### 1. PROJECT DETAILS

- **Project Title:** California Applications Program  
- **Principal Investigator(s):** Daniel R. Cayan  
- **Affiliation(s):** Scripps Institution of Oceanography  
- **Keywords:** regional climate applications  
- **Task/Theme:** Human Dimensions, RISA Program  
- **NOAA Strategic Goal(s):**  
  - **Goal 2:** Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond;  
  - **Goal 3:** Serve Society's Needs for Weather and Water Information  
- **NOAA Line Office / Program Officer:** Caitlin Simpson, OGP/RISA

### 2. RESEARCH OBJECTIVES AND SPECIFIC PLANS TO ACHIEVE THEM:

The California Applications Program (CAP) and the California Climate Change Center (CCCC) aim to develop and provide better climate information and forecasts for decision makers in California and the surrounding region. Applications addressed include problems involving water resources, wildfire, and human health. Time scales of interest range from seasonal to secular changes associated with natural and anthropogenic influences. By working directly with users and practitioners, CAP and CCCC are working to evaluate climate information needs and utility from the user perspective.

### 3. RESEARCH ACCOMPLISHMENTS:

Working with scientists from the NOAA Earth Systems Research Laboratory, Dettinger and Cayan are investigating the impact of atmospheric rivers (ARs) of water vapor on western flooding. In the coastal Russian River of central California, all 7 of the major floods during the past 9 years (when SSM/I imagery has been available to catalog all ARs at the west coast) have been associated with the arrival of ARs.

A variety of data sets (both satellite and ground-based) were examined by Iacobellis to determine the spatial variability and coherence of cloud properties over the California and the Western United States.

Gershunov with Kanamaru and Kanamitsu are studying the probability structure of extreme precipitation events over California's complex topography. Using daily station observations (> 400 stations) and a fine scale (10km) downscaling (CaRD-10) of the NCEP/NCAR reanalysis over California. Although modeled precipitation is biased, many of the biases appear to be systematically related to topography, suggesting that model precipitation can be corrected statistically. Gershunov has begun collaborations with colleagues in Spain to study/compare Mediterranean climate variability in California and Spain.

A small database of escaped fires for California has been developed by Brown to allow for the development of an escaped burn index based upon weather and climate elements. Prescribed fire and wildland fire use surveys were undertaken to better understand the utilization of climate information for fuels management operations.

Westerling led a research effort (CAP and Univ. of Arizona) describing recent changes in western US forest wildfire: Increased wildfire activity was strongly associated with warmer temperatures and an earlier spring snowmelt. Westerling worked with PNNL (DOE) and University of Washington researchers to demonstrate the utility of seasonal temperature and streamflow forecasts for managing western electrical markets.

During this last year, Georgakakos and HRC staff participated in Interagency Northern California Meetings, which aim to improve efficiency of operational water management in the region. The INFORM project, funded by a consortium of Federal and State Agencies, provides the forecast and management numerical tools that form the basis of a common
Graduate student J. O’Hara and Georgakakos focused on the formulation of a capacity expansion model and the use of climate model output to examine the financial impacts of a projected climatic change for the city of San Diego under projected population and demand growth. Costs associated with the climate change scenarios are higher than the historical scenario for all sensitivities and climate change scenarios except for the winter scenario.

Graduate student S. Taylor is investigating spatio-temporal variability of northwesterly surface wind along the US west coast using observational records from satellite scatterometer winds and coastal buoy observations. During March-September, the strongest and most persistent winds in the northeastern Pacific Ocean are concentrated along the California coast from Cape Mendocino to just south of Point Conception.

Randy Hanson is building a new, comprehensive groundwater modeling system for the California Central Valley including an extensive set of meteorological input and irrigation demand and supply via a “farm package”, and a large collection of water level observations from groundwater well logs. This modeling utility will provide crucial information to water managers and users in this critical agricultural region of the state where, historically, groundwater usage has not been monitored.

Kelly Redmond is working with CEC to improve California climate monitoring, and working with CalFed to reconstruct California paleoclimate, and with NOAA to develop a National Integrated Drought Information System with applications to western drought and on their Hydromet Testbed in the American River Basin.

Beginning in Summer 2005, Cayan has been involved in organizing and preparing a climate change scenarios assessment for the California governor and legislature. Cayan is also contributing to projects involving water resources and hazards, human health (climate and mosquitoes), regional wind and weather and wildfire and also working to improve climate observations in California watersheds.

4. HIGHLIGHTS:

- Work with Martin Ralph, Paul Neiman and others at NOAA ESRL shows that in the coastal Russian River of central California, all 7 of the major floods during the past 9 years at the west coast have been associated with the arrival of atmospheric rivers.
- Although precipitation derived from the CaRD-10 regional model is biased, many of the biases are systematic and are systematically related to topography, suggesting that model precipitation can be corrected stochastically. (Figure 2)
- Prescribed fire and wildland fire use surveys were undertaken to better understand the utilization of climate information for fuels management operations.
- Westerling et al found that forest wildfire activity increased suddenly and dramatically in the mid-1980s, with more large fires, longer burn times and longer fire seasons occurring in warm, dry years with early spring snowmelts. (Figure 1)
- The INFORM project, is continuing work with key state and federal agencies in California to provide the forecast and management numerical tools to improve water management in the region.
- Redmond has worked with NOAA to develop a National Integrated Drought Information System with applications to western drought.
- CAP scientists have worked with State Agencies to produce an assessment of a few selected scenarios of climate change, as it impacts several sectors of California’s society, economy, and ecosystem.
- Dettinger appointed science advisor in climate and hydrology issues by CalFED.
- Hansen, along with other USGS colleagues, has begun work to build a new California central valley groundwater modeling utility.

5. COLLABORATION:

**Interagency (Any Federal Agency or Office akin to NOAA. e.g., OGP, ONR, NASA, JPL, DOE, etc.):**
Cayan, Dettinger, Redmond, Westerling, Brown, Georgakakos, and Hanson are working with scientists and staff from the U.S. Geological Survey, U.S. Forest Service, National Park Service, Bureau of Reclamation, D.O.E., Lawrence Livermore National Laboratory California Department of Water Resources, California Department of Boating and Waterways, California Energy Commission, California Air Resources Board, and several university scientists.

**Partnerships (Other Academic and Research Institutions, as well as state, local, foreign, and private sector agencies):**
California Energy Commission. Through the California Climate Change Center. See [http://meteora.ucsd.edu/cap/](http://meteora.ucsd.edu/cap/)
UC Davis, mosquito-human health program; William Reisen, PI.
## 6. COMMUNICATIONS, NETWORKING & OUTREACH:

<table>
<thead>
<tr>
<th>Activity</th>
<th>Objective</th>
<th>Partners</th>
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<tbody>
<tr>
<td>Communications</td>
<td>To inform Californians about risks of possible climate change.</td>
<td>State of California (several state agencies), Union of Concerned Scientists, numerous university and government scientists.</td>
</tr>
<tr>
<td>&quot;Our Changing Climate, Assessing the Risks to California&quot;</td>
<td>To explain elements of climate variability and change.</td>
<td>State of California (several state agencies), Union of Concerned Scientists, numerous university and government scientists.</td>
</tr>
<tr>
<td>Numerous interactions with California press on a routine basis, by Redmond, Dettinger, Westerling, Cayan, and other CAP scientists.</td>
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<tr>
<td>Networking</td>
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<td>Developing cross-RISA activity involving climate change and management of the Colorado River, to improve access to climate monitoring information, relating to natural resource management in the western states, and with NOAA and Climate Testbed to improve linkages between climate forecasts and regional applications, and to improve institutional linkages to universities by Redmond and other CAP scientists.</td>
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## 7. CONFERENCES, SEMINARS, SYMPOSIUMS, PRESENTATIONS, WORKSHOPS

<table>
<thead>
<tr>
<th>Conference Name</th>
<th>Dates/Location</th>
<th>Representatives</th>
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<tbody>
<tr>
<td>National Phenology Wksp Planning Meeting</td>
<td>Aug 2005/Tucson, AZ</td>
<td>Dettinger, Cayan</td>
</tr>
<tr>
<td>2nd Annual California Climate Change Workshop</td>
<td>Sept 2005/Sacramento, CA</td>
<td>Cayan, Dettinger, Gershunov</td>
</tr>
<tr>
<td>Western Urban Water Resources-Climate Change Wksp</td>
<td>Sept 2005/Las Vegas, NV</td>
<td>Redmond, Dettinger</td>
</tr>
<tr>
<td>Climate Diagnostics Wksp</td>
<td>Oct 2005/Madison, WI</td>
<td>Redmond</td>
</tr>
<tr>
<td>CCSP Wksp</td>
<td>Nov 2005/Arlington, VA</td>
<td>Redmond, Dettinger, Westerling, Cayan, Brown</td>
</tr>
<tr>
<td>AGU Fall Meeting</td>
<td>Dec 2005/San Francisco, CA</td>
<td>Cayan, Dettinger, Westerling, Redmond, Gershunov</td>
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<tr>
<td>AMS Annual Meeting</td>
<td>Jan 2006/Atlanta, GA</td>
<td>Redmond</td>
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<tr>
<td>Hydropower-Climate Change Wksp</td>
<td>Feb 2006/Davis, CA</td>
<td>Cayan</td>
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<tr>
<td>PACLIM Wksp</td>
<td>Mar 2006/Pacific Grove, CA</td>
<td>Cayan, Redmond</td>
</tr>
<tr>
<td>NOAA CPASW Wksp</td>
<td>Mar 2006/Tucson, AZ</td>
<td>Westerling, Redmond</td>
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## 8. PERSONNEL:

<table>
<thead>
<tr>
<th>Category</th>
<th>Name</th>
<th>Job Title</th>
<th>Brief Biographical Sketch</th>
</tr>
</thead>
<tbody>
<tr>
<td>D. Cayan</td>
<td>Researcher</td>
<td>SIO &amp; USGS</td>
<td>Climate Researcher</td>
</tr>
<tr>
<td>M. Dettinger</td>
<td>Researcher</td>
<td>USGS &amp; SIO</td>
<td>Hydroclimate Researcher</td>
</tr>
<tr>
<td>K. Georgakakos</td>
<td>Researcher</td>
<td>HRC &amp; SIO</td>
<td>Hydrologist</td>
</tr>
<tr>
<td>K. Redmond</td>
<td>Researcher</td>
<td>DRI Western Regional Climate Change Center</td>
<td>Climate Researcher</td>
</tr>
<tr>
<td>S. Iacobellis</td>
<td>Researcher</td>
<td>SIO</td>
<td>Climate Modeler</td>
</tr>
</tbody>
</table>
10. PUBLICATIONS:

Journal Articles:


Hanson, R.T., and Dettinger, M.D., 2005, Ground-water/surface-water responses to ensembles of global climate simulations, Santa Clara- Calleguas basin, Ventura County, California, 1950-93: *Journal of the American Water Resources Association*, 41, 517-536.


Books/Articles-in-Books:

Reports:

http://www.climatechange.ca.gov/climate_action_team/reports/index.html

Cayan and others, 2006: Climate Scenarios for California. FINAL white paper from California Climate Change Center, publication # CEC-500-2005-203-SF, posted: March 15, 2006. (PDF file, 52 pages, 2.8 megabytes)
http://www.climatechange.ca.gov/climate_action_team/reports/index.html

Cayan and others, 2006: Projecting Future Sea Level. FINAL white paper from California Climate Change Center, publication # CEC-500-2005-202-SF, posted: March 15, 2006. (PDF file, 64 pages, 1.6 megabytes)
http://www.climatechange.ca.gov/climate_action_team/reports/index.html


Conference Proceedings/Workshops:


Submitted and In Press:


Field, D., Cayan, D. and F. Chavez, 2006: Secular warming in the California Current and North Pacific. Accepted for publication in CalCOFI Reports.


Shachat, J., and A.L. Westerling 2005: "Information Aggregation in a Catastrophe Futures Market," Managerial and Decision Economics, Accepted.


11. FIGURES/PHOTOS/ILLUSTRATIONS Please provide up to two (2) figures/photos/etc. related to your report.

Figure 1:
FIGURE 1 CAPTION: [Westerling] (top) Annual frequency of large (> 400 ha) western U.S. forest wildfires (bars) and mean March through August temperature for the western US (line) (26, 30). Spearman’s rank correlation between the two series is 0.76 (p < 0.001). Wilcoxon test for change in mean large forest fire frequency after 1987 was highly significant (W = 42 (p < 0.001)). (middle) 1st principle component of center timing of streamflow in snowmelt dominated streams (line). Low (pink shading), middle (no shading) and high (light blue shading) tercile values indicate Early, Mid, and Late timing of spring snowmelt. (bottom) Annual time between first and last large fire ignition, and last large fire control.
Figure 2:
FIGURE 2 CAPTION: [Gershunov] Year-to-year correlation of modeled and observed max/median precipitation (a measure of volatility) as a function of location (left) and as a function of slope and aspect (right). Contours show elevation in 250m (1000m) increments in black (blue).