

CASCade Project-Task 1: Providing climate-change scenarios for analysis by others

CASCade is a CALFED-funded project that is linking models of components of Bay-Delta resources & ecosystems ranging from climate through watershed through Delta & Bay hydrodynamics to sediment transports & geomorphological change, aquatic ecosystems & fisheries, and the fates of contaminants and invasive species. By creating and exploiting these linked models, we hope to provide new tools for identifying & quantifying many of the interwoven connections & impacts of future climatic and structural changes within the Delta.

Because one of the important drivers of future change in the Delta is likely to be global climate change, Task 1 of the CASCade project has been to provide several plausible scenarios of 21st Century climate change in the central California region to other members of the project team. Because interest in the scenarios from beyond CASCade, and beyond even California, has been expressed, scenarios were developed that cover the entire conterminous US, with internal consistency, fidelity to the climate-model outputs, and reasonably high spatial (12 km) and temporal (daily) resolutions as their hallmarks.

Choice of global climate-change scenarios

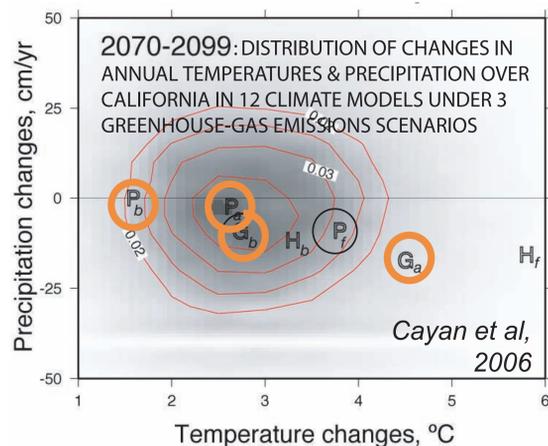
In order to more-or-less span the range of current projections of 21st Century climate change for central California, four scenarios were selected for analysis by the CASCade project. These scenarios also have been analyzed in the State's 2006 and 2008 California Scenario Assessments, and might loosely be described according to:

Gb: Medium warmer and drier (GFDL climate model - moderate B1 emissions)

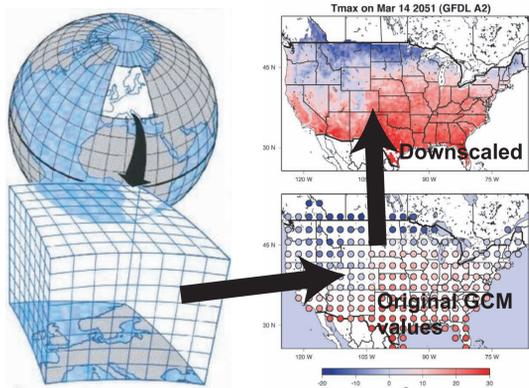
Ga: Much warmer and drier (GFDL model - accelerating A2 emissions)

Pb: Not so much warmer with no ppt change (PCM model - B1 emissions)

Pa: Medium warmer with no ppt change (PCM model - A2 emissions)



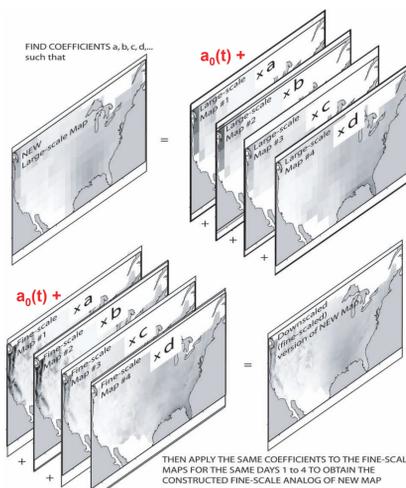
Downscaling--A necessary step



Climate scenarios simulated by global climate models (GCMs) are typically provided on grid cells that are from 100 to 200 km on a side. As such, the whole of California might be represented by 8 to 10 simulated climate time series. The watershed/hydrodynamic/geomorphic/ecological/contaminant models used in the CASCade project address processes at much higher spatial resolutions. Therefore in order to be useful to the project, the climate-change scenarios needed to be "downscaled". Task 1 used a recently developed method for downscaling

global-scale scenarios onto a 12-km grid over the conterminous US, from 1950-2100, so that the scenarios provided could be used by other models in the project and by other scientists elsewhere.

Constructed analog method used for CASCade downscaling

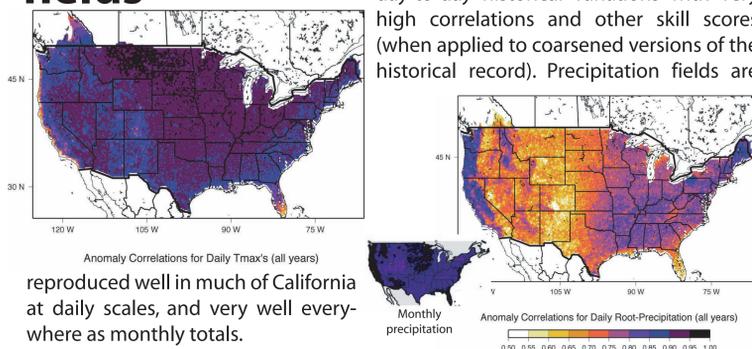


A new downscaling method, called constructed analogs (Hidalgo et al., 2008), was developed--in part--to meet the the downscaling demands of CASCade. The method has the advantage that it yields better resolution of gradients of projected climate changes in near-coastal settings like the Bay-Delta, and because it maintains exact synchronization with the day-to-day weather generated by the global climate models. The latter is crucial to CASCade because synchronization of storm-generated floods and storm surges into the Bay-Delta are expected to be important determinants of future risks of levee failures and ecosystem disruptions...and previous downscaling methods did not provide the needed synchronization.

The method identifies linear combinations of (coarsened) historical weather maps that best reproduce daily weather patterns simulated by the GCMs. The same linear combination of the high-resolution versions of those historical weather maps are surprisingly high-fidelity downscaled versions of the GCM weather (and climate). For details, see

<http://www.energy.ca.gov/2007publications/CEC-500-2007-123/CEC-500-2007-123.PDF>

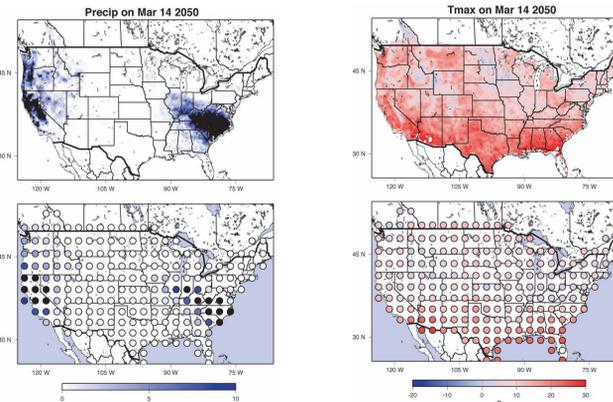
Accuracy & texture of downscaled fields



Downscaled temperature fields reproduce day-to-day historical variations with very high correlations and other skill scores (when applied to coarsened versions of the historical record). Precipitation fields are

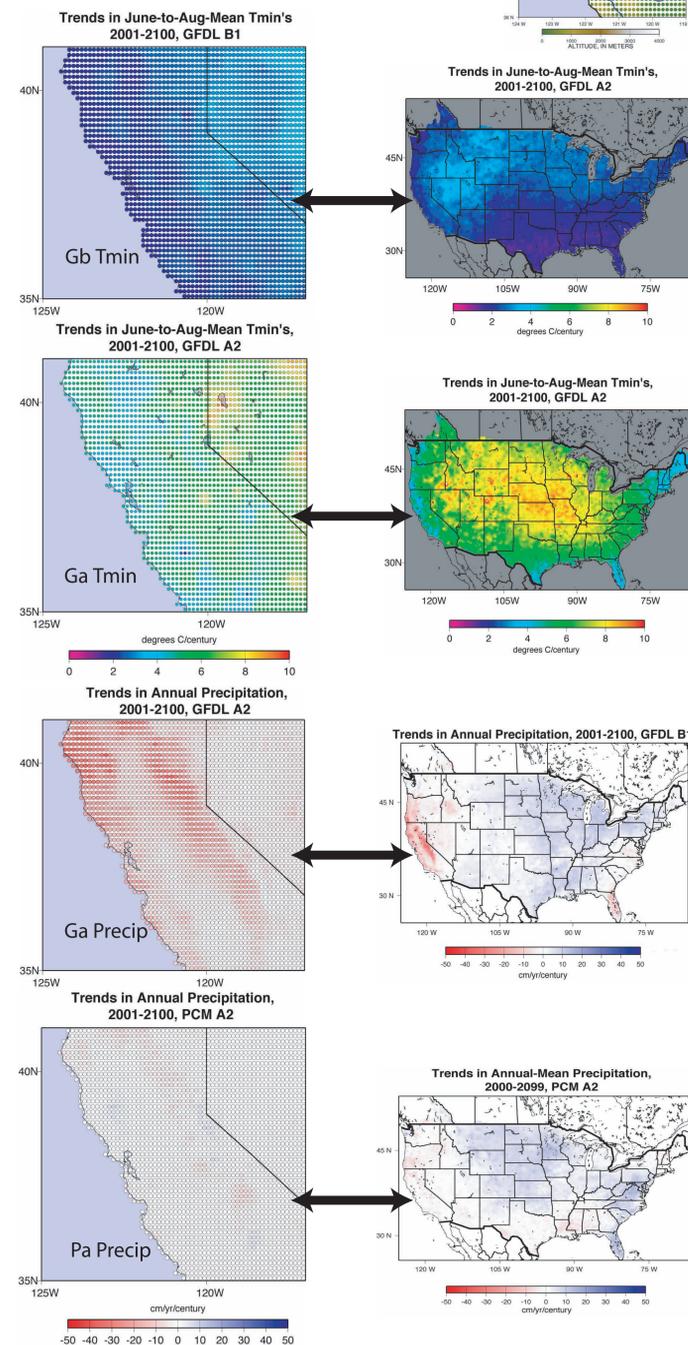
reproduced well in much of California at daily scales, and very well everywhere as monthly totals.

Below are examples of the precipitation & temperature fields simulated for one day (chosen at random) by the GFDL climate model under A2 greenhouse-gas emissions, as produced by the climate model and as downscaled by constructed analogs. Notice the topographic effects and realistic sub-GCM-grid textures present in the downscaled fields.



Some downscaled climate trends for Central California

Trends in some of the resulting downscaled fields are illustrated below, at National and Central-California scales. Grid spacing of downscaled field is illustrated with respect to topography in map at right.



References

- Cayan, D.R., Maurer, E.P., Dettinger, M.D., Tyree, M., and Hayhoe, K., 2008, Climate change scenarios for the California region: Climatic Change, 87(Suppl 1), doi10.1007/s10584-007-9377-6, S21-S42.
- Hidalgo, H., Dettinger, M., and Cayan, D., 2008, Downscaling with constructed analogues—Daily precipitation and temperature fields over the United States: California Energy Commission PIER Final Project Report CEC-500-2007-123, 48 p