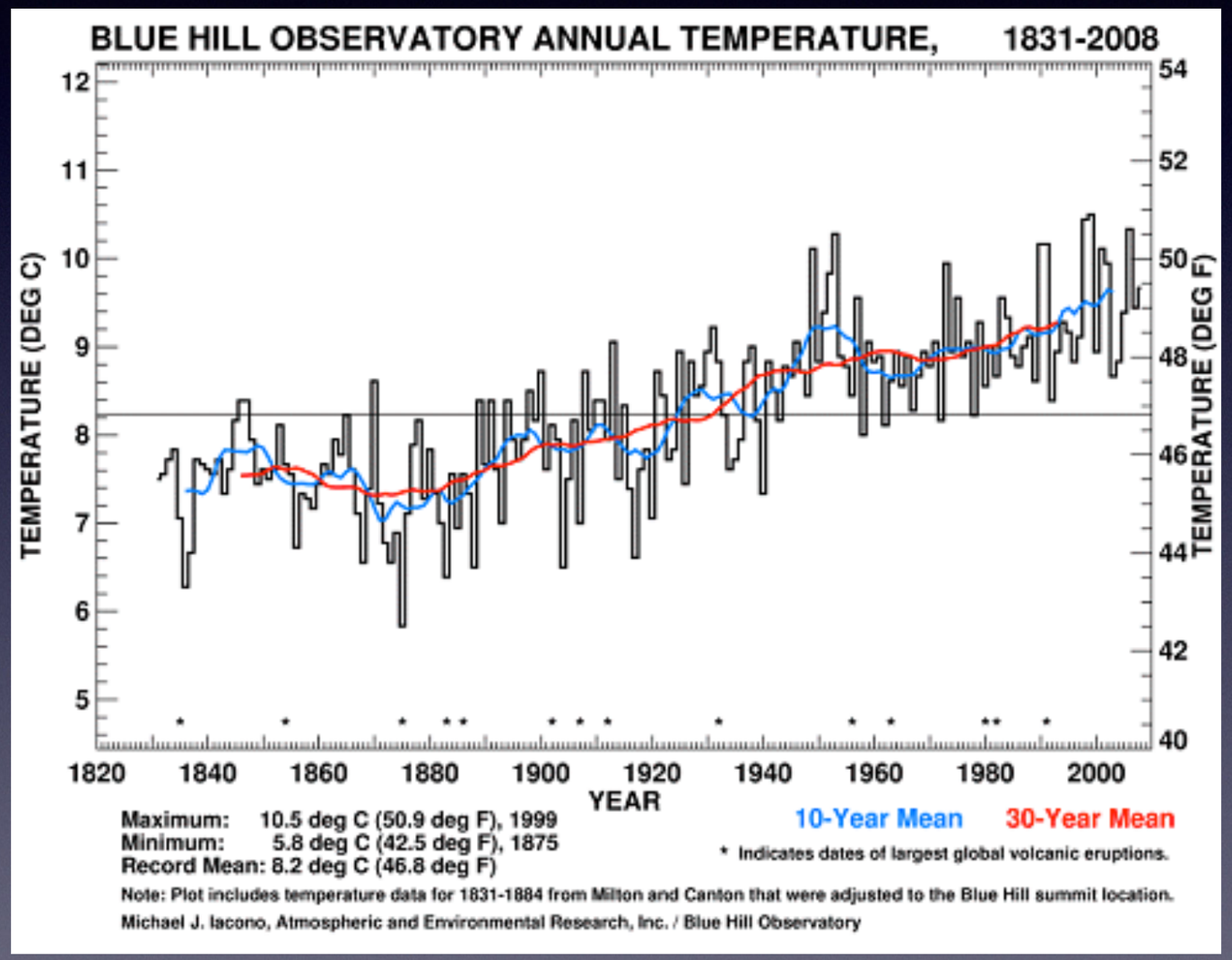
Vulnera**b**i**l**ity and **R**isk Assessment **T**ool for Water **U**tiliti**e**s (ViRTUE)

UMass Hydrosystems Research Group

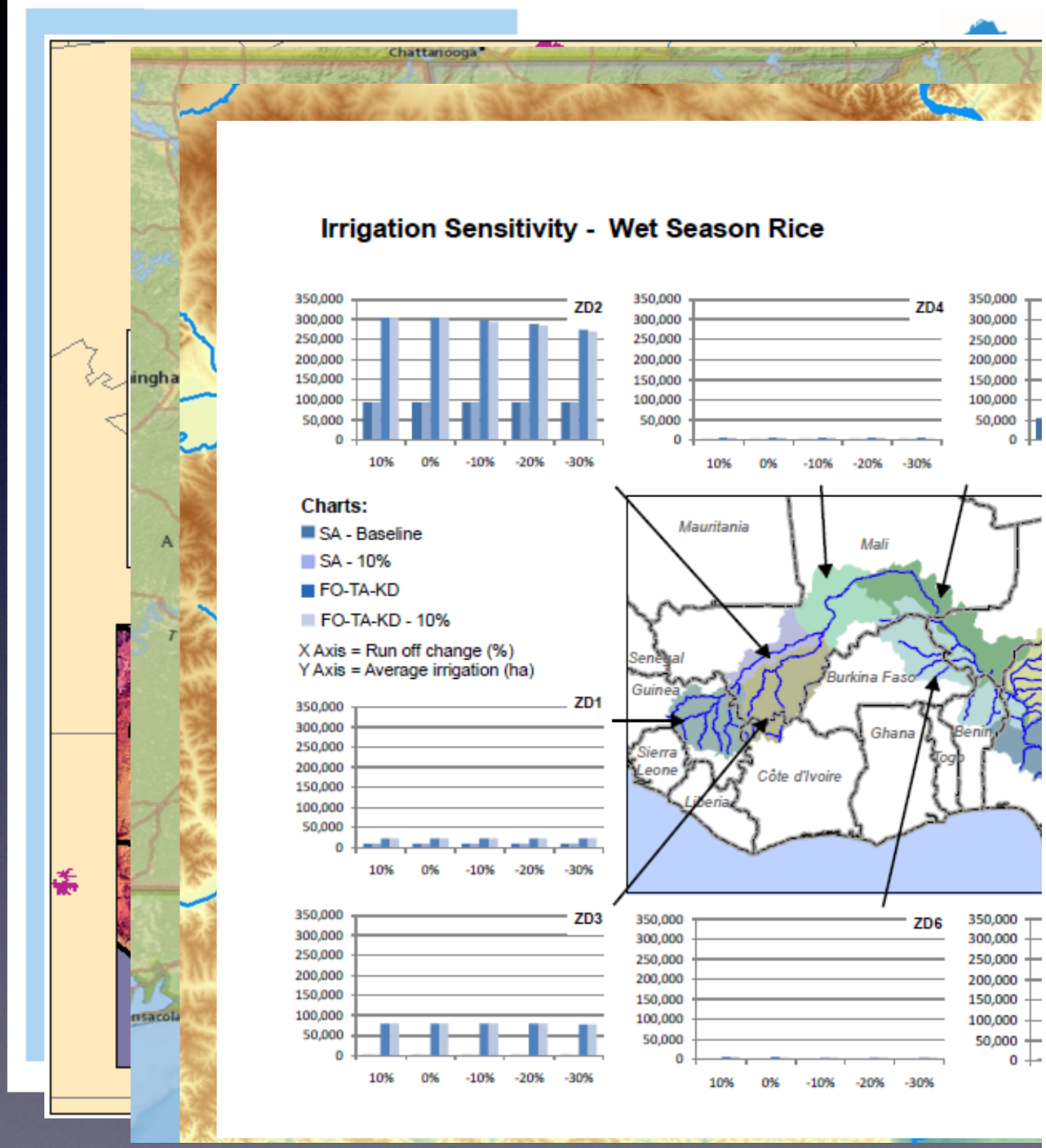
hydrosystems.ecs.umass.edu

Introduction

- Climate change poses risks to water supply utilities
- What do the climate changes imply for your utility?
- Need process for assessing climate change risks



UMass Hydrosystems Research Group



UMASS NEWSLETTER

Issue #

FARMLAND SURROUNDS THE CONNECTICUT RIVER NEAR SUNDERLAND, MASS.
GENE AHRENS/SHOSTAL ASSOCIATES

UMass
Newsletter

April 5, 2012

2012 SPRING FORECAST

A Climate Outlook for New England

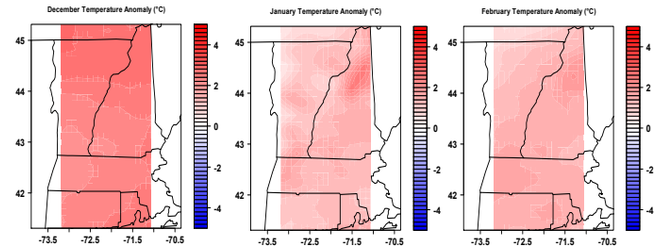
by Sarah Whateley, Scott Steinschneider, Casey Brown

You may remember last year's spring workshop, put on by the Hydrosystems Research Group at the University of Massachusetts Amherst. The workshop was designed to bring water managers together and provide them with useful information about current local climate in context:

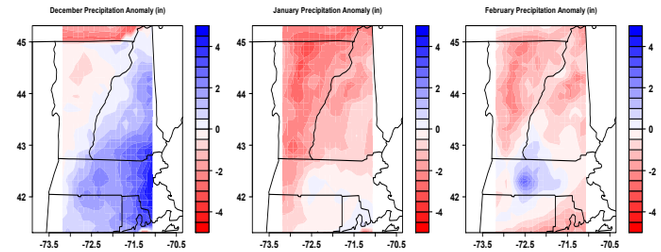
- Latest snow pack information
- Hydrologic outlook
- Seasonal climate outlook
- Current climate trends and change

Taking into consideration water manager and stakeholder input from last year's workshop, a new 2012 spring forecast was developed.

To the seasoned New Englander, this past winter has seemed warm and dry. Wintertime temperature and precipitation anomalies confirm this view, with high 2011/2012 average winter temperatures and low average winter precipitation compared with the historic average. These conditions could be cause for concern with regard to expected water availability and flows going into the spring and summer seasons.



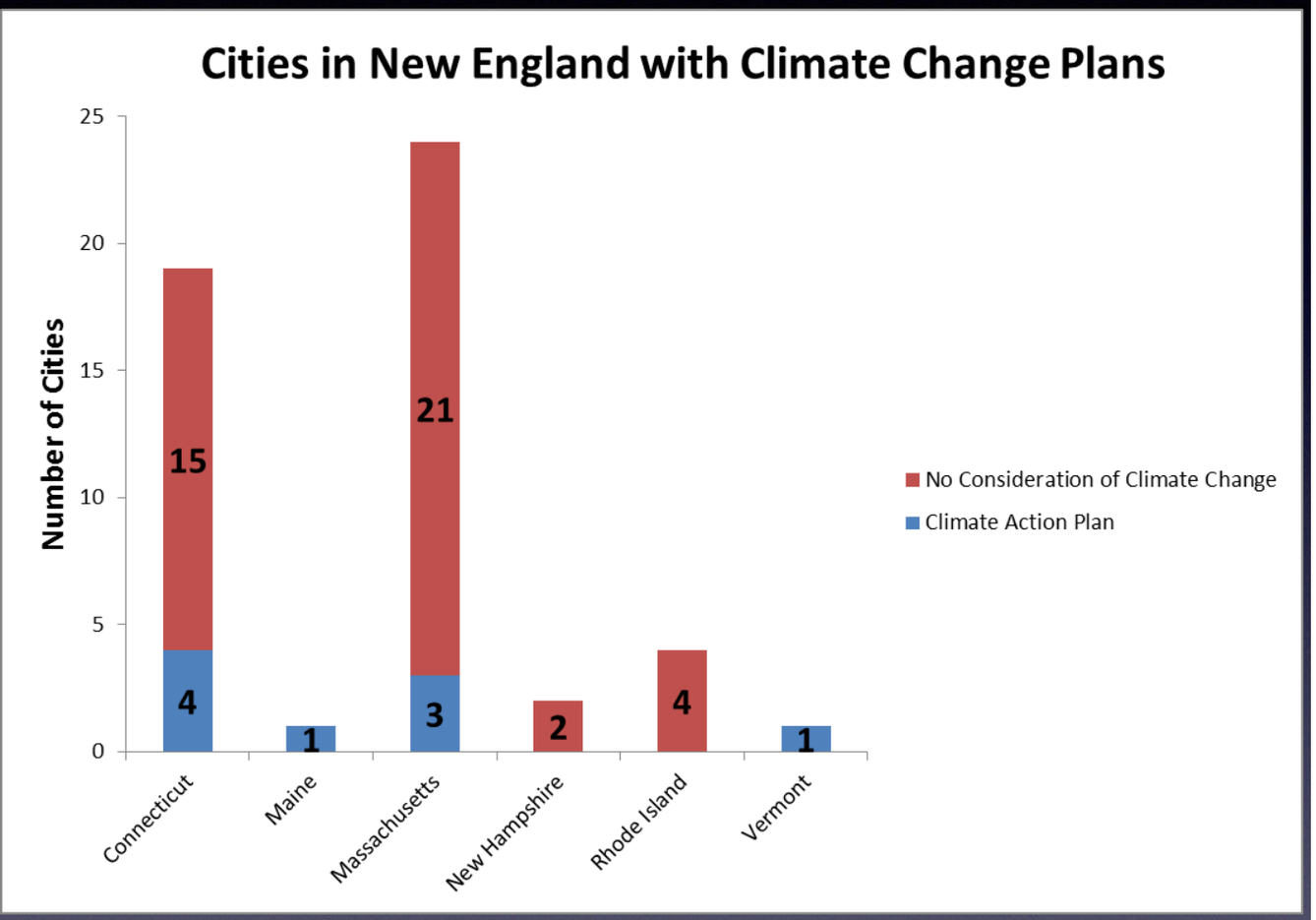
Wintertime temperature (degrees Celsius) anomalies from this past winter



Wintertime precipitation (inches) anomalies from this past winter

Led by Prof. Casey Brown, P.E.

UMass Hydrosystems Research Group



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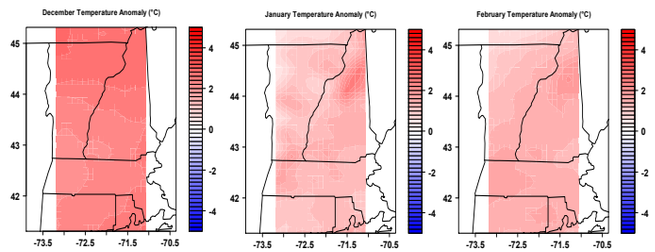

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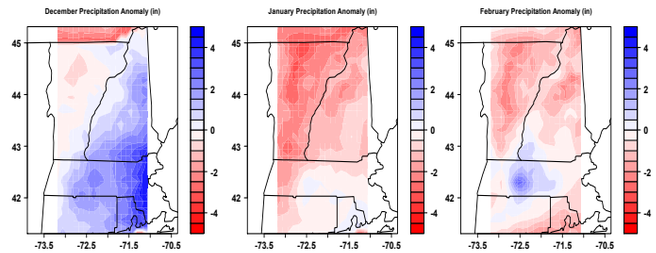
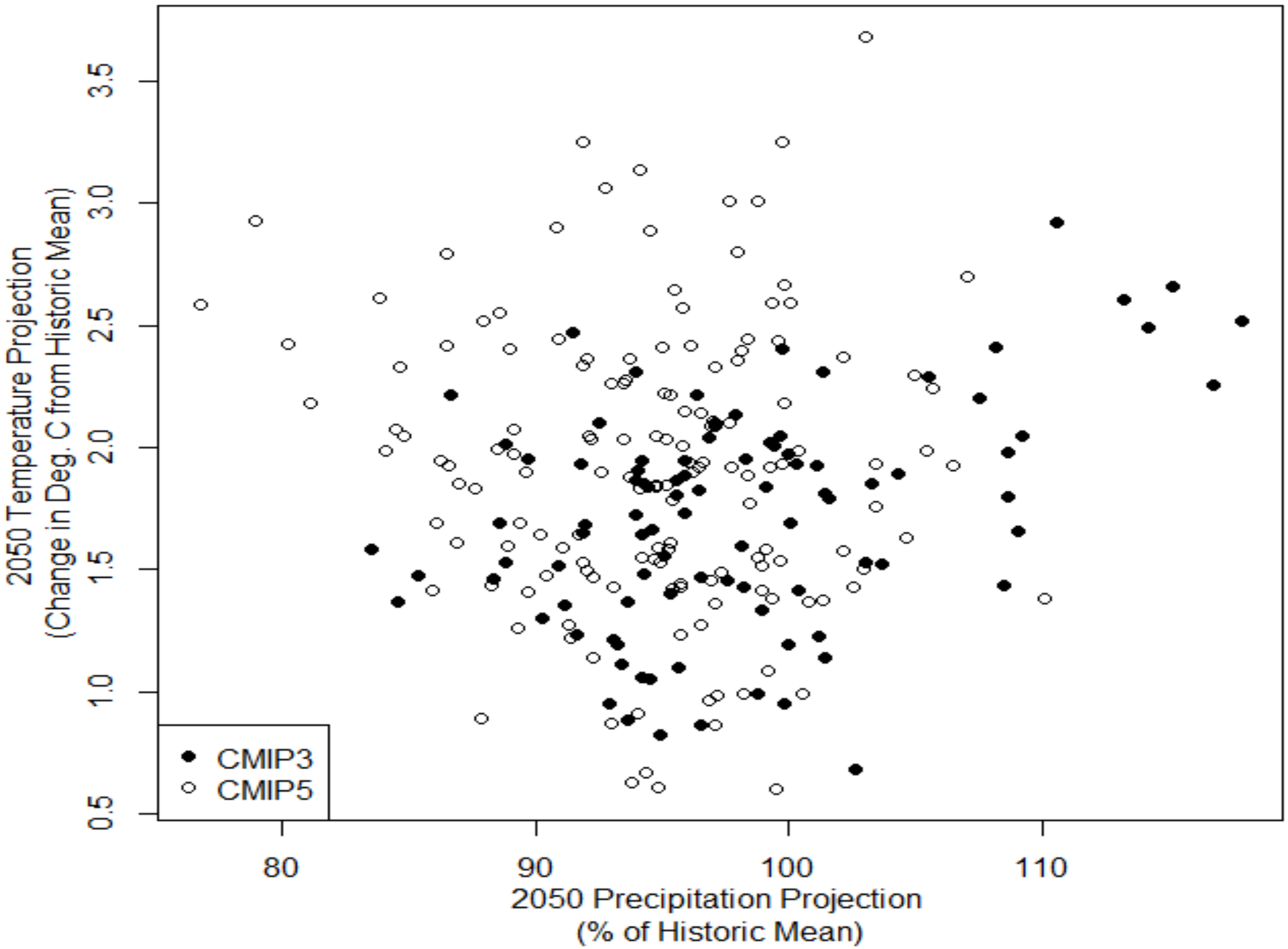


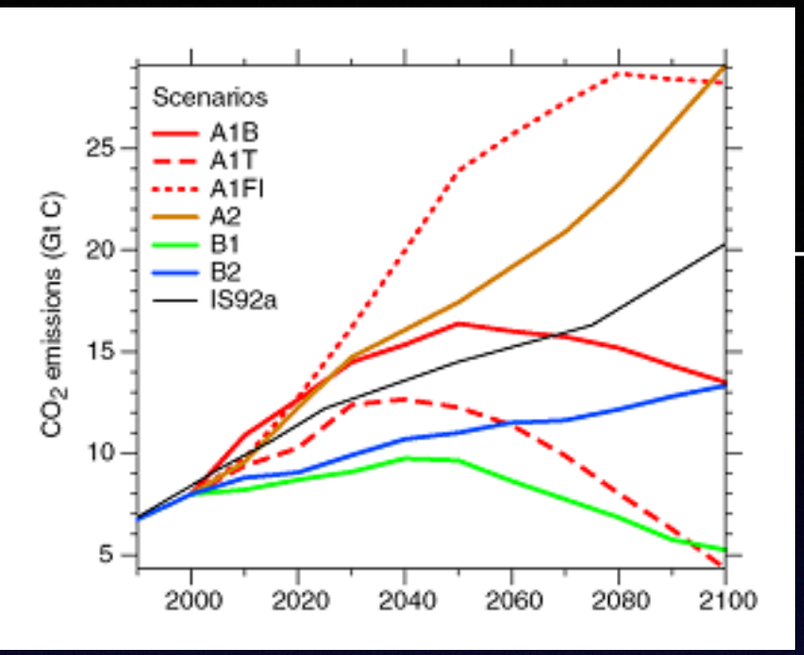
Wintertime precipitation (inches) anomalies from this past winter

Led by Prof. Casey Brown, P.E.

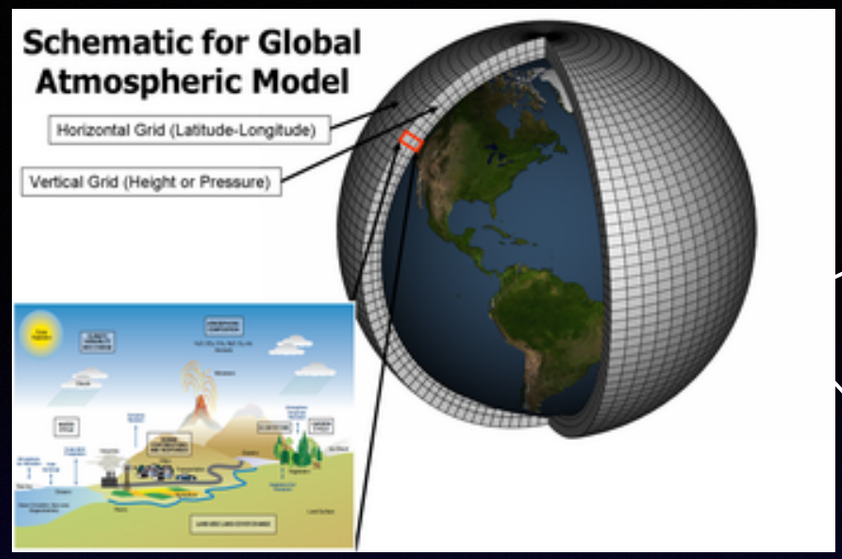
Now What?


2050 Temperature Projection
(Change in Deg. C from Historic Mean)
0.5
1.0
1.5
2.0
2.5
3.0
3.5
CMIP3
CMIP5
80
90
100
110
2050 Precipitation Projection
(% of Historic Mean)

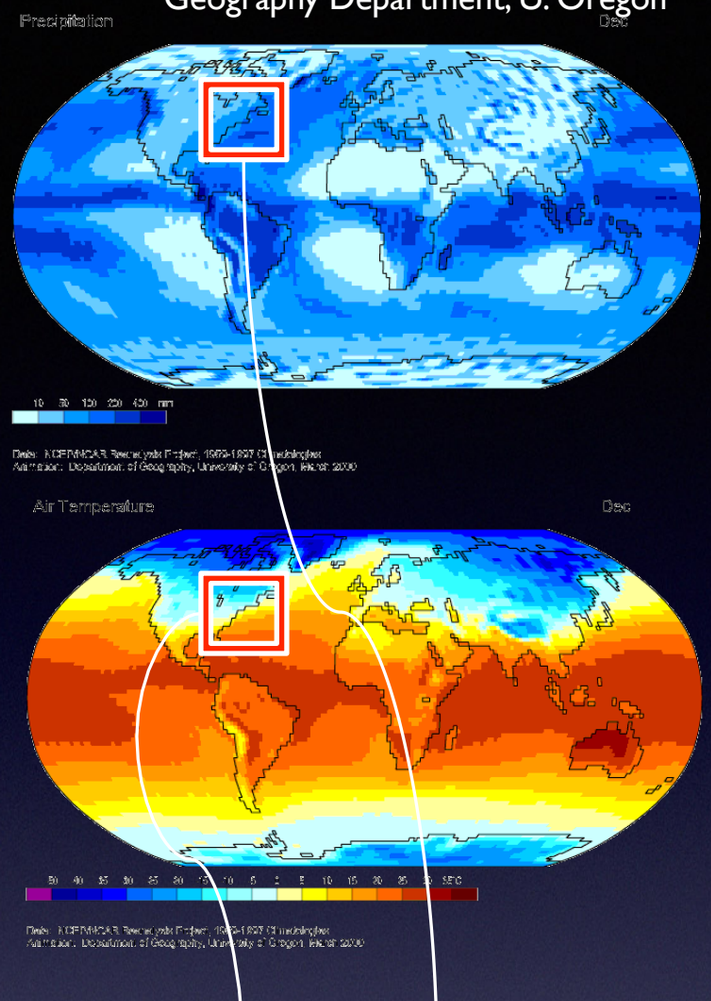
Emission Scenarios



General Circulation Models (GCMs)

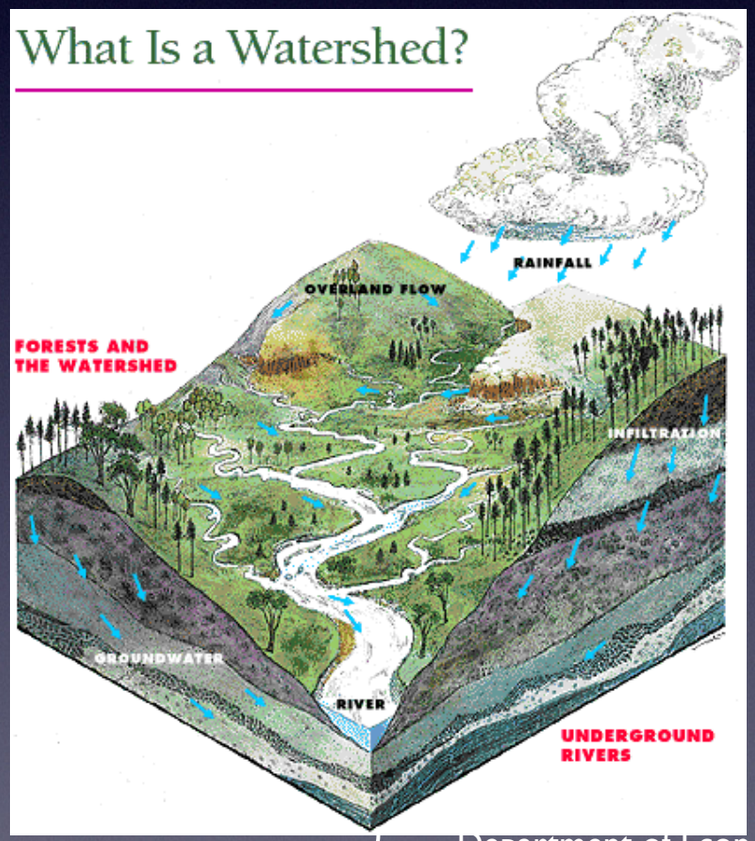


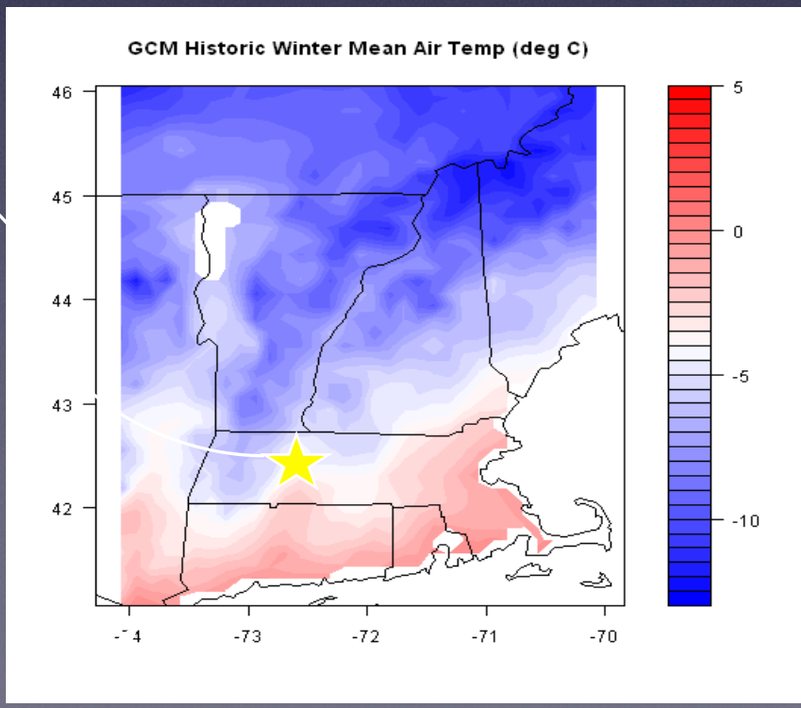
Geography Department, U. Oregon



Downscaling

Hydrologic Model

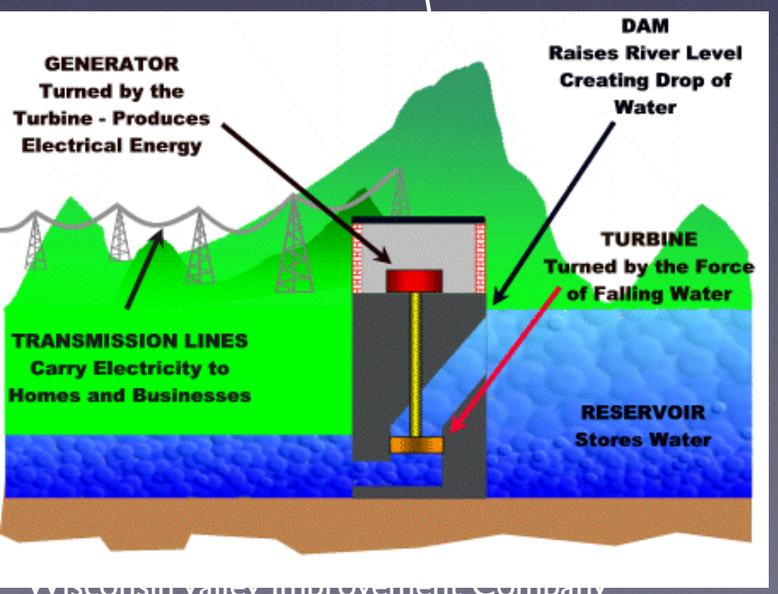




Water Resources System Model

Department of Econ. Development

Water System Performance Under Future Climate Scenarios



Wisconsin Valley Improvement Company

Decision-Scaling

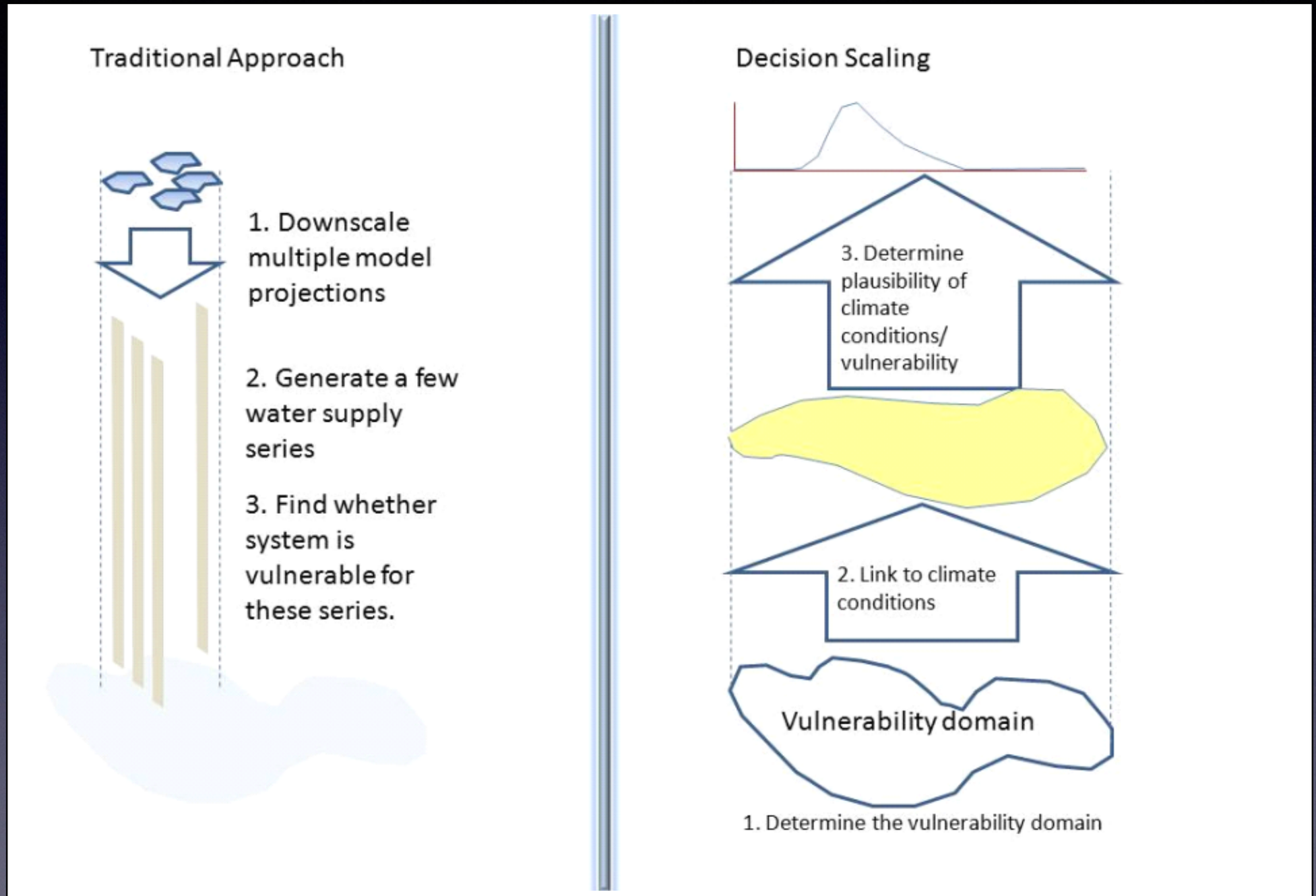
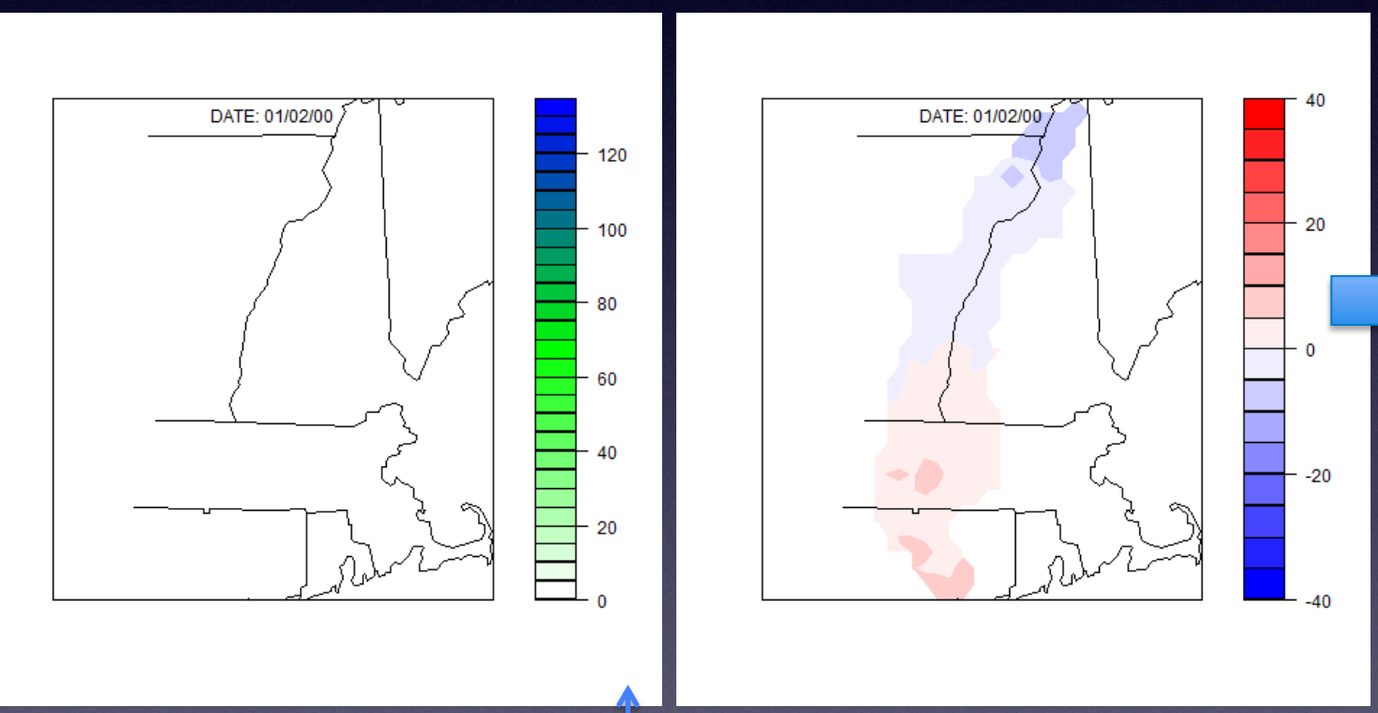


Figure 1 Steps in decision scaling vs. traditional approach

Climate "Stress Test"

Stochastic Climate/WX Generation



Impact Levels, z-axis

Δ Precipitation

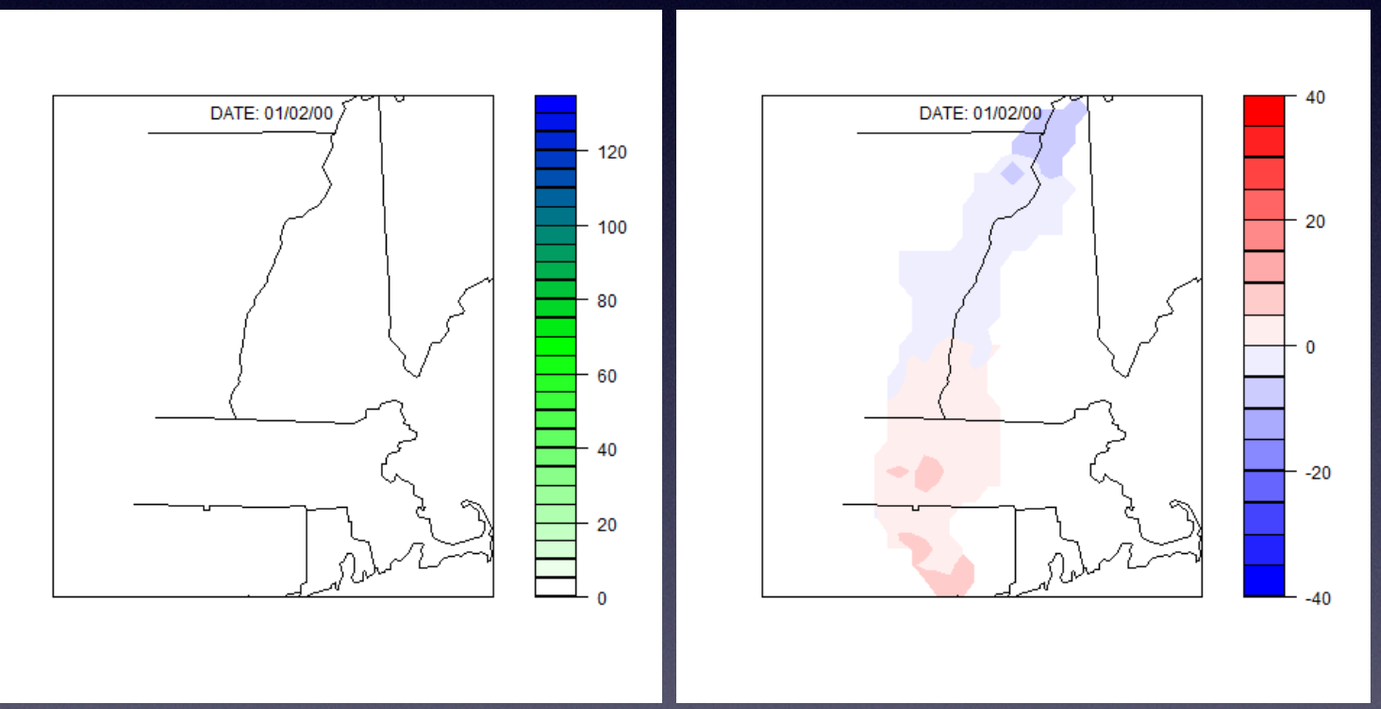
Δ Temperature

Plausible Climate Change explored by Climate/weather generator

Level of Impact plotted versus that climate change

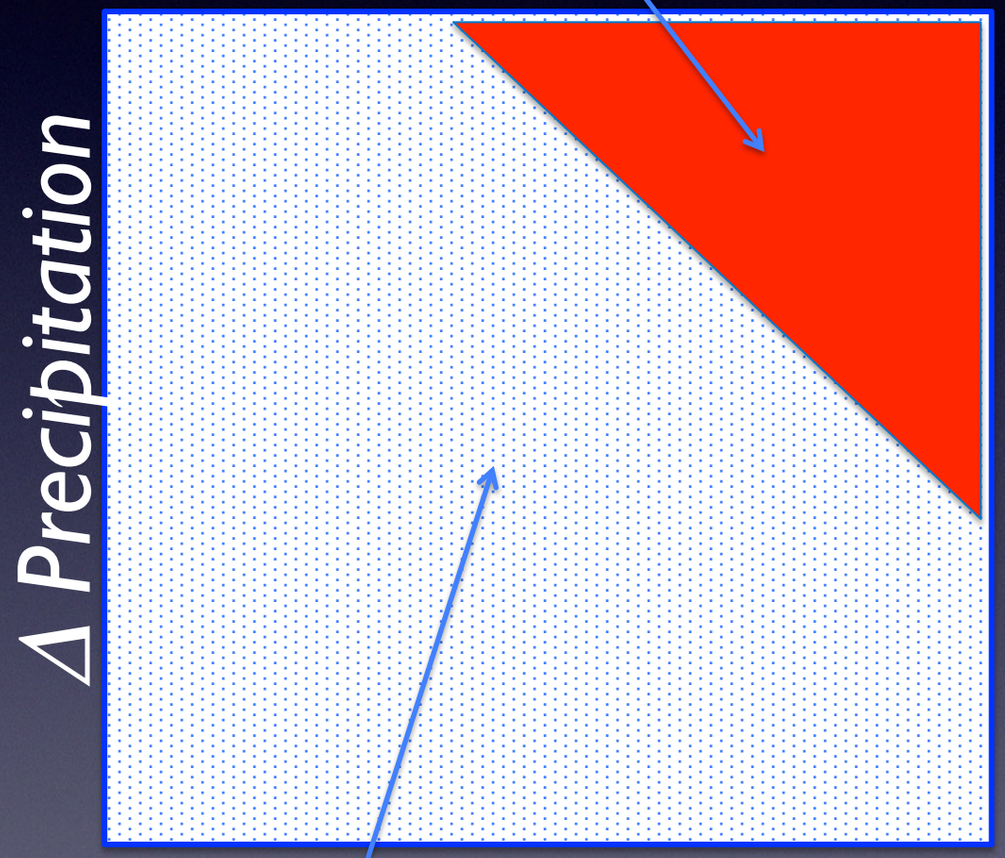
Climate "Stress Test"

Stochastic Climate/WX Generation



Area of Hazard

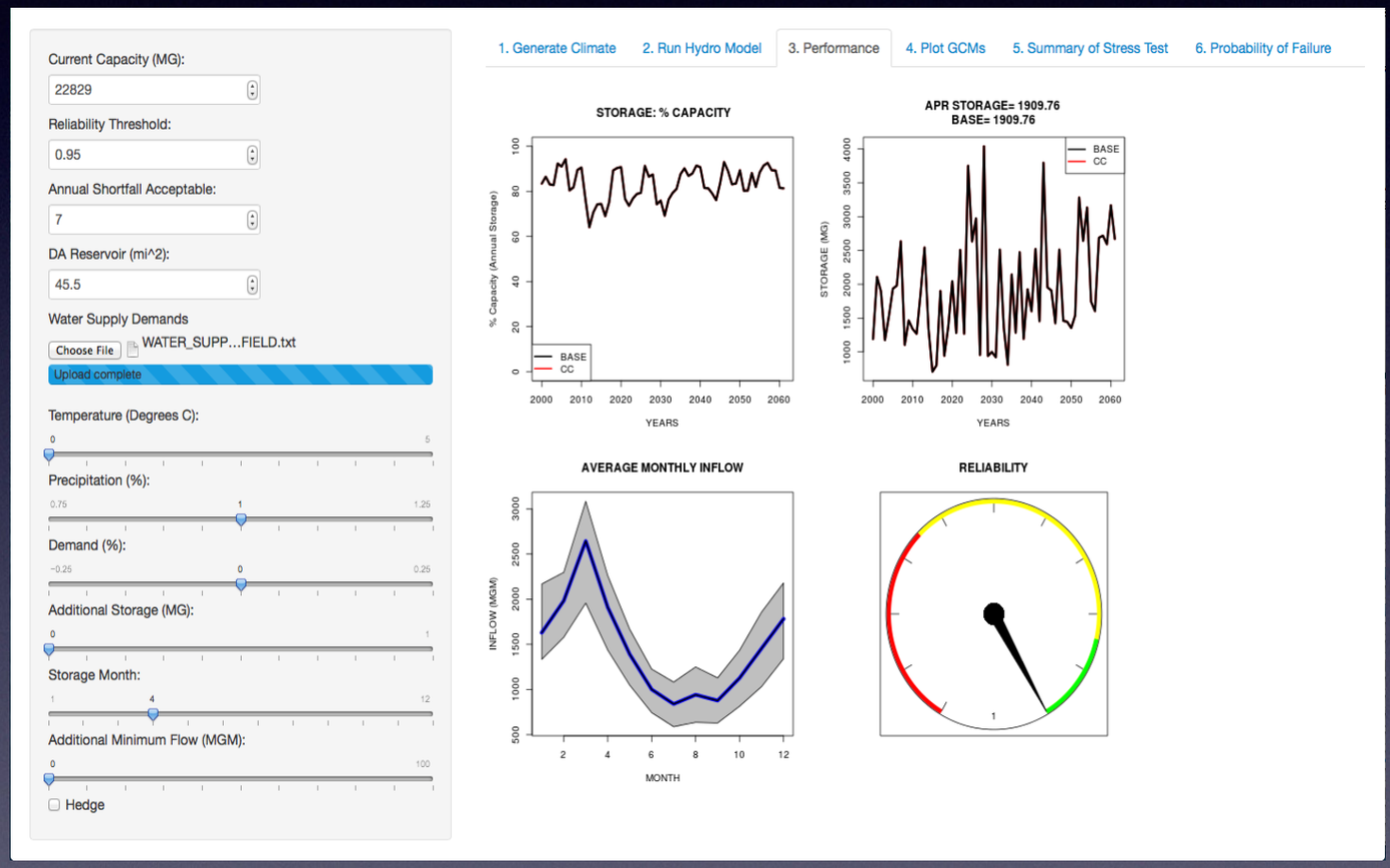
Impact Levels, z-axis



Area of Acceptable Performance => Robustness

Introduction to ViRTUE

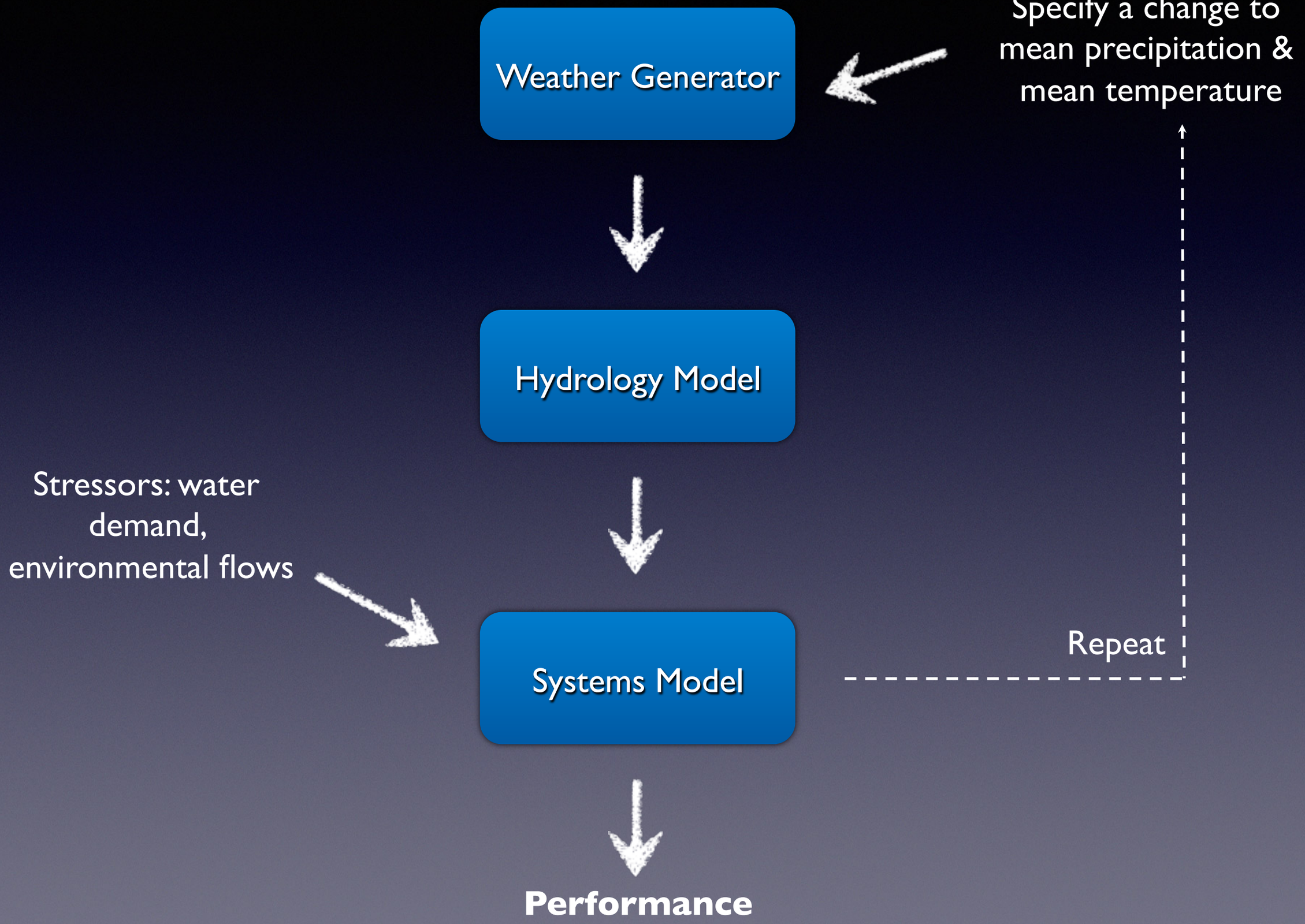
- Allows self-assessment of climate change risks
- Applicable to most surface water systems (hope to include GW also!)
- Planning tool – what does climate change mean to my system?
  - Is this something I need to worry about?



How the Tool Works

- Inputs:
  - Reservoir storage volume
  - Inflows or inflow location
  - Water Demand
  - Minimum release requirements (e.g., env. flows)
- Results:
  - Water supply performance under climate change
  - Risks to water supply under climate change projections
  - Sensitivity analysis to changes in demand and minimum flow requirements

ViRTUE: Single Tool for Climate Change Risk



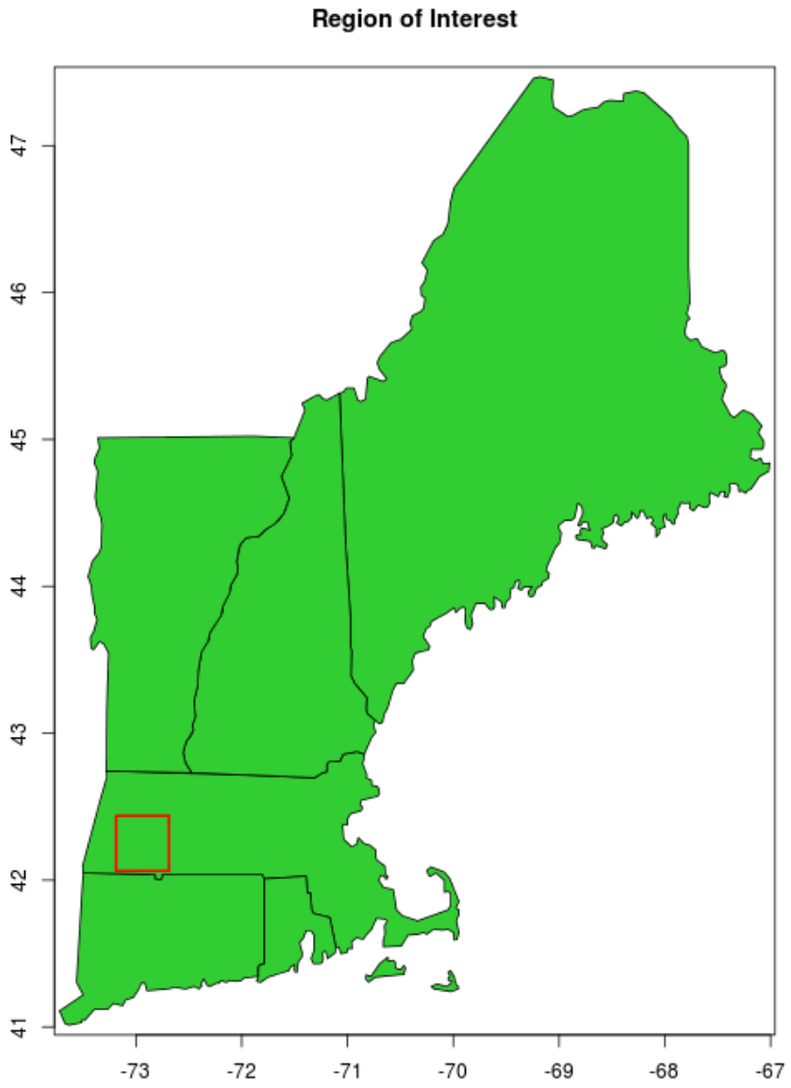
Input location of system

Inputs:
Latitude/Longitude

ViRTUE

Choose upper latitude:
42
Choose upper latitude decimal:
.4375
Choose lower latitude:
42
Choose lower latitude decimal:
.0625
Choose upper longitude:
-72
Choose upper longitude decimal:
.6875
Choose lower longitude:
-73
Choose lower longitude decimal:
.1875

1. Generate Climate | 2. Run Hydro Model | 3. Performance | 4. Plot GCMs | 5. Summary of Stress Test | 6. Probability of Failure



Explore effects of Temperature Change

Weather Generator

Specify a change to mean precipitation & mean temperature

Temperature (Degrees C):

0 5

Precipitation (%):

0.75 1 1.25

Demand (%):

−0.25 0 0.25

Additional Storage (MG):

0 1

Storage Month:

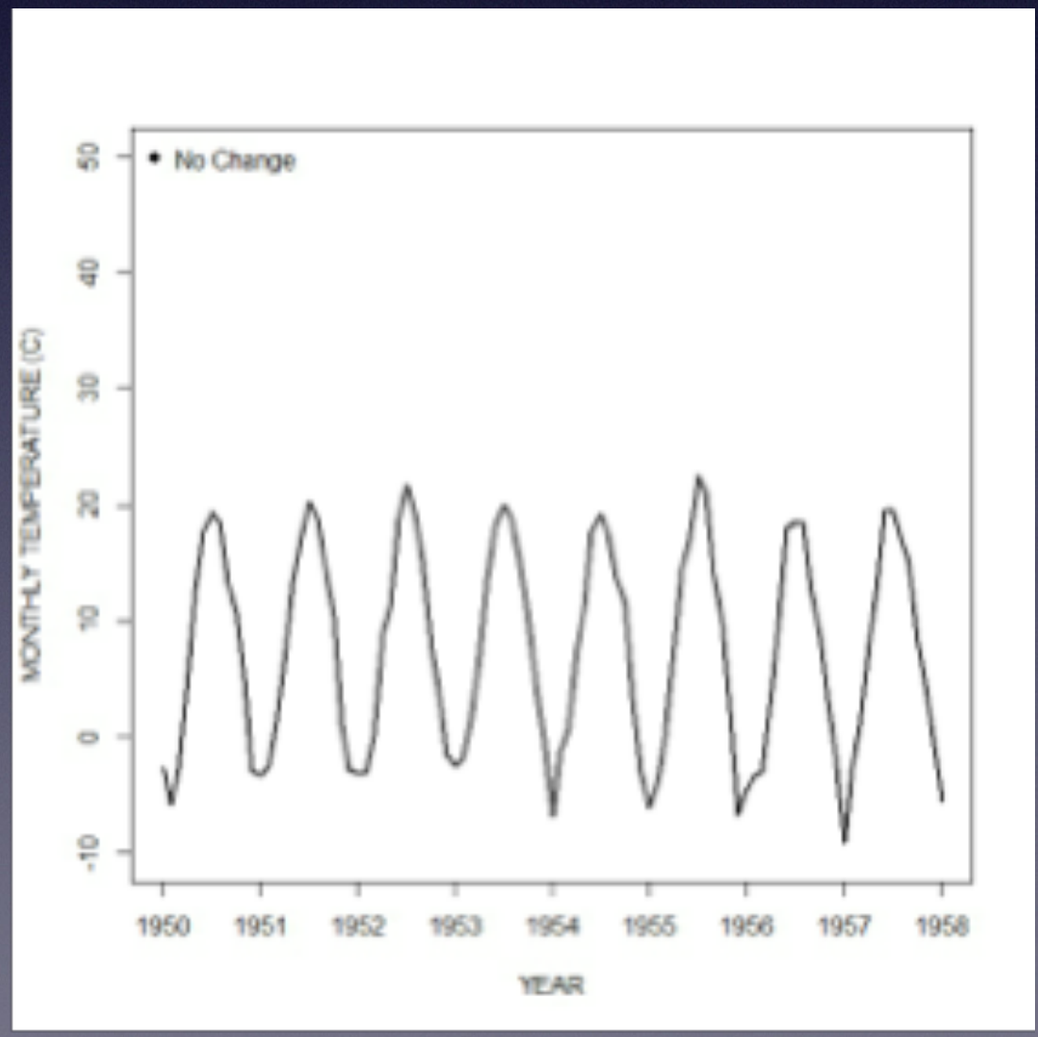
1 4 12

Additional Minimum Flow (MGM):

0 100

Hedge

Average Monthly Temperature (C)



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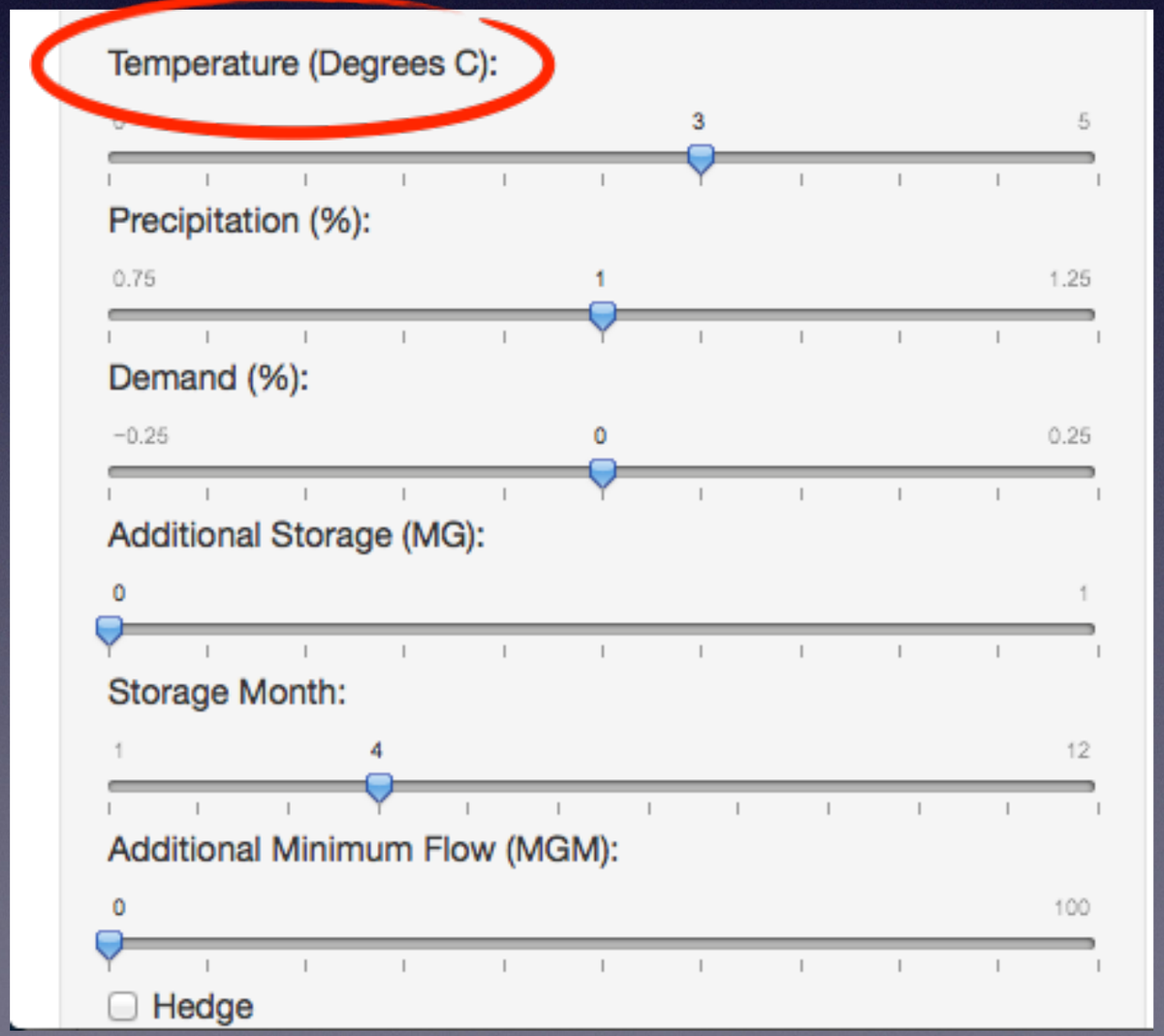

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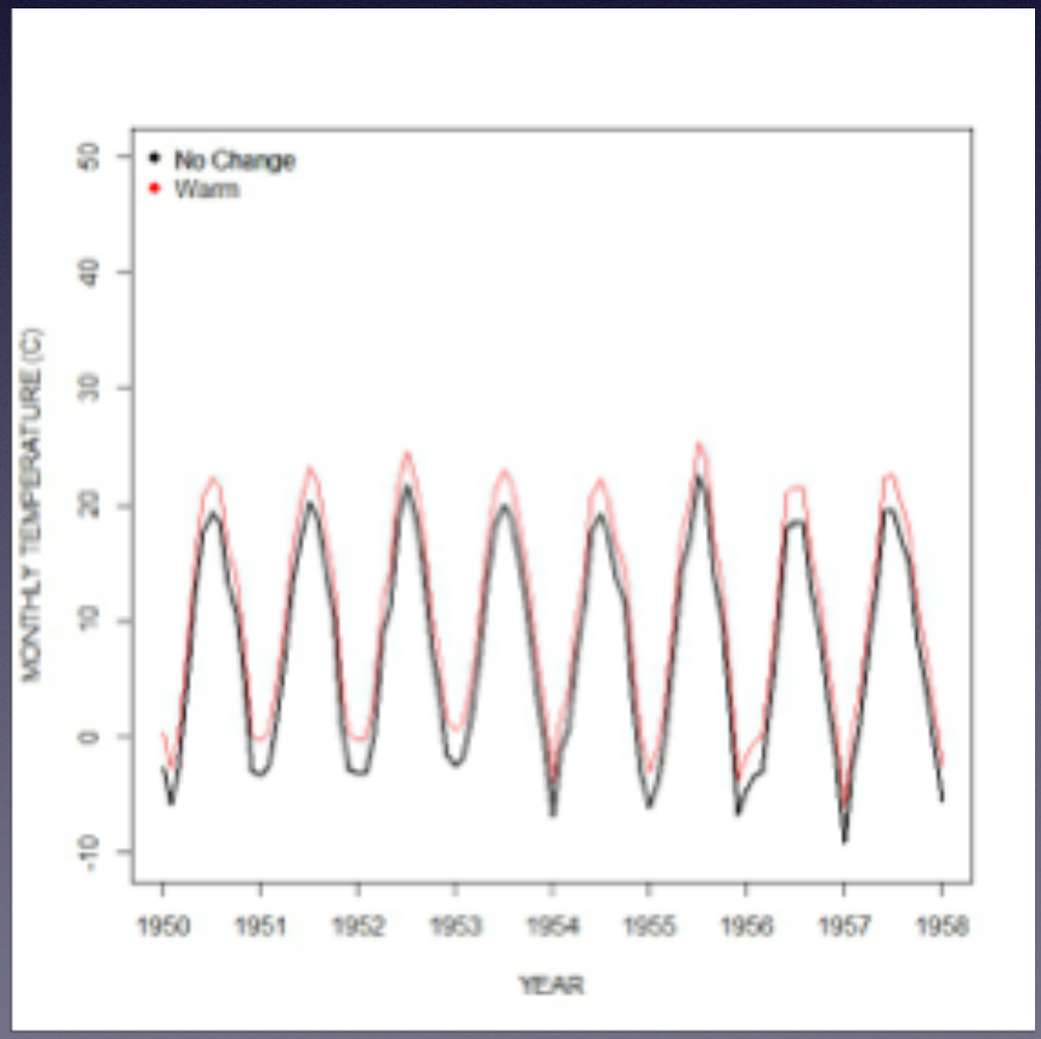

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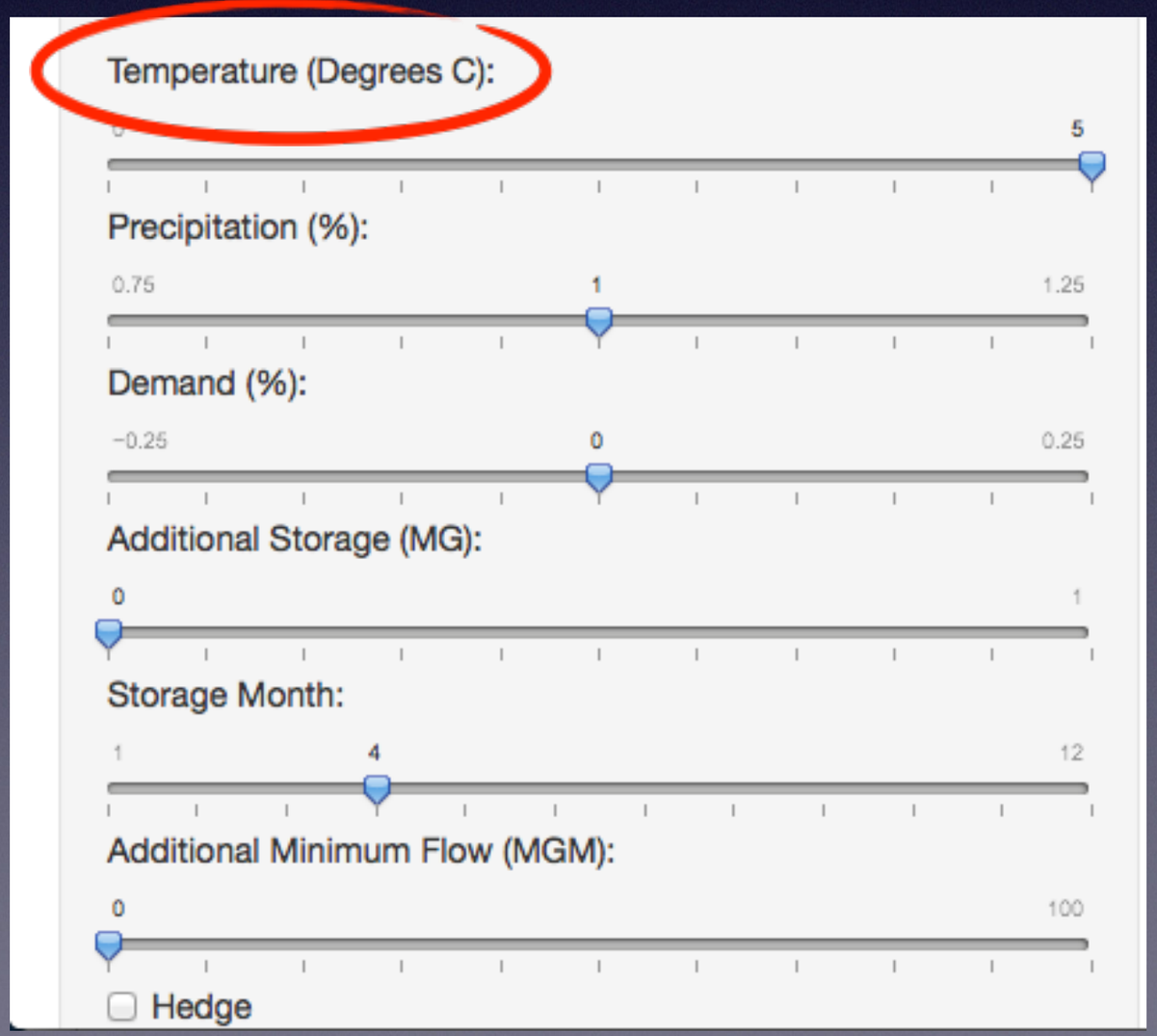
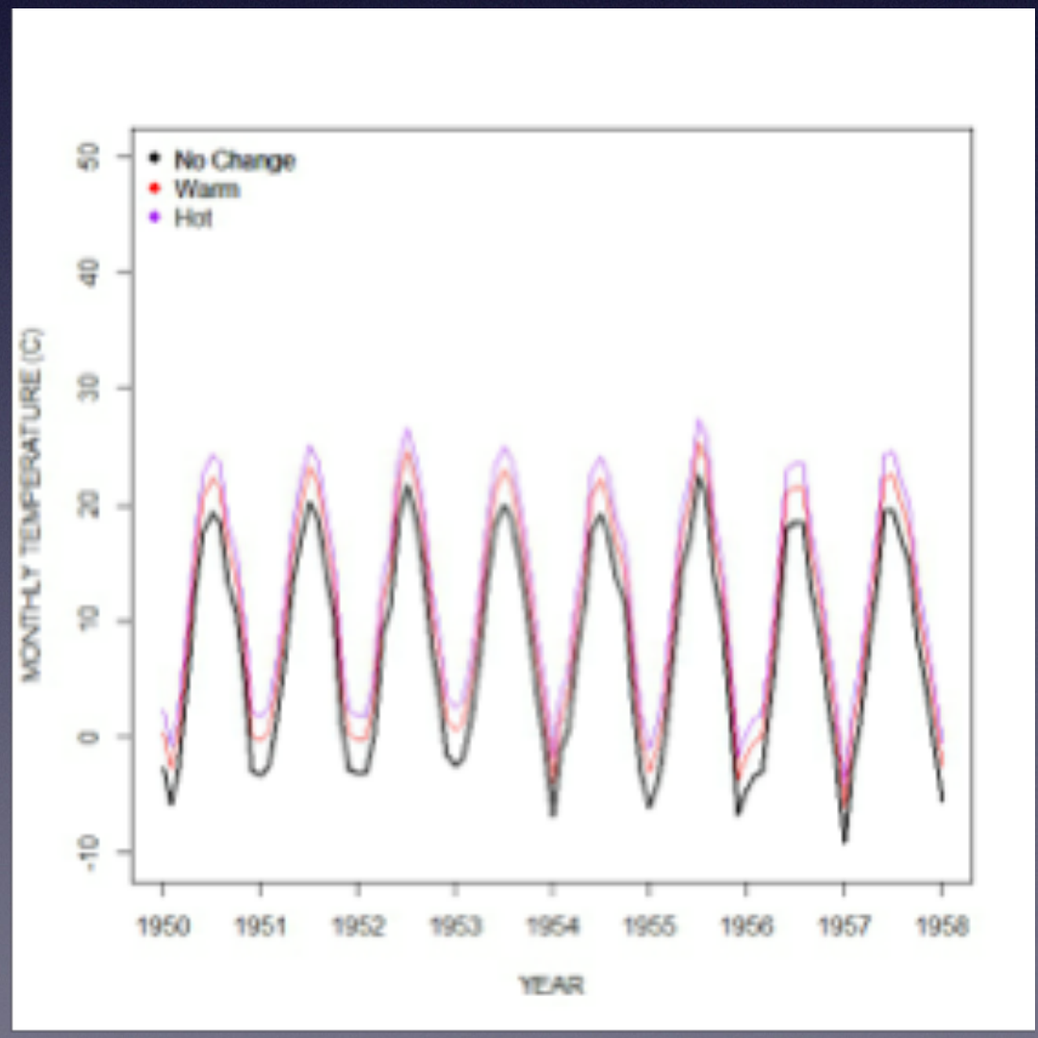


Average Monthly Temperature (C)



Explore effects of Precip Change

Weather Generator

Specify a change to mean precipitation & mean temperature

Temperature (Degrees C):

0 — 5

Precipitation (%):

0.75 — 1 — 1.25

Demand (%):

−0.25 — 0 — 0.25

Additional Storage (MG):

0 — 1

Storage Month:

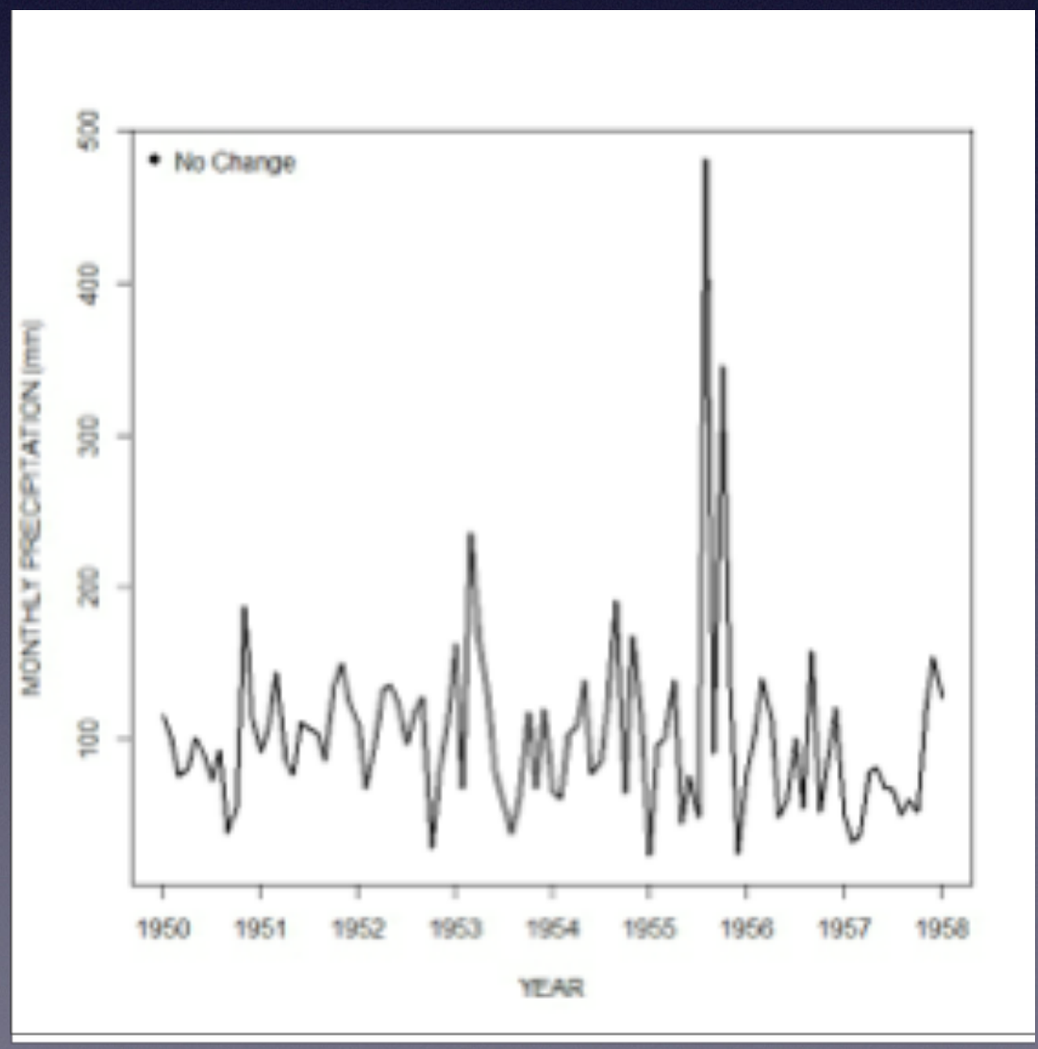
1 — 4 — 12

Additional Minimum Flow (MGM):

0 — 100

Hedge

Average Monthly Precipitation (mm)



Explore effects of Precip Change

Weather Generator

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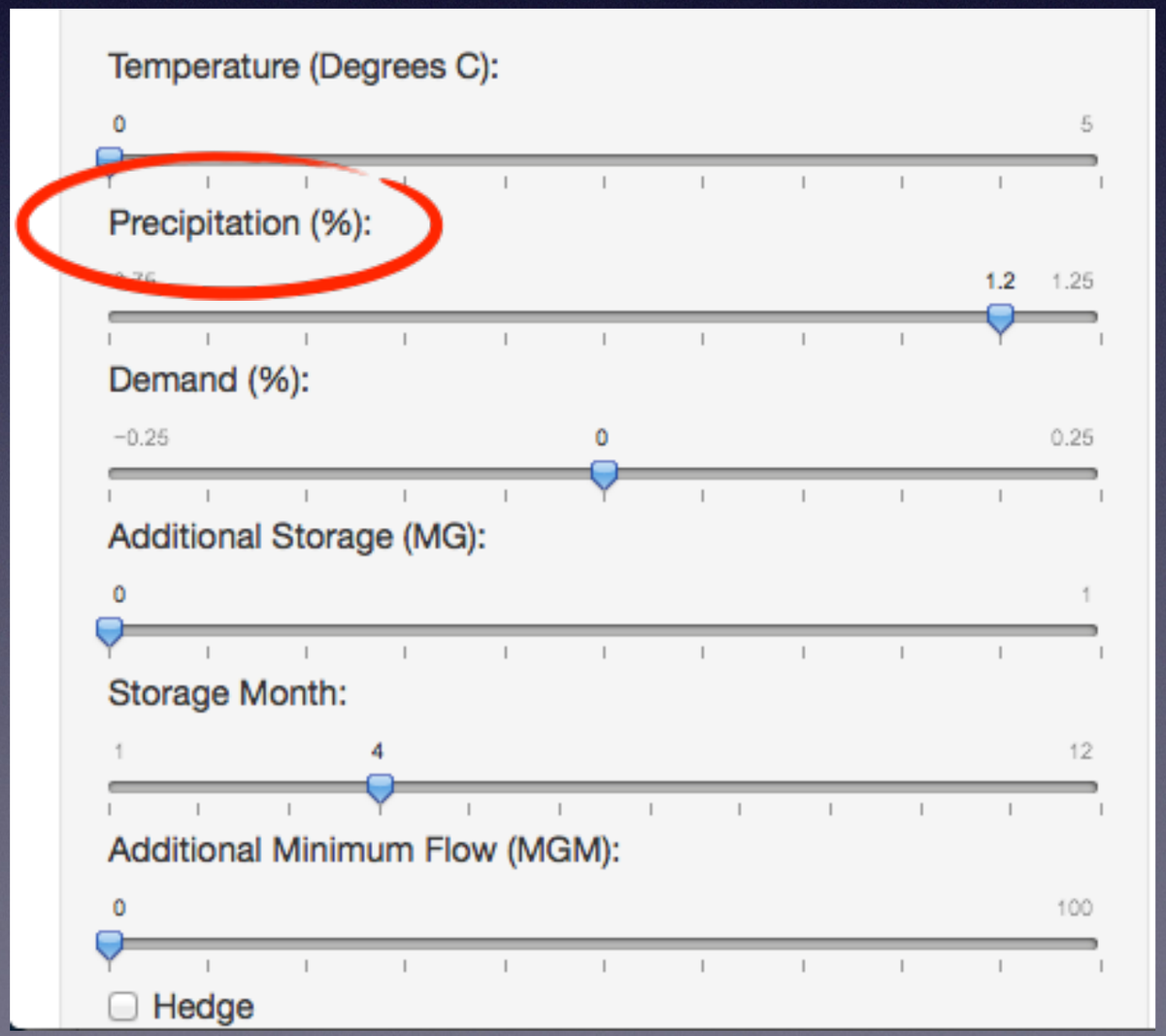
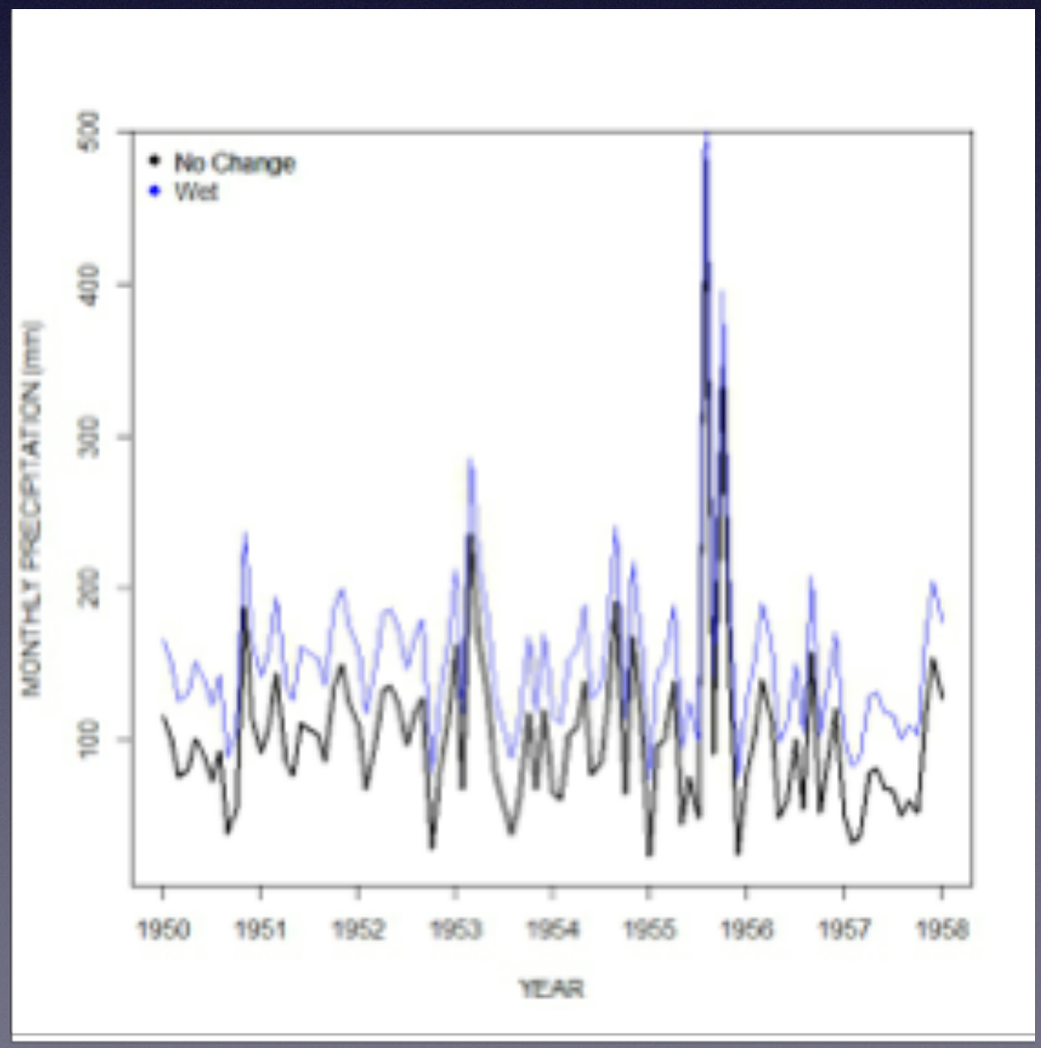


Average Monthly Precipitation (mm)



Explore effects of Precip Change

Weather Generator

Specify a change to mean precipitation & mean temperature

Temperature (Degrees C):

0 — 5

Precipitation (%):

0.75 — 0.8 — 1.25

Demand (%):

−0.25 — 0 — 0.25

Additional Storage (MG):

0 — 1

Storage Month:

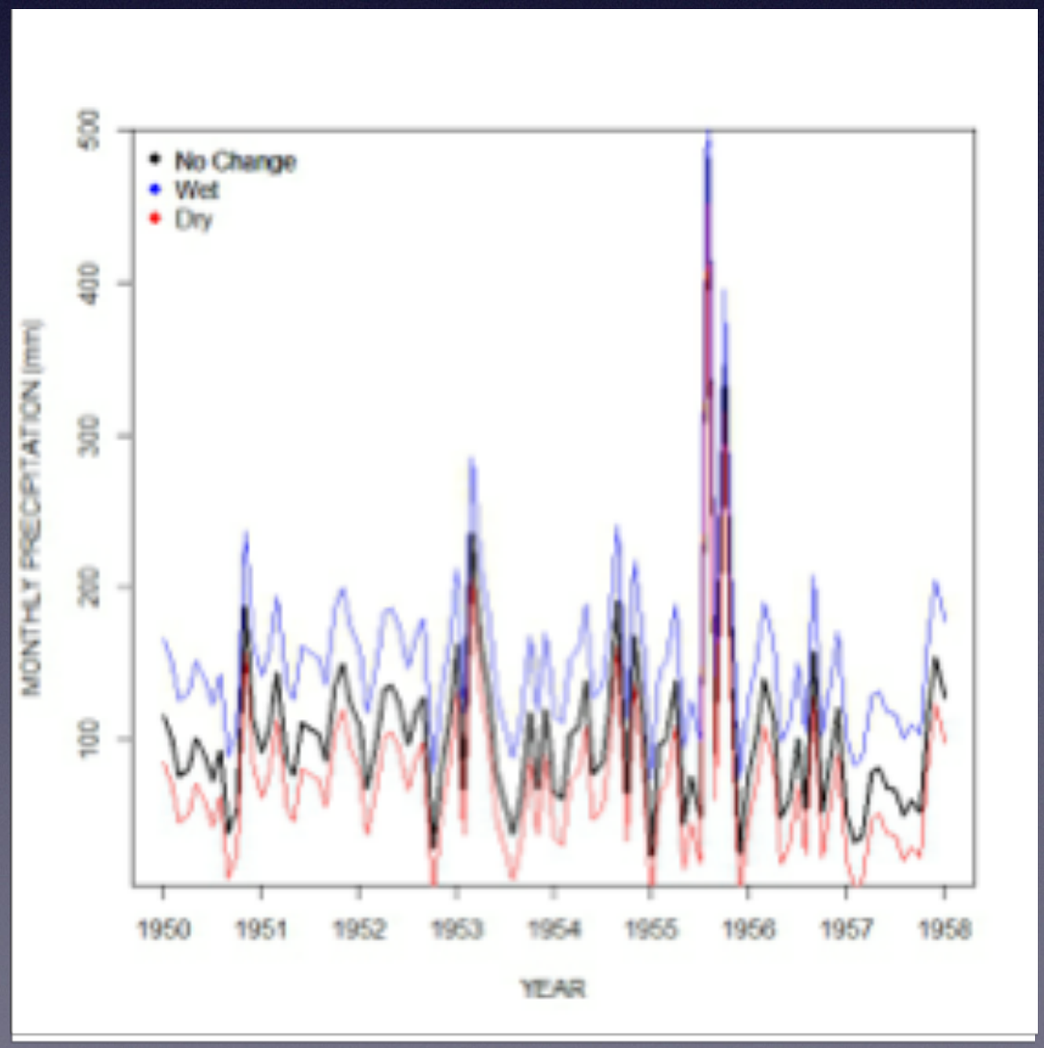
1 — 4 — 12

Additional Minimum Flow (MGM):

0 — 100

Hedge

Average Monthly Precipitation (mm)



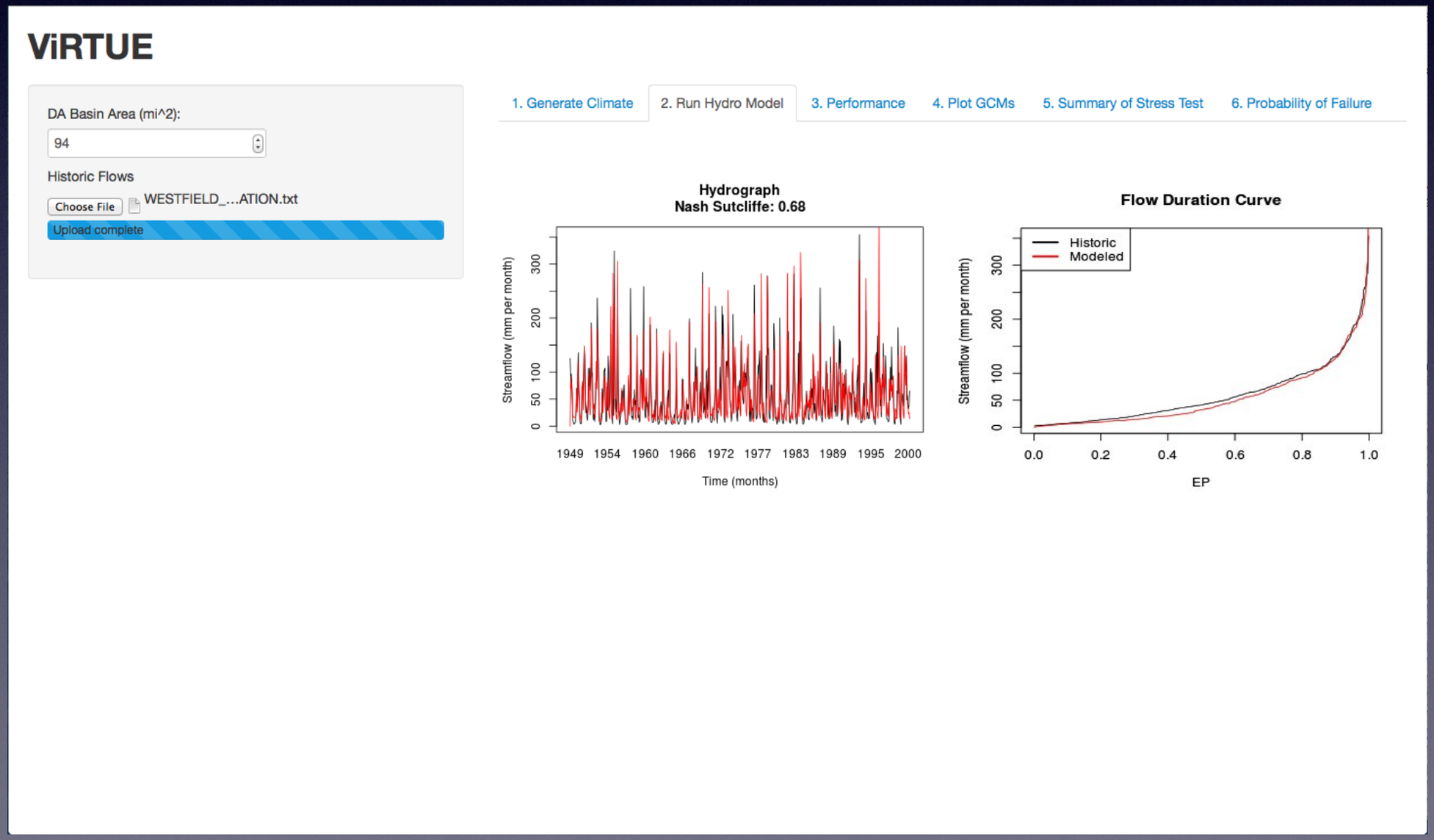
Model Inflow Changes

ABCD Hydrology Model

Inputs (direct data):
Historic reservoir inflows
Drainage area of reservoir

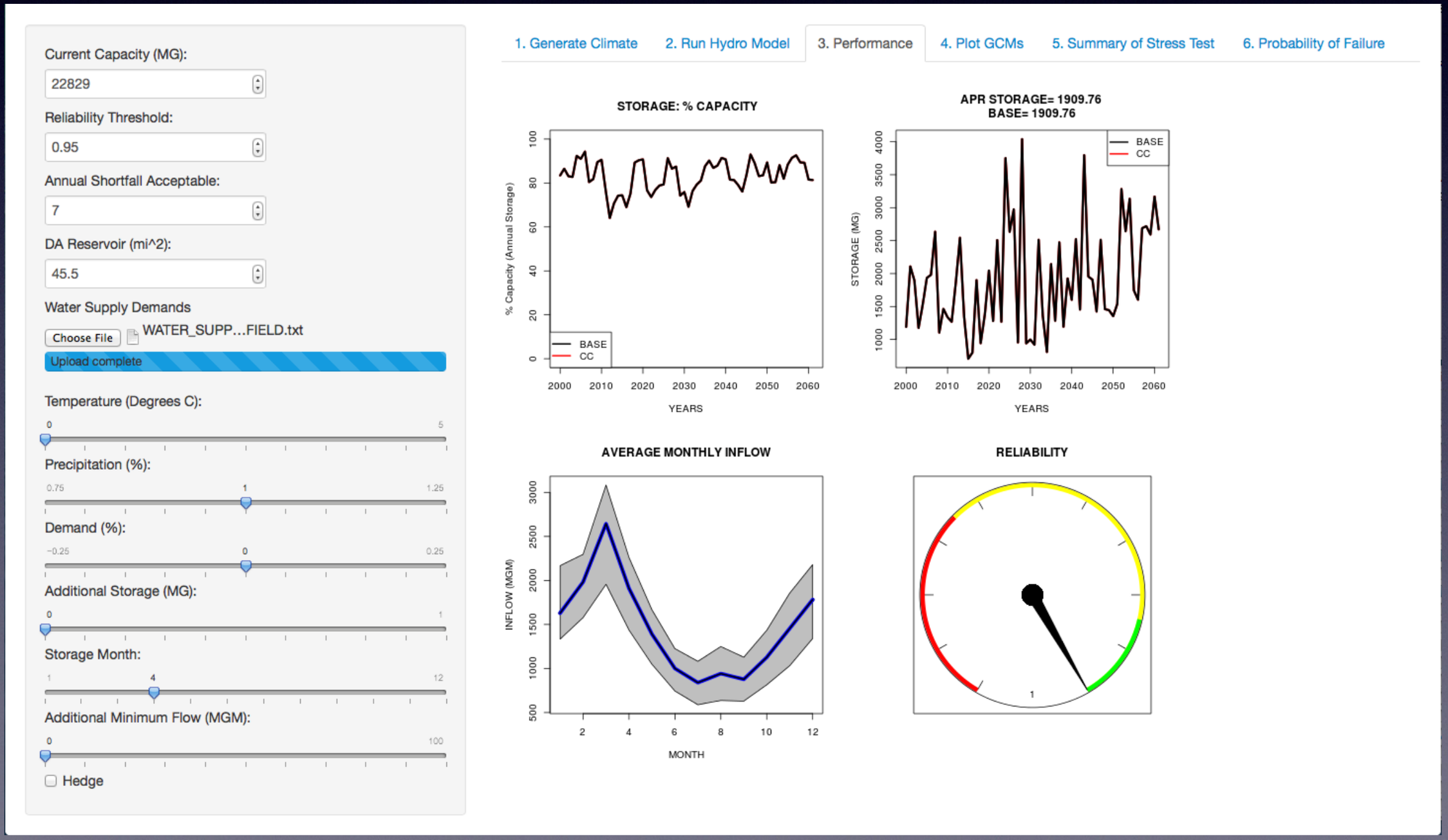
Inputs (regionalized):
Historic gaged inflows
Drainage area of reservoir
Drainage area of gage

Hydrology Model



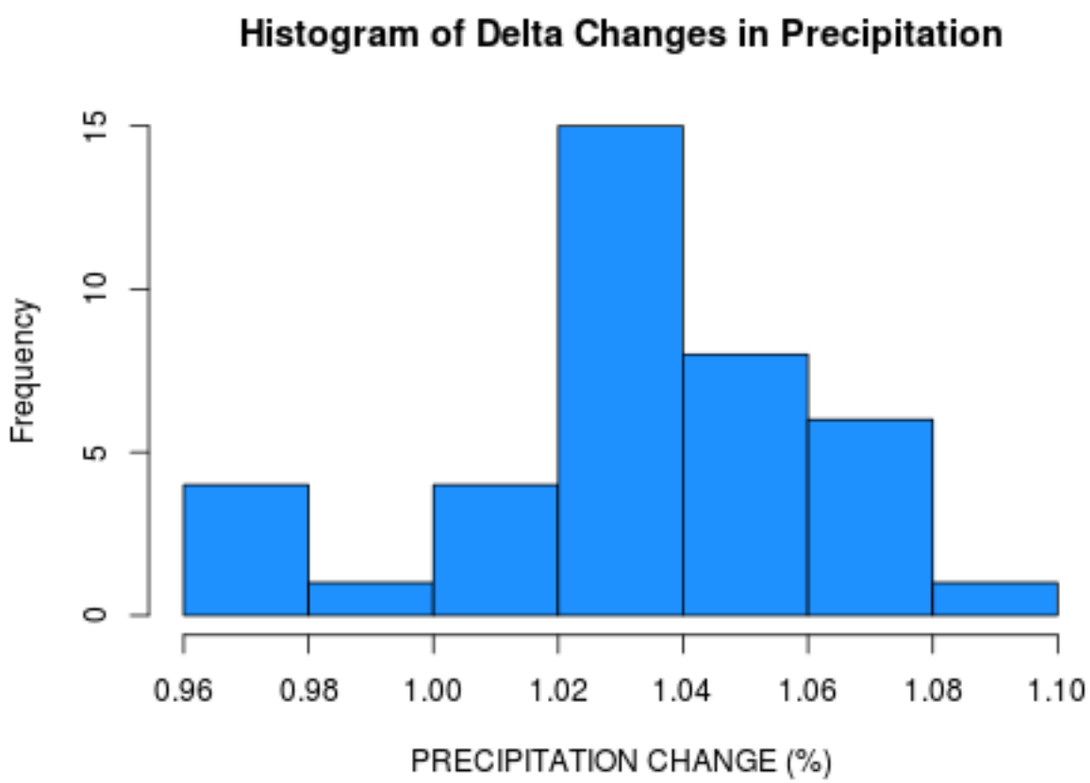
Results: Water Supply Performance

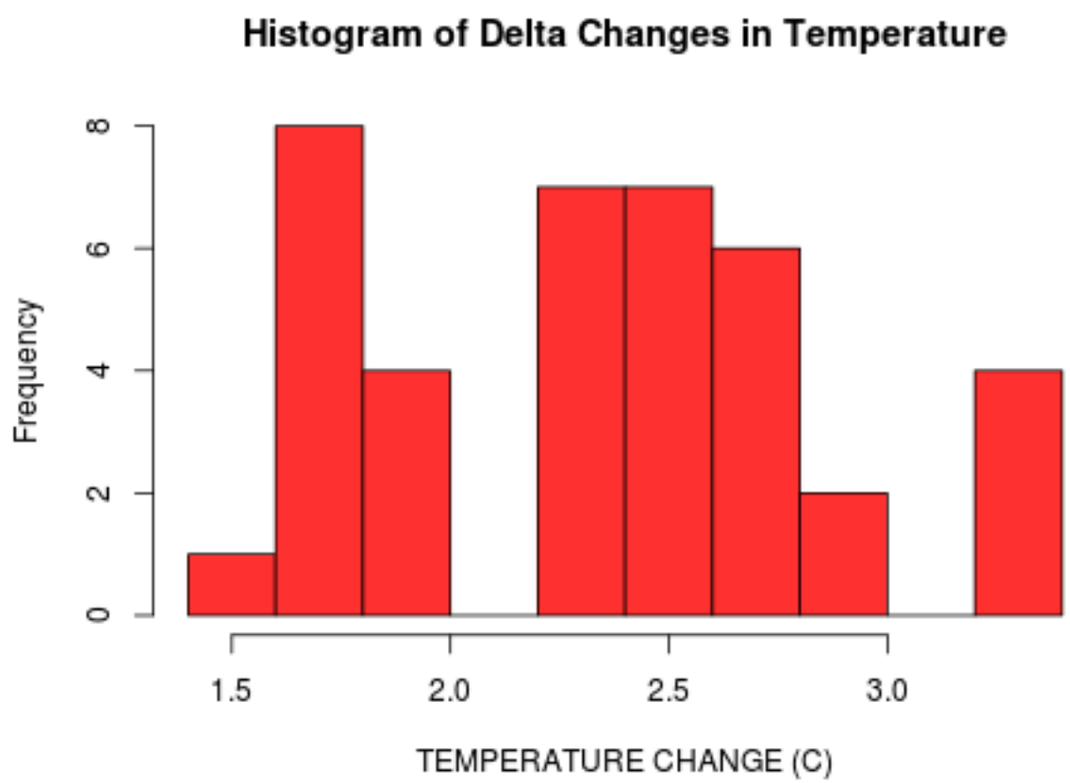
Inputs:
Reservoir capacity
Monthly water demands
Reliability threshold
Drainage area of Reservoir



Projections of climate change from climate models

1. Generate Climate | 2. Run Hydro Model | 3. Performance | 4. Plot GCMs | 5. Summary of Stress Test | 6. Probability of Failure





Climate Change in Context

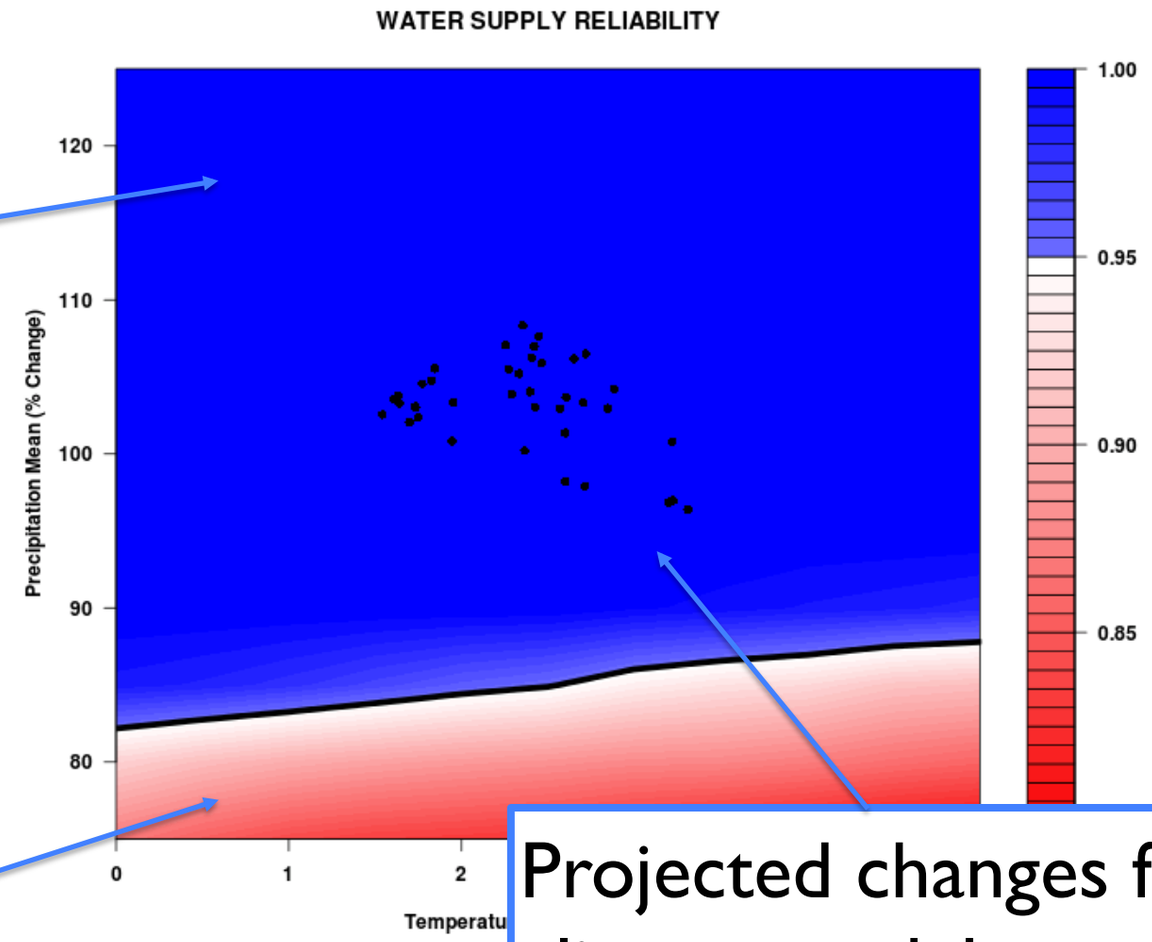
ViRTUE

Reliability Threshold:

0.95

Hedge

1. Generate Climate | 2. Run Hydro Model | 3. Performance | 4. Plot GCMs | 5. Summary of Stress Test | 6. Probability of Failure



Blue = climate changes that pose no problems

Red = climate changes that pose problems

Projected changes from climate models

Probability of Problematic Climate Change

ViRTUE

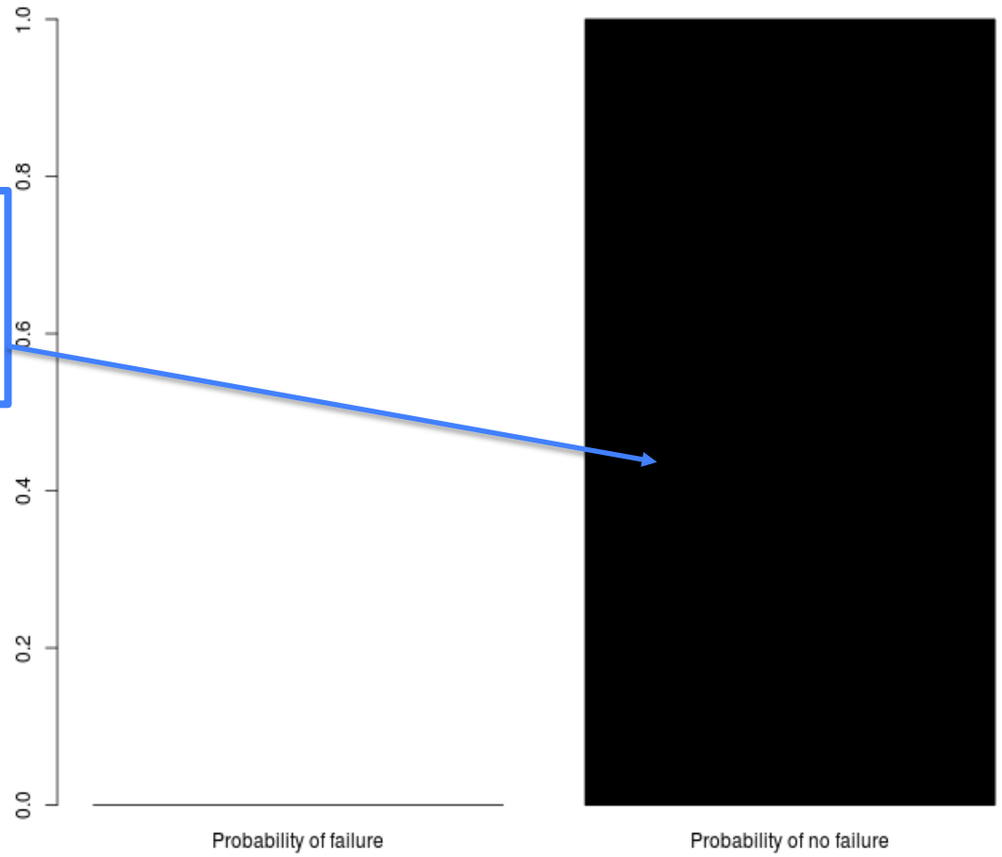
Reliability Threshold:

0.95

Hedge

1. Generate Climate | 2. Run Hydro Model | 3. Performance | 4. Plot GCMs | 5. Summary of Stress Test | 6. Probability of Failure

Probability of failure based on CMIP3 climate projections



Probability of acceptable climate change

Summary

- ViRTUE designed for easy assessment of climate change risks to any surface water system
  - (Would like to incorporate GW)

- Provides context for the overwhelming uncertainty of climate change projections

- Online platform for open access

- Looking for case studies, interest, support, feedback.

Summary

- ViRTUE: tool designed for rapid assessment of water supply risks due to climate change

- User inputs the attributes of their system

- Calculates system performance under climate change
  - Automatic calibration of hydrologic model
  - Simulate basic reservoir operations
  - Statistically downscaled climate projections

- Options for user to explore various future scenarios
  - Changes in precipitation and temperature
  - Changes in demand
  - Changes in minimum flow releases

Questions?

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hydrosystems.ecs.umass.edu

http://spark.rstudio.com/climatetool/myapp/

Sponsored by NOAA Sectoral Applications Research Program and RISA – Consortium for Climate Risk in the Urban Northeast