Statistically Downscaled Climate Data using the Multivariate Adaptive Constructed Analogs (MACA) Approach

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Introduction

- Downscaled climate datasets needed to drive hydrologic and ecologic models.
- Statistical downscaling methods are very efficient
- MACA method has recently been improved and applied
- MACA dataset is being used across the PNW for hydrological, ecological and crop modeling.

MACA Dataset Available for Download

- Multivariate Adaptive Constructed Analogs(MACA, Abatzoglou, Brown, 2012) Statistical downscaling method
- 1/16-deg(~6-km) gridded daily downscaling of 20 GCM outputs from CMIP5
- Covers CONUS and Canadian Columbia River Basin
- Historical, RCP 4.5, RCP 8.5 scenarios for 1950-2100
- Statistics from Livneh meteorological training dataset (Livneh et al, 2014)
- Variables:
  - tasmax -maximum temperature
  - tasmin -minimum temperature
  - pr -precipitation amount
  - rsds -downward solar radiation
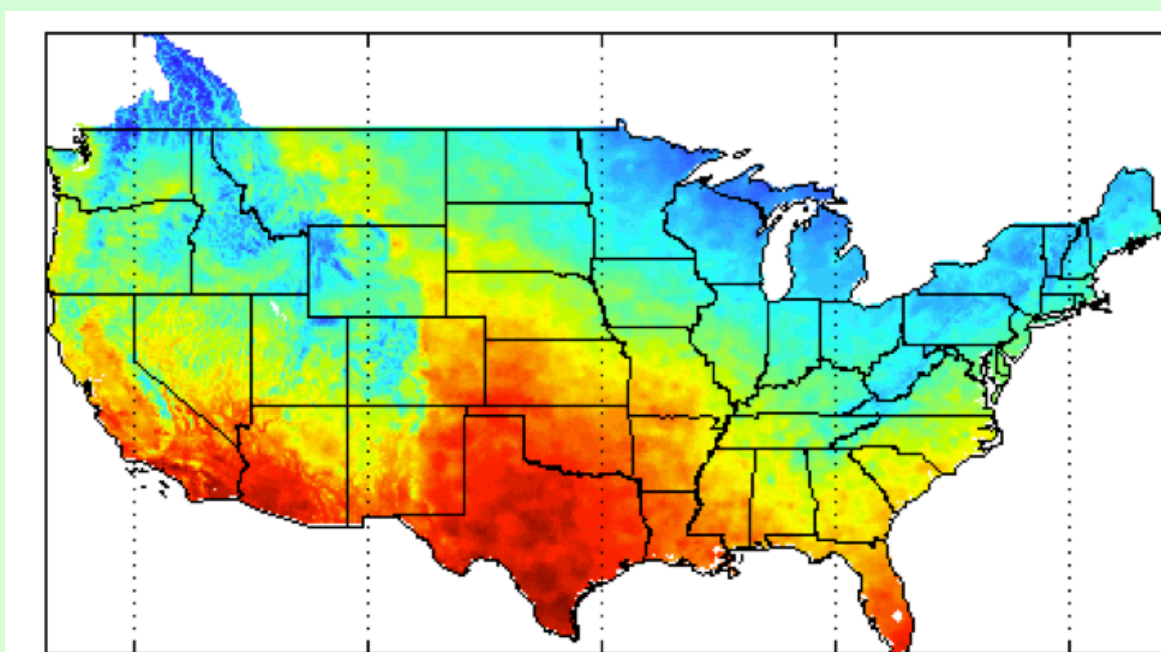 - huss -specific humidity
  - was -wind speed

Figure 1: *Spatial domain for MACA downscaling.*

Why MACA?

- Daily data
- Diverse set of variables
- Many scenarios and models available
- Multivariate approach captures co-dependencies in variables
- Improved downscaling over complex terrain
- Fewer stationarity assumptions
- Improved accuracy
- Better resolution of snow statistics
- Better preservation of GCM signal
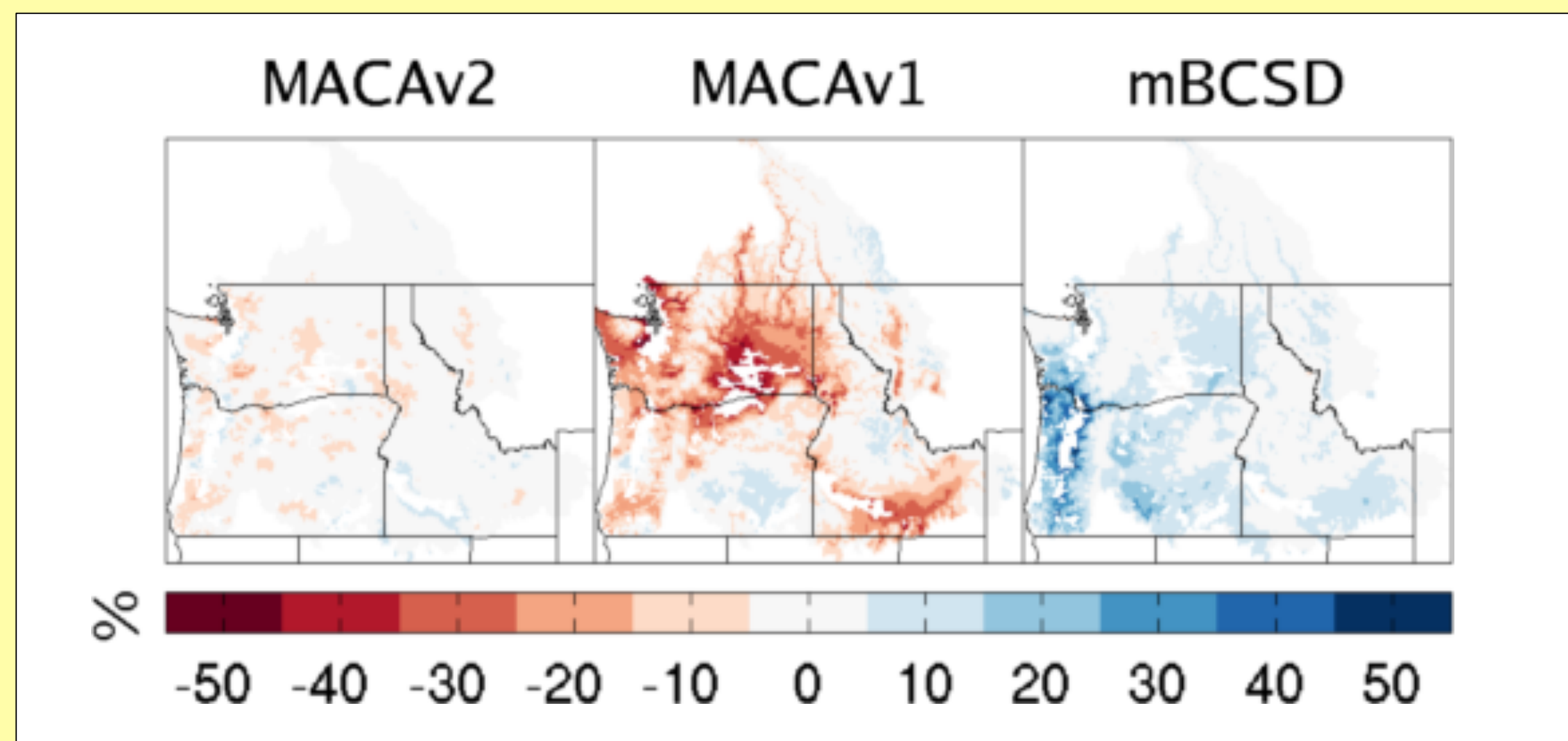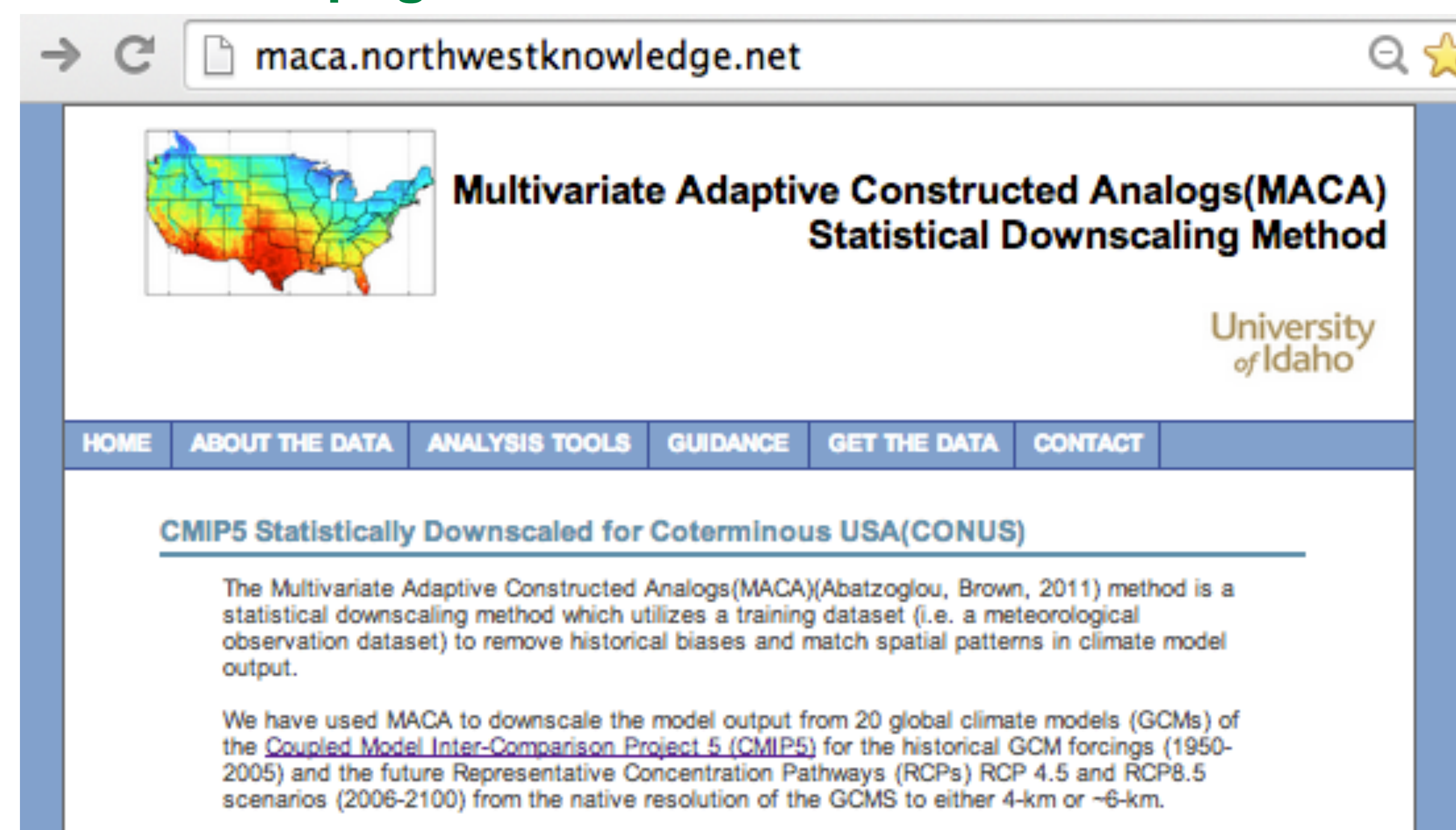- Current research on method (Hegewisch, Abatzoglou, in prep)

Figure 1: *Spatial map of historical percent bias in average annual snowfall(SFE) calculated from 3 statistical downscalings (MACAv2, MACAv1 and monthly Bias Correction Spatial Disaggregation (mBCSD, Wood et al, 2002)) of CCSM3e GCM outputs. SFE was estimated with the Dai method using downscaled temperature/precipitation and compared to that from the training dataset(OBS) used in the downscalings (Livneh et al, 2013) to calculate biases. MACAv2's Joint BC of T/P shows improvement over MACAv1 Indep BC of T/P comparable to mBCSD (which takes days of T/P directly from the OBS dataset). Locations with annual SFE<50 mm are masked out from the map.*

MACA Webpage

maca.northwestknowledge.net

Description of the Data

- CMIP5 Project and Scenarios
- Training dataset
- Technical details of MACA method

Analysis Advice/Guidance

- Ensemble vs Scenario Studies
- Selecting GCMs
- Best analysis practices

Download Tools to Get Data

- Northwest Knowledge Network (http://maca.northwestknowledge.net)
  - netCDF format
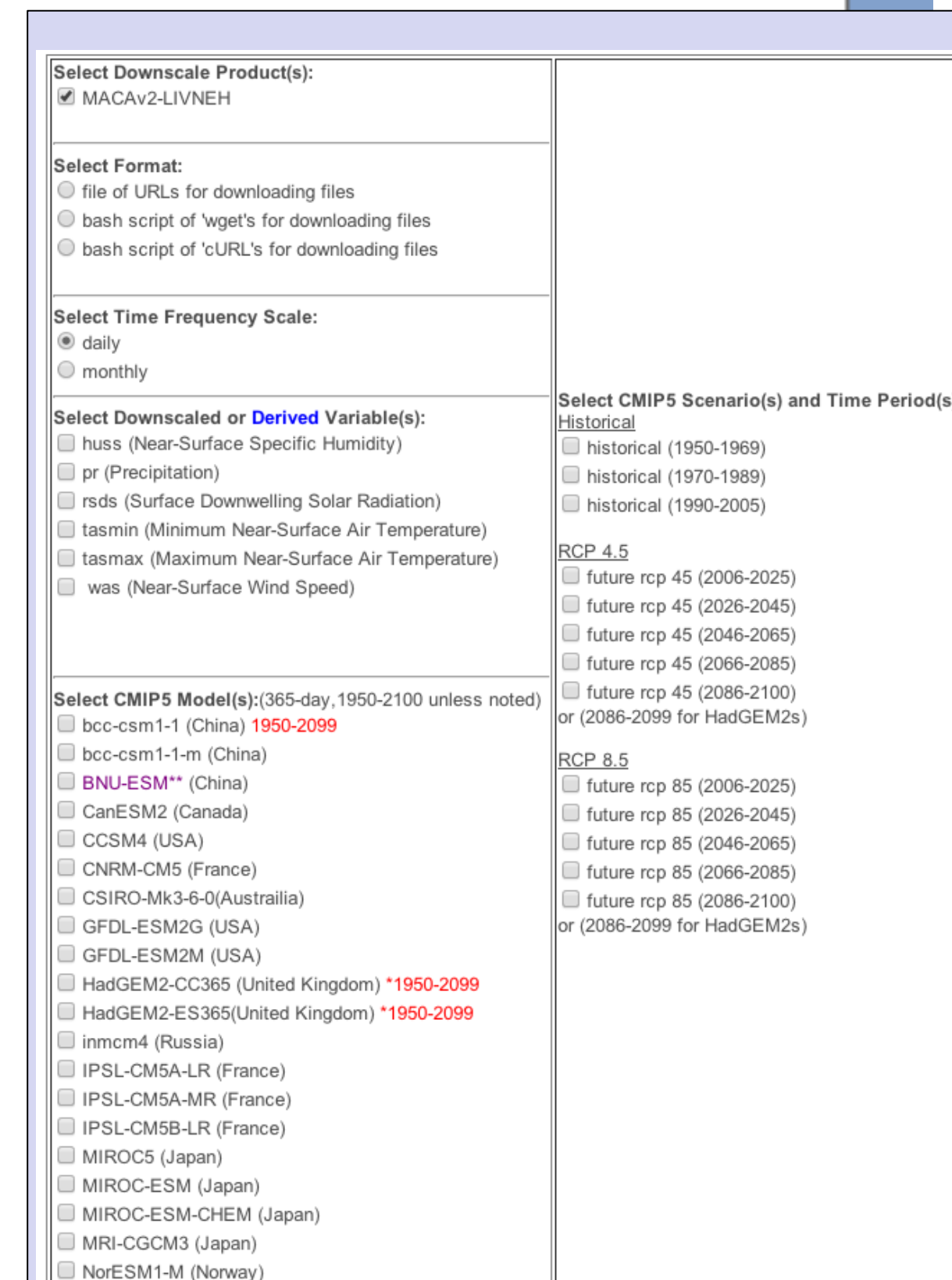 - THREDDS subsetting
  - OPeNDAP access

Figure 2: *Selector tool from MACA website for bulk data download.*
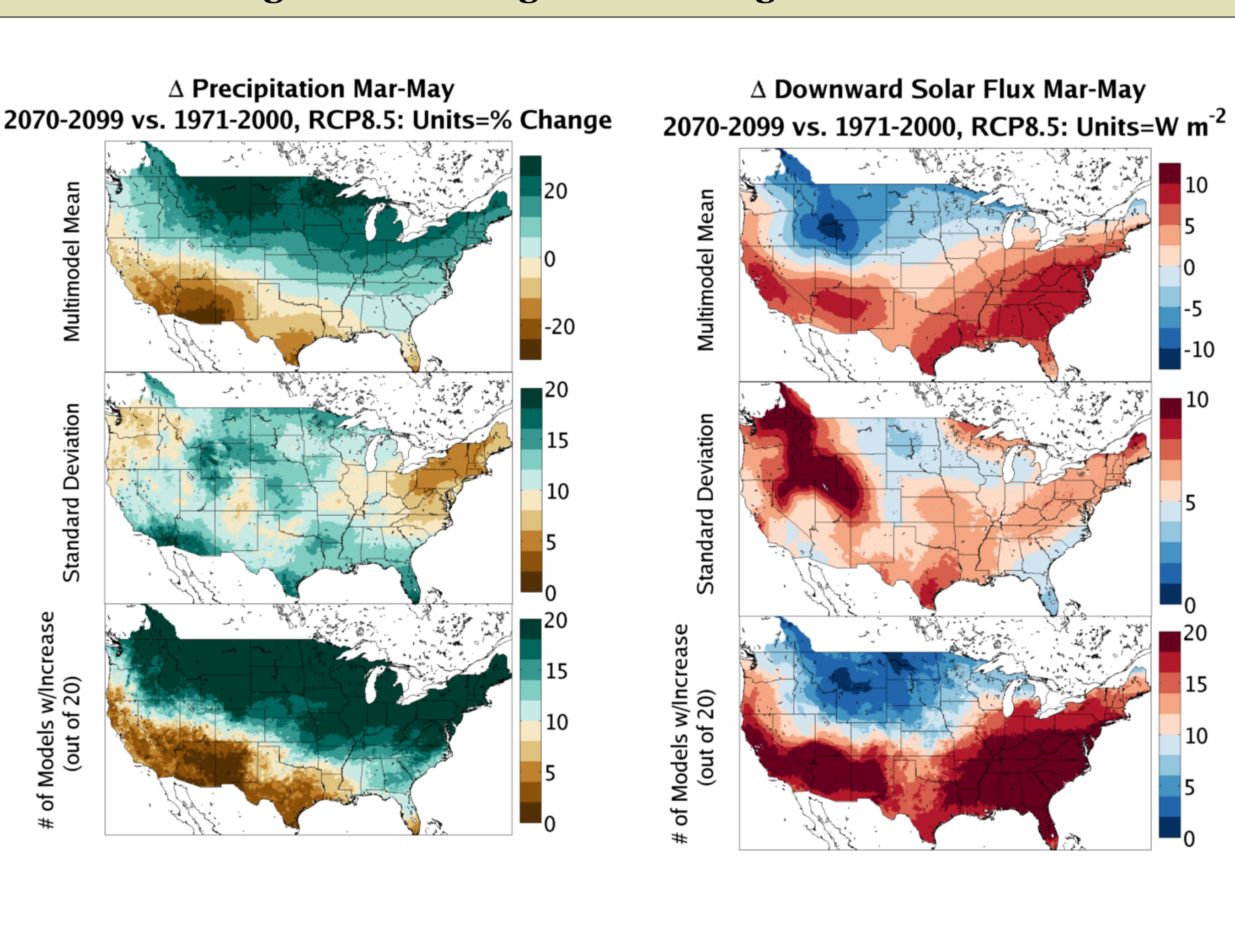
Multi Model Agreement in Signals of Change

Figure 5: *Multi-model mean, standard deviation and agreement in signal of change over 20 GCMs for downscaled MACA for precipitation (left) and radiation (right).*

Analysis Tools

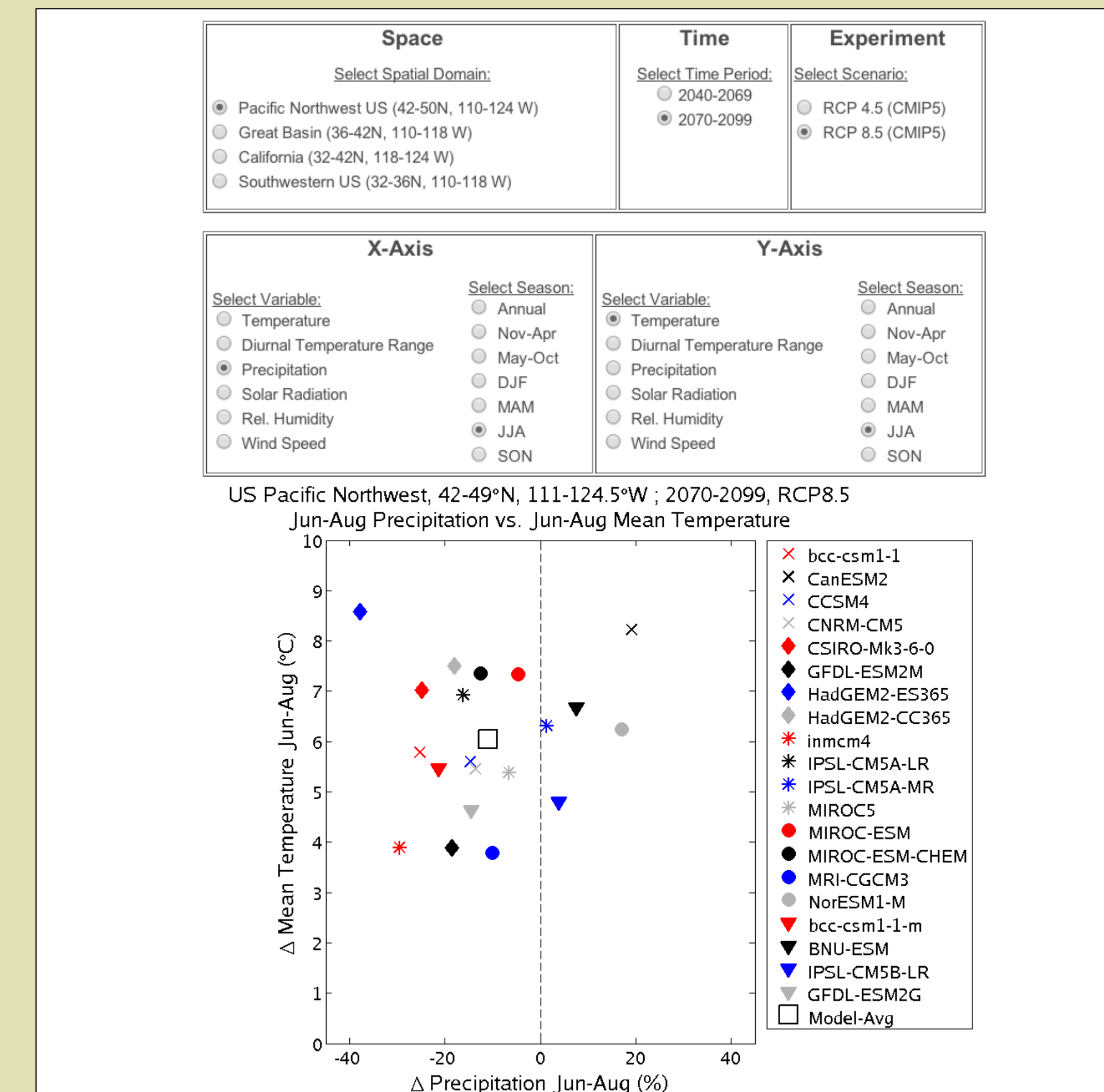### Projected Changes from the Different GCMs Downscaled by MACA

Figure 3: *Selector tool from MACA website and displayed graph of projections.*
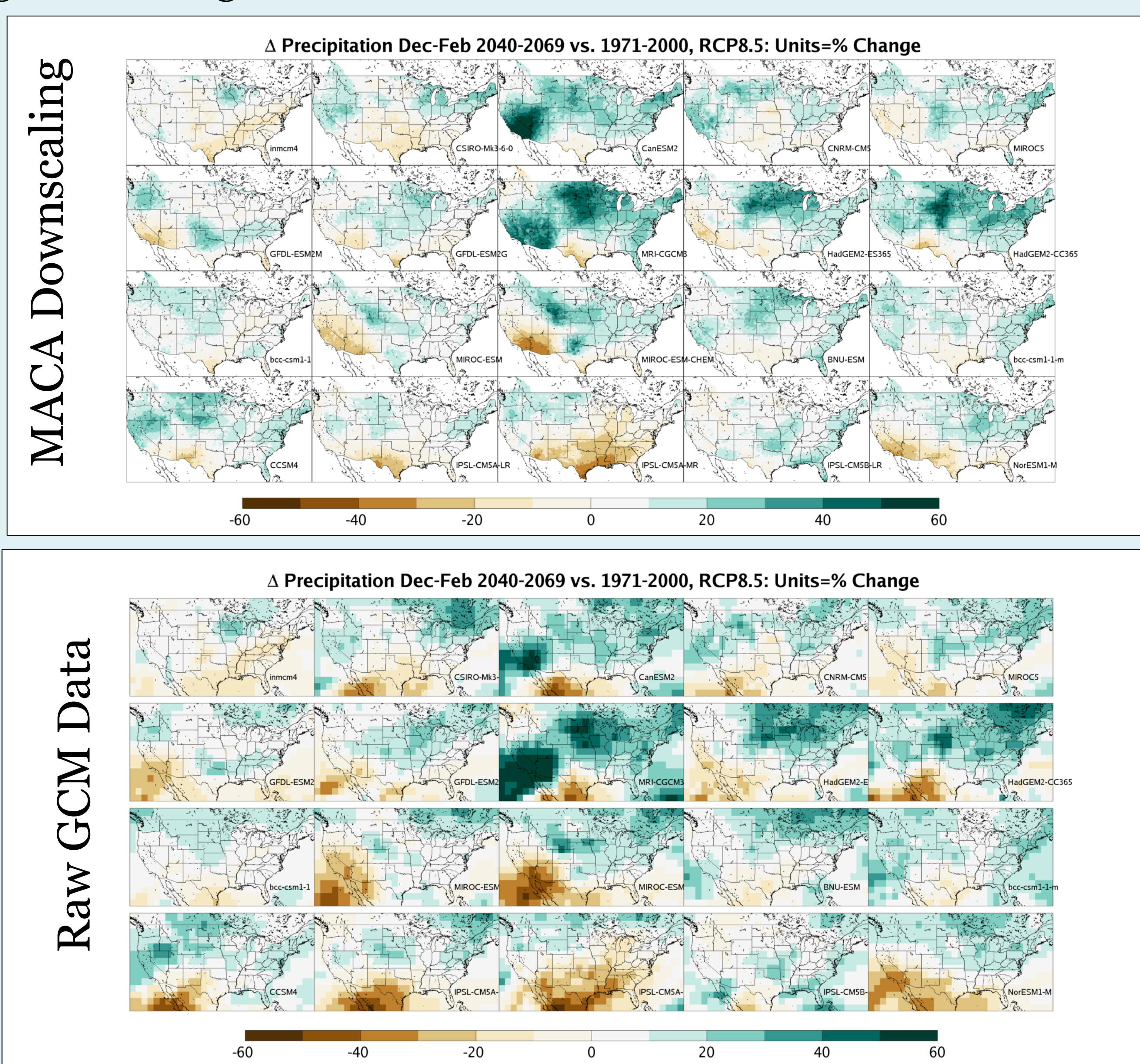
Signals of Change from Climate Models

Figure 4: *RCP8.5 projected changes in daily precipitation amount from Dec-Feb for 2014-2069 vs 1971-2000 calculated using MACA downscaling (Upper) and from the raw GCM data(Lower) shown for 20 GCMs from CMIP5.*

References
Abatzoglou J.T. and Brown T.J. "A comparison of statistical downscaling methods suited for wildfire applications " International Journal of Climatology (2012) doi: 10.1002/joc.2313

Hegewisch, K.C., and Abatzoglou, J.T., "An Improved Multivariate Adaptive Constructed Analogs(MACA) statistical downscaling method", in preparation.

Livneh B, E.A. Rosenberg, C. Lin, V. Mishra, K. Andreadis, E.P. Maurer, and D.P. Lettenmaier, 2013: A long-term hydrologically based data set of land surface fluxes and states for the conterminous United States: Updates and extensions, Journal of Climate doi:10.1175/JCLI-D-12-00508.1.