Climate Change Toolbox: Developing Scenarios for Climate Impact Assessments

Mike Crimmins
Dept. of Soil, Water, & Env. Science &
Arizona Cooperative Extension
The University of Arizona

Presentation Overview

- What are climate change scenarios and what are they good for?
- How are climate change scenarios developed?
- Case study: Mojave Desert Site

What are climate change scenarios?

- "…a coherent, internally consistent and plausible description of a possible future state of the world…" (Parry and Carter 1998)
- "…a plausible future climate that has been constructed for explicit use in investigating the potential consequences of anthropogenic climate change…" (IPCC TAR, 2001)
- **A scenario is not a prediction of future climate**

From the Canadian Climate Scenarios Network Website
http://www.ccsn.ca/Scenarios/Scenarios_Introduction-e.html

What can you do with scenarios?

- Climate change data for vulnerability, impacts, and adaptation assessment studies
- Guidance for strategic planning and policy development
- Device to raise awareness of potential changes
- Tool to link changes in large-scale means and variability on local climate regimes

From the Canadian Climate Scenarios Network Website
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Types of climate scenarios

- Synthetic scenario: perturb historic climate by arbitrary amounts; useful in model sensitivity analyses
- Analog scenario: Use climate records from the past (temporal analogs) or other locations (spatial analogs) that may represent future climate regimes
- GCM-based scenarios: projections of future climate based on numerical models representing physical processes including changes in greenhouse gas concentrations

IPCC-TGCIA 1999

Downscaling GCM Projection Data for Local Climate Scenarios

- Downscaling: a method for generating high-resolution climate change information from coarse-resolution GCMs
- GCM Resolutions: 100–300km (regional climate models ~50km)
- Impact and vulnerability assessments often require much finer spatial and temporal resolutions
- Regional climate models (dynamical downscaling)
- Statistical downscaling methods are most common

Downscaling GCM-based Scenarios

- Derive statistical relationships between observed station-scale climate variables and large-scale GCM variables
- Main statistical downscaling methods
  - Weather typing
  - Regression methods
  - Stochastic weather generators
- General strengths: Easy to implement; generate site specific information
- General weaknesses: assume that statistical relationships are time invariant under different future climates/forcings; mis-interpretation of increased resolution

Wilby et al., 2004

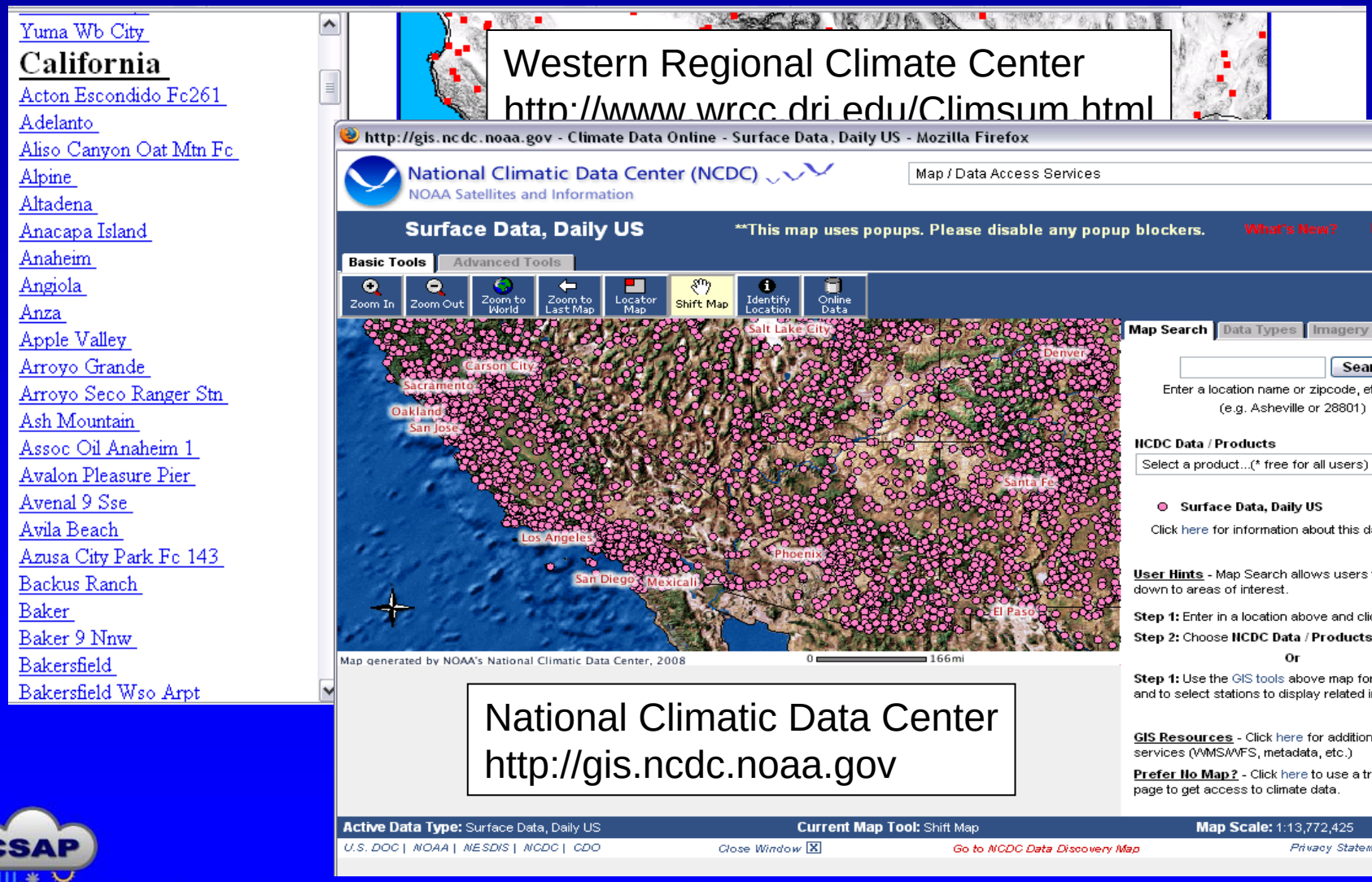
Case Study: Climate Change Scenario for Mojave Desert Site

- Develop plausible temperature and precipitation time series based on GCM output for Mojave desert location
- Connect climate change scenario to creosote state & transition model to assess potential future transitions
- Use weather generator (LARS-WG; http://www.rothamsted.bbsrc.ac.uk/mas-models/larswg.php) to connect GCM projections to local climate regimes

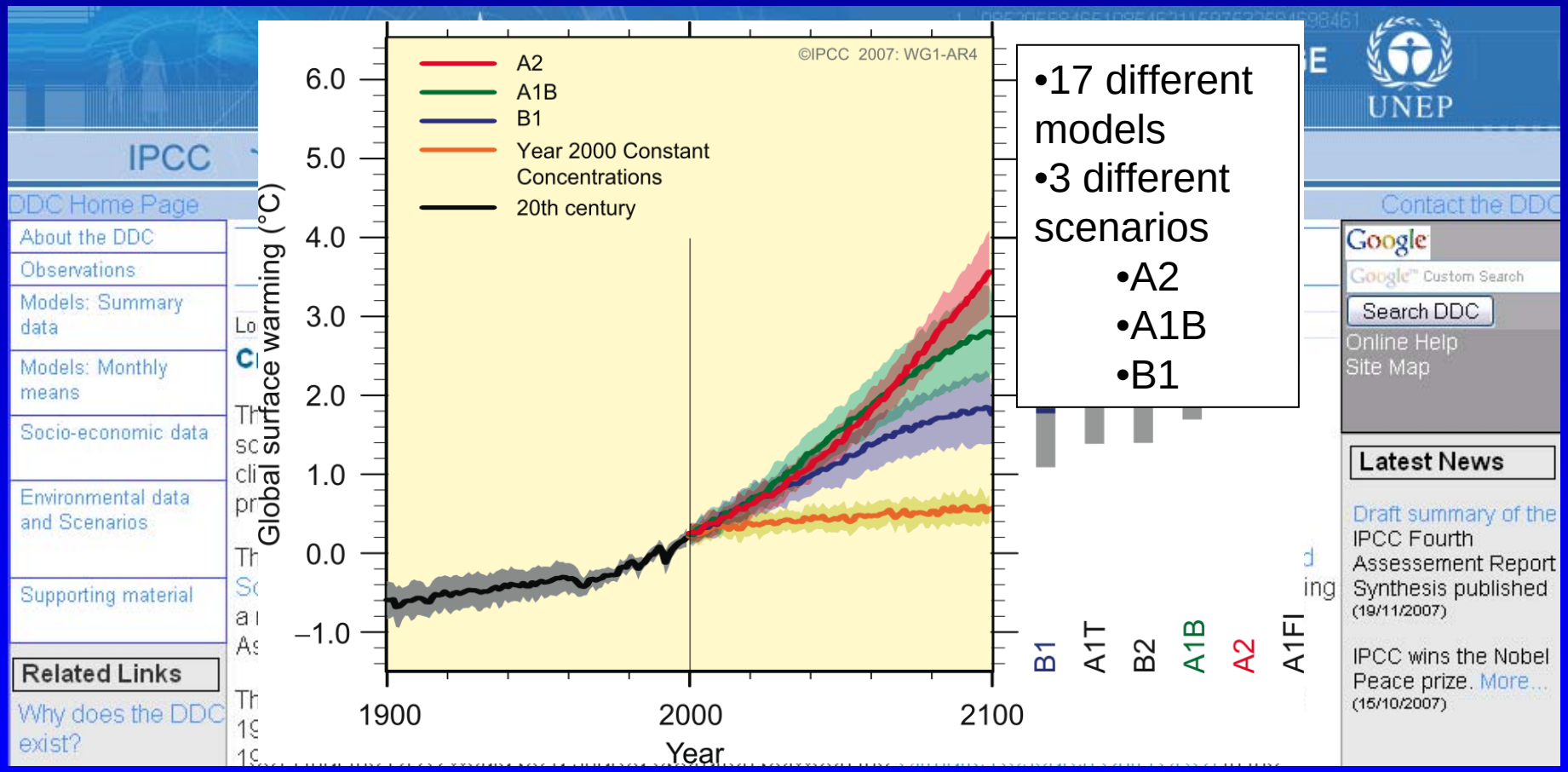
LARS-WG

- Produces synthetic time series of weather data based on statistical characteristics of observed weather at a location
- Precipitation: alternating wet/dry series from empirical distribution
- Temperature: randomly sampled with daily means/std dev conditioned on wet/dry status of day.
- Site analysis used to capture statistics of local time series
- Scenario file used to change statistical properties of site analysis

Step 1: Find local climate data

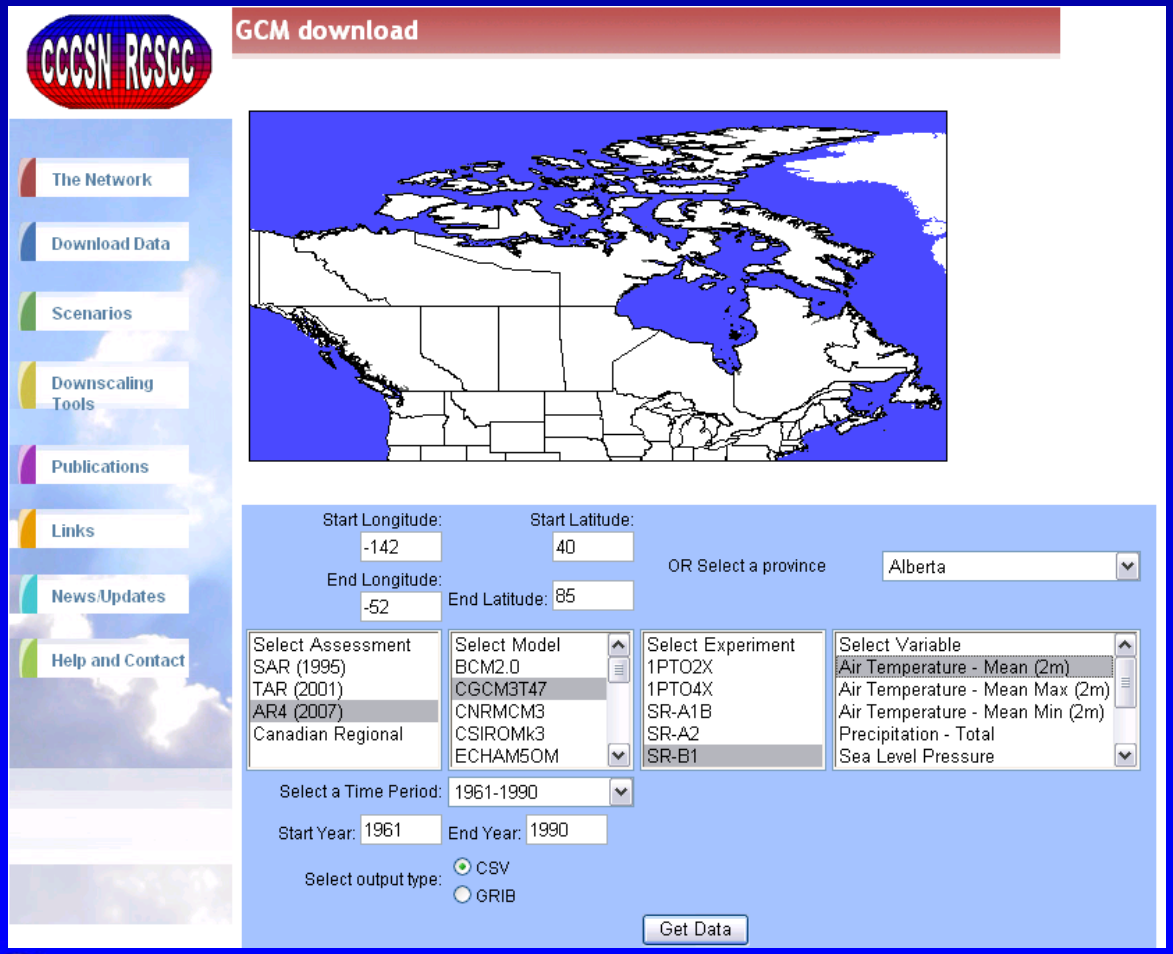


Step 2: Find GCM data



http://www.ipcc-data.org/index.html

Alt. Step 2: Find GCM data



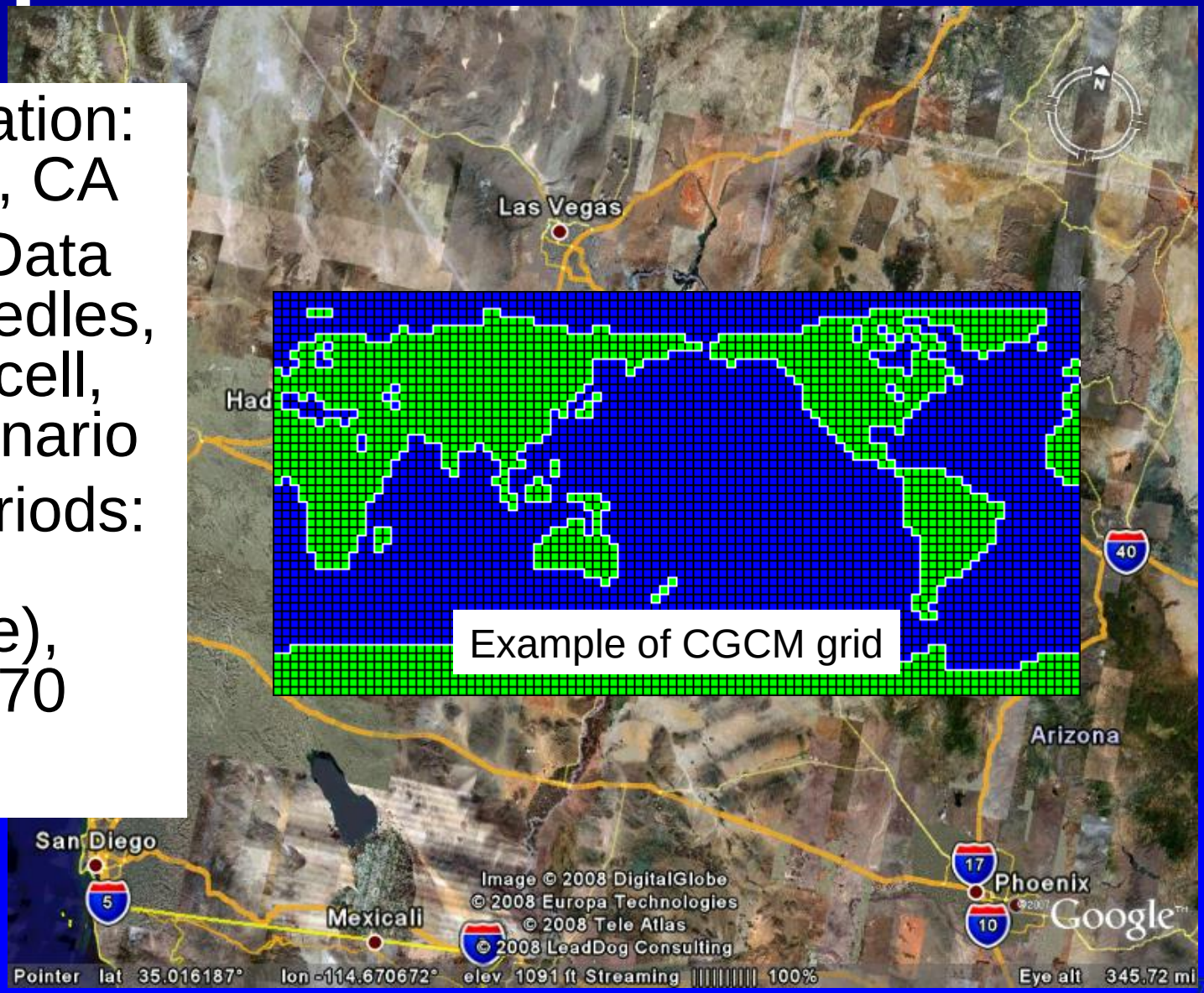
5 Models Examined

- Canadian Center for Climate Modeling and Analysis (CGCM3)
- NOAA Geophysical Fluid Dynamics Laboratory (CM2.0)
- NASA Goddard Institute for Space Studies (AOM)
- National Center for Atmospheric Research (PCM)
- UK Met Office (HadCM3)

http://www.ccsn.ca/Download_Data/Download_Data_GCM-e.html

Step 3: Extract GCM data

- Local station: Needles, CA
- GCMs: Data from Needles, CA grid cell, A1B scenario
- Time periods: 1961-90 (baseline), 2011-2070 (future)



Step 4: Develop change scenarios

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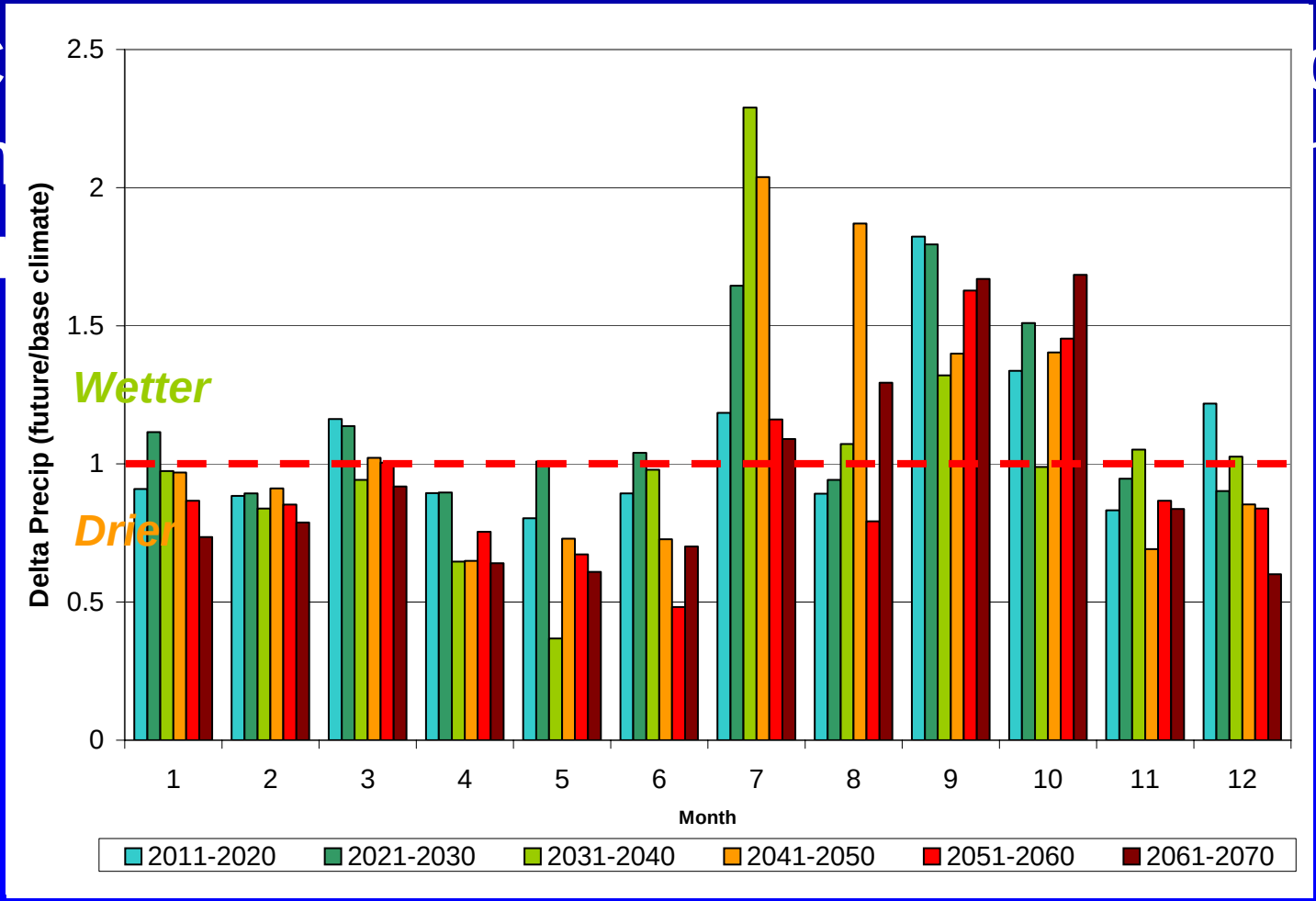
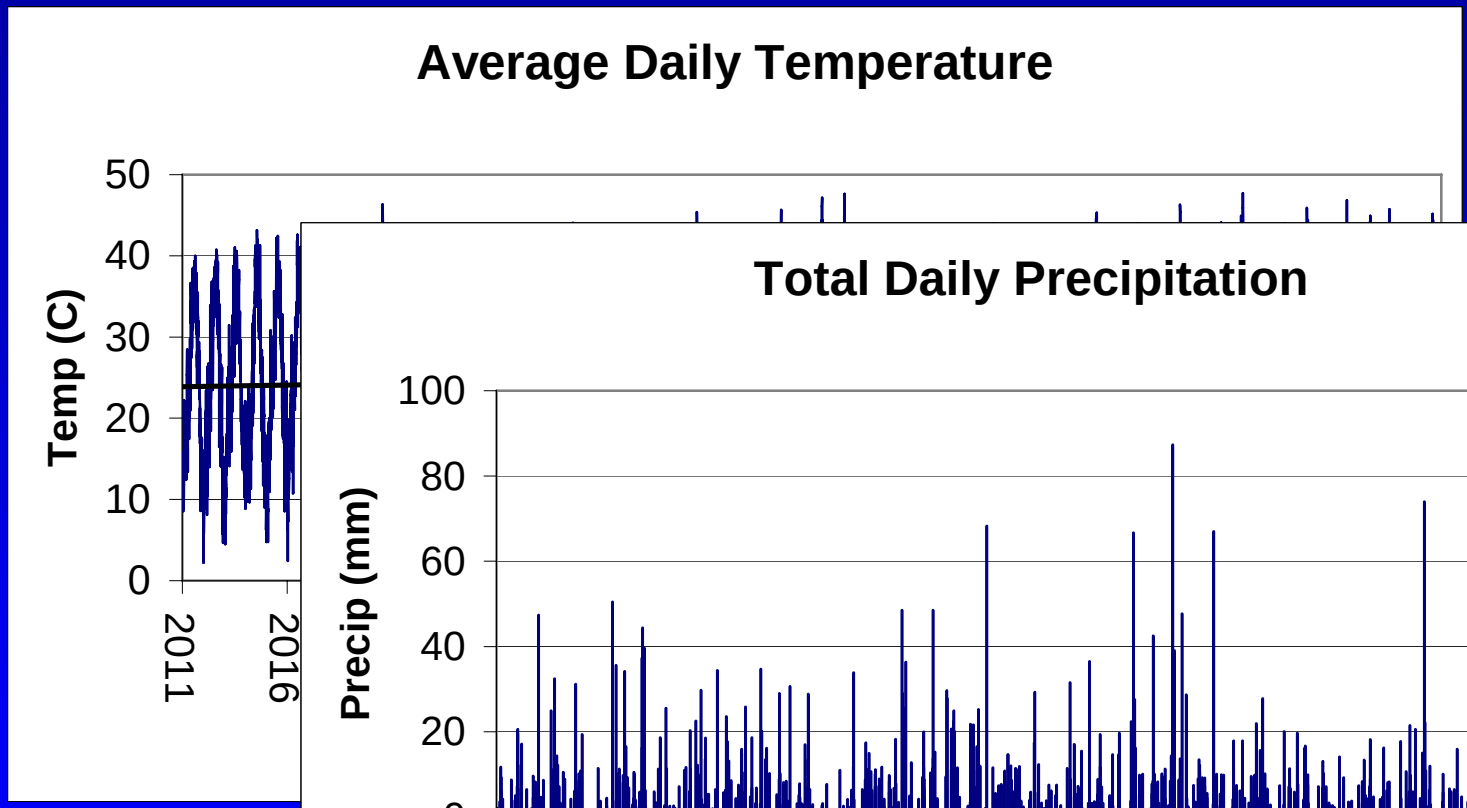


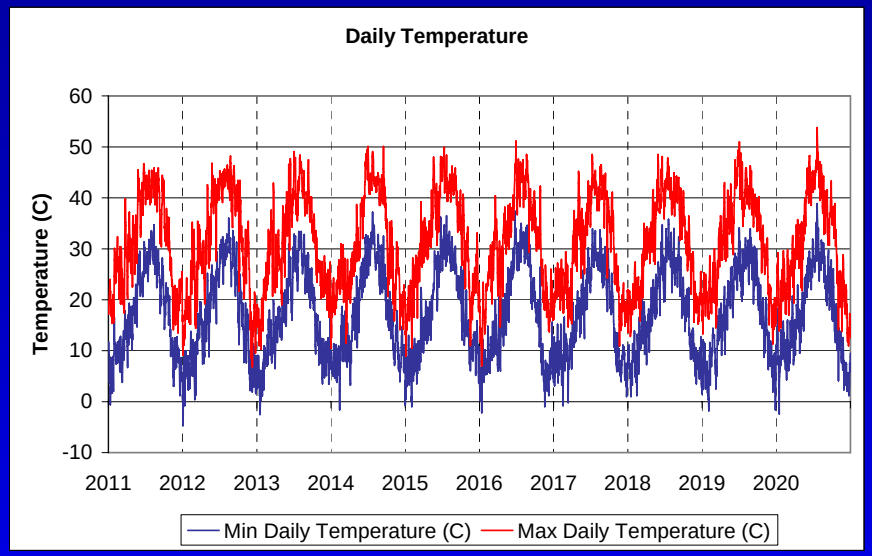
Step 5: Generate synthetic time series

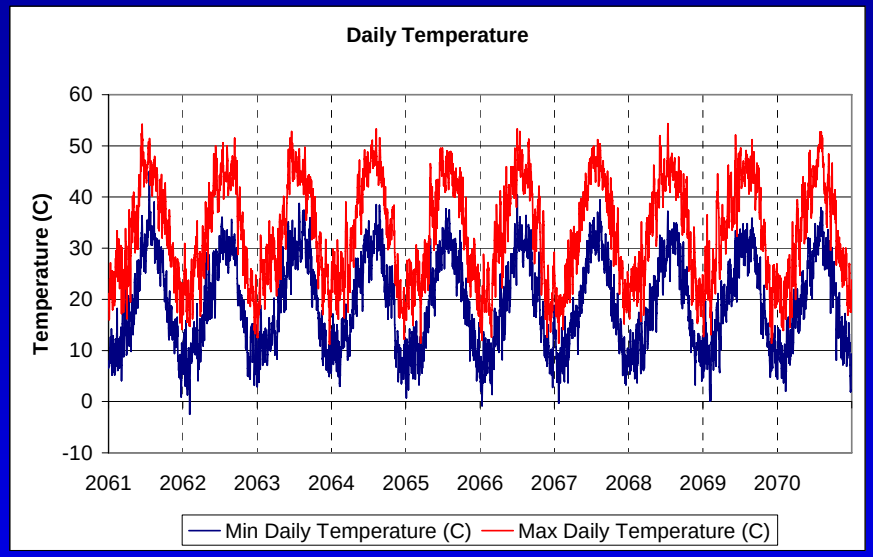
- Initialize LARS-WG with Needles temperature and precipitation data (1949-2007)
- Implement scenario data file (5 model ensemble means, six 10-yr periods, 2011-2070)
- Generate synthetic time series for each 10-yr period

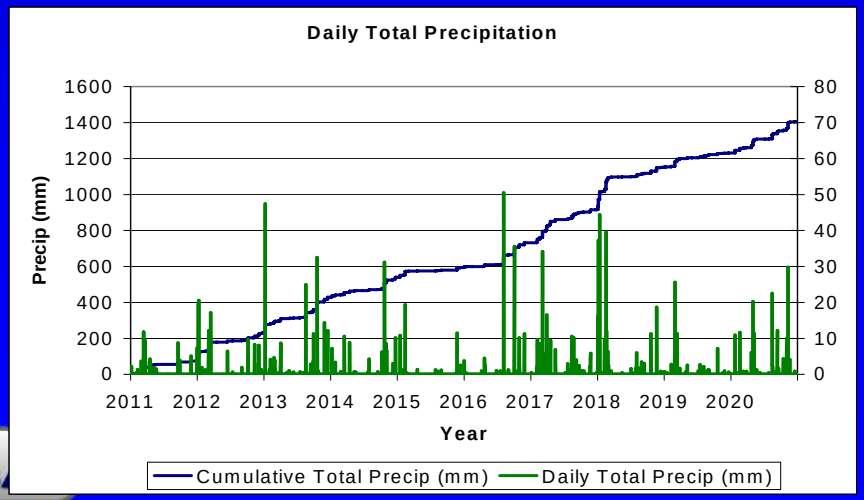
Downscaled Scenario Data

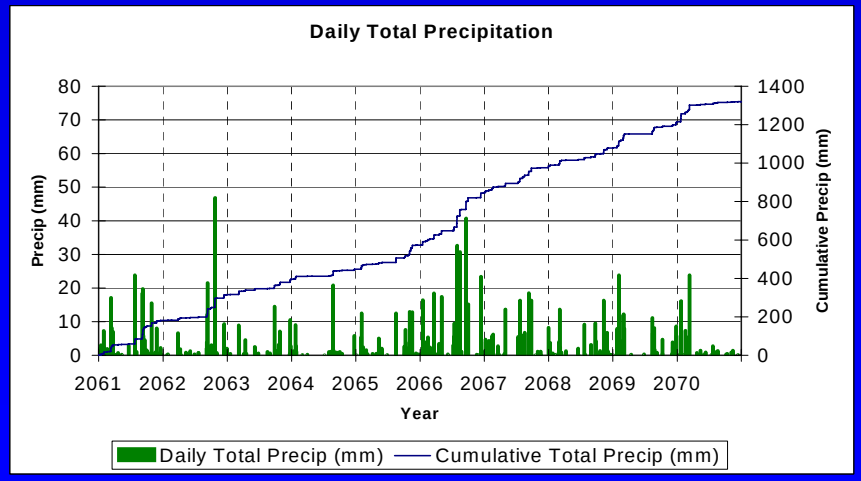


Downscaled Scenario Data









Caveat Emptor!

- Weather generators do not reproduce low-frequency variability (e.g. ENSO-precipitation relationships)
- Daily GCM data required to evaluate changes in variability
- GCMs have trouble capturing precipitation variability-lower confidence in projections (evaluate baseline period against local data)

Lessons Learned

- Many datasets and guidance documents are available on the web for climate impact assessments, but difficult to find, access, and process
- Need for better guidance in selecting GCM data (evaluation with respect to local observations)
- Need for better data access tools (multiple formats, visualization)
- Online downscaling tools? Regional climate model data access?
- Are ecosystem/resource management models available to use with climate change scenario data?

Resources

- Canadian Climate Change Scenarios Network - http://www.cccsn.ca
- Information on Stochastic Weather Generators - http://www.ipcc-data.org/ddc_weather_generators.html
- General Guidelines on the use of Scenario Data for Climate Impact and Adaptation Assessment - http://www.ipcc-data.org/guidelines/index.html
- Southwest Climate Change Network – Coming soon!

email: crimmins@u.arizona.edu
http://cals.arizona.edu/climate