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

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

National Center for Atmospheric Research

# Outline

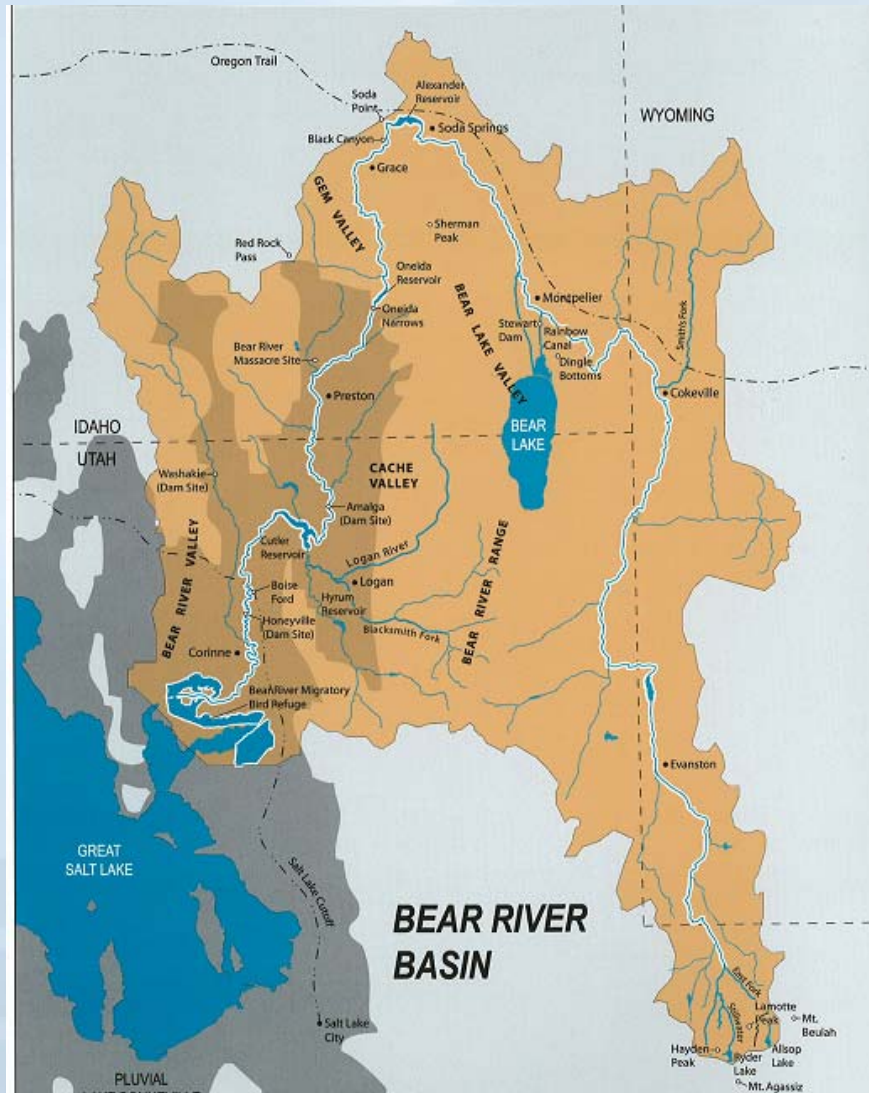


- Different perspectives on future climate
  - What we know about future climate change
- Main Scenario for this Workshop
- Higher Resolution Scenarios
  - Alternative scenario

# Bear River Basin



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# Bear River Basin



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The Nature Conservancy  
Protecting nature. Partnering with you.

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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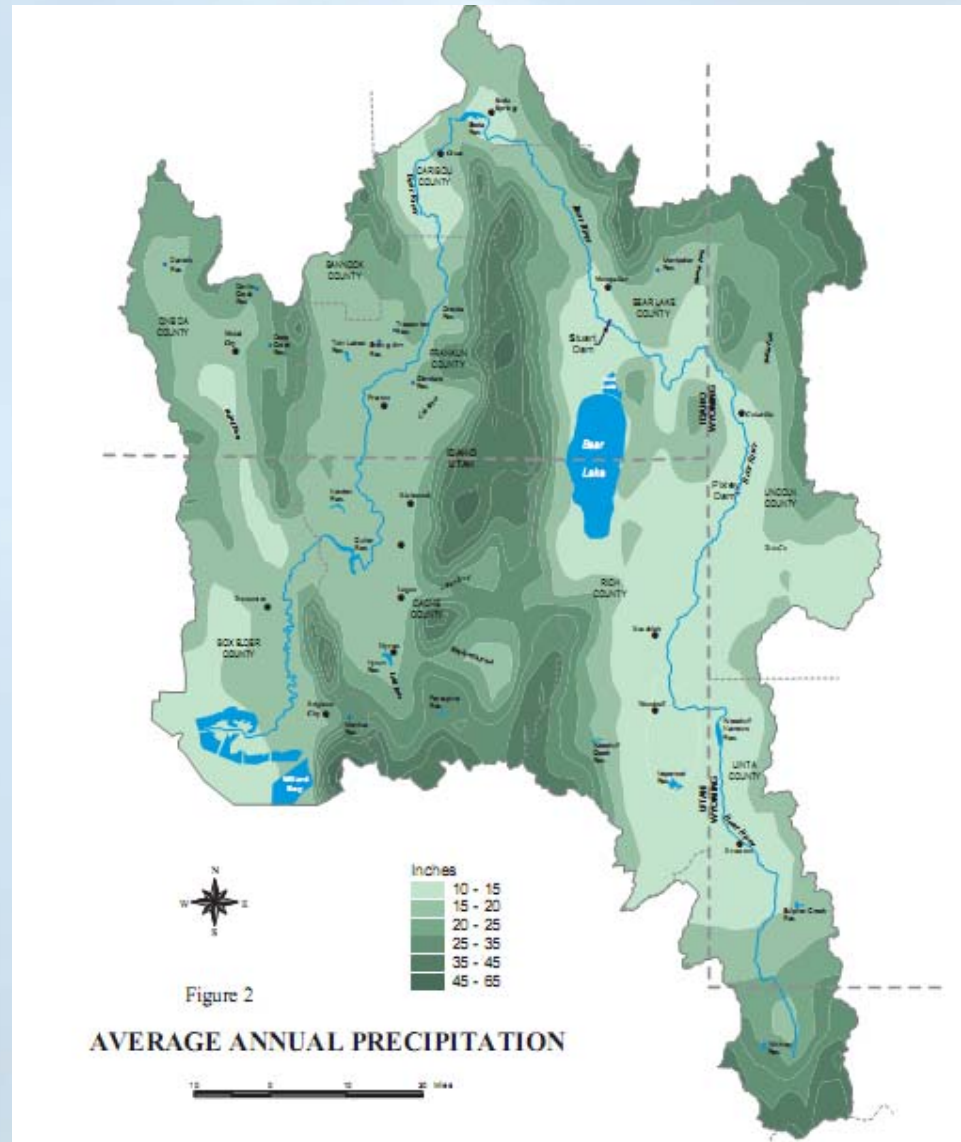


Figure 2

AVERAGE ANNUAL PRECIPITATION





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# The Future

# North American Projections

(end of 21<sup>st</sup> century,  
assuming A1B scenario)

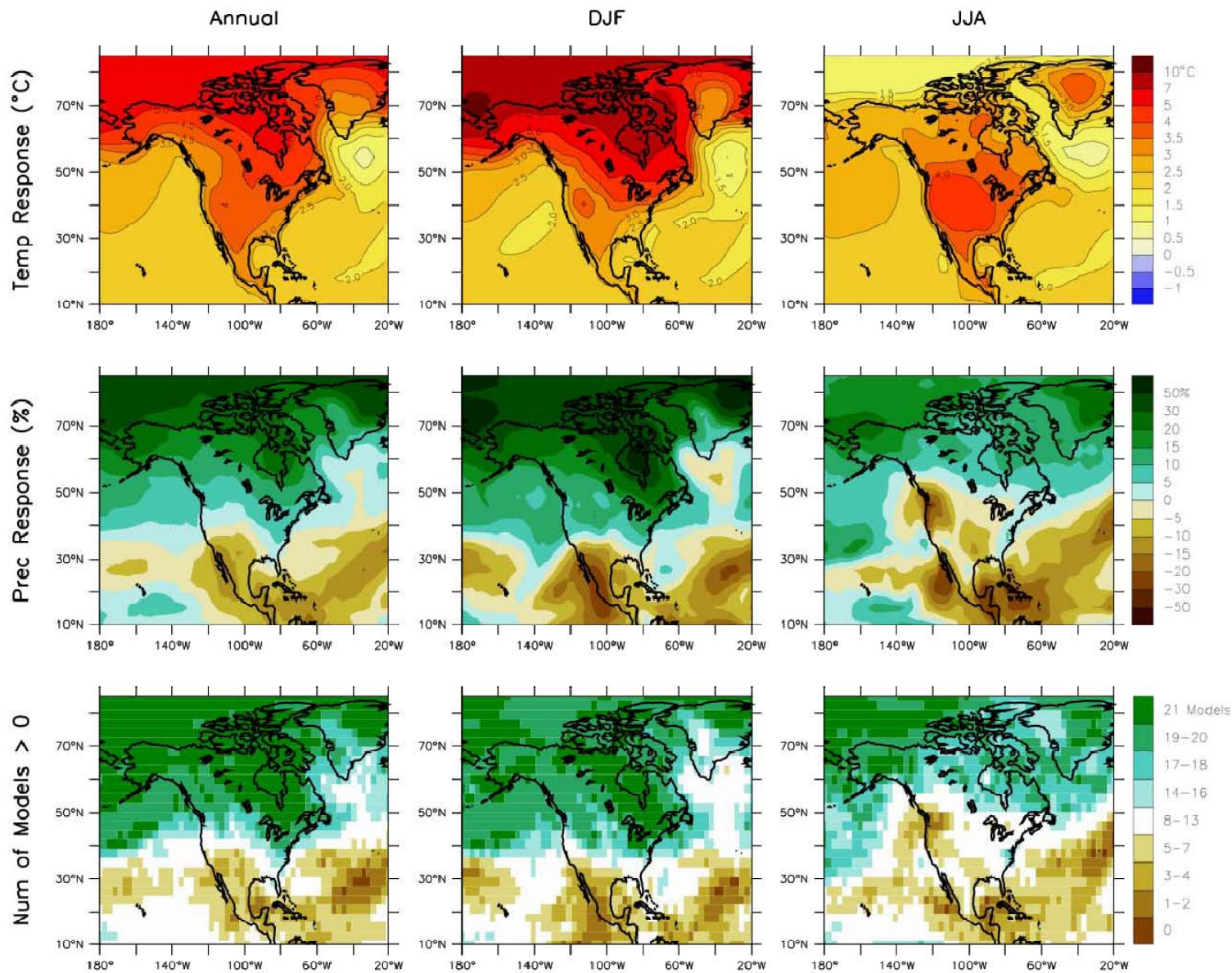
- Based on 21 global climate model results
  - expert judgment of model results
- Always note model limitations (e.g., coarse spatial resolution of models, ~ 2 deg.)

# 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)

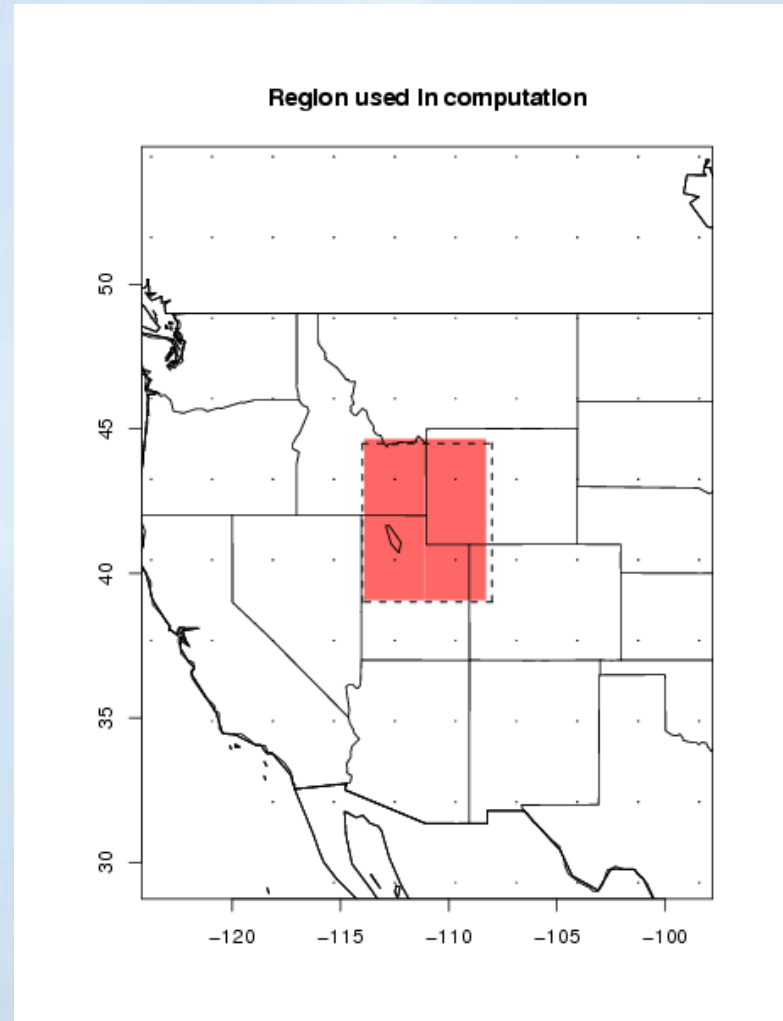
### for North America

- (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<sup>th</sup>

75<sup>th</sup>

### Annual changes:

Temperature °C (°F): 2.3 (4.1) 3.0 (5.4)

Precipitation - 5 +8  
(% change)

### 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



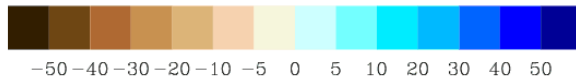
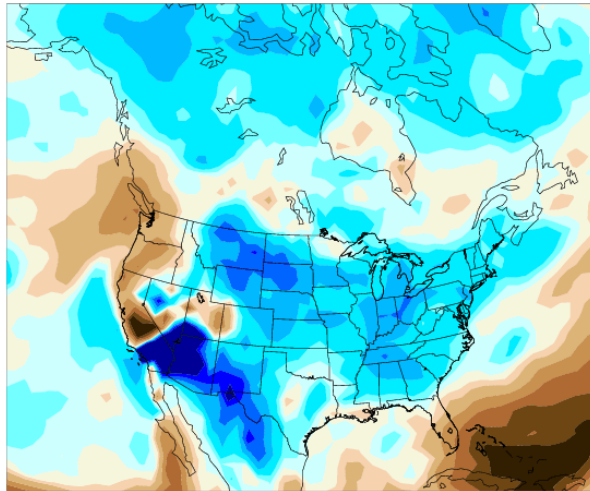
# Main Scenario

	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

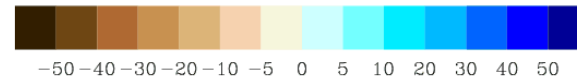
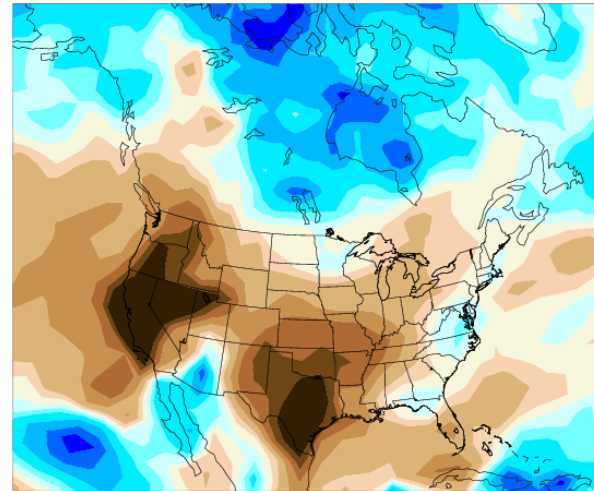
## CCSM Change In Seasonal Avg Precip

JJA 2041-2070 minus 1971-2000 %



## GFDL Change In Seasonal Avg Precip

JJA 2041-2070 minus 1971-2000 %

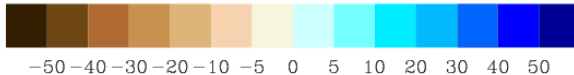
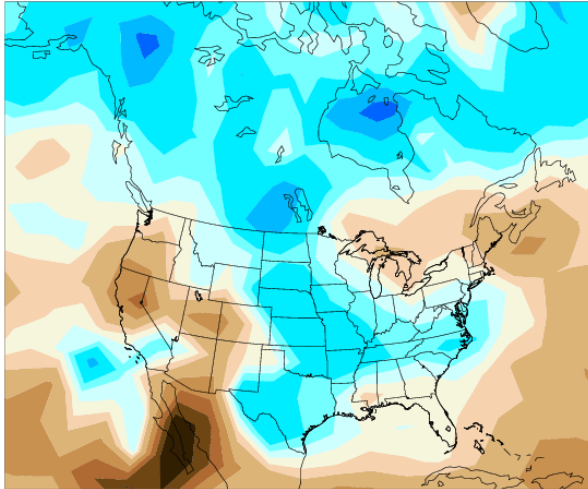




# Global Model Change in Precipitation - Summer

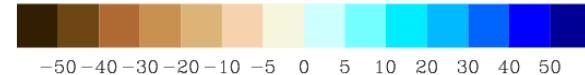
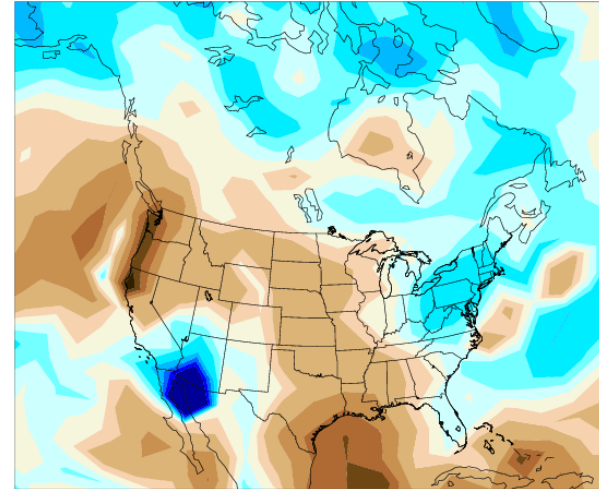
### CGCM3 Change In Seasonal Avg Precip

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

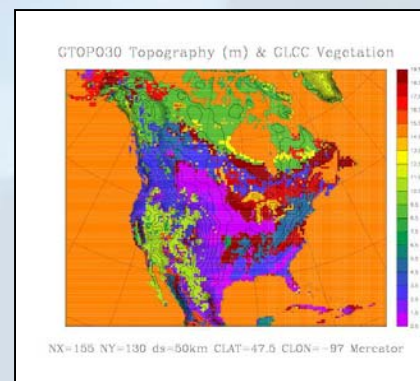
## Dynamical Downscaling

# The North American Regional Climate Change Assessment Program (NARCCAP)



[www.narccap.ucar.edu](http://www.narccap.ucar.edu)

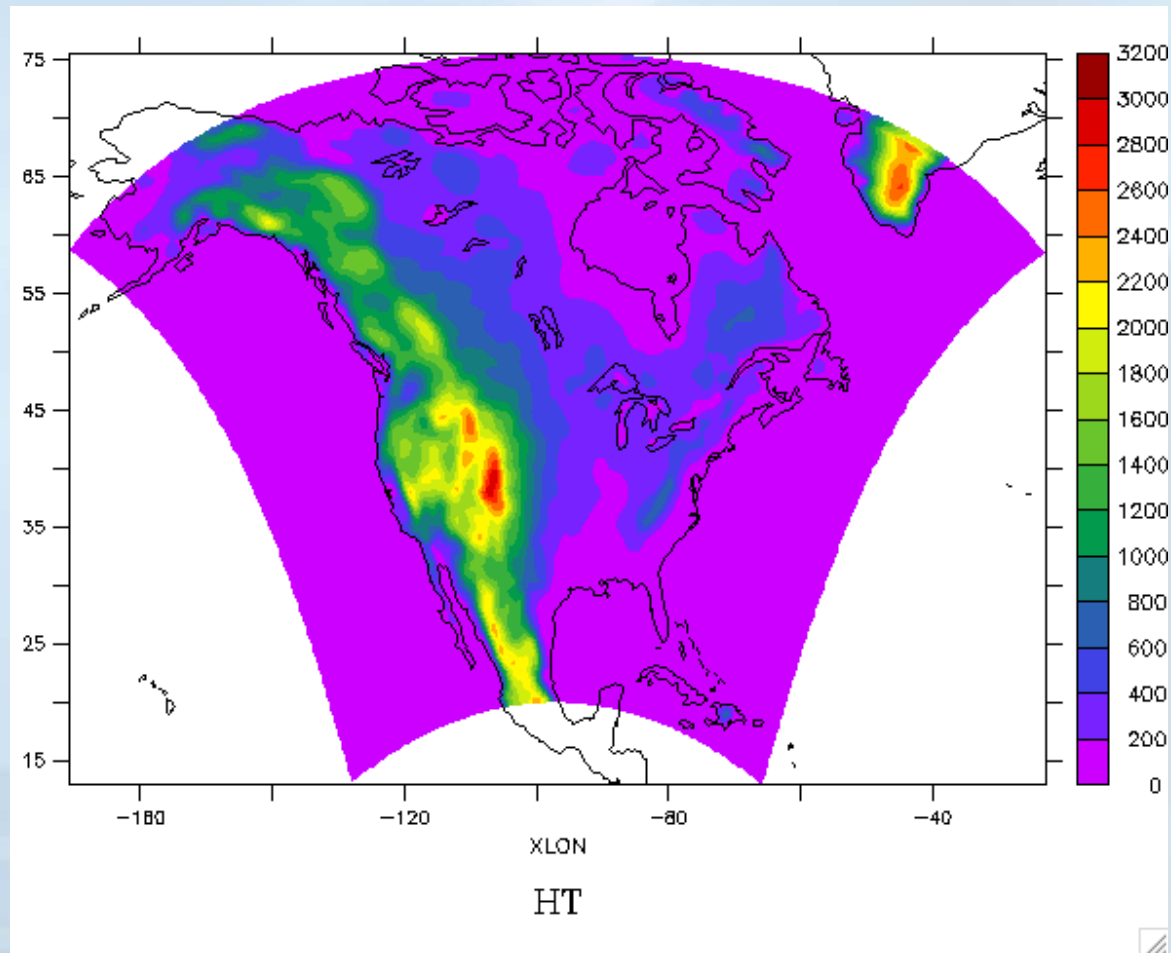
- Explores multiple uncertainties in regional and global climate model projections
  - 4 global climate models x 6 regional climate models
- Develops multiple high resolution regional (50 km, 30 miles) climate scenarios for use in impacts and adaptation assessments
- Evaluates regional model performance 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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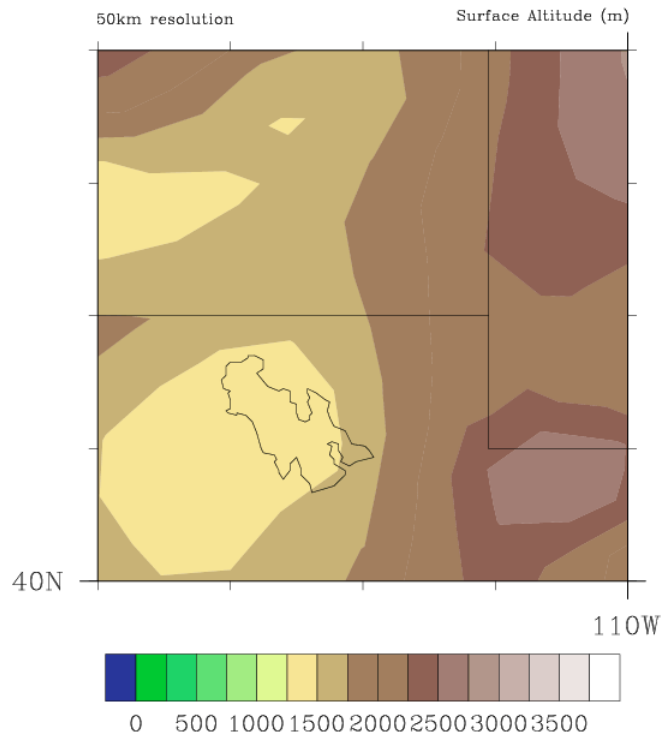
# Orography – Bear River

## 2 different spatial resolutions



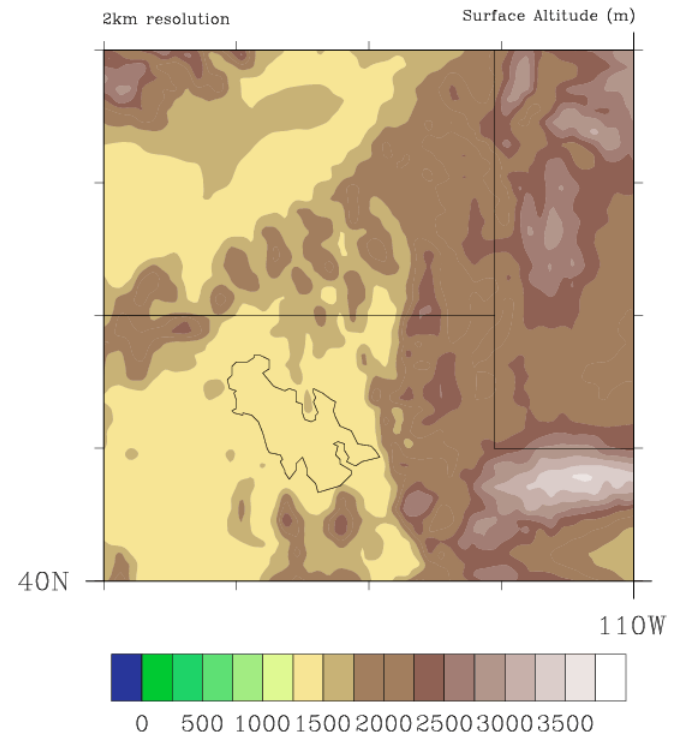
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### CRCM Elevations



50 km (30 miles)

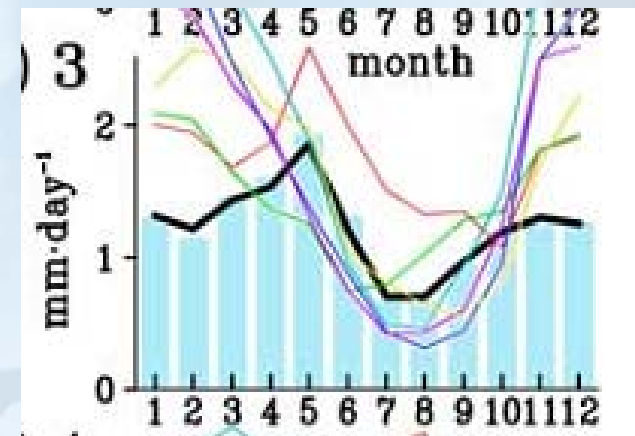
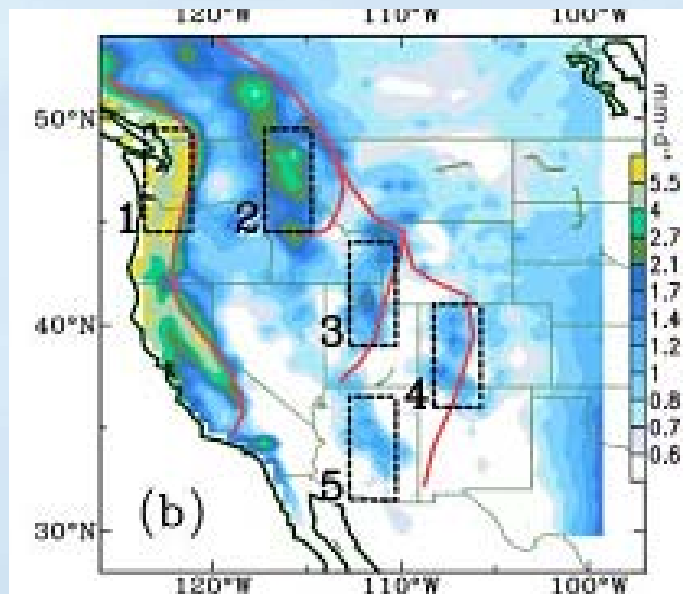
### WRF Elevations



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

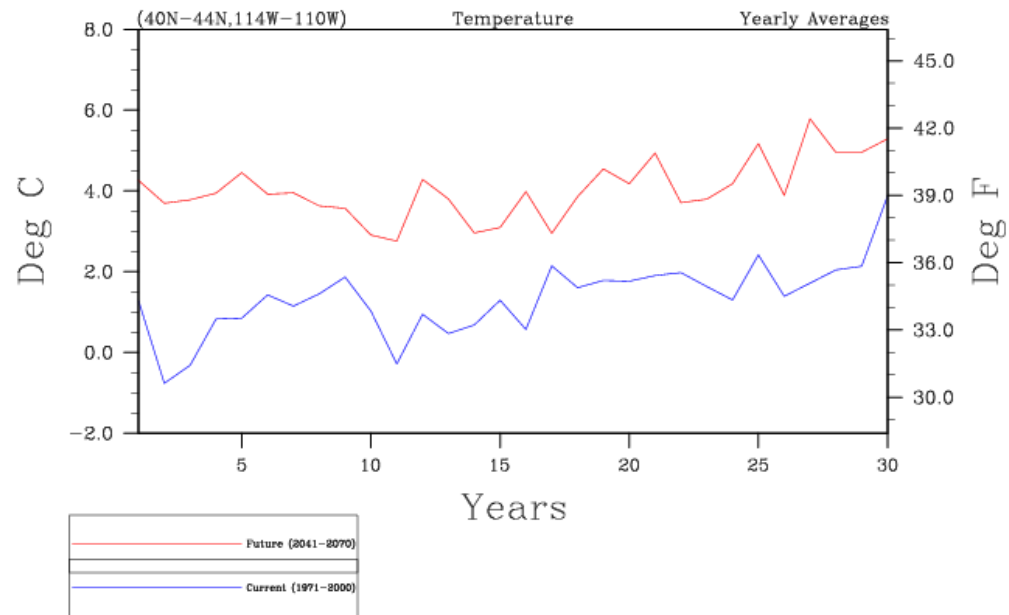
Wang et al., 2009

Sample scenario from one RCM (Canadian model)

# Temperature Current and Future



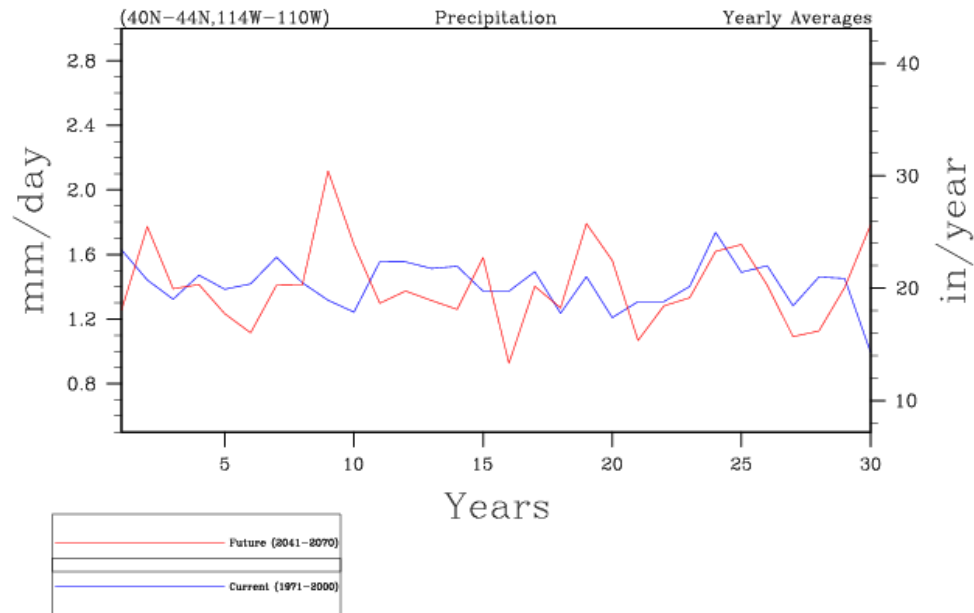
CRCM+cgcm3 Spatial Avg Bear River Region



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



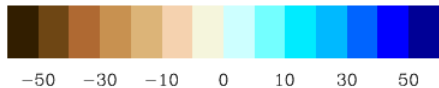
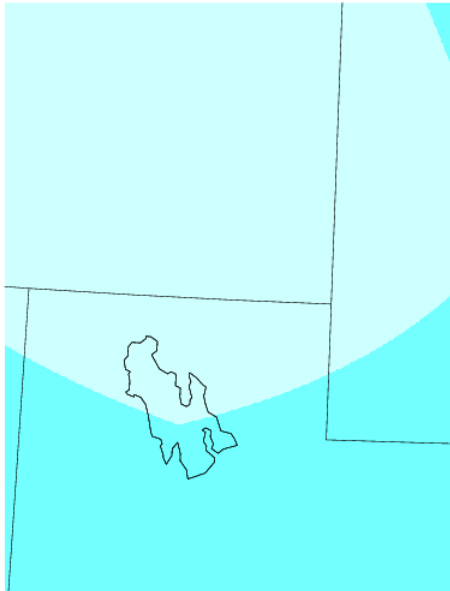
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Global Model

Regional Model

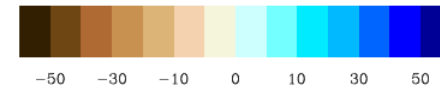
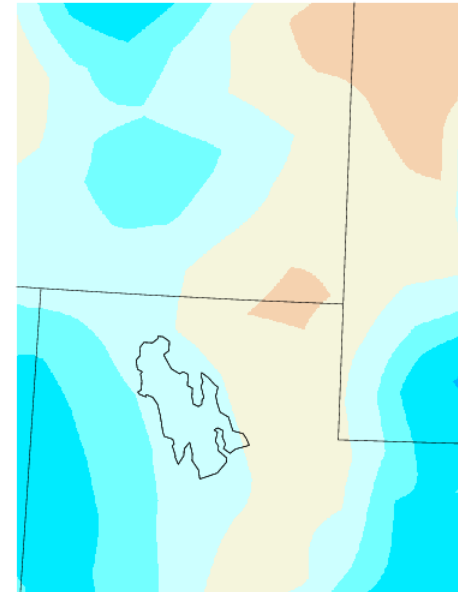
**cgcm3 Change In Seasonal Avg Precip**

DJF 2041-2070 minus 1971-2000 %



**CRCM+cgcm3 Change In Seasonal Avg Precip**

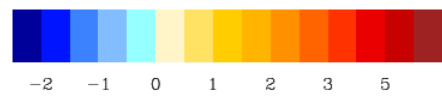
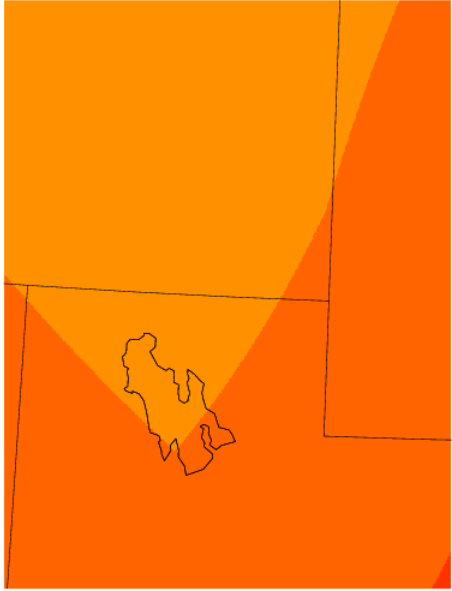
DJF 2041-2070 minus 1971-2000 %



# Change in Winter Temperature

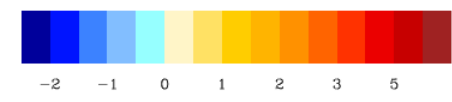
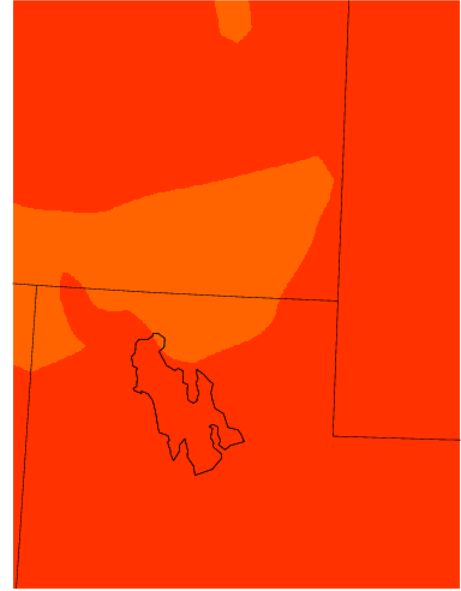
**cgcm3 Change In Seasonal Avg Temp**

JJA 2041-2070 minus 1971-2000 Deg C



**CRCM+cgcm3 Change In Seasonal Avg Temp**

JJA 2041-2070 minus 1971-2000 Deg C





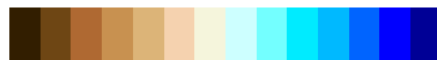
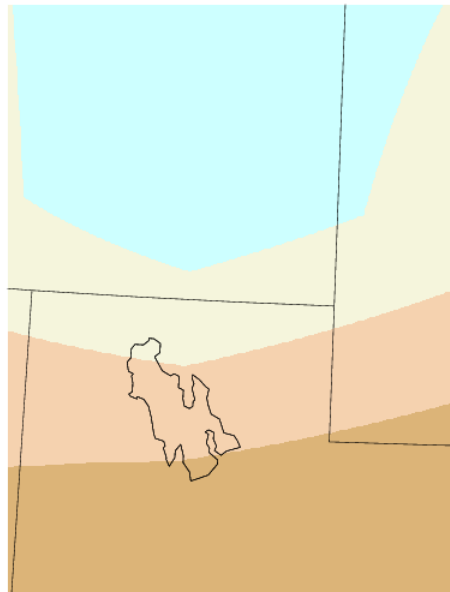
# Change in Summer Precip

Global Model

Regional Model

cgcm3 Change In Seasonal Avg Precip

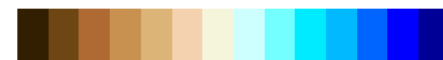
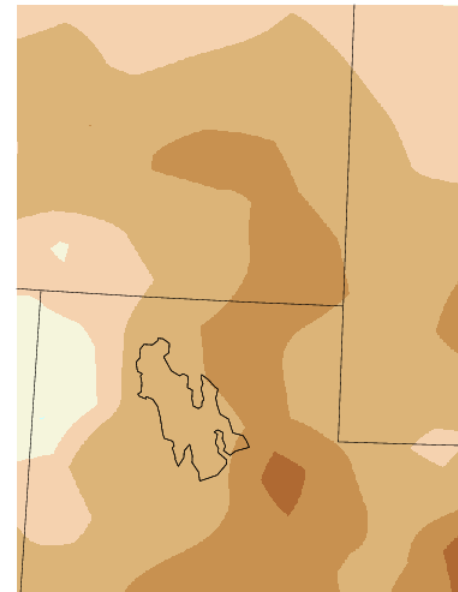
JJA 2041-2070 minus 1971-2000 %



-50 -30 -10 0 10 30 50

CRCM+cgcm3 Change In Seasonal Avg Precip

JJA 2041-2070 minus 1971-2000 %



-50 -30 -10 0 10 30 50

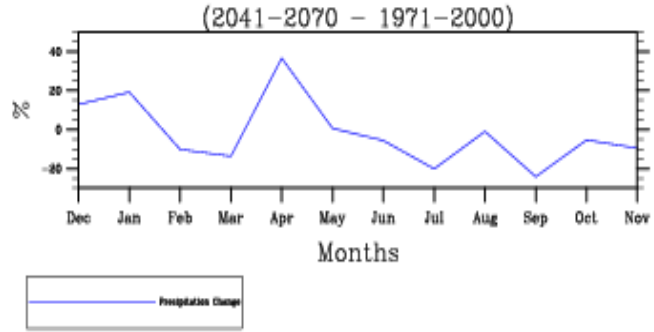
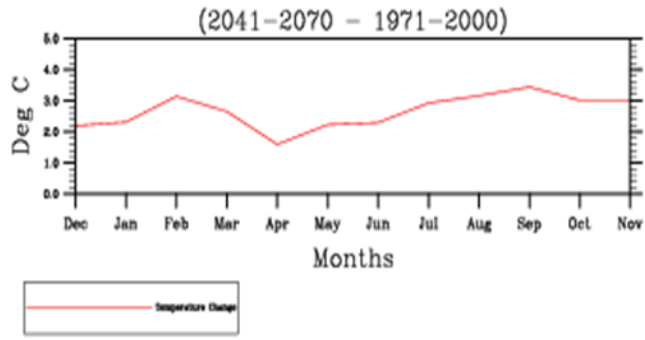


# Alternative Scenario

	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

