Report for 2005CA129B: California-2100: Assessing Future Water Resources over California

Publications

- Articles in Refereed Scientific Journals:
  - Lara M. Kueppers, Mark A. Snyder, Lisa C. Sloan, Dan Cayan Jiming Jin, Hideki Kanamaru, Masao Kanamitsu, Norman L. Miller, Mary Tyree, Hui Du, and Bryan Weare, 2006. Multi-model comparison of the climate response to land-use change in the western United States. Global and Planetary Change. Submitted.
- Conference Proceedings:
  - Weare, Bryan C., 2005, Global climate change in the past century: Focus on California in Climate Change: Challenges And Solutions For California Agricultural Landscapes, California Energy Commission, CEC-500-2005-189-SF

Report Follows

Problem and Research Objectives

This project implemented the initial phase of California-2100 (Cal21), which is aimed at making and evaluating high resolution estimates of climate change over California out to the year 2100. The initial WRC component of this project has been focused on evaluating how well regional climate models reproduce the variations of important components of the water budget for California, and estimating the climatic effects of the increases over the past century in irrigation in California on regional climate.

Methodology

The utilized regional model is the widely used MM5 running at 30km grid spacing and having 45 levels (Chen and Dudhia, 2001). The outer boundaries, which are placed in the central Pacific Ocean and Midwestern United States are from the ERA-40 reanalysis (Uppala et al., 2005). Currently, we have made more than eight runs for the period 1 August, 1995- 30 September, 1996. Initial statistical comparisons of the output of these model runs have been made with the Climate Research Unit's (CRU) surface climatology (Mitchell and Jones, 2005) and other observations for the California region.

Principal Findings

Six present-day MM5 runs with slightly different parameterizations of rainfall and the planetary boundary layer have been run. In general these simulate well the observed patterns of variation of precipitation and surface temperature. However, the surface temperatures are approximately two degrees Centigrade colder than the CRU nearly everywhere. Preliminary studies show that this is related to an excess of high thin cloud generated in the model.

To properly simulate the effects of irrigation MM5 was modified to include irrigation water which is added every 10 days during warm months at about the observed rate of approximately one meter per season. In the primary experiment all of the present day irrigated and urban areas are replaced by scrub land. The preliminary results indicate that the climate of an irrigated California has lower maximum and largely unchanged minimum temperatures. These changes are associated with significantly higher soil moisture and latent heat fluxes and lower sensible heat fluxes.

Significance

These results help interpret the observed trends in surface temperatures over California in the past century (Christy et al. 2006). Observed downward trends of maximum temperature are associated the expected changes resulting from the known 10-fold increase in irrigation in the same period. The observed upward trend in minimum temperature can be attributed to the influence of greenhouse gas induced global warming and a lack of effect of increased irrigation.

References

Chen, F. and Dudhia, J., 2001. Coupling an advanced land surface-hydrology model with the Penn State-NCAR MM5 modeling system. Part I: Modeling implementation and sensitivity. Monthly Weather Review, 129: 569-585.

Christy, J.R., Norris, W.B., Redmond, K. and Gallo, K.P., 2006. Methodology and Results of Calculating Central California Surface Temperature Trends: Evidence of Human-Induced Climate Change? Journal of Climate, 19(4): 548-563.

Mitchell, T.D. and Jones, P.D., 2005. An improved method of constructing a database of monthly climate observations and associated high-resolution grids. International Journal of Climatology, 25: 693-712.

Uppala, S. M. and coauthors, 2005: The ERA-40 re-analysis. *Q. J. R. Meteorol. Soc*., **131**, 2961- 3012.