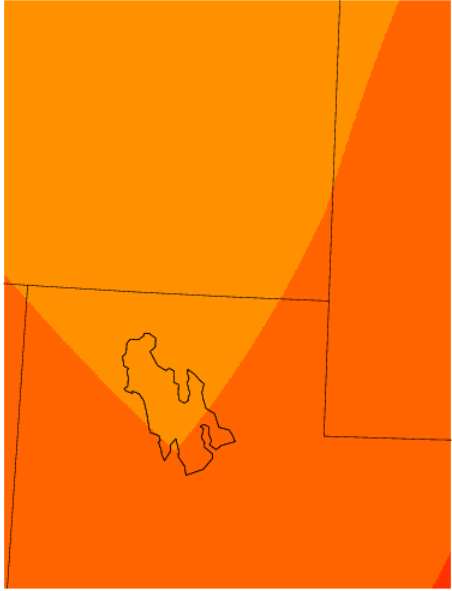
DJF 2041-2070 minus 1971-2000 %



Change in Winter Temperature

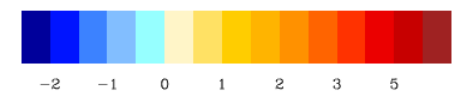
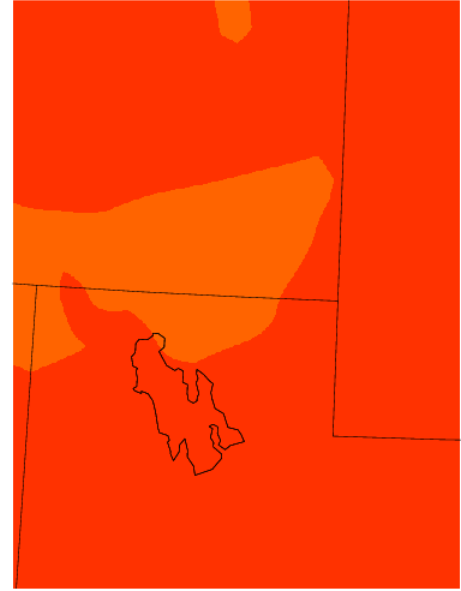
cgcm3 Change In Seasonal Avg Temp

JJA 2041-2070 minus 1971-2000 Deg C



CRCM+cgcm3 Change In Seasonal Avg Temp

JJA 2041-2070 minus 1971-2000 Deg C



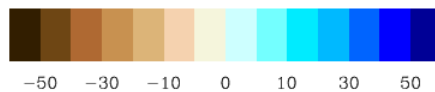
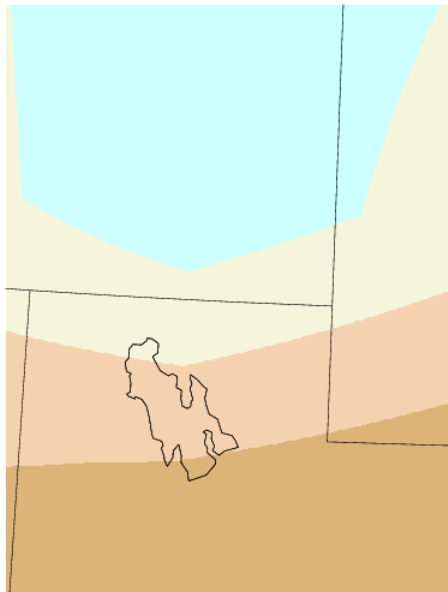
Change in Summer Precip

Global Model

Regional Model

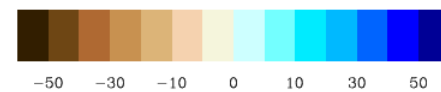
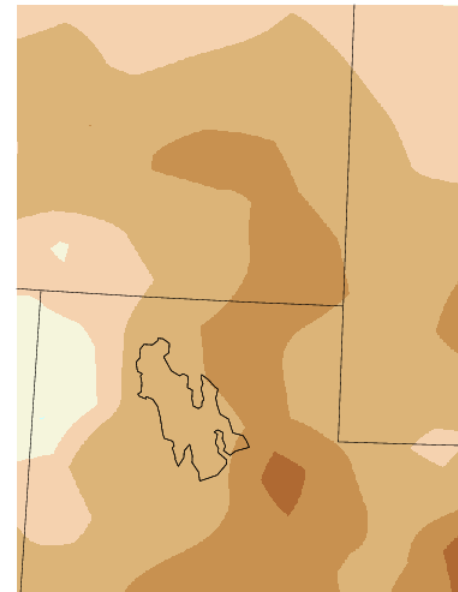
cgcm3 Change In Seasonal Avg Precip

JJA 2041-2070 minus 1971-2000 %



CRCM+cgcm3 Change In Seasonal Avg Precip

JJA 2041-2070 minus 1971-2000 %

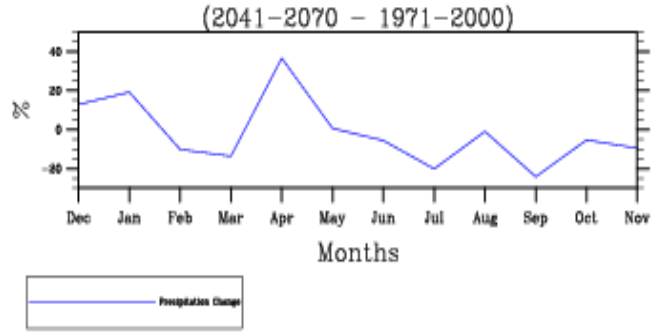
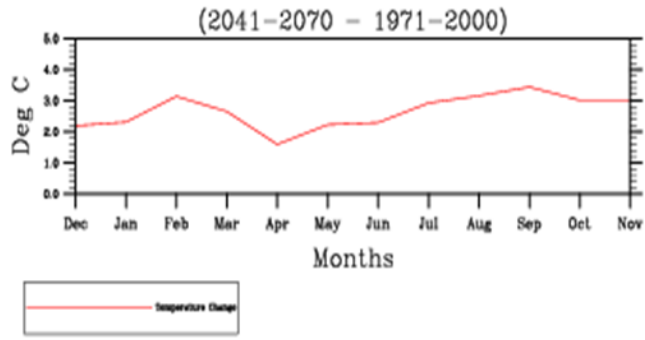


Alternative Scenario

	Temperature Change °C	Precipitation % Change
Annual	2.7	- 3
Winter	2.7	- 5
Spring	2.0	10
Summer	3.0	-20
Fall	3.0	3

Monthly Changes in Temperature and Precipitation

CRCM
Regional
Model





THE NEW YORKER

BIG BOOK OF GLOBAL WARMING CARTOONS - 2007-2107

