California Application Program

Dan Cayan ***and*** ***Tony Westerling***
Scripps Institution of Oceanography, Climate Research Division
and US Geological Survey

with input from
Mike Dettinger
Kelly Redmond
Tim Brown
Sasha Gershunov
Kosta Georgakakos
Randy Hanson
Mary Tyree

funding:
NOAA OGP RISA element

http://meteora.ucsd.edu/cap

California Applications Program

Established 1999 OGP CDEP + Human Dimensions Elements

The Climate Forcing: natural climate variability
climate change
water is a common theme

Time scales: weather-seasonal-interdecadal + global change

Thrusts: Water Resources, Wildfire
Human Health, Climate Observation Capacity

Science Team: disciplinary expertise covering thrust topics
experience working with outside users
experience working with each other

Collaborators: steady group of selected insiders
broad based outreach groups
State, Federal agencies, water orgs, other university scientists,……

CAP Strategy

CAP team selected for strong disciplinary expertise.

Choose societally-important, climate-connected sectors

Identify able partners. *Use web site, media interviews and invited presentations for more general outreach.*

Partners help gauge user info needs (themselves/their networks).

ex. wildfire management, water resources, health community,

Adapt to user's interests

ex. Global change emphasis

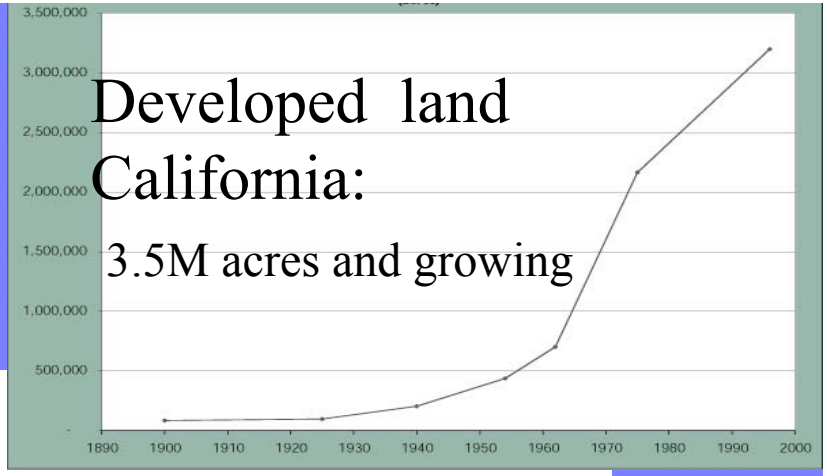
In some years, forecasts not needed by some agencies.

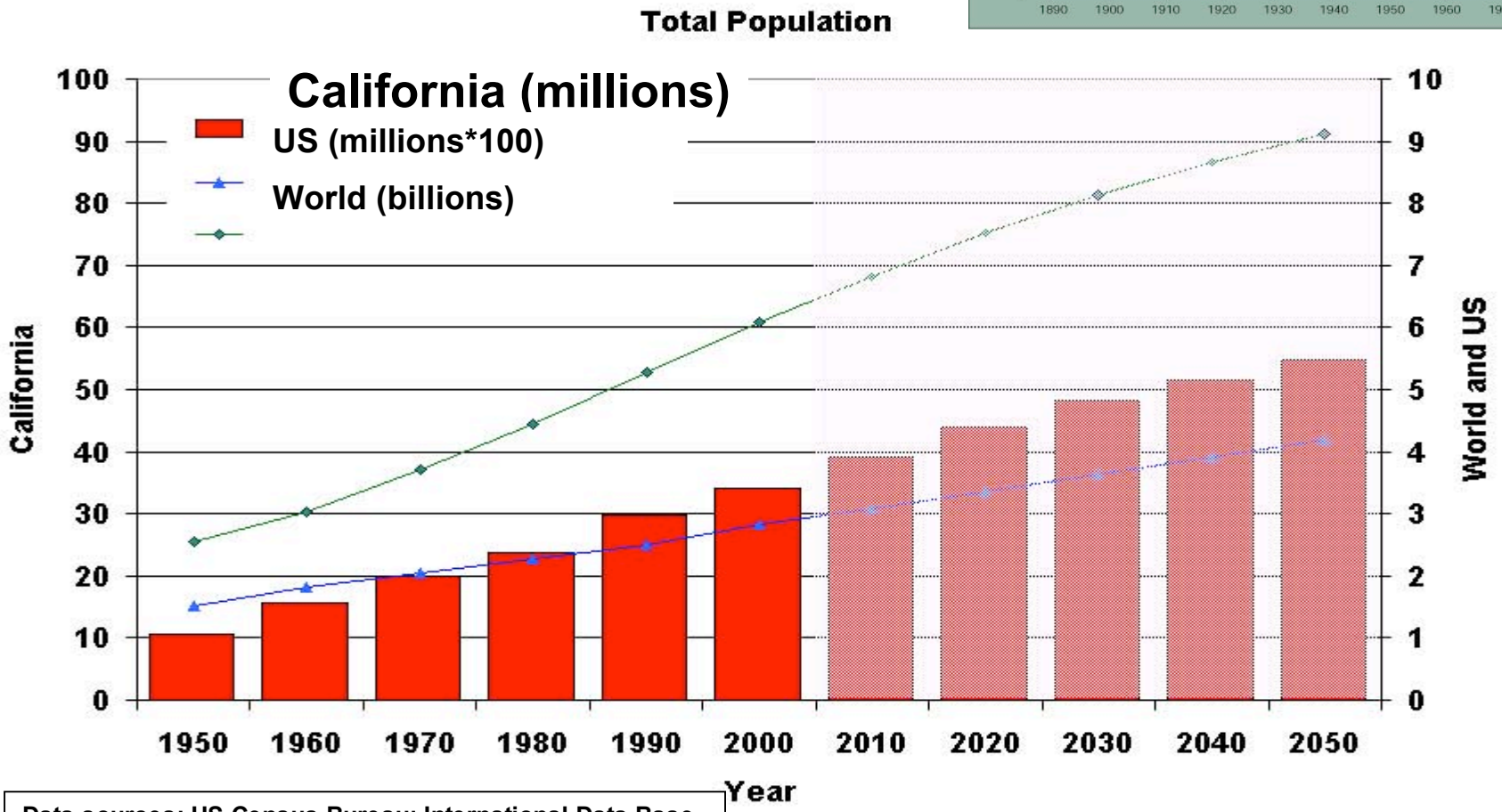
Publish in technical outlets but also condense for non-specialist.

Leverage other agencies provide needed addtnl funding
but, this broadens our focus.

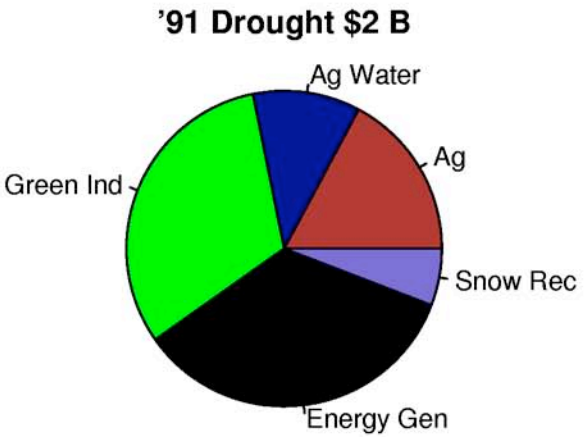
California's population increase closely mirror's global total sharper rise than whole US

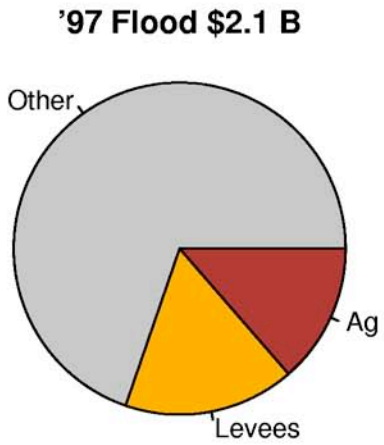
Climate stress adds to growing population, land use change, air pollution

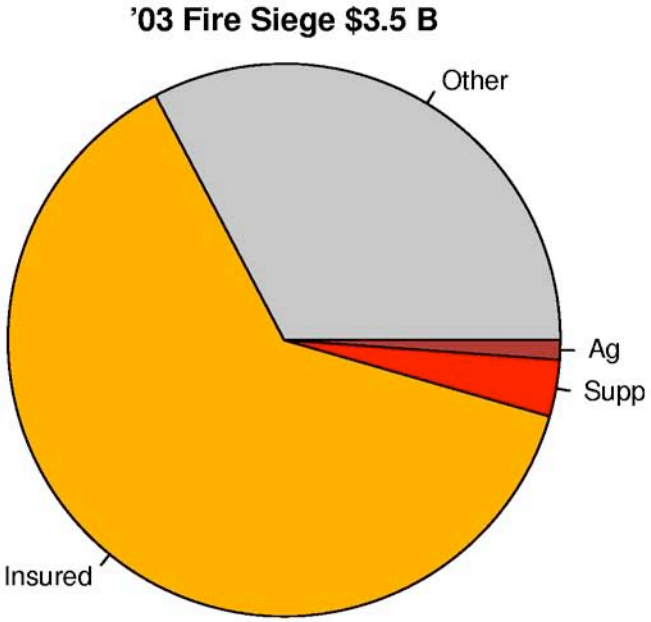




Data sources: US Census Bureau: International Data Base
World Population Prospects (2004)
California Department of Finance (Oct 2004)

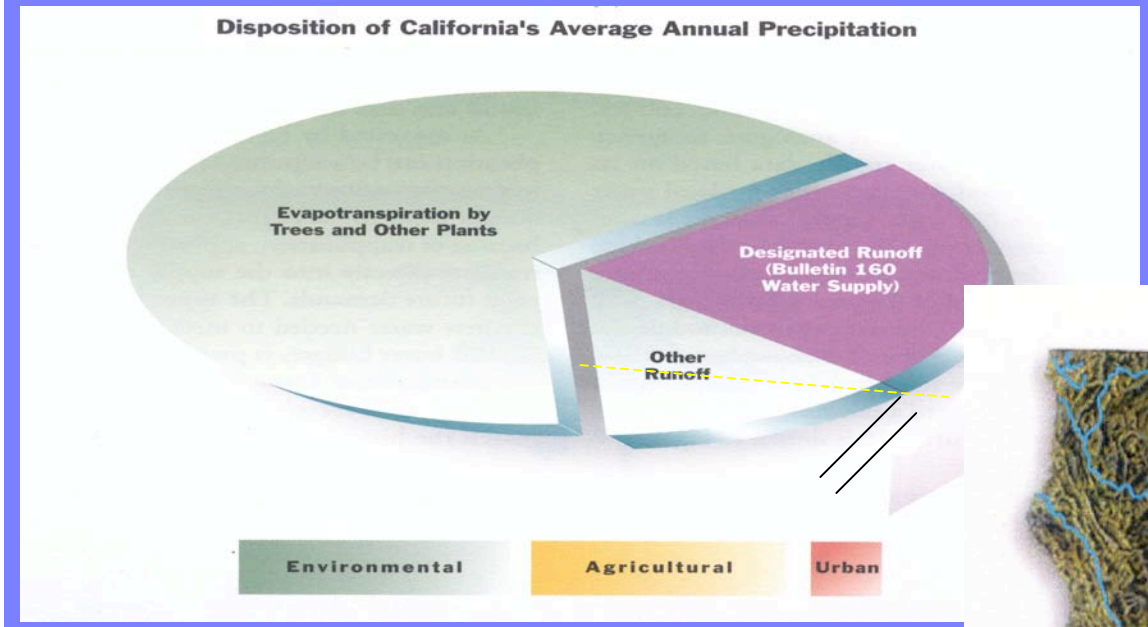






Economic Impact of Recent California Weather Disasters

2003 dollars



California's Developed Water supply is just over 20% of its annual precipitation

The State's Plumbing System,
a massive adaptation to climate:
>1200mi of aquaduct
~43MAF reservoir storage
(one yr supply of annual runoff)

- 75% of runoff occurs in north; 72% of consumptive use in south

- 6 km^3/yr of water is pumped from the Delta by State & Federal systems for San Joaquin Valley agriculture & Southern urban uses

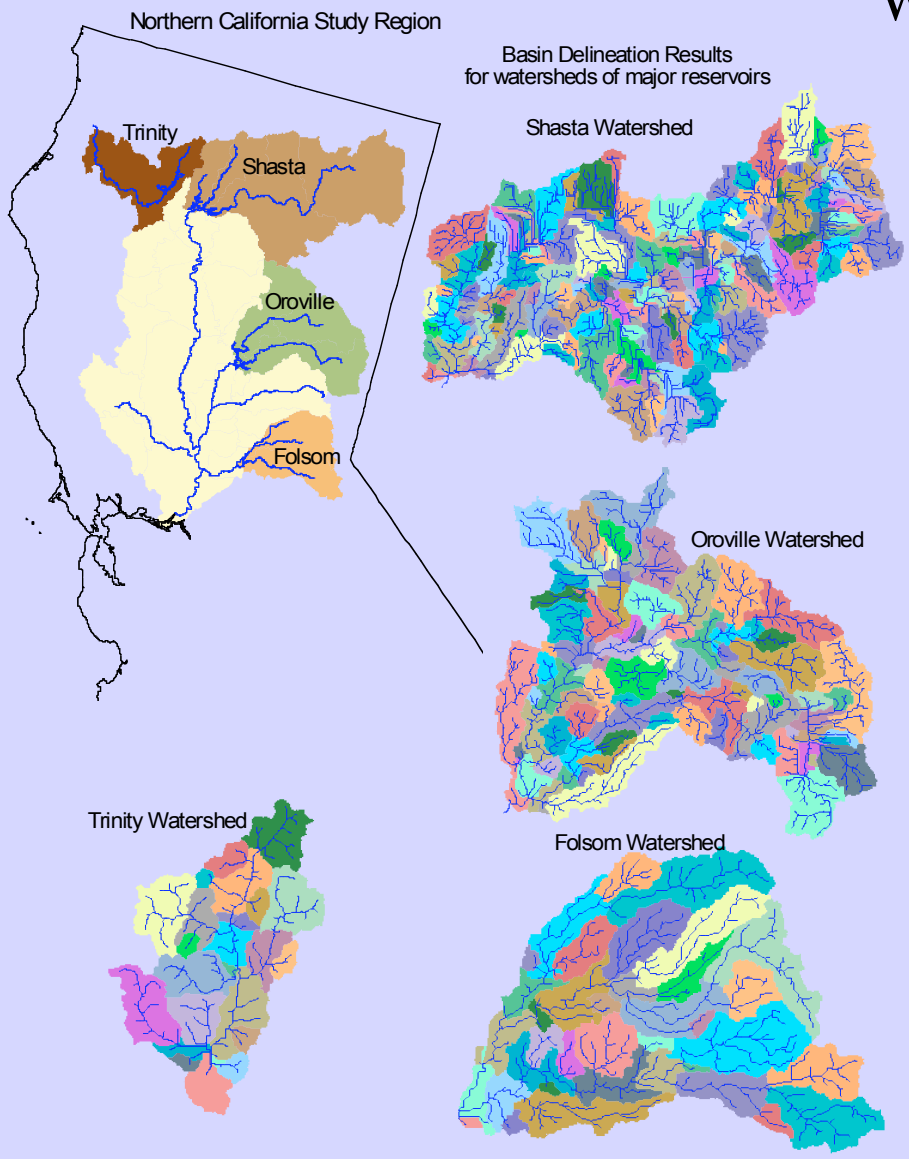
Ground water not metered, but plays major role

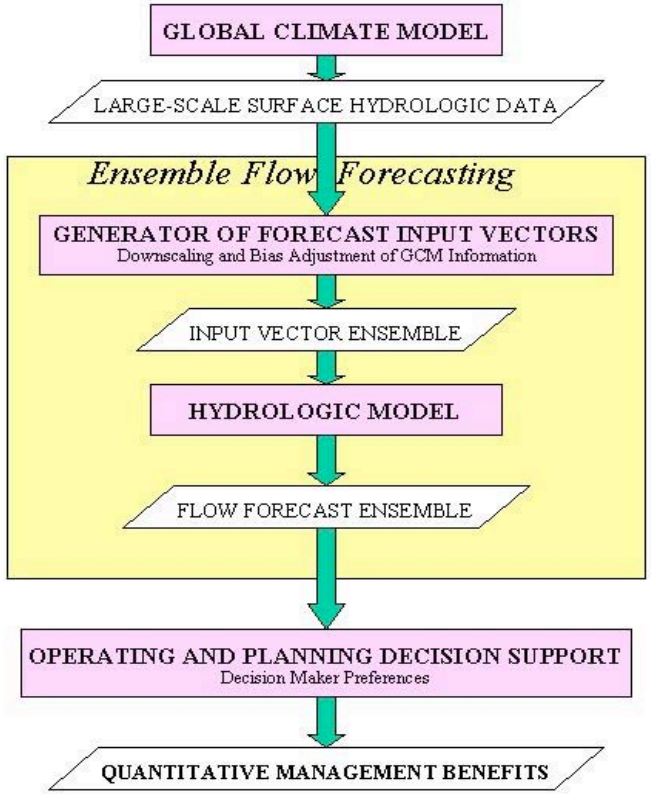
Average annual precip 200M AF , Developed Runoff ~42 MA

800K AF Colorado River "surplus" ~1.7% of developed suppl

Water Resources Forecasting for Northern California watersheds and reservoir systems

(K. Georgakakos And collaborators, HRC)





In collaboration with

California Department of Water Resources

US Bureau of Reclamation

California's Central Valley USGS ground water model

20,000 sq miles

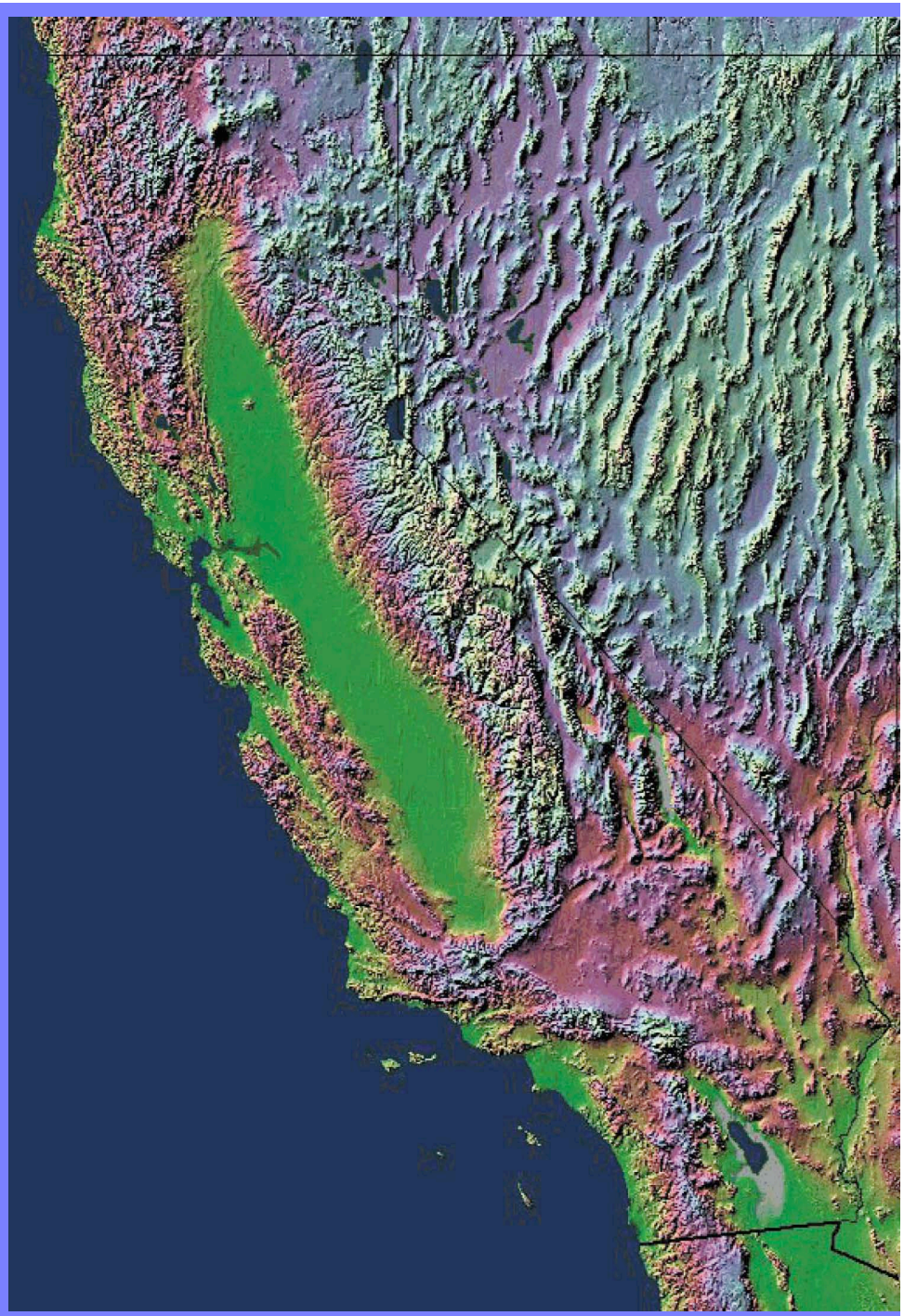
Some of most productive agricultural land $17B/yr

1/6 of U.S. irrigated land

1/5 of U.S. grd water pumping

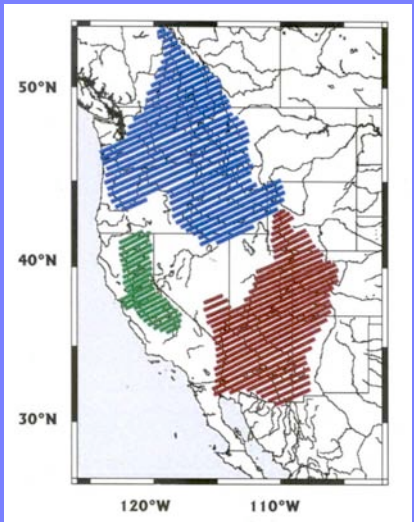
Pumping not metered

Ground water will need to Play increasing role in California water management



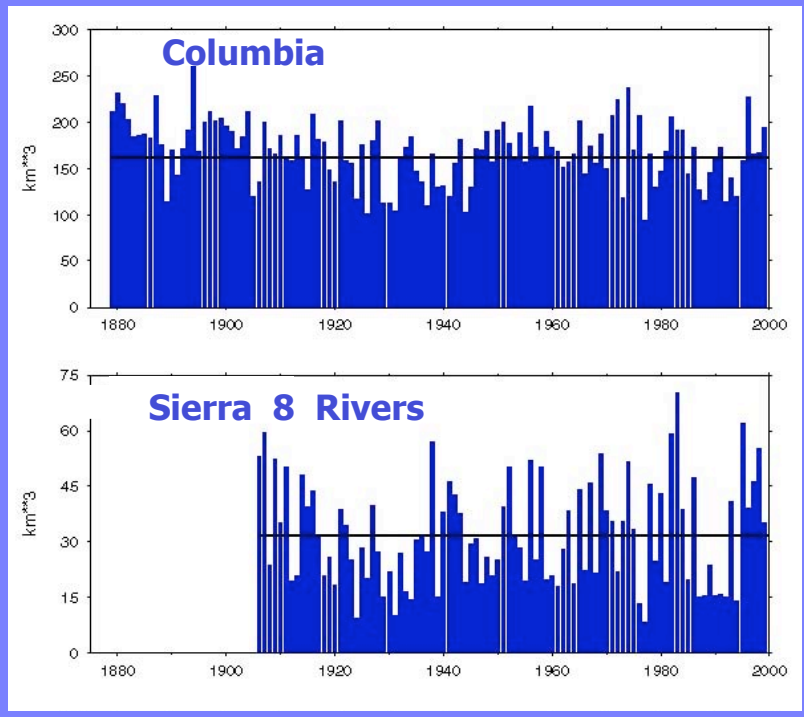
California's volatile Water Supply

Annual Discharge



Sierra drainage (140,000km2 is only about 1/4 of the area of the Columbia or the Colorado. Sierra drainage generates 31.8km3 runoff , ~1/5 of that in the Columbia but ~2x of that in the Colorado.

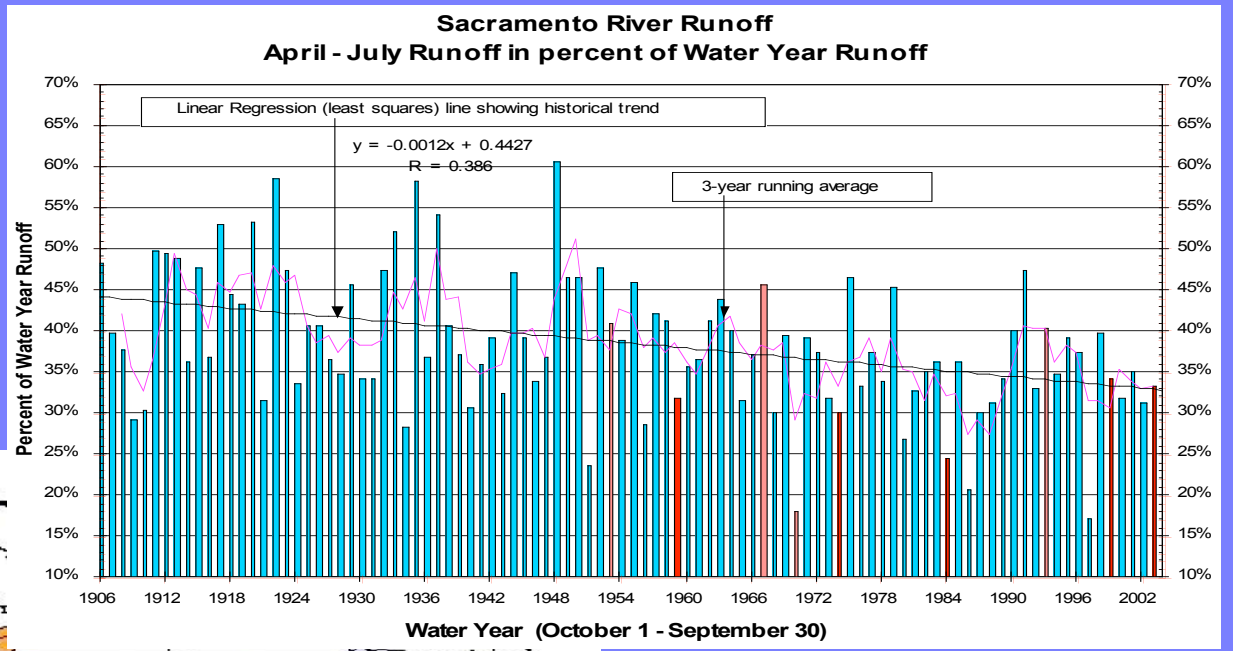
Reservoir storage in California is about 49 km3. This is the equivalent of about 1yr supply of State's developed runoff. Storage on the Columbia (60km3) and Colorado (74km3) is larger, but still is impacted by climate variability.

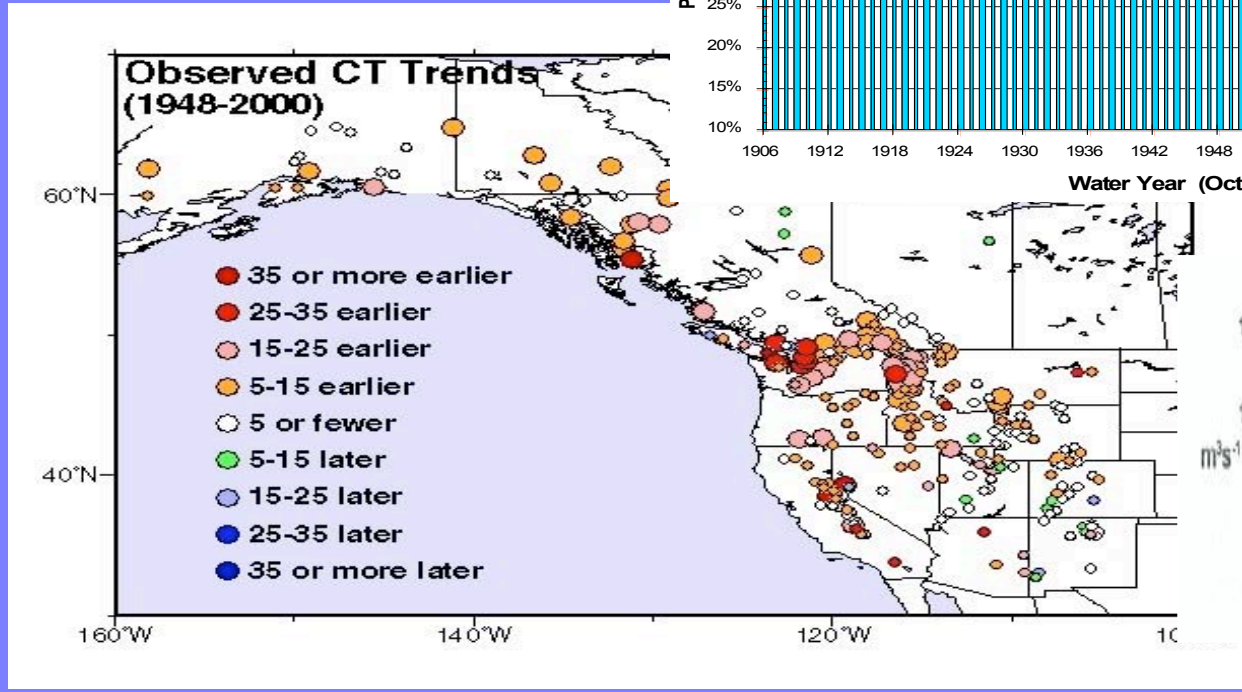


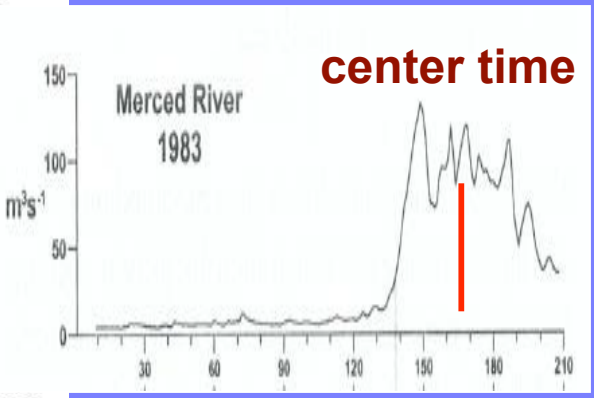
Record has multi-year dry spells

The relative variability of the Sierra stream discharge is the largest of the three major watersheds in the western United States. Compared to Columbia Basin whose coefficient of variation (*std dev/mean*) is 0.19, the Sierra combined basins Vary greatly, with c.v. of 0.44. The Sierra annual discharge has varied from twice to half of historical average

Earlier spring flows last 2-3 decades



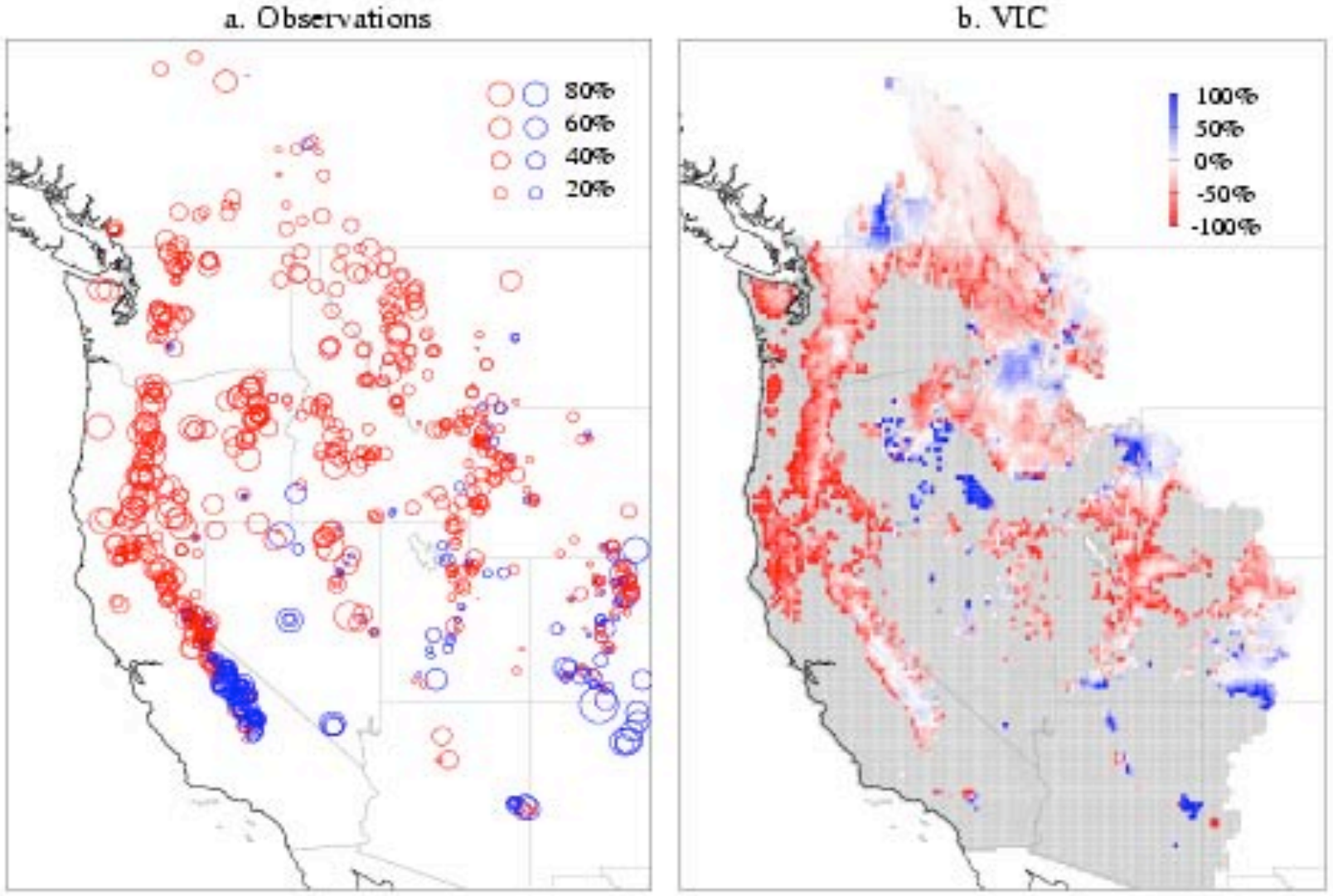




"Center Timing" of snowmelt watersheds
have advanced by 1-5 weeks earlier across West

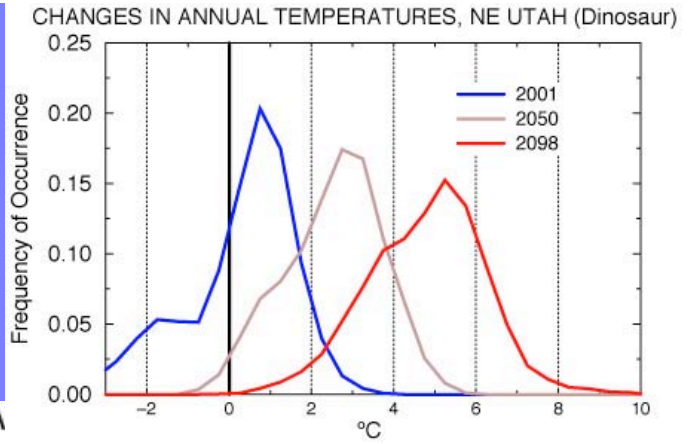
Iris Stewart

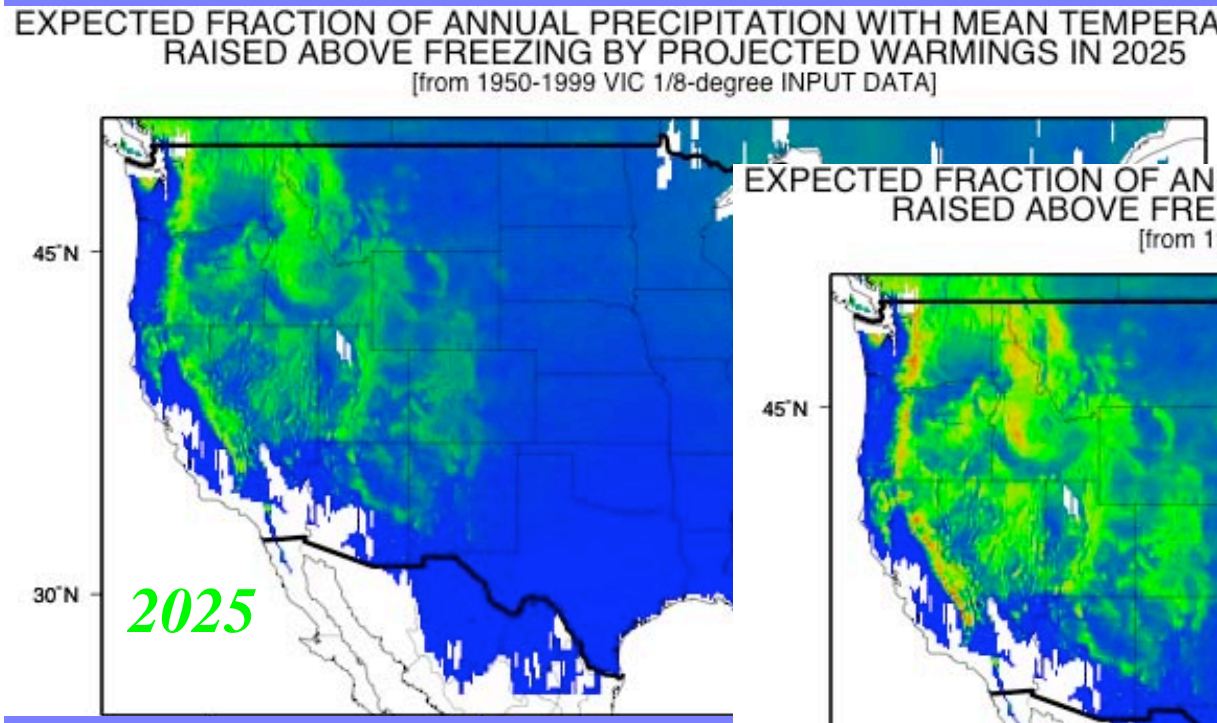
Downward Trends in April 1 Snow Water Equivalent 1950-1997

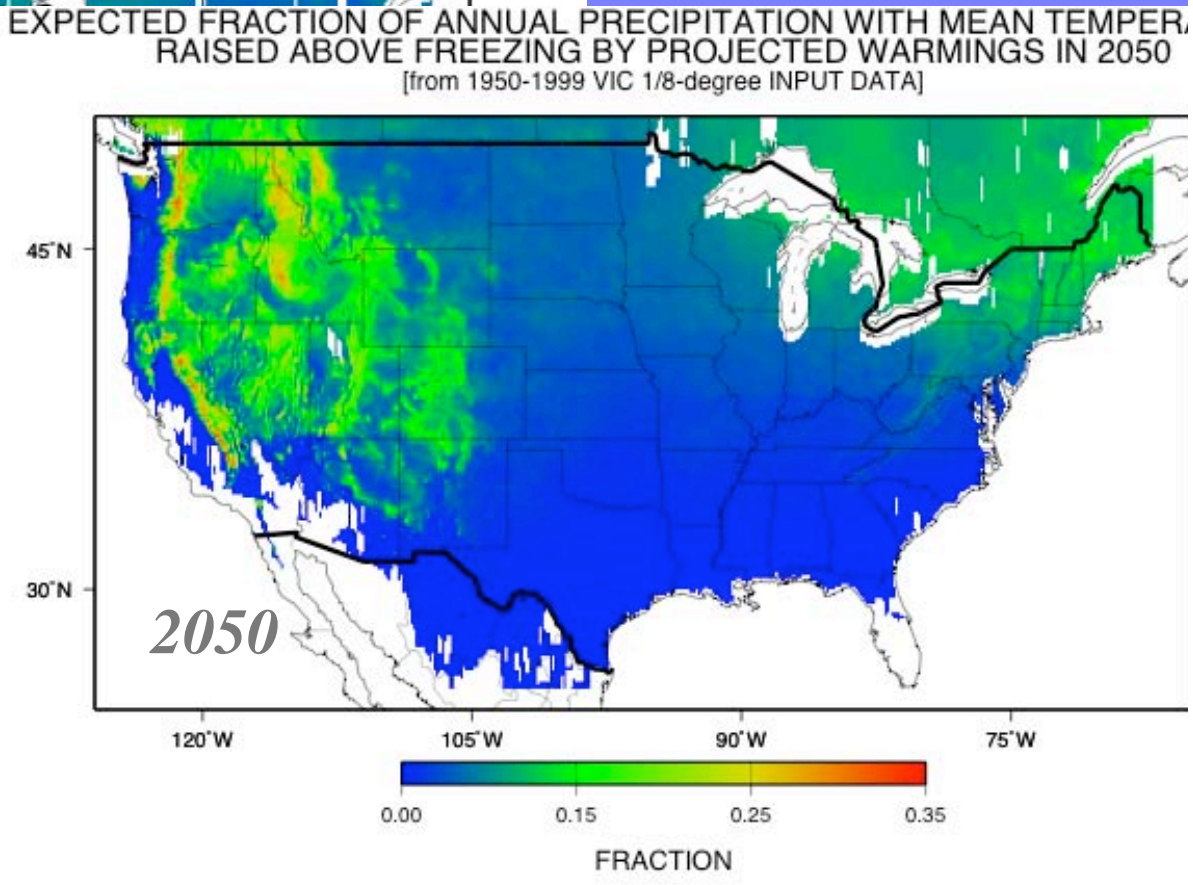


Source: Mote et al. (2004)

Estimating Influences of the full Ensemble of Projected Warmings on RAIN-vs-SNOW



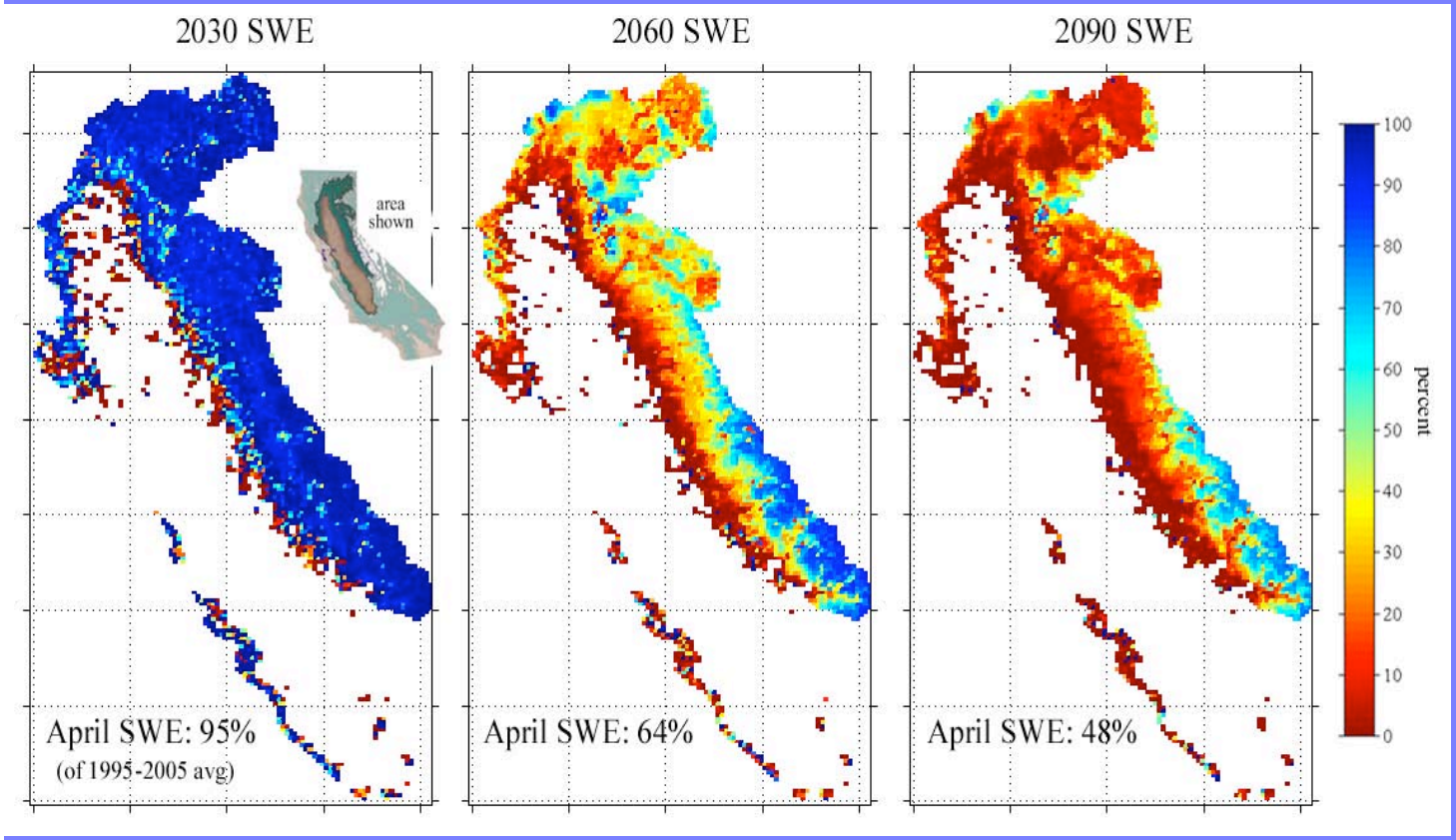




Derived from monthly IPCC GCM-grid pdfs, and UW's VIC model daily inputs, 1950-1999

USGS

We face significant losses of spring snowpack



- Less snow, more rain
- Particularly at lower elevations
- Earlier run-off
- More floods
- Less stored water

By the end of the century California could lose half of its late spring snow pack due to climate warming. This simulation by Noah Knowles is guided by temperature changes from PCM's Business-as-usual coupled climate simulation.
(a middle of the road emissions scenario)

better understanding of present day and future snow accumulation and melt processes is needed

First Annual Climate Change Conference Highlights Measures to Address California's Warming Climate and Impacts on Energy, Water, and Environment*California Energy Commission Hosts the First Annual Climate Change Research Conference with a focus on California*

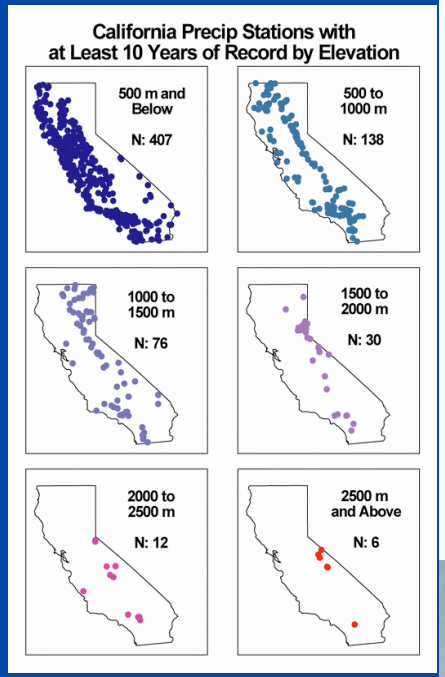
Sacramento, May 19, 2004 — Documented reports of warmer temperatures, decliningspring snowpack, and earlier snowmelt in California have raised concerns about the State's future ability to generate sufficient electricity to meet the increased demand brought about by these factors. To address those concerns, the California Energy Commission created the California Climate Change Center (Center), which supports research to identify climate trends in California, as well as methods for reducing adverse impacts.

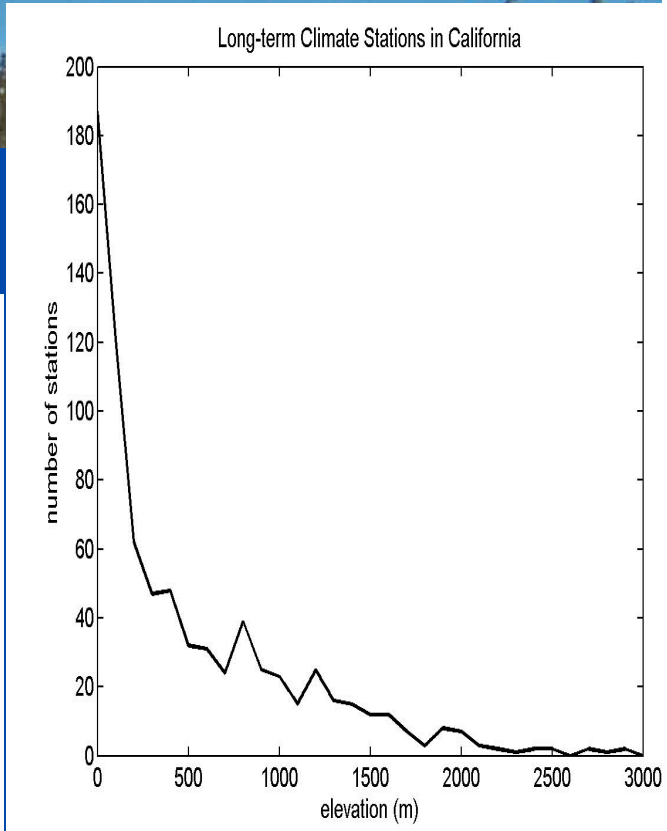
The Center is hosting the First Annual Climate Change Conference on June 9 and 10, 2004, in Sacramento, California. The conference will focus on California and its immediate region, and will feature experts in energy, climate, and water supply, economics and management. This conference is noteworthy in being the first to focus such a broad range of experise on the State's climate and impacts.

we know too little about high-altitude meteorology and hydrology.

We need more high elevation climate stations!

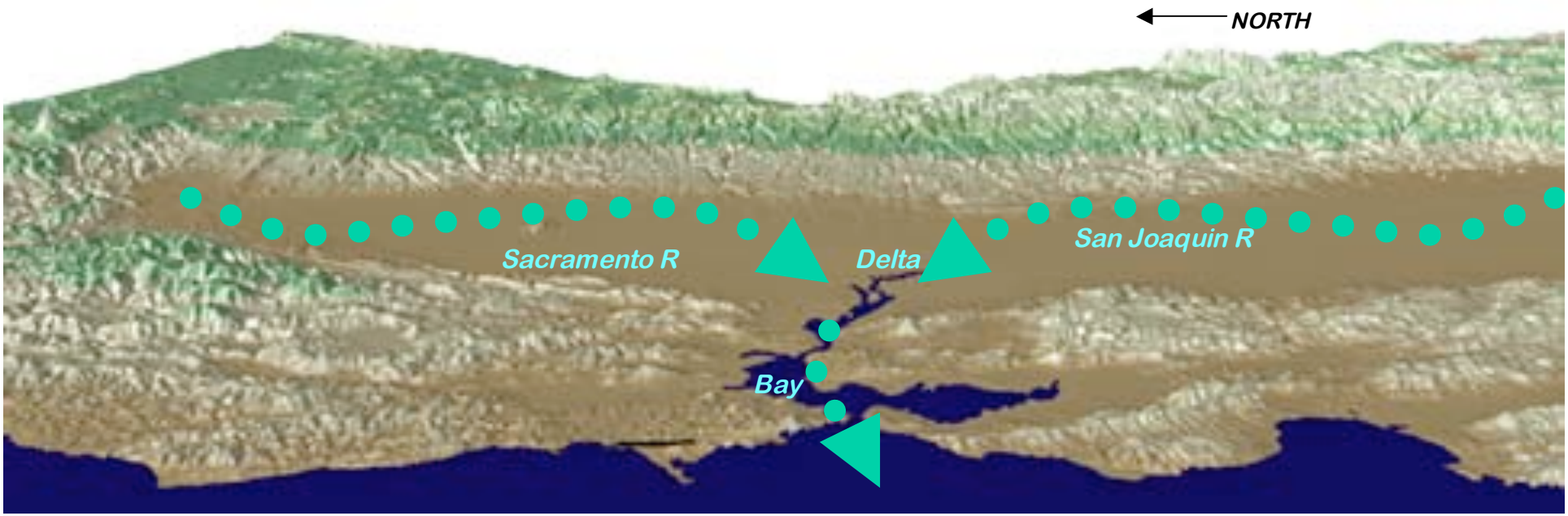
Most of California's Precip gauges are sited in low elevation population centers. Yet, a lot of our concern is for climate changes in mid-high elevations.

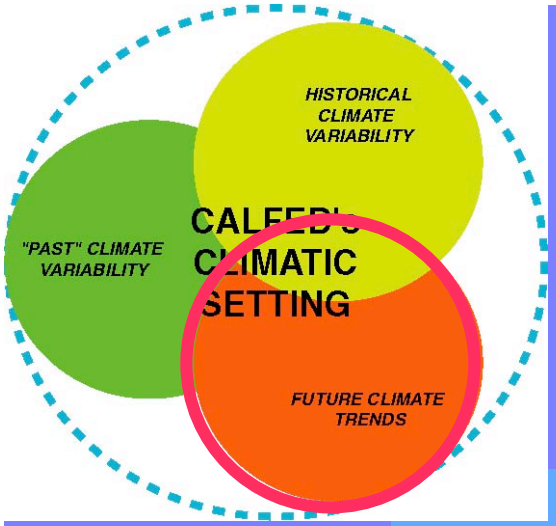




CALFED attempts to resolve 4 competing primary objectives:

1. Reliability of water supplies
2. Water quality improvement
3. Ecosystem restoration
4. Levee stabilization





FUTURE CLIMATE & CALFED

CAP and collaborators are working on:
Two strategies for coping with uncertain projections

SCENARIO BUILDING/ANALYSIS

Knowledge of future climates → Knowledge of impacts

VULNERABILITY ASSESSMENT (Pielke, Sr, et al)

Knowledge of thresholds for impacts → Risk in future climates

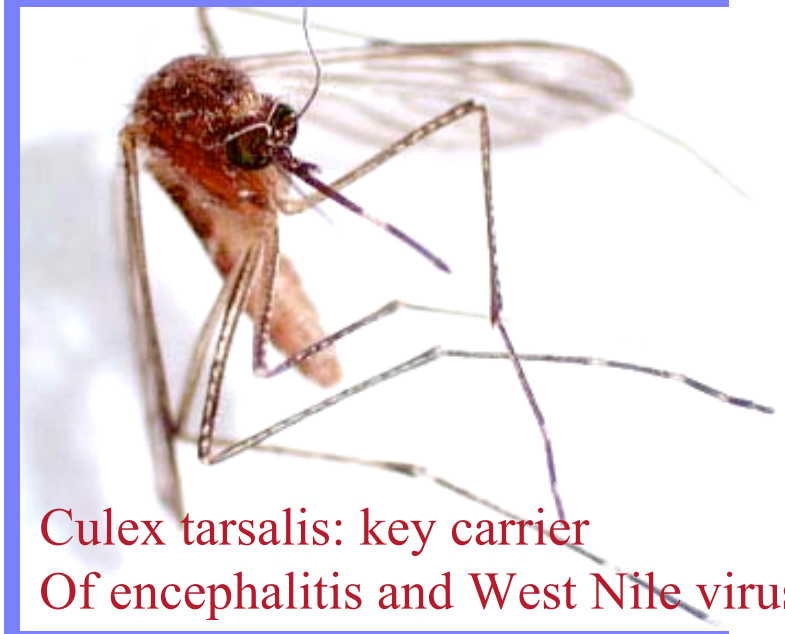
climate consideration crucial in CALFED's 30yr building of a many decade re-designed water system.

USGS

Mosquitos!

Kern County, California—a good nights' catch

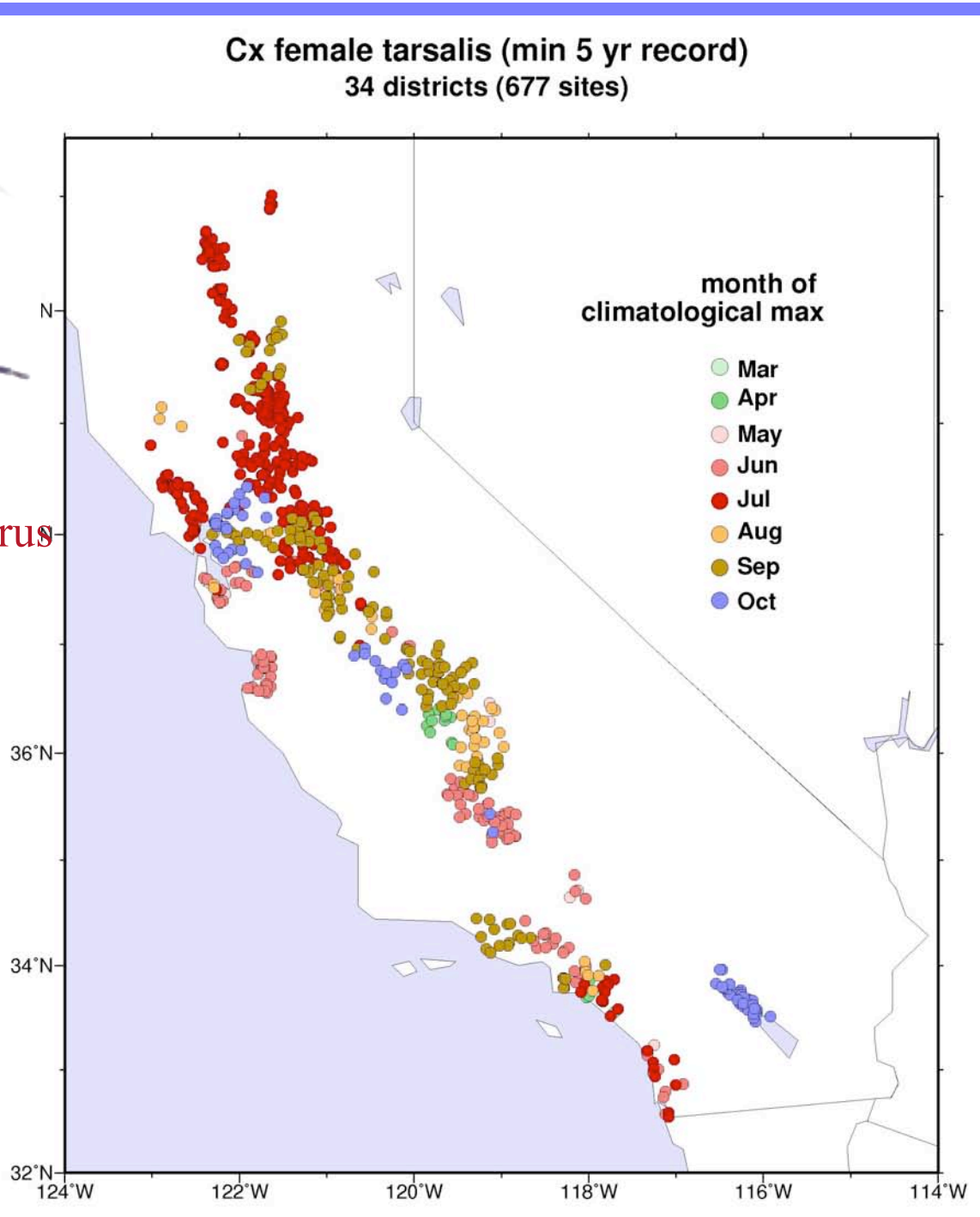
Dr. Bill Reisen, a UC Davis entomologist, is P.I. of a NOAA sponsored investigation to quantify links between climate patterns and mosquito populations and to learn to mitigate encephalitis outbreaks.



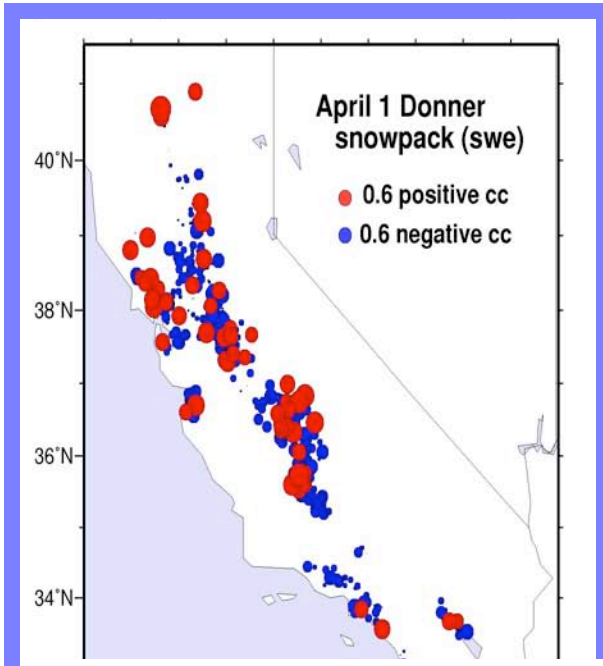
Culex tarsalis: key carrier
Of encephalitis and West Nile virus

Peak female tarsalis population in many locations in California occur in summer, but some sites are shifted to fall, likely a response to management practices—irrigation, duck club Activity that provides water when temperatures cool a bit.

These sites have at least 5 years of data between 1976 and 2001

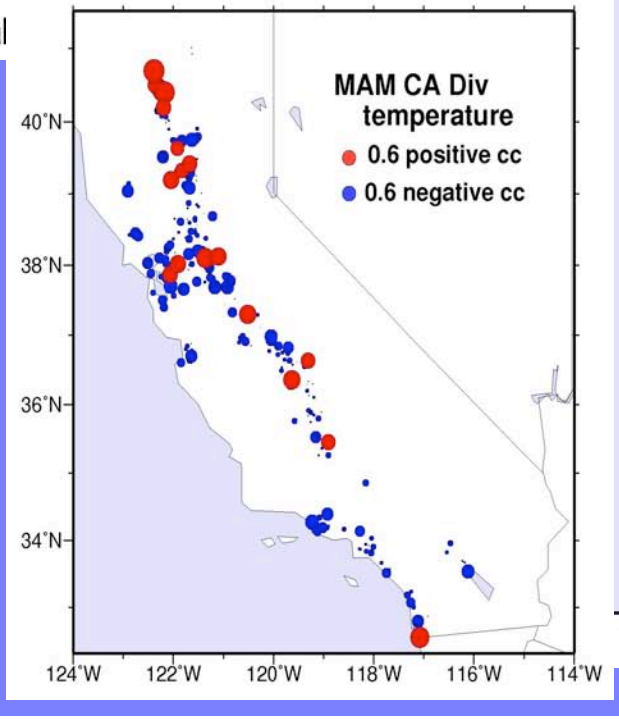


aiming to forecast mosquitos

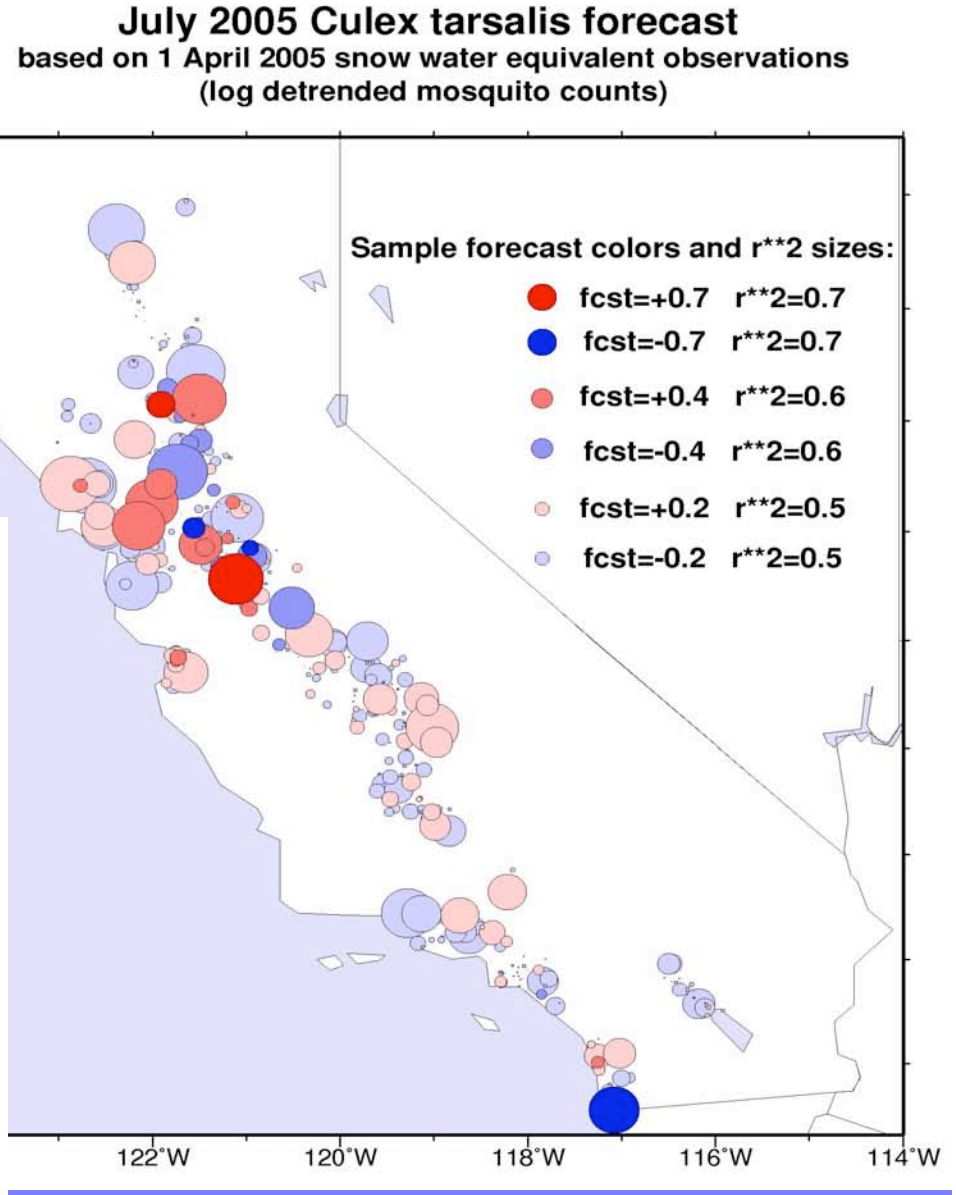


JJA Cx female tarsalis cc

(detrended) female tarsal



Correlations April snow and MAM temp



CAP Lessons Learned

Seasonal-to-interannual time frame commands interest, but not uniformly.
asymmetric--some need fcts for drought, some for wet spells

Global change is a BIG and growing issue to regional stakeholders.
"*we just need to learn how to sell it*" --- California Governor's staff
Uncertainty, e.g. precipitation change is key stumbling block.

Why this interest? **Growing population, but no growth in water supply**
paleoclimate evidence suggests big droughts possilbe
ecosystem restoration, habitat management, levee protection

There are many more interests than a modest climate applications center can serve *e.g.* agriculture, coasts, urban climates

California's climate observation&modeling capacity has not kept pace with its needs, in the face of growing populations, demands, and changing climate.

Climate expertise plus observational and model data
is vital currency for establishing credibility with users.
University reputation and science administration key assets

Agencies often don't/can't rise above operational or provincial perspectives.

California Applications Program - Microsoft Internet Explorer

File Edit View Favorites Tools Help

Back Search Favorites Media

http://meteora.ucsd.edu/cap/

Address http://meteora.ucsd.edu/cap/caphome.html Go Links

California Applications Program (CAP) & The California Climate Change Center (CCCC)

Climate information for California decision makers

Funded by the NOAA Office of Global Programs and California Energy Commission

2003 CAP Annual Report
CAP References
Contacts

CAP Success Stories - May 2003

The California Applications Program (CAP) aims to develop and provide better climate information and forecasts for decision makers in California and the surrounding region. By working directly with users, CAP is working to evaluate climate information needs and utility from the user perspective.

Objectives

- Evaluate weather and climate forecasts for California
- Improve local models and forecasts of water resources and fire risks
- Tailor and disseminate forecasts to local users

Approach

- Downscale climate forecasts and simulations from global to regional to local scales
- Provide a variety of forecasts in real time
- Determine forecast reliability using historical hindcasts
- Work directly with users to develop useful forecast applications

Lessons Learned

Special CAP Topics

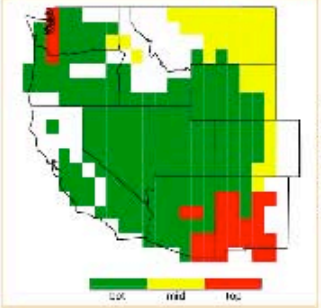
Drought grips western US

Hetch Hetchy in 1977 drought (from Sierra Club)

Updated 10 May 2004

Much of the west faces a severe drought after 5 dry winters in a row

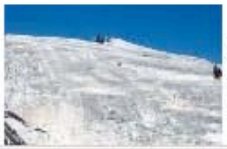
2004 Wildfire Forecast



Updated: 30 April 2004

Forecasts for the 2004 fire season (sample shown above) indicate low area burned for most of the western United States (green regions).

(Click here for more details)

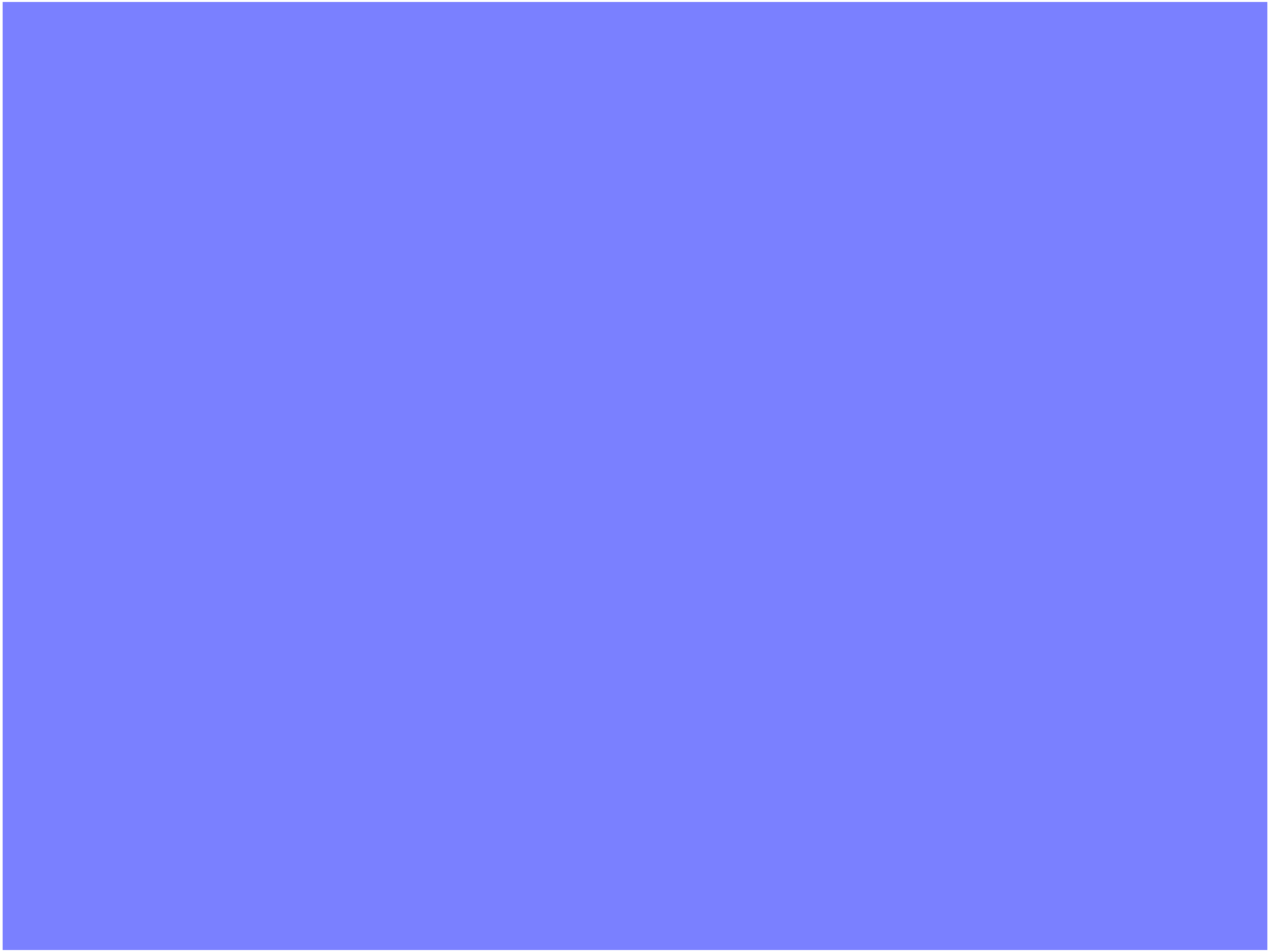


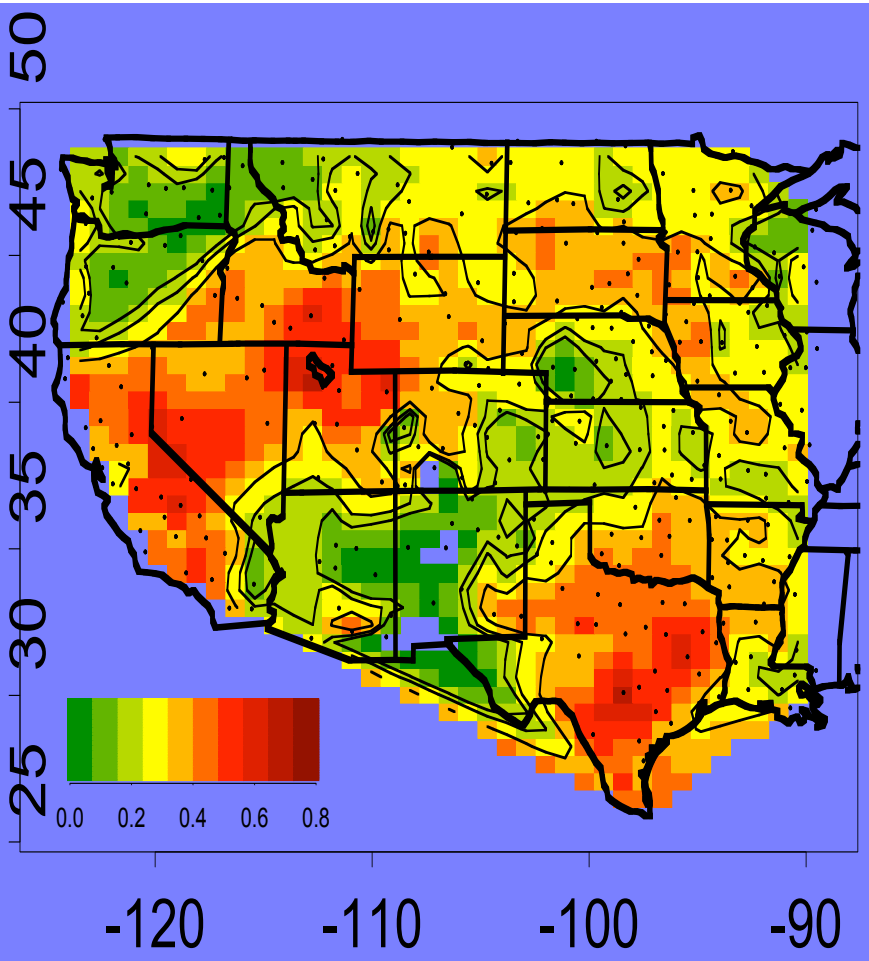
Yosemite National Park Hydroclimate Monitoring

CAP Research

- *Updated daily*
  Medium-range Hetch Hetchy precipitation and Tuolumne Meadows temperature forecast
- **The CALFED Bay-Delta Program: Climate Science issues and needs of the CALFED Bay-Delta Program**
- **Climate Variability and CALFED -- CAP Contributions to the 2003 CALFED Science Conference**
- **US Streamflow Probabilities and Uncertainties based on Anticipated El Niño, Water Year 2003**
- **El Niño and California 2002-2003**
- **2002 Experimental Forecast of Maximum Daily Snowmelt Discharge**
- **Maximum Daily Snowmelt Discharge, A Review of the 2001 Forecast**
- **Potential Impacts of Global Warming on California's Hydrology**
- **Changes in Spring in the Western United States: Updated for 1999-2001**
- **Climate and Human Health**

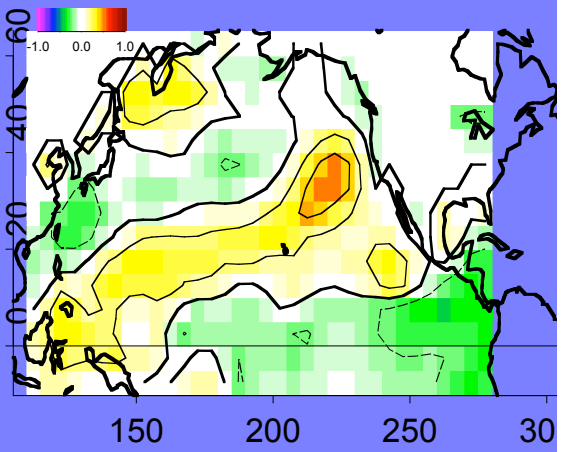
Done Internet





JJA Tmax
cross-validated skill
May PDSI & PSST predictors
(Canonical Corr'n scheme)

PSST
Cancor
Mode 1



PDSI
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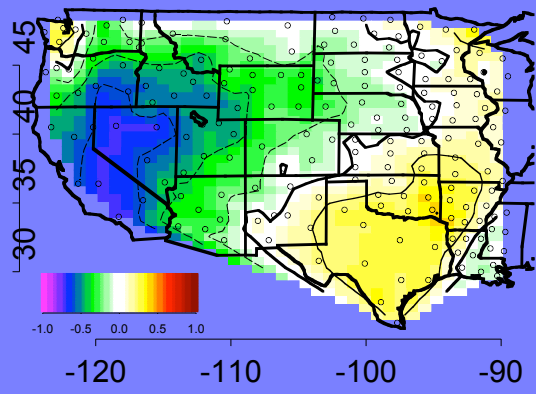

Tmax
Cancor
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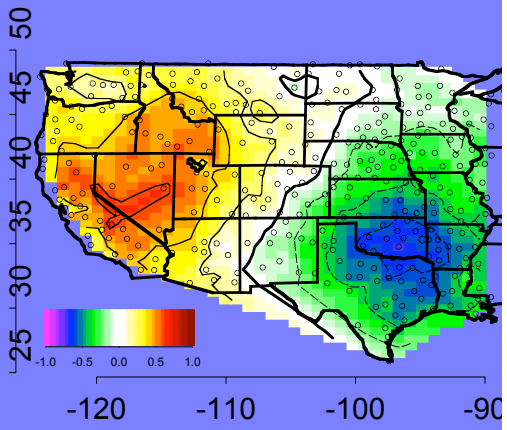


A few messages:

short term climate forecasts “count” more in some years than others.

climate change is a growing issue

need for fine scale (km) climate data in many applications

application communities hampered by lack of quality datasets

THE ENCEPHALITIS MOSQUITO (CULEX TARSALIS)

Culex tarsalis is widely distributed in North America. It occurs throughout California, from sea level up to nearly 10,000 feet elevation, and is especially abundant in the Central Valley and coastal regions, including Marin and Sonoma Counties.

This mosquito develops rapidly and produces multiple generations. In the hot summer season, egg to adult development occurs in as few as four to ten days. A female can lay six or seven times, with some 300 eggs in a batch. Without control efforts, local populations can reach huge numbers in a short time.

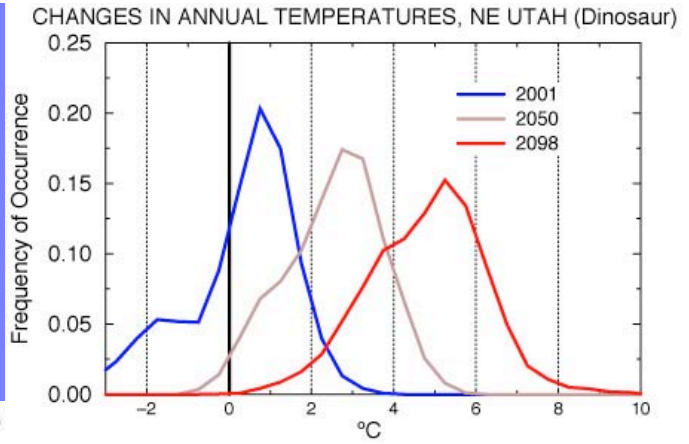
Culex tarsalis breeds in nearly every freshwater source except tree holes. Larvae are found in all but the most polluted ground pools. Summer agricultural irrigation produces an especially favorable environment, with highest population densities coinciding with the months of most intense irrigation.

During the daytime, adults rest in tree cavities, animal burrows, and artificial habitats like barns, chicken houses and culverts. In most areas, they feed equally on birds and mammals including man, depending on availability. After years of intense efforts to keep them under control, vast populations in the central valley have become resistant to nearly all the common chemical insecticides.

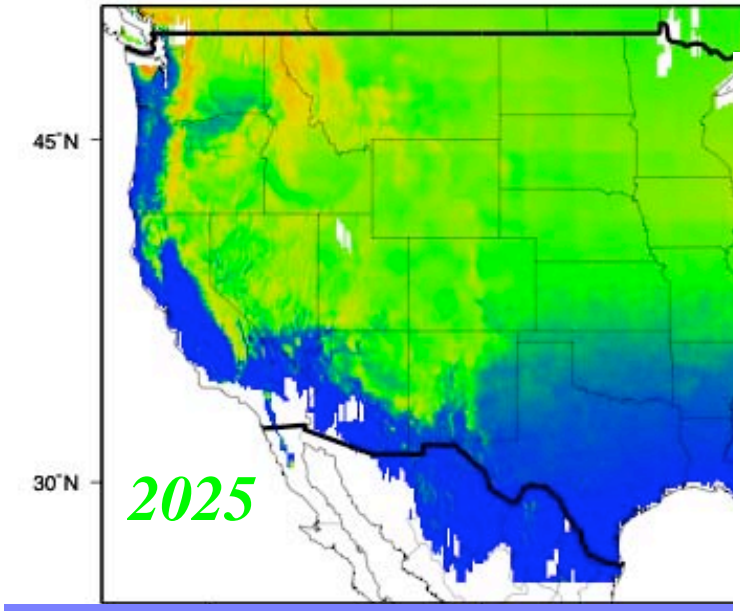
Culex tarsalis is the most important carrier of western equine and Saint Louis encephalitis in California, as well as in much of the western U.S. It occurs together with wild birds - the natural reservoir of infection, and virus is often discovered in field-collected specimens. It is also readily infected after taking an infected blood meal, and easily transmits the virus during its later blood meals. The appearance of antibodies against encephalitis virus in the flocks of sentinel chickens kept in several parts of the state is a signal alarm to the

From http://www.msmosquito.com/ctarsals.html

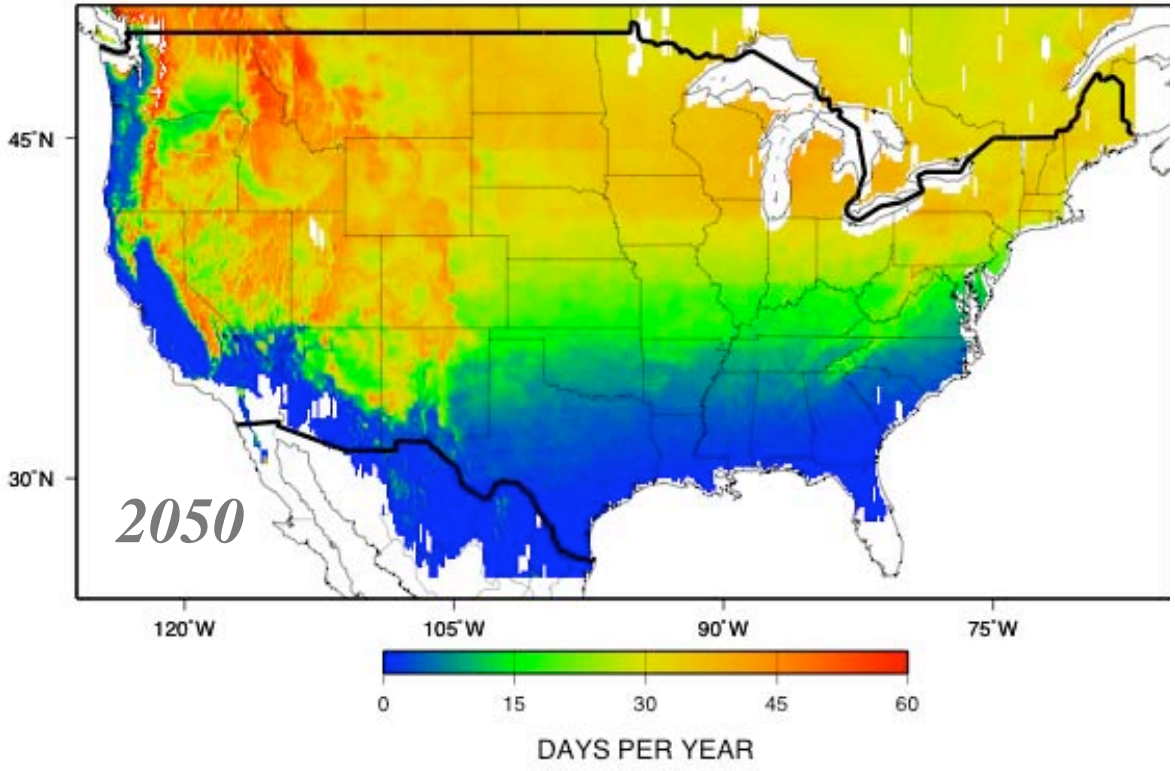
Estimating Influences of the full Ensemble of Projected Warmings on FROZEN-SEASON LENGTH



EXPECTED NUMBER OF DAYS/YEAR WITH MEAN TEMPERATURES RAISED ABOVE FREEZING BY PROJECTED WARMINGS IN 2025
[from 1950-1999 VIC 1/8-degree INPUT DATA]

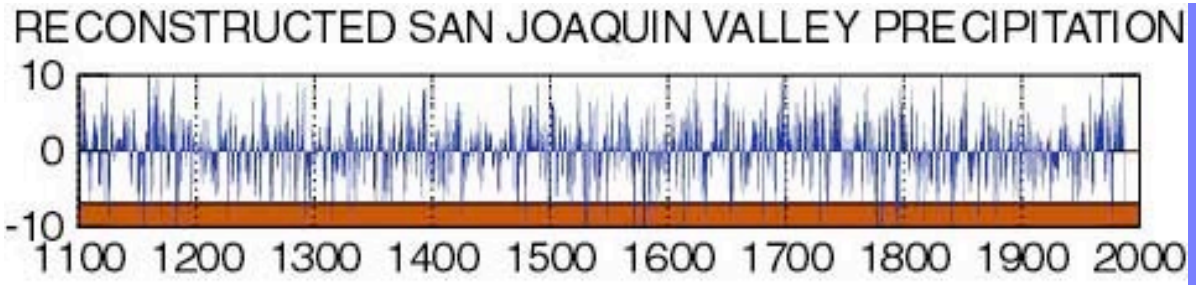


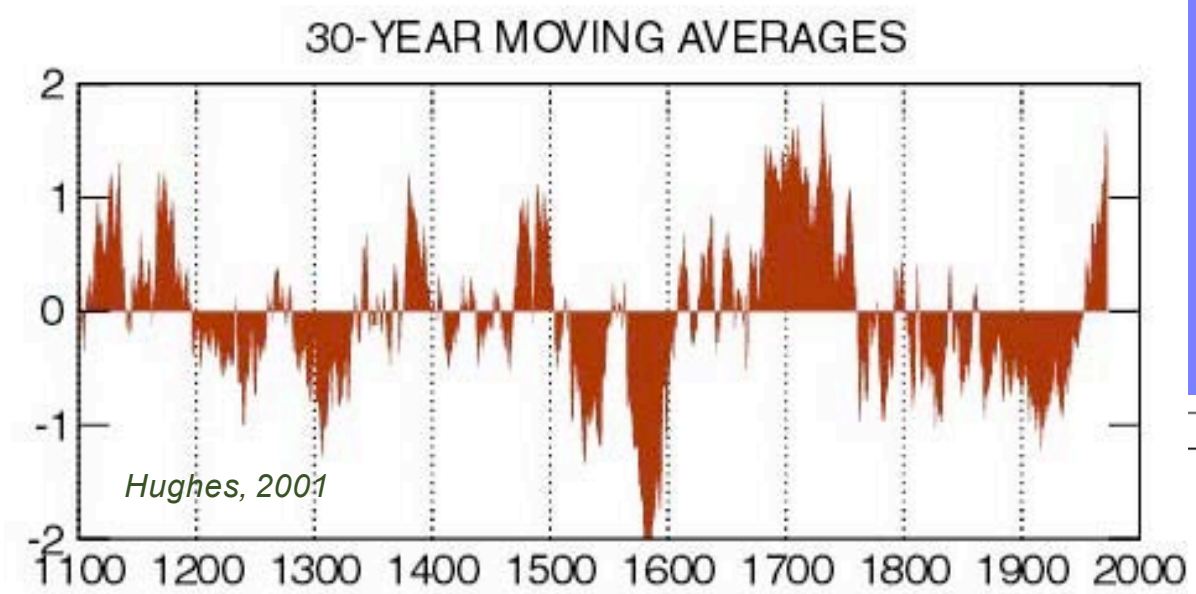
EXPECTED NUMBER OF DAYS/YEAR WITH MEAN TEMPERATURES RAISED ABOVE FREEZING BY PROJECTED WARMINGS IN 2050
[from 1950-1999 VIC 1/8-degree INPUT DATA]



Derived from monthly IPCC GCM-grid pdfs, and UW's VIC model daily inputs, 1950-1999

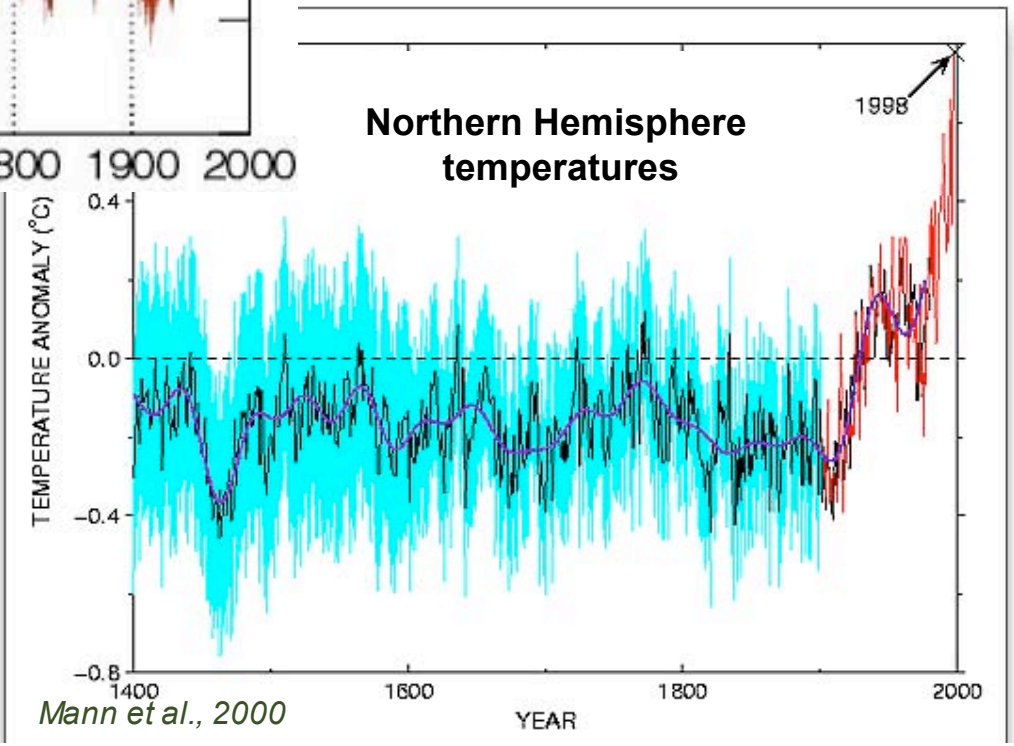
USGS





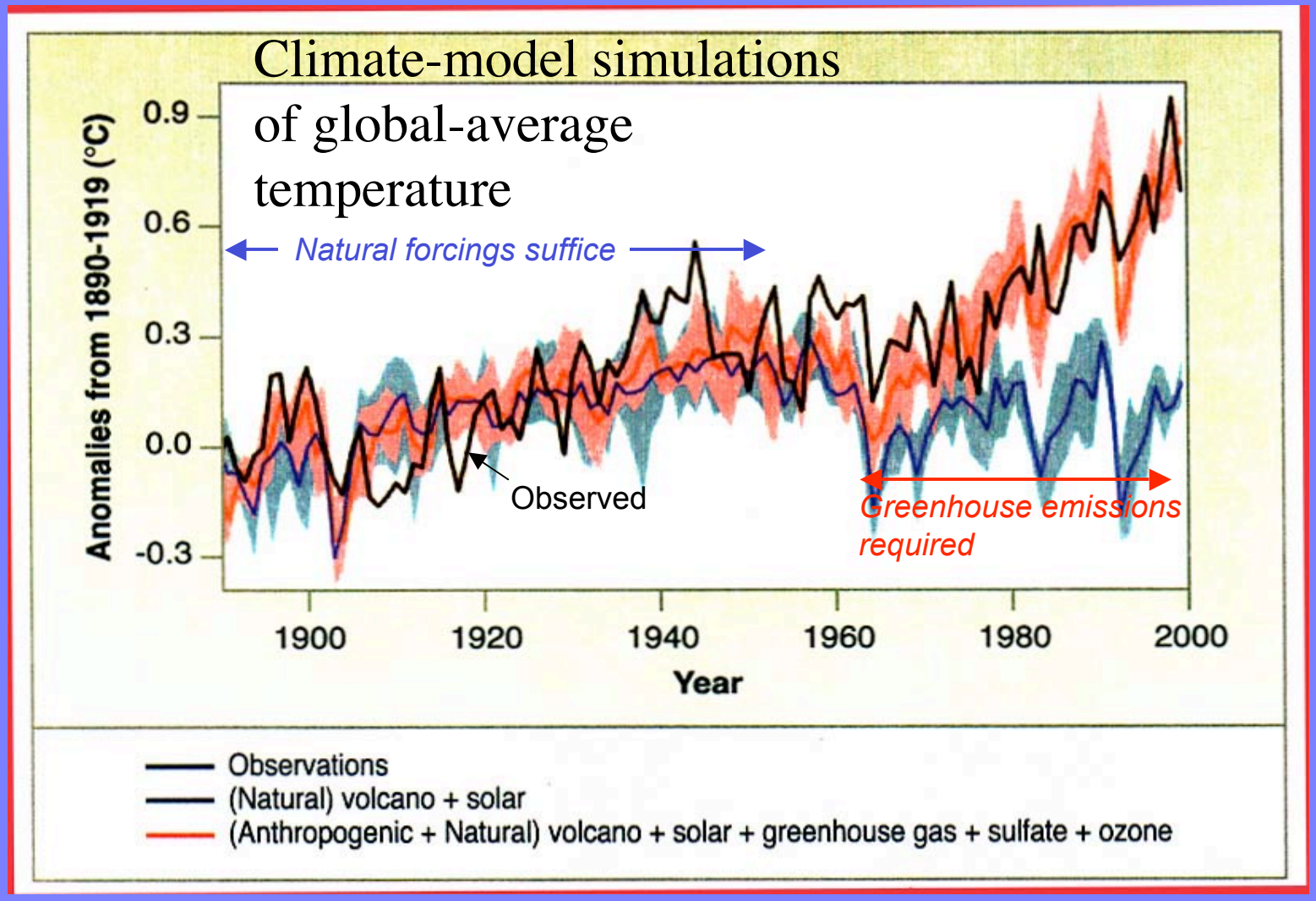
More than 1000 years of climate reconstructions now suggest that even wilder variations are California's norm.

USGS



Model experiments indicate that

The recent western warming appears to be *largely* due to increases in the global greenhouse effect.

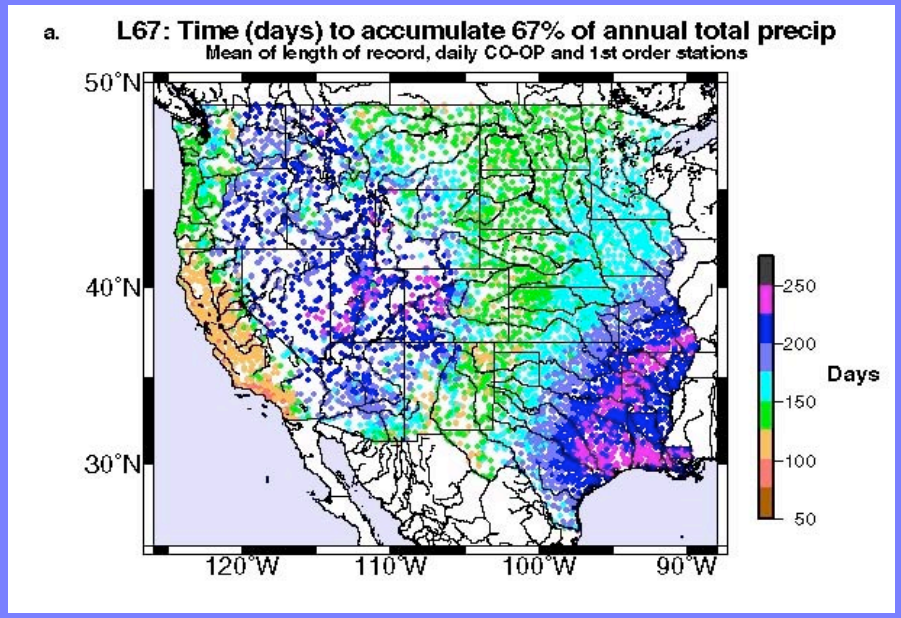


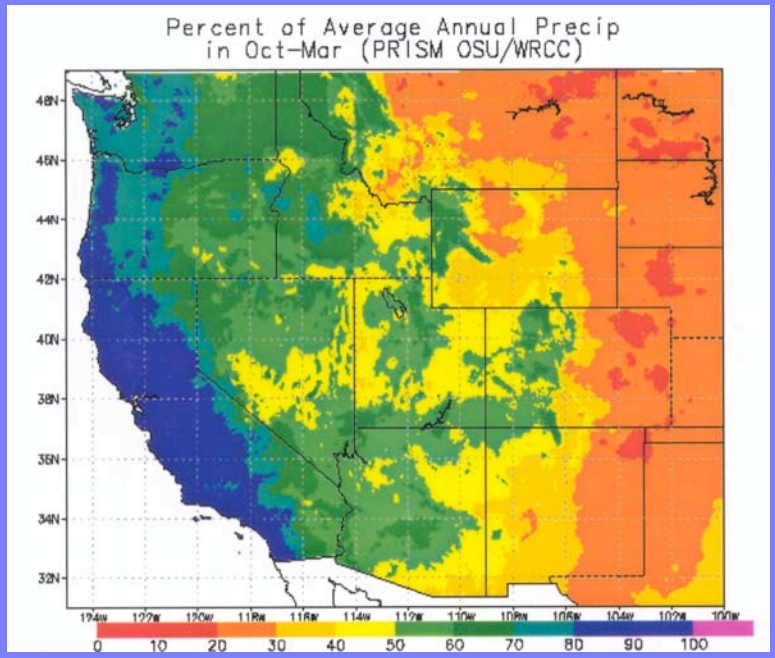
Meehl et al., in press

North Pacific storms are seasonal

so

California's Precipitation season is very brief



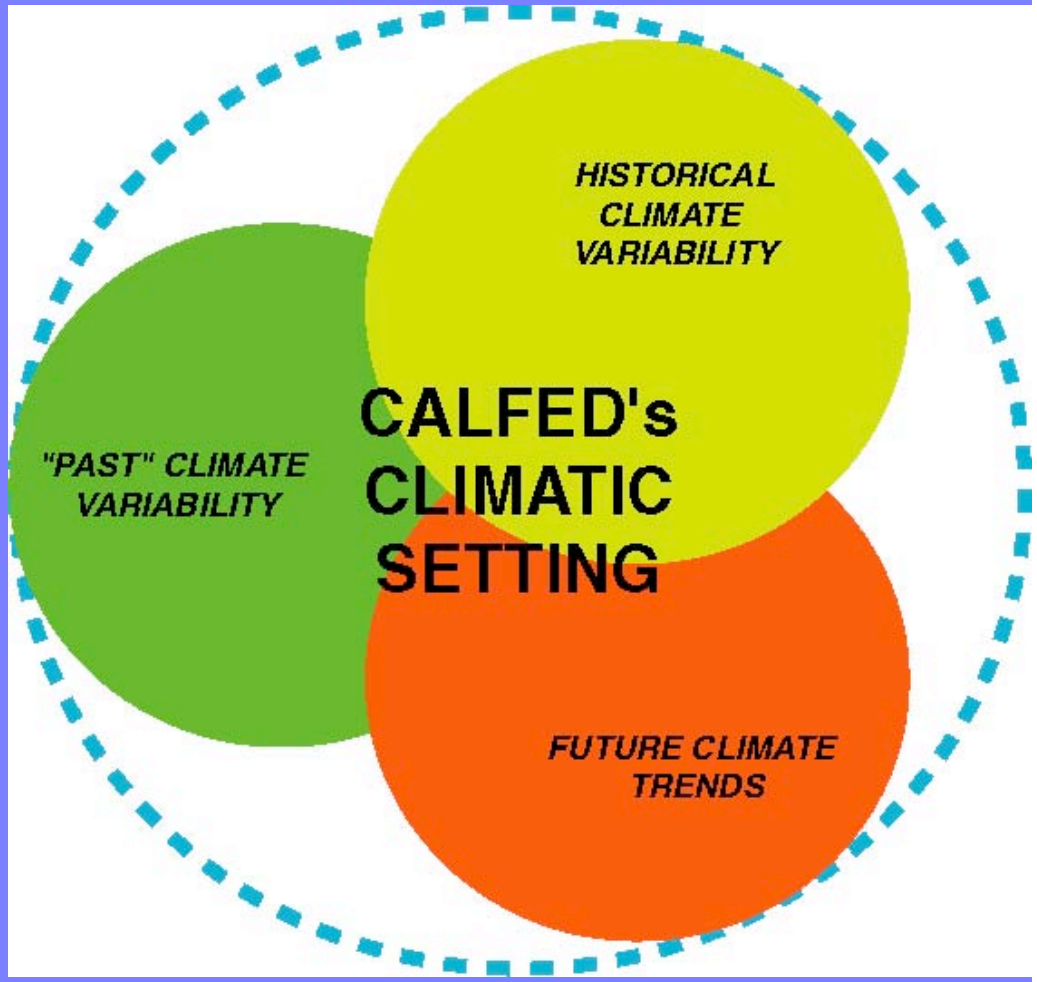


In about 120 days, California must accumulate two thirds of its annual precipitation

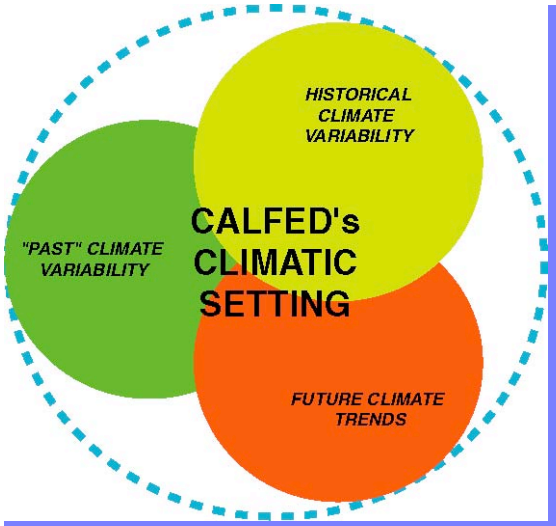
Our water supply comes mainly during Oct-Mar , owing to the North Pacific storm regime

So, what climate-science questions face CALFED?

- Paleoclimatic variability
- Historical climate variability
- Climate monitoring
- Future climates



USGS



POTENTIAL CALFED CLIMATE-SCIENCE ACTIVITIES *(examples)*

- Regular independent reviews of networks, data & dissemination, & climate knowledge
- Retrospectives on impacts of current climate events on CALFED efforts
- Targeted monitoring efforts in key & sensitive parts of the Bay-Delta watershed
- Physics-based evaluations of current (& future) climate-change projections
- Regionalizations of climate-change projections

USGS

WHAT ARE OBSERVATIONS AND MODELS TRYING TO SAY?

Humans have altered atmospheric composition and thus are altering the earth's climate; GH gases have long lifetimes, so choices made now and in future will determine future climate.

Warming already underway and coming fast.

California temperature projections are broadly in consensus (+3 to +6 or more ºC by 2100), enough for earlier flows, more floods & drier summers.

California precipitation projections scattered, with MOST showing small (drier?) changes but a couple of wet outliers.

Estimated changes would likely have adverse impacts on California resources, such as water, ecosystems, coastlines, and human health. Compensating benefits—longer growing seasons?

Careful monitoring and modeling crucially needed.

Water and energy issues are closely linked

Energy is required to:

- lift water from aquifers, pump water through canals, pipes
- manage water flow, treat waste water, desalinate salt water
- Globally, commercial energy consumed for delivering water is more than 26 quads, 7 percent of total world consumption

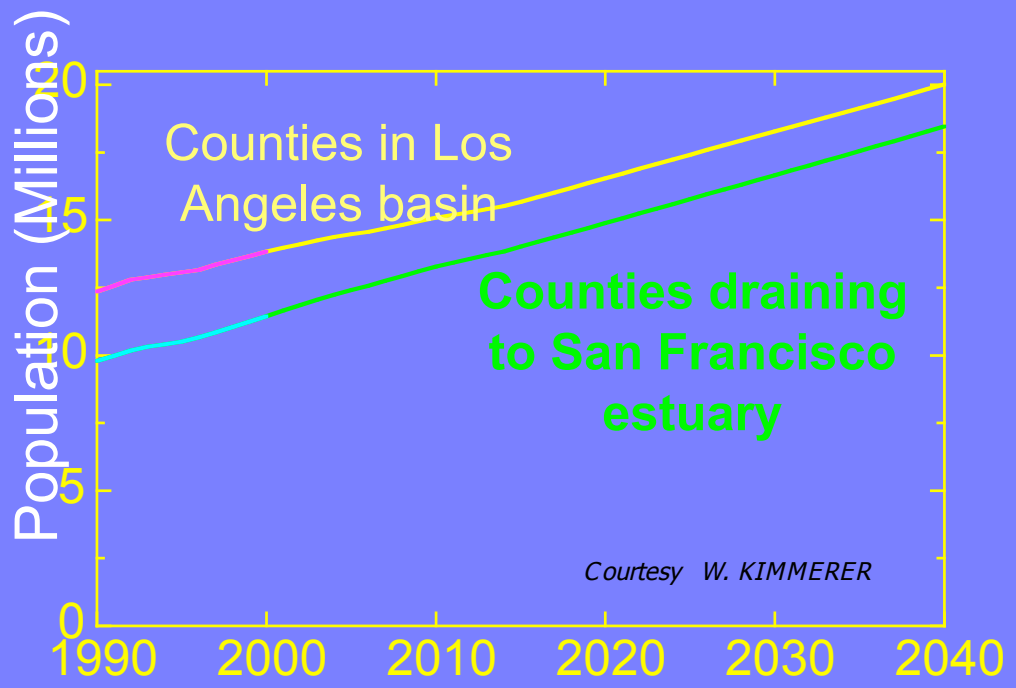
in Calif, ~10% of total electrical is consumed by water system*

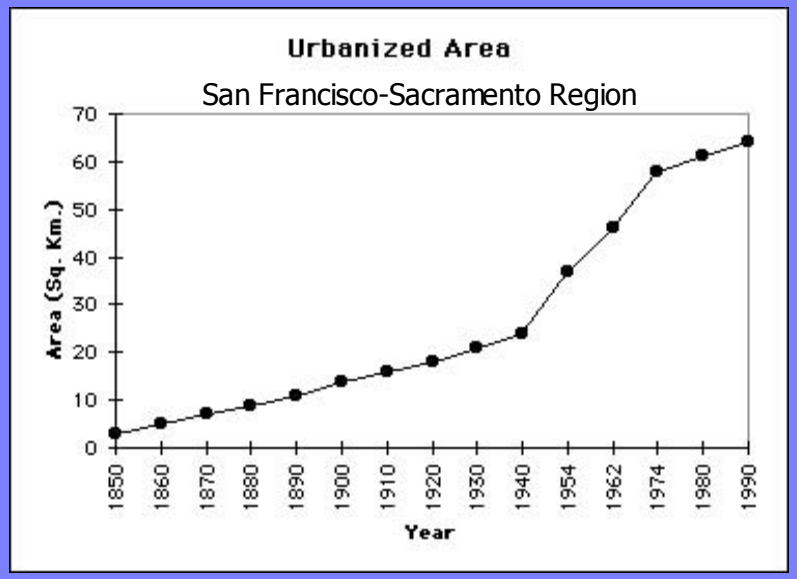
The Growing Demand for Water

- **Population growth and economic development are driving a steadily increasing demand for new clean water supplies**
- **World water demand has more than tripled over the past half century**
- **Global water withdrawal in 2000 (1,000 cubic miles) is estimated to be about 30% of the world's total accessible fresh water supply, and may reach 70% by 2025**
- **Many see water security as the key environmental issue, 21st century**
- **Lack of access to clean water has major health implications**

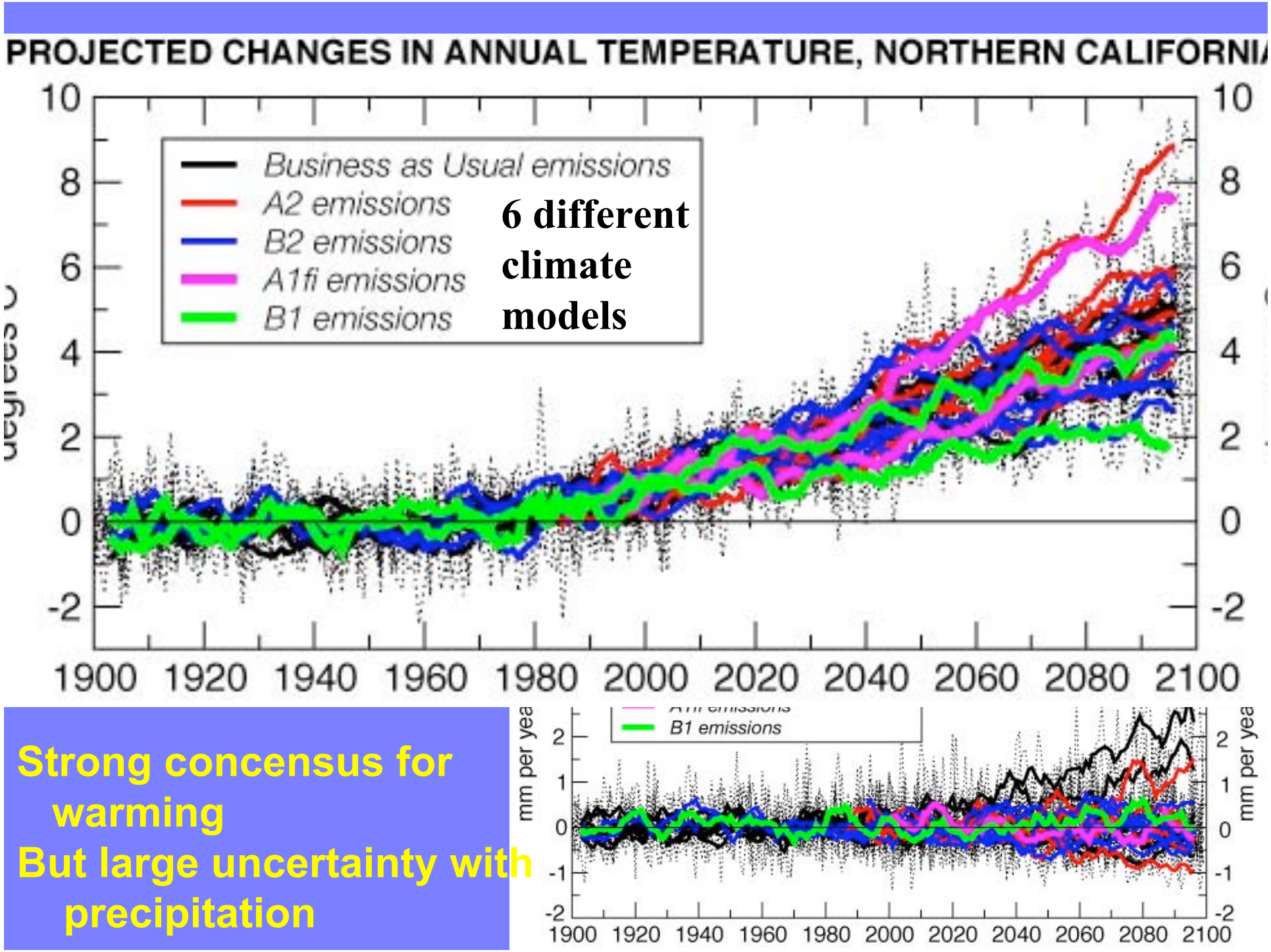
Allan Hoffman, DOE fall 2004

Meanwhile, the Estuary's watershed and structure are expected to continue experiencing high rates of population growth and urbanization.





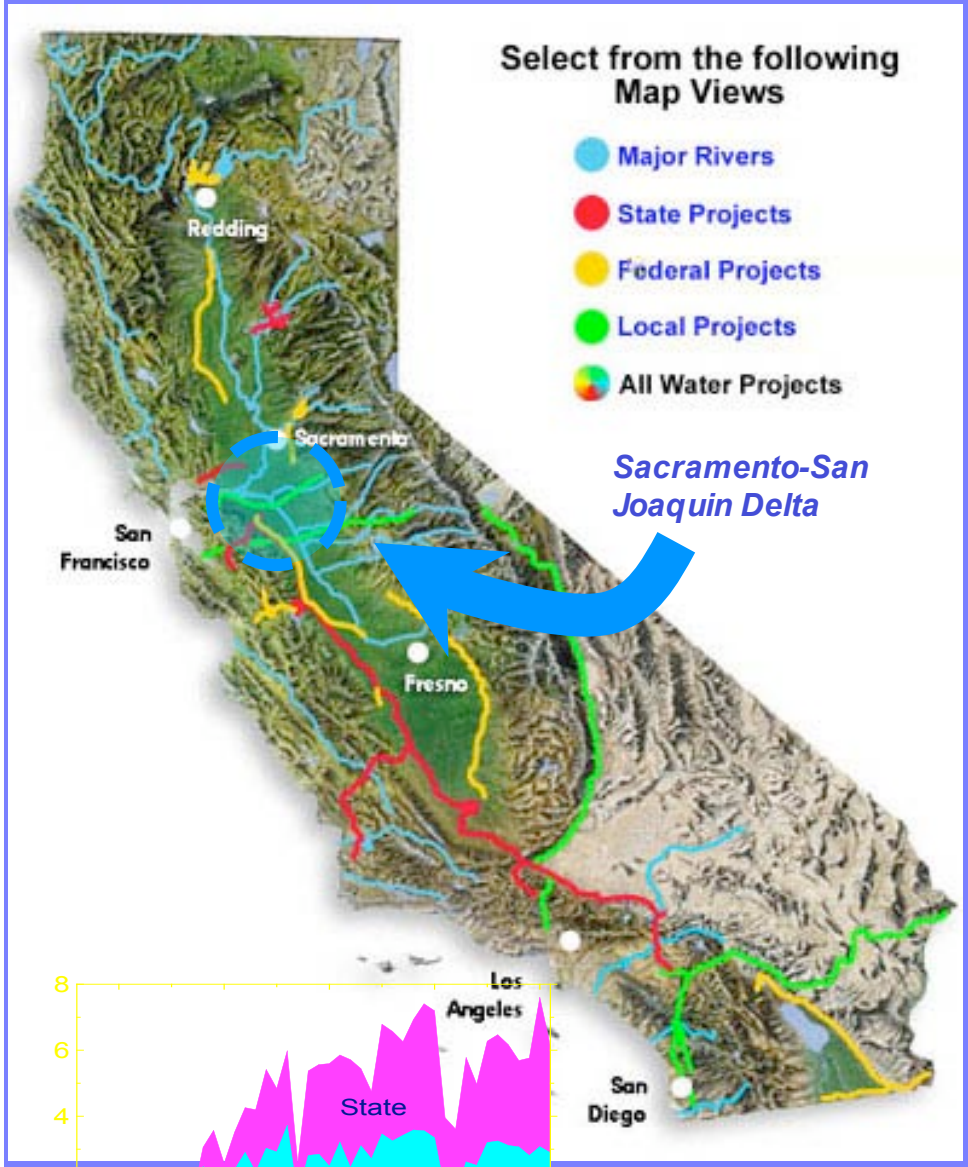
USGS URBAN DYNAMICS PROGRAM



Strong concensus for warming

But large uncertainty with precipitation

CA Water Resources System



- California's extensive plumbing system 1200 miles of aquaduct, 43MAF storage

  - 75% of runoff occurs in north; 72% of consumptive use in south

- 6 km^3/yr of water is pumped from the Delta by State & Federal systems for San Joaquin Valley agriculture & Southern urban uses

- 7000+ agencies/cities have permits for water from Delta & its watershed
- About 42% of runoff exits by way of Bay/Delta

Average annual precip 800M AF

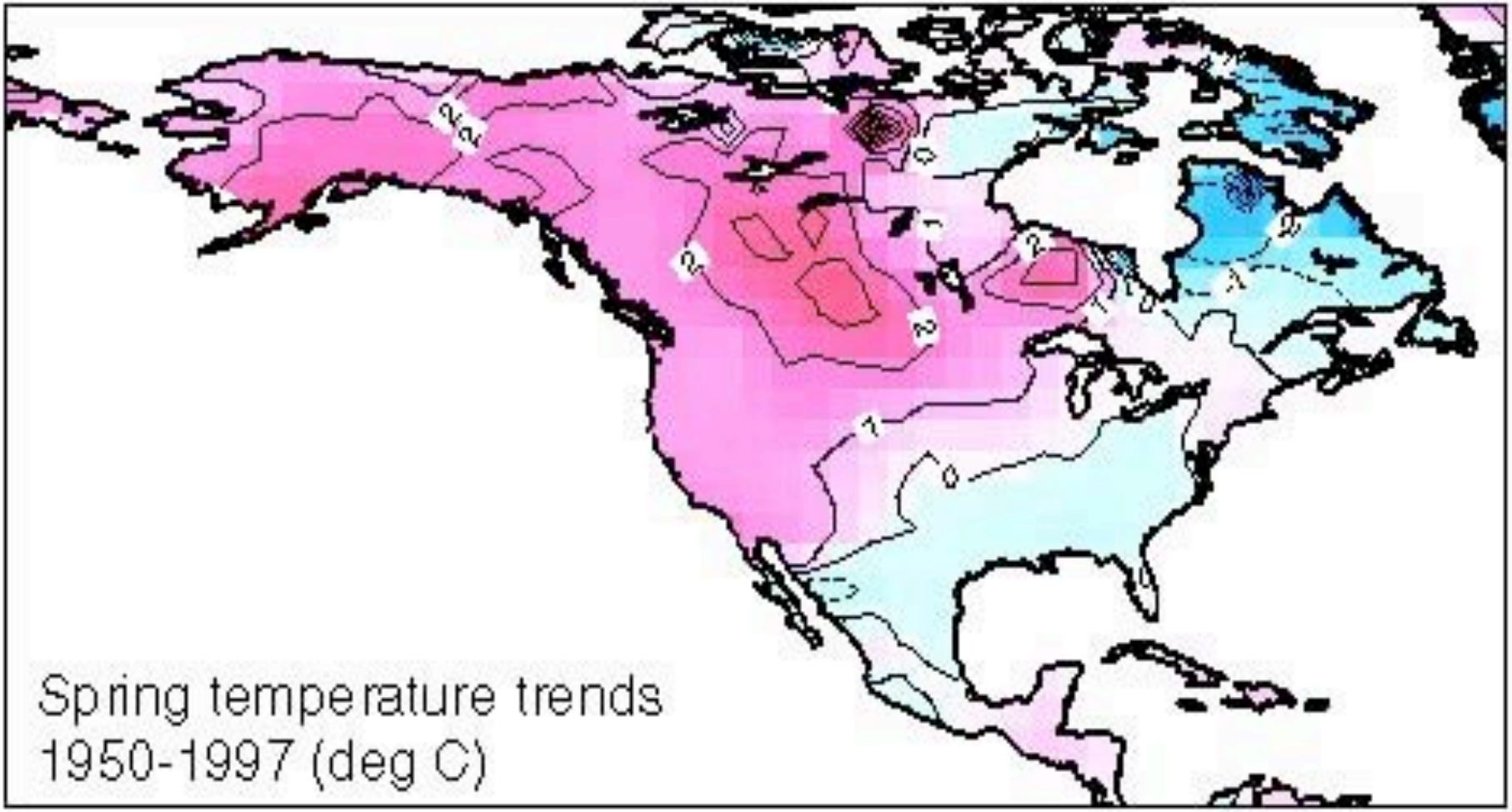
Developed Runoff ~42 MAF

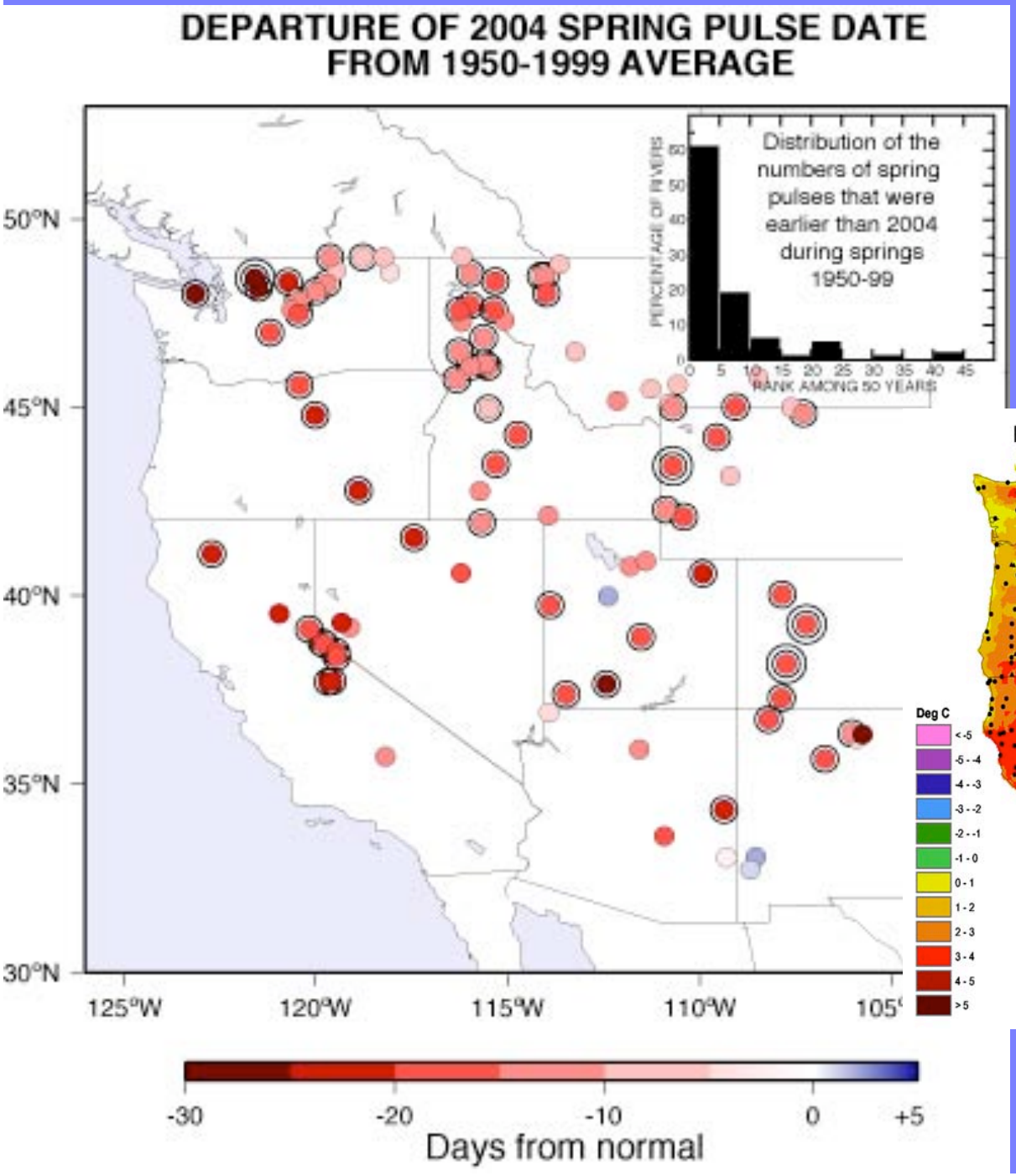
800K AF Colorado River

"surplus" ~1.7% of developed supply

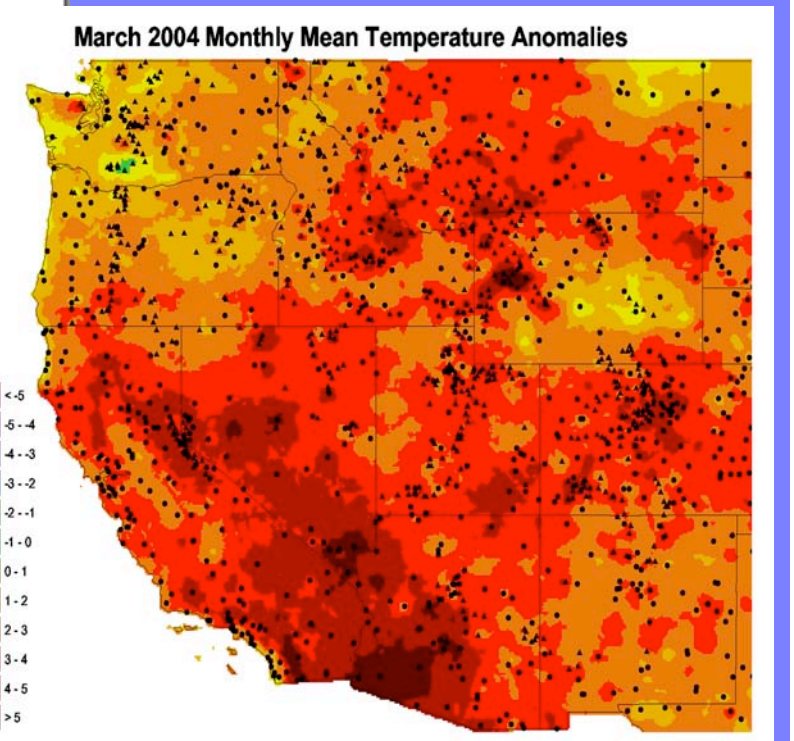
Very broad winter and spring warming 1950-1997

California warmed 0.5-1.5C

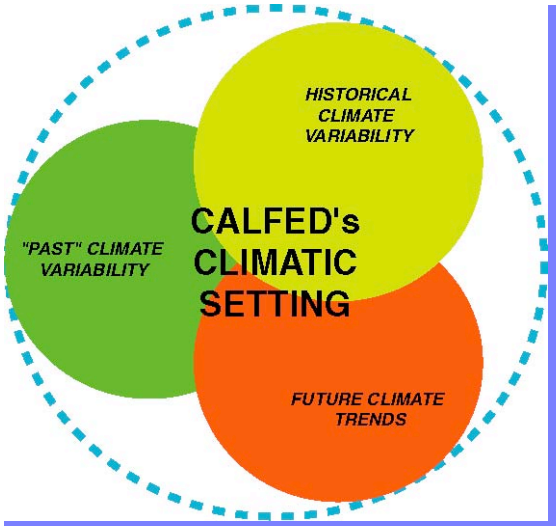




Mar-Apr 2004 record warmth and early runoff



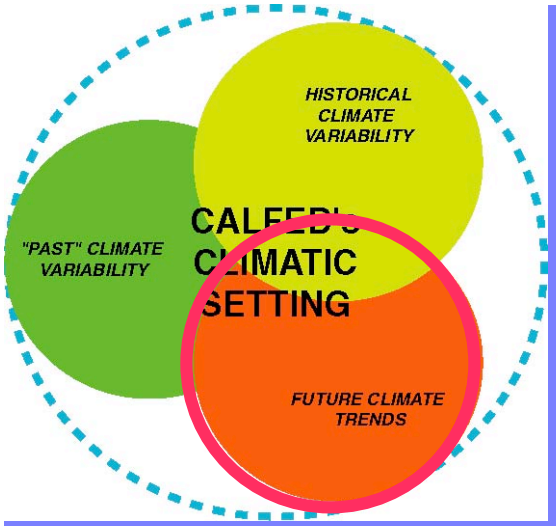
Pagano et al EOS Oct 2004



POTENTIAL CALFED CLIMATE-SCIENCE ACTIVITIES *(examples)*

- Paleoclimatic transects linking Sierra Nevada to Bay/Delta/ocean
- Integrated models of paleo- ecosystem & water climate responses
- Integrated models & evaluations of sensitivities of modern eco-, water, levee & policy systems to climate variations & change
- Research describing climatic influences in ecosystems & water operations
- Threshold vulnerabilities in water, levee & ecosystems

USGS



FUTURE CLIMATE & CALFED

* Full plausible, and most likely, ranges of climate change during the next 100 years?

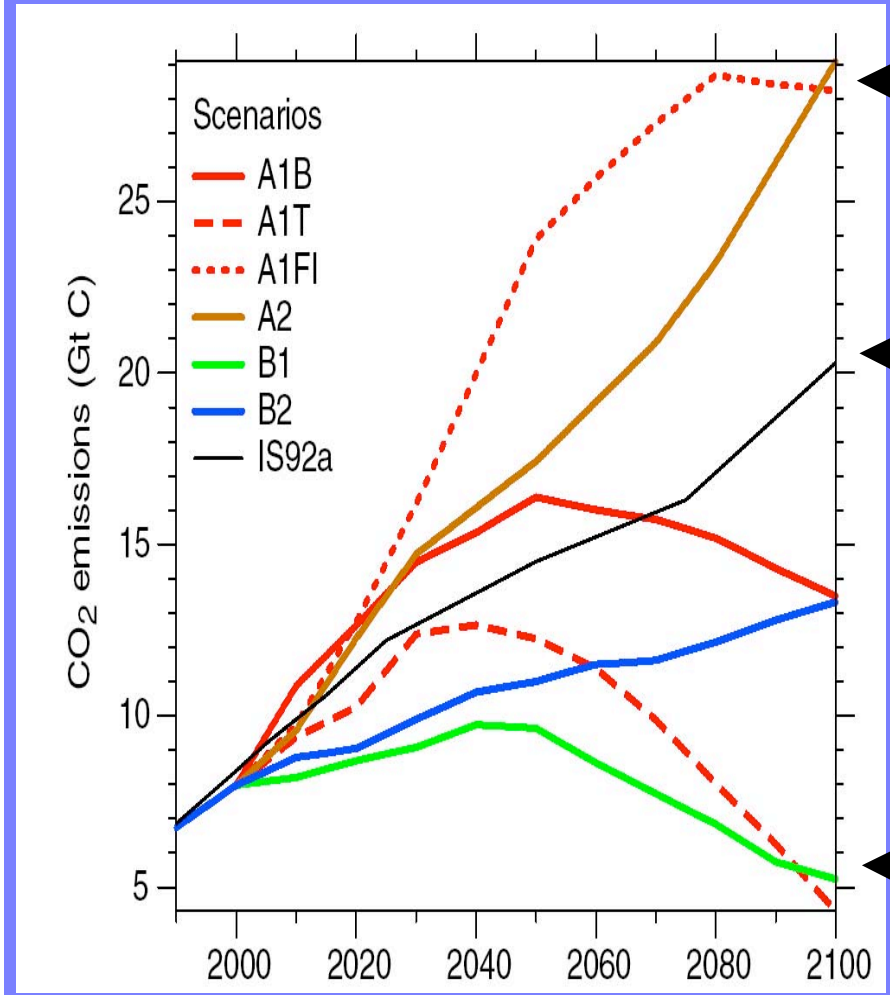
- Local variations of climate change?
- Climate-change effects on water, sediment & geochemical budgets?
- Climate-change effects on wetlands, ecosystems, and water quality?
- Are we changing these sensitivities?

USGS

But, while future emissions will continue, their levels could be could be more or could be less…, and climate would respond accordingly

Global CO2 Emissions Scenarios

Intergovernmental Panel on Climate Change (IPCC)



Higher (A1fi)

Previous (IS92a)

Lower (B1)

Two state-of-the-art climate models (GCMs):

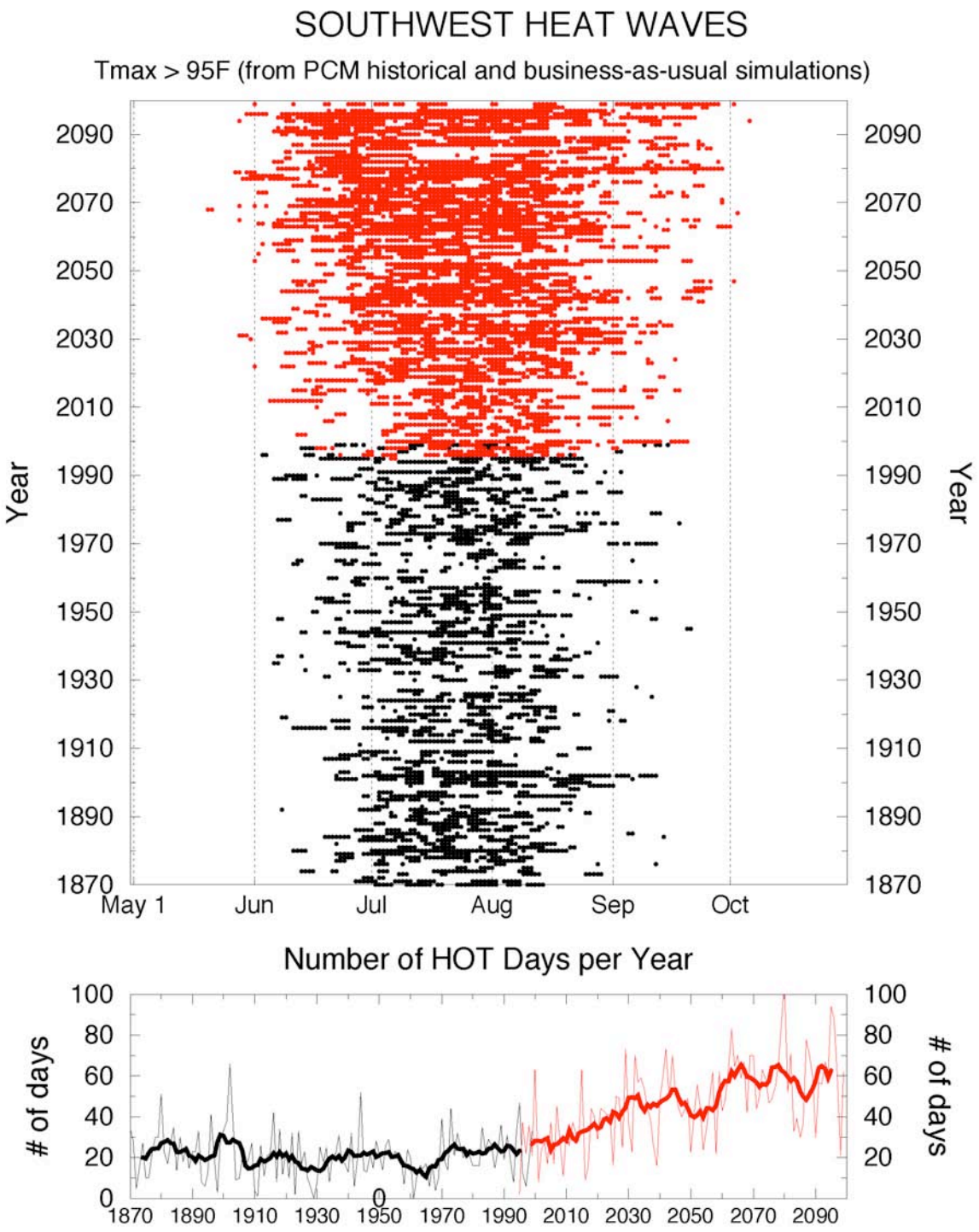
HadCM3 medium sensitivy
PCM lower sensitivity

PNAS study
Hayhoe et al
Summer 2004

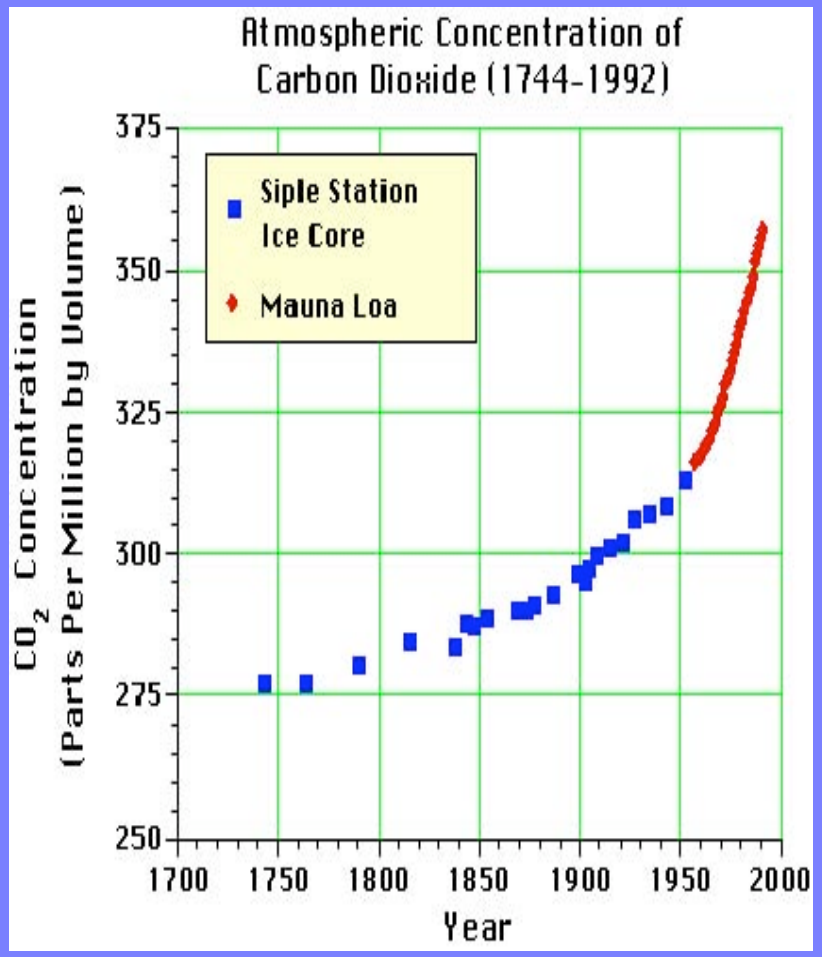
Even moderate climate changes in average conditions translate into large changes in the extremes

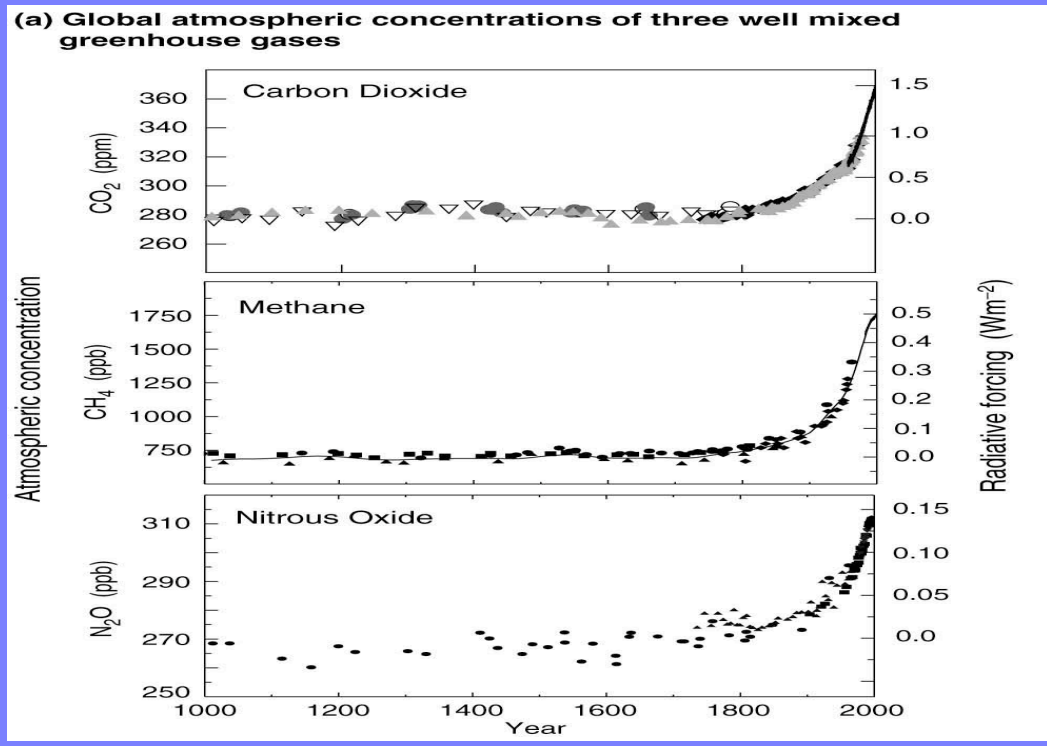
hot days increase In intensity and There is longer season

from ACPI Parallel-Climate model simulations,



Humans have greatly Influenced the Atmosphere during the Industrial Era

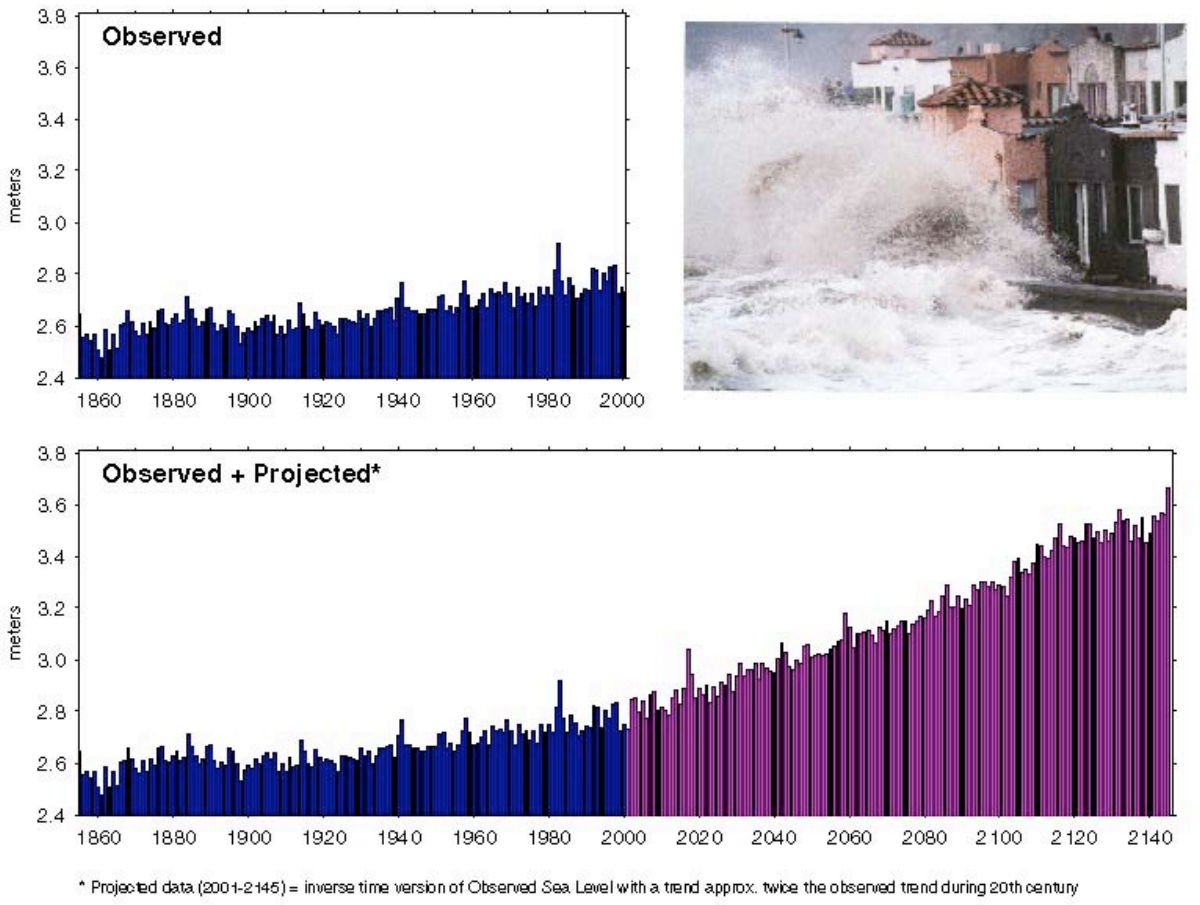


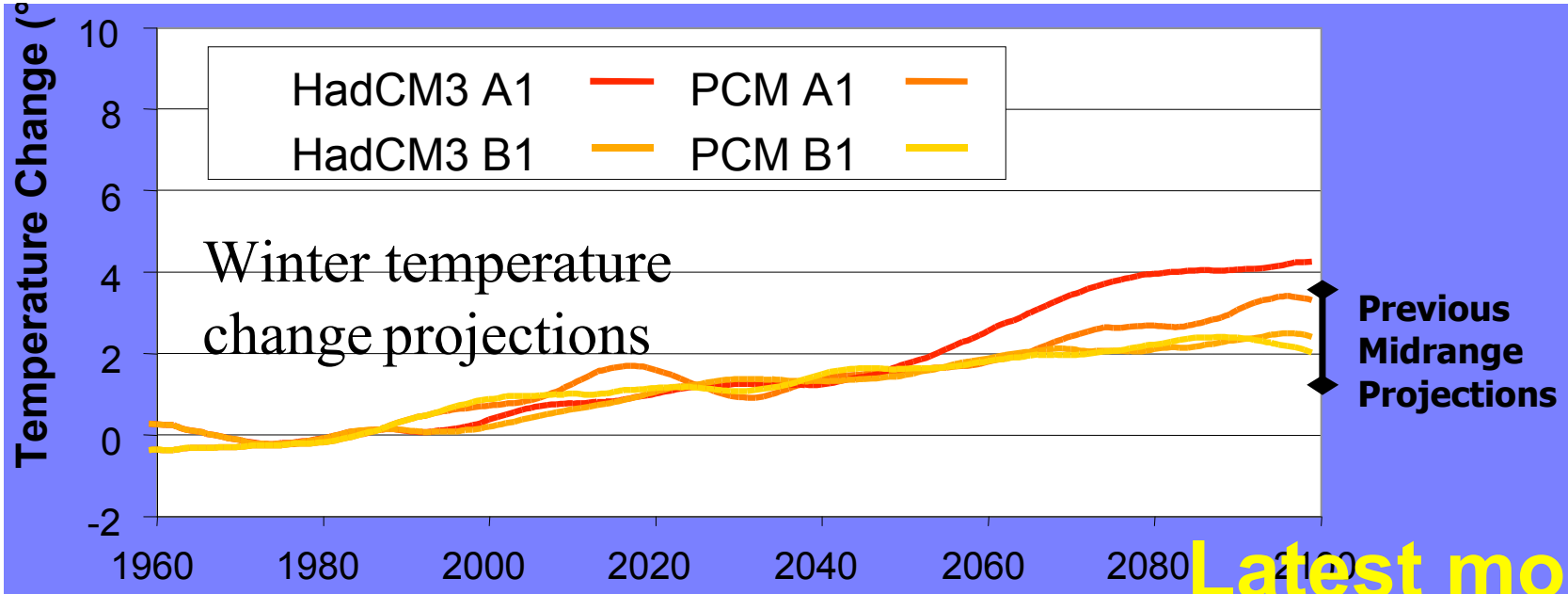


While these are relatively low concentrations, these trace gases are critical because they absorb infrared radiation and thus change the temperature of the atmosphere

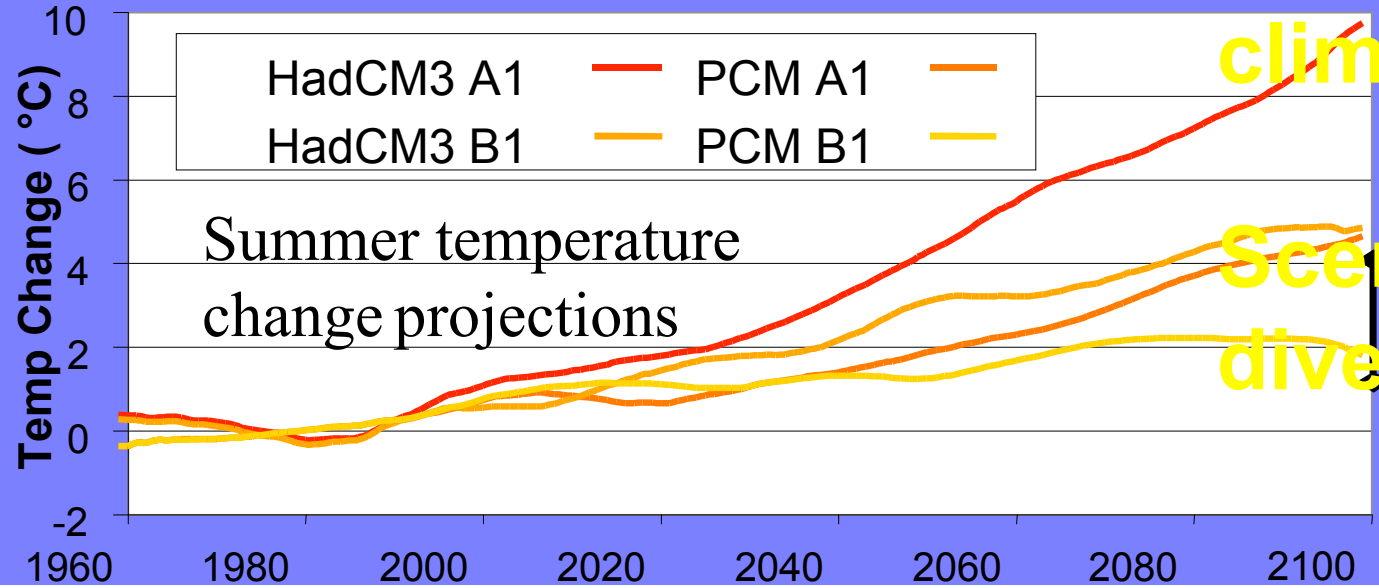

1900

The California coast is likely to face rather dramatic sea-level rises that may threaten its shoreline and its estuaries.





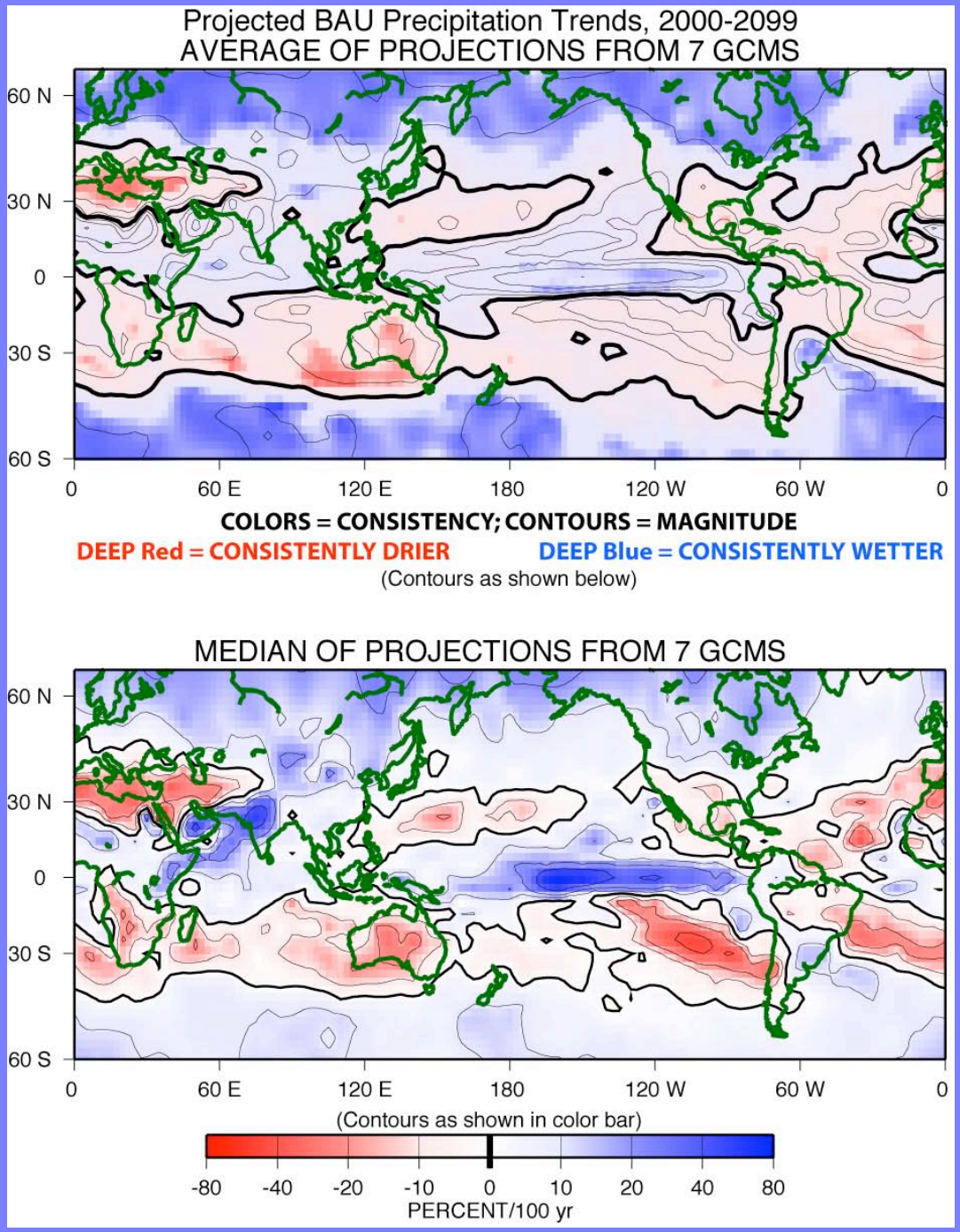
Latest models Have warmer Summer climate



Scenarios diverge ~2040

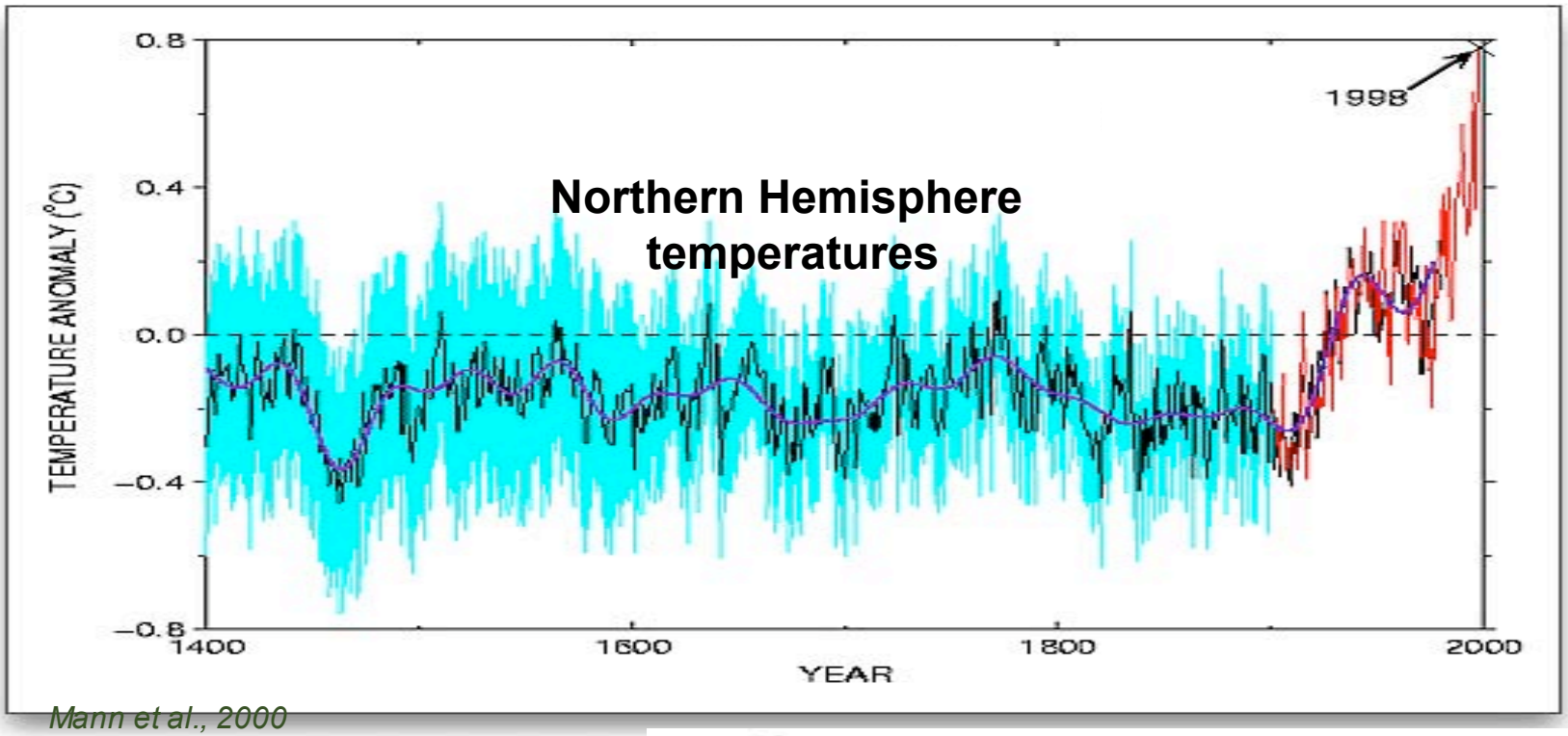
Projections of Precipitation Trends

Precipitation generally projected to increase at high latitudes; decrease in subtropics; patchy & uncertain in between *(e.g., thruout lower 48)*



USGS

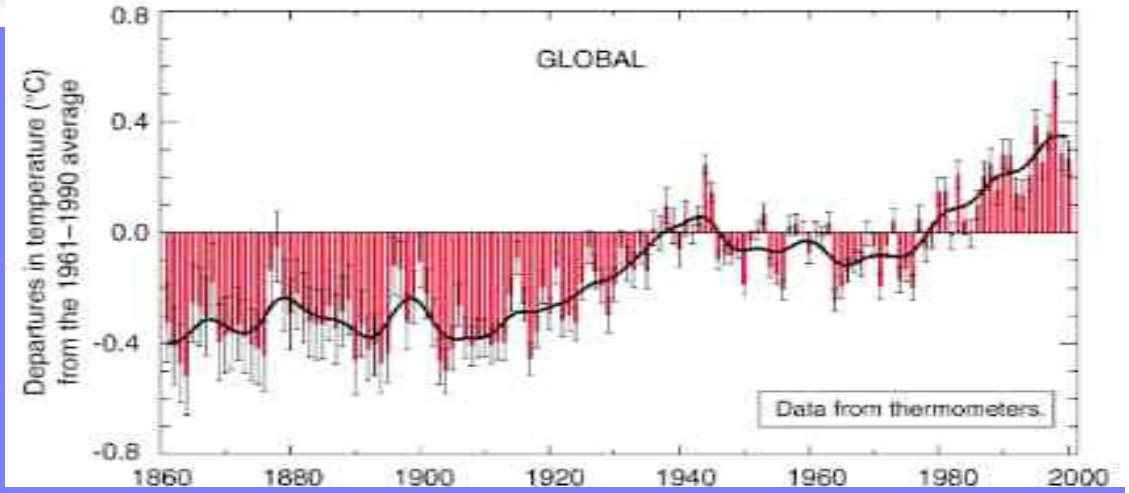
Observations suggest that global temperatures have *already* risen at a extremely rapid pace.



Mann et al., 2000

1990's warmest decade in instrumental record (NASA/NOAA)

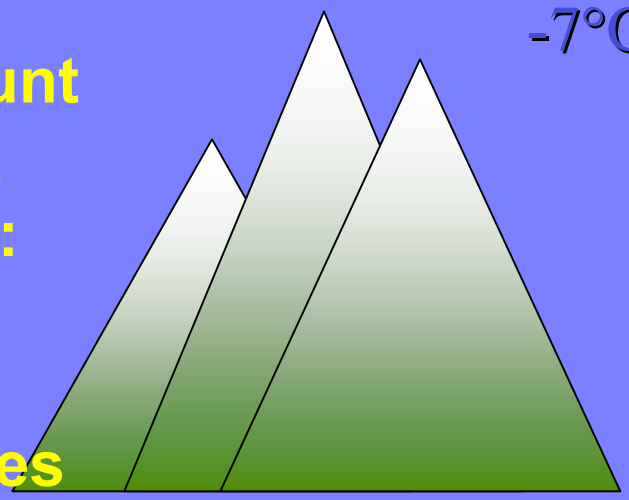
1. 1998 warmest year
2. 2002
3. 2003
4. 2004
****2005 may turn out warmest**



Temperature Decreases with Altitude

and there is diminishing amount of land surface at higher elevations:

major problems for water resources and ecosystems

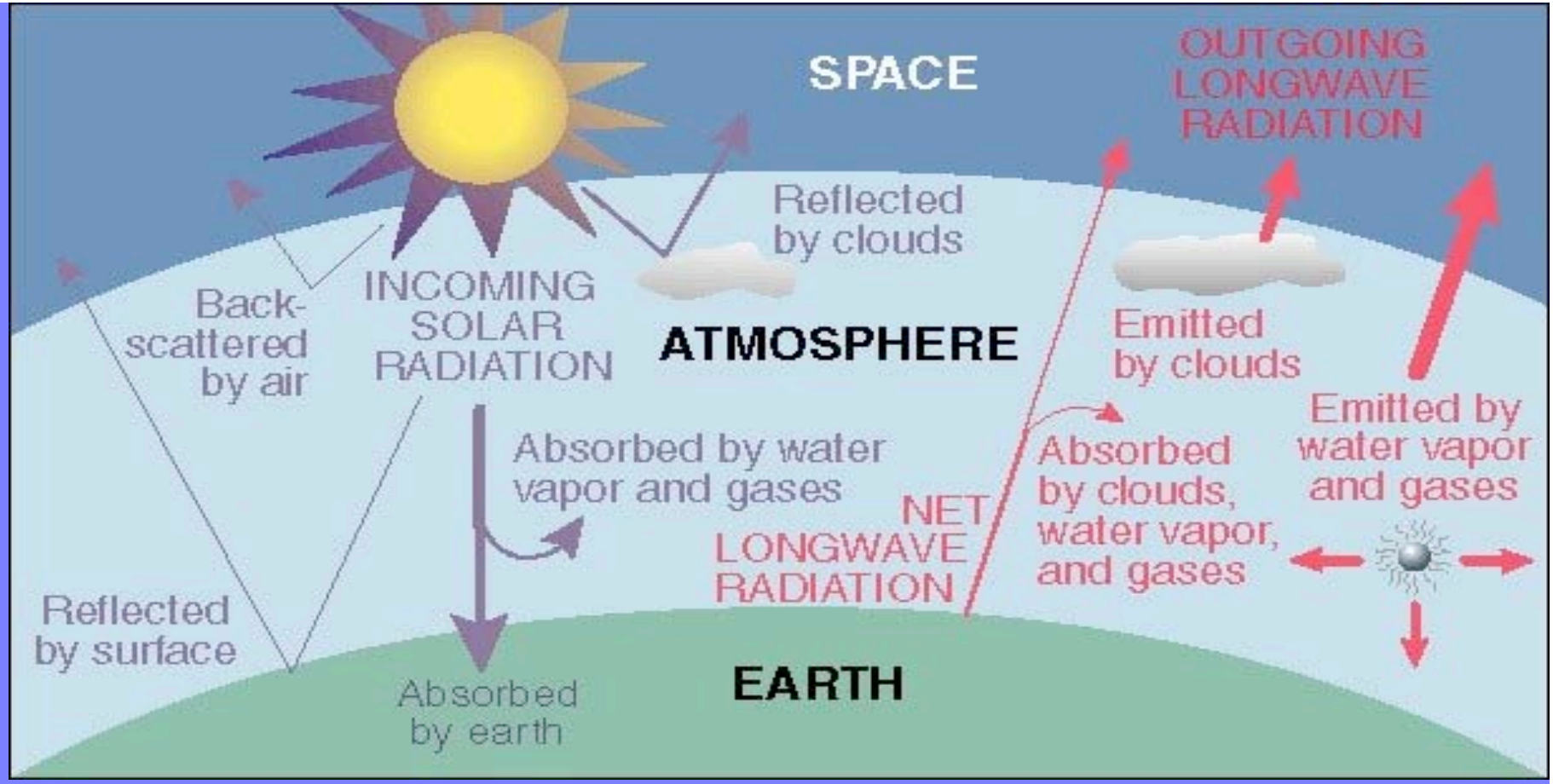


-7°C 3500 m, Mt. Lyell

+15°C Sea level

Average decrease = 6.5°C per km

In 2100 snow line could be 500 meters (1650' higher than today

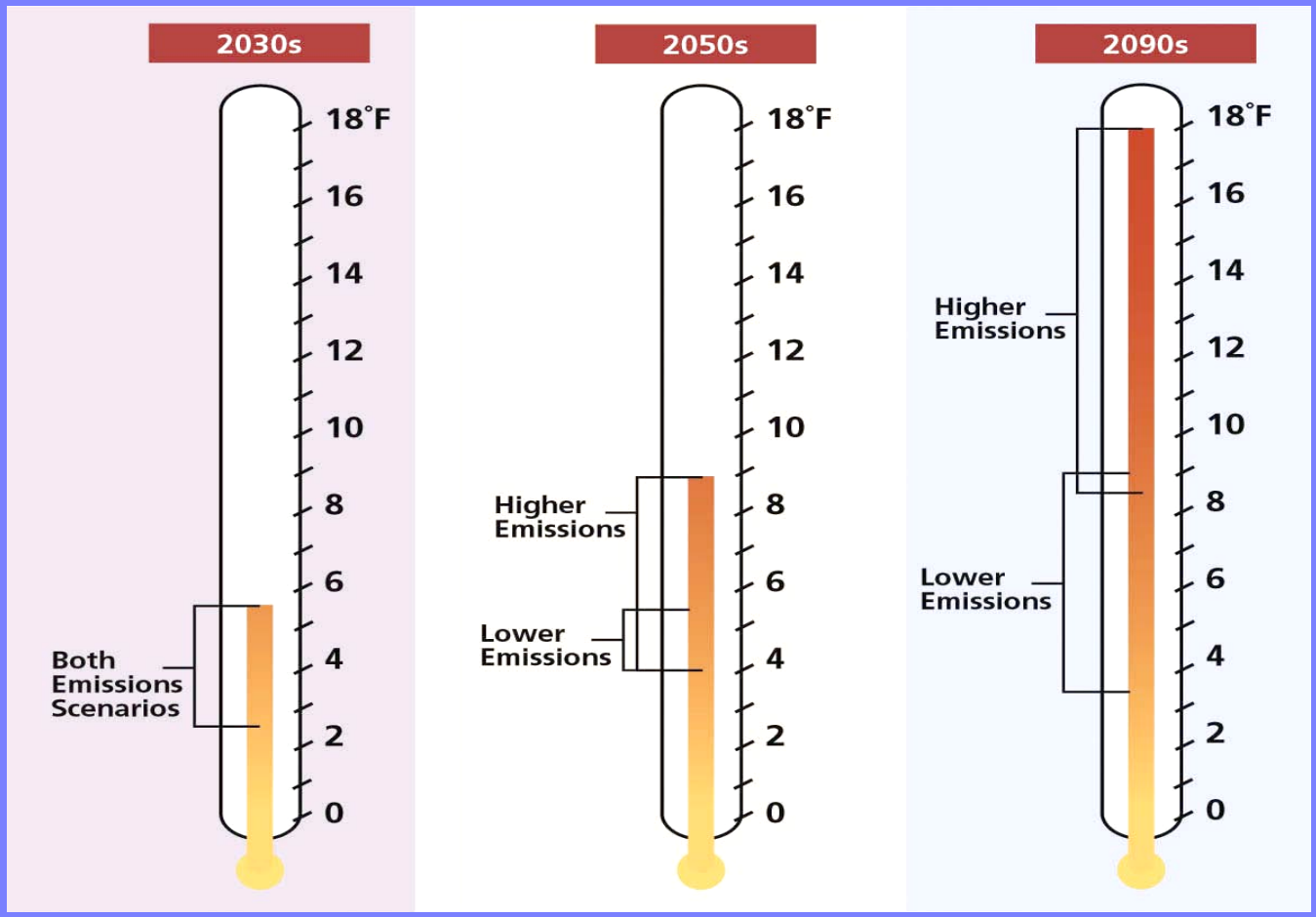


Global Energy Balance: The overall state of the global climate is determined by the balance between energy the Earth receives from the Sun and the energy which the Earth releases back to space. Absorption of long wave
Terrestrial radiation by gasses in the atmosphere causes

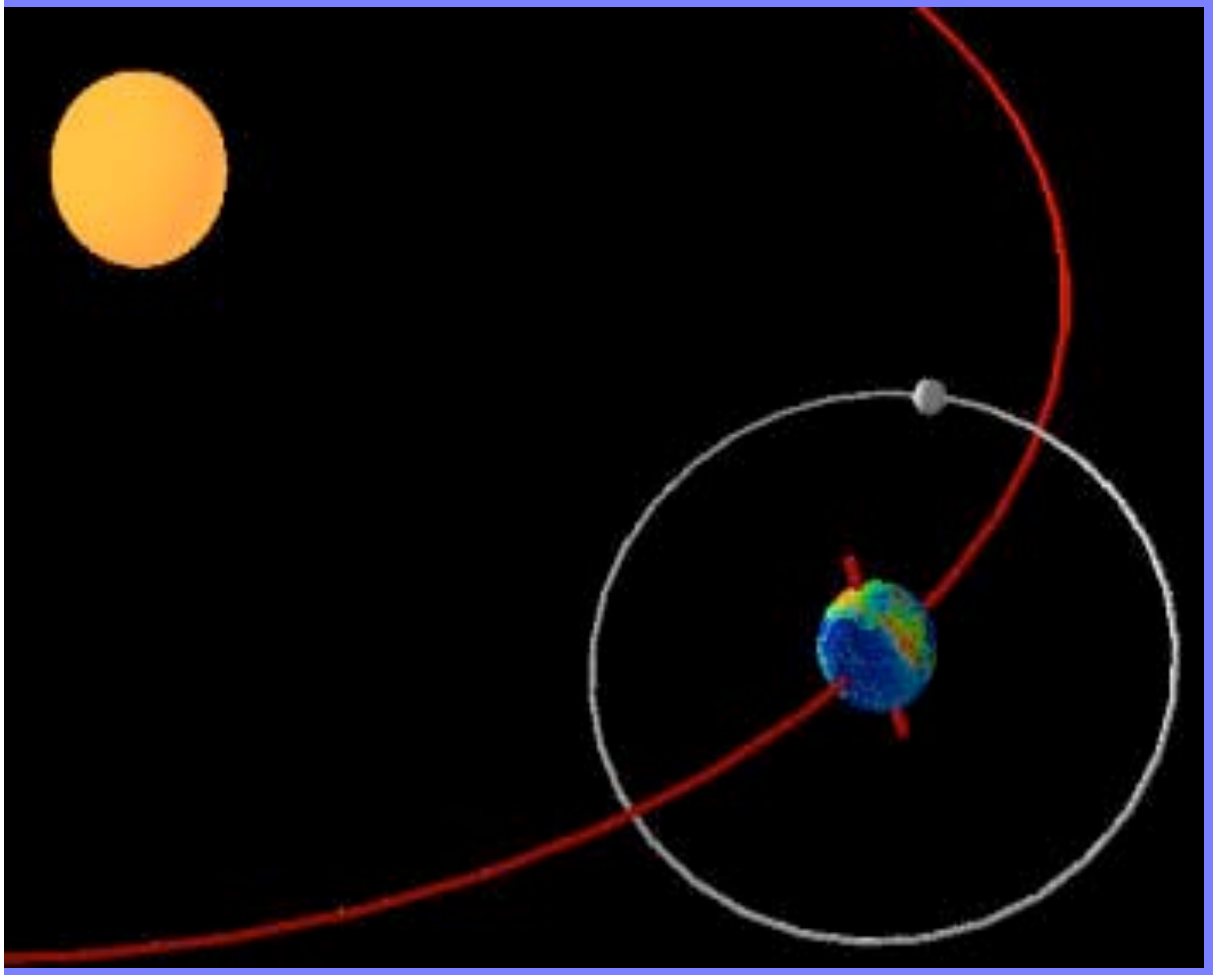
2 climate models, 2 emissions scenarios

California statewide

Projected average summer temperature changes



The result of the natural Greenhouse effect can be seen by comparing the temperature of the *moon* with that of the *earth* which are about the same distance from sun but moon is 33C (60F) cooler



The average surface temperature of the moon is -18°C. *The moon, of course, has no atmosphere.*

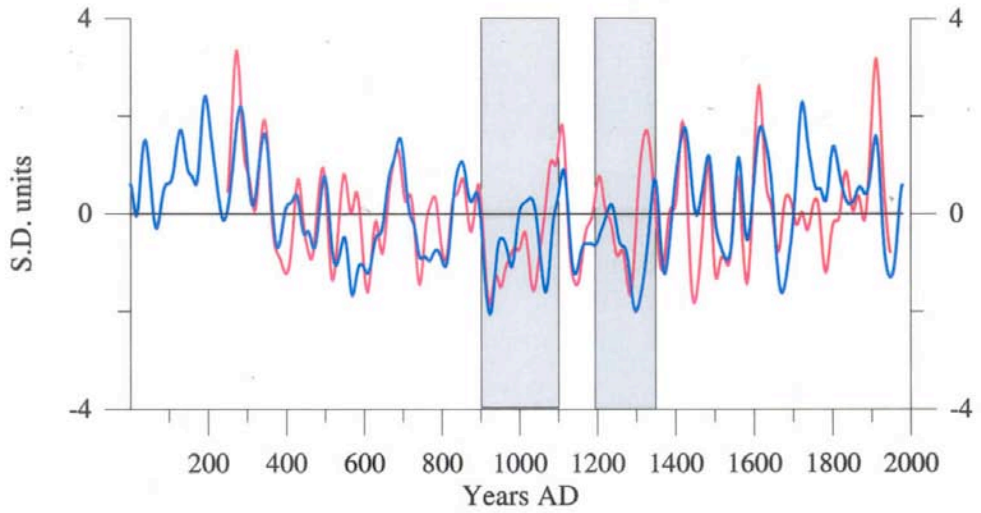
.

By contrast, average surface temperature of the Earth is 15°C.

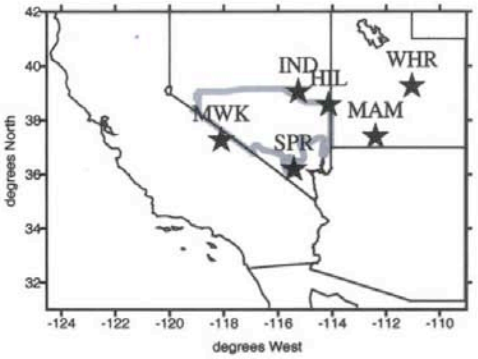
DROUGHT: A major puzzle

What causes drought and how bad can it get?

submerged tree stumps have 70+ rings!

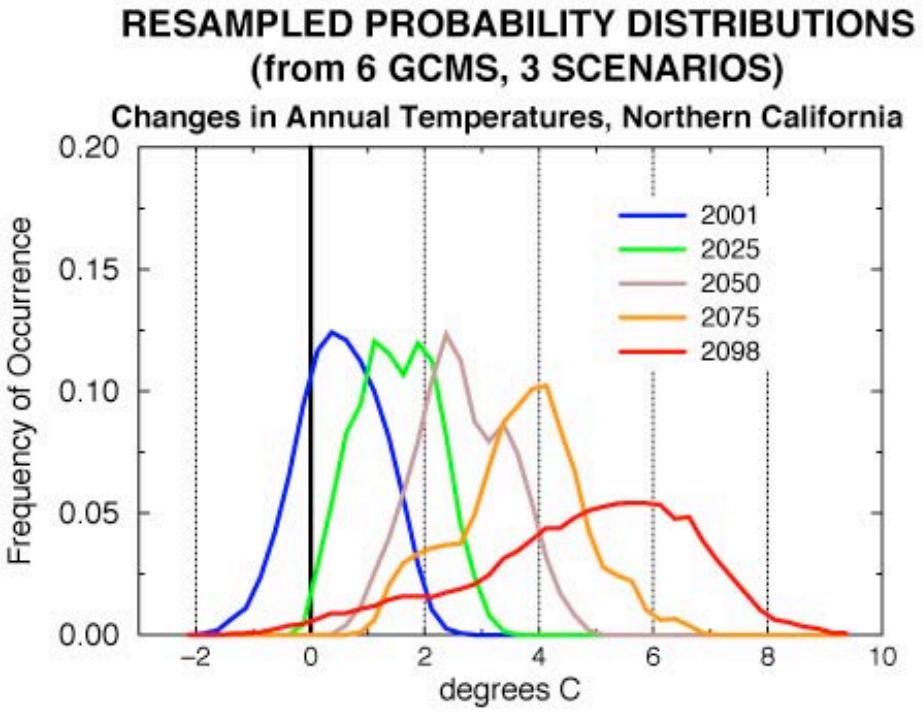


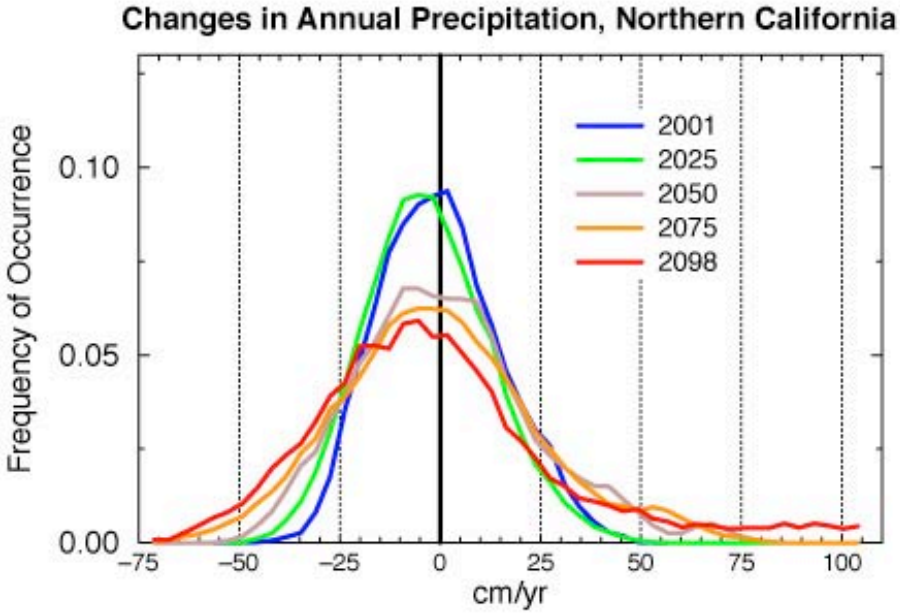
- The blue line is the reconstruction shown in the previous slide, using only the MWK site, the red line is based on 6 sites throughout the Great Basin (see map).
- The gray areas indicate low stands of nearby Mono Lake – see photo of tree stumps tens of meters below present natural water level (Stine, 1993).



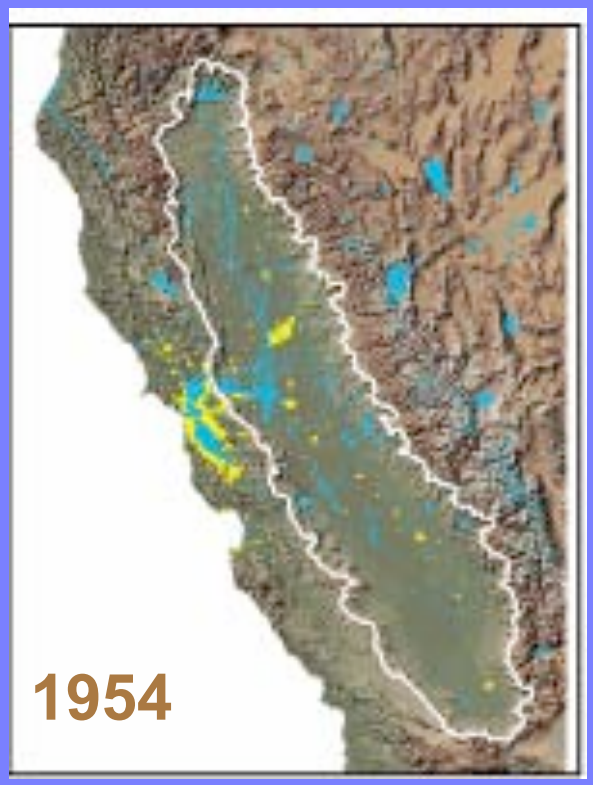
If we fit time-varying joint temp/precip probability distributions to this ensemble:

- Important temperature (& snowmelt) changes within about 20 years
- Strong tendency toward little precipitation change, with a hint of slightly drier
- General spreading of possibilities (espec. temperatures) due to model and emissions uncertainties

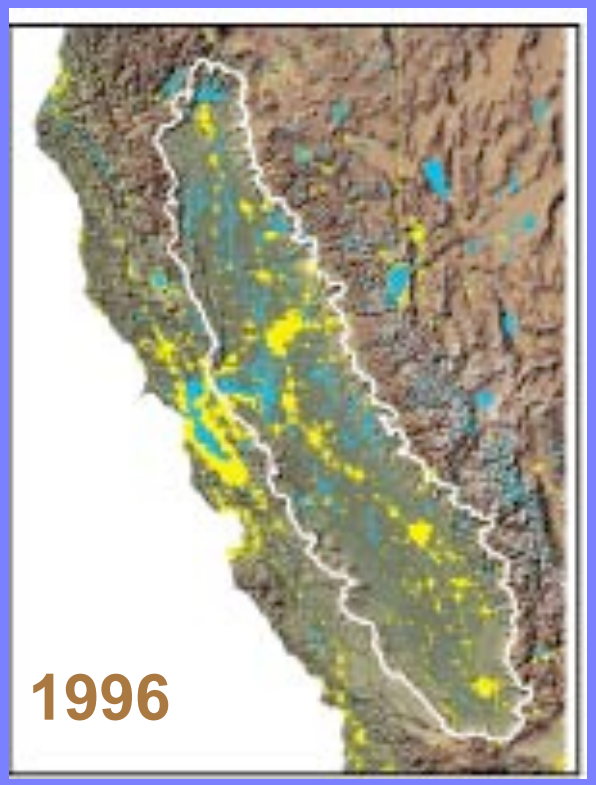




By 1900 small urban cores were established in San Francisco, Oakland, Sacramento, San Jose, Stockton, and Alameda. The locations of many small Central Valley towns were found adjacent to the railroad that traversed the Valley and linked these towns to the urban centers around the San Francisco bay.



Significant changes occurred during the post-World War II era. By 1954 an urban corridor had developed on the San Francisco Peninsula and was stretching towards San Jose. Suburbs around Sacramento were expanding quickly.



By 1996 a strong national economy contributes to increased urban growth and significant infill development. The growing prominence of the Highway 99 corridor becomes apparent. The Central Valley approached a linear city anchored by Redding and Bakersfield at each end with numerous cities in-between.

Some info:

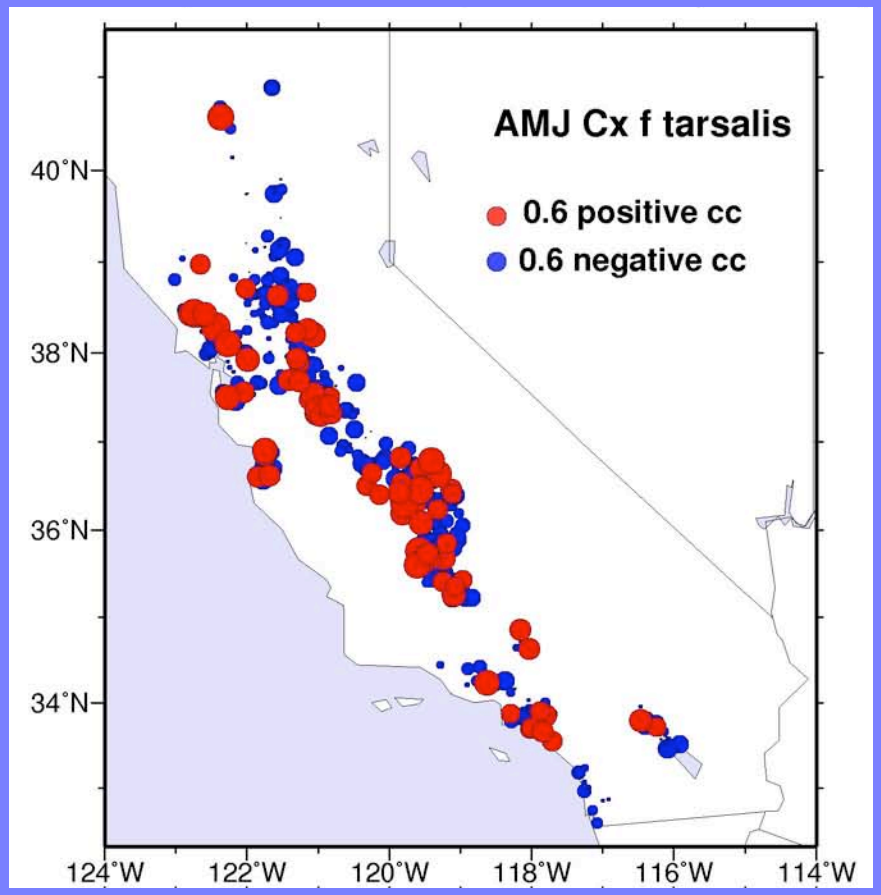
- Males do not attack humans or animals. Males feed only on plant nectar.
- *Culex tarsalis* is widely distributed west of the Mississippi River. Females feed mainly on birds, but will also attack humans and domesticated animals. They are most active at dusk, and will enter buildings in search of a blood meal.
- Members of the genus *Culex* are the primary vectors for the West Nile Virus.
- A close relative of the *Cx. tarsalis,* the *Cx. pipiens*, is the primary carrier of the West Nile Virus along the eastern half of the United States.
- *Culex tarsalis* is a very common mosquito in most states west of the Mississippi, and is considered to be the most important vector of viral encephalitis to horses and humans in the western states. West Nile Virus has been isolated from pools of *Cx. tarsalis* from South Dakota, and this species will very likely be the predominant vector for this virus throughout the western states.
- The larval habitat of this species differs considerably from that of *Cx. pipiens*, and control measures designed to control *Cx pipiens* will not likely work effectively for *Cx tarsalis*.
- M[illegible]ormation: http://biomicro.sdstate.ed[illegible]Mosquito/index.html

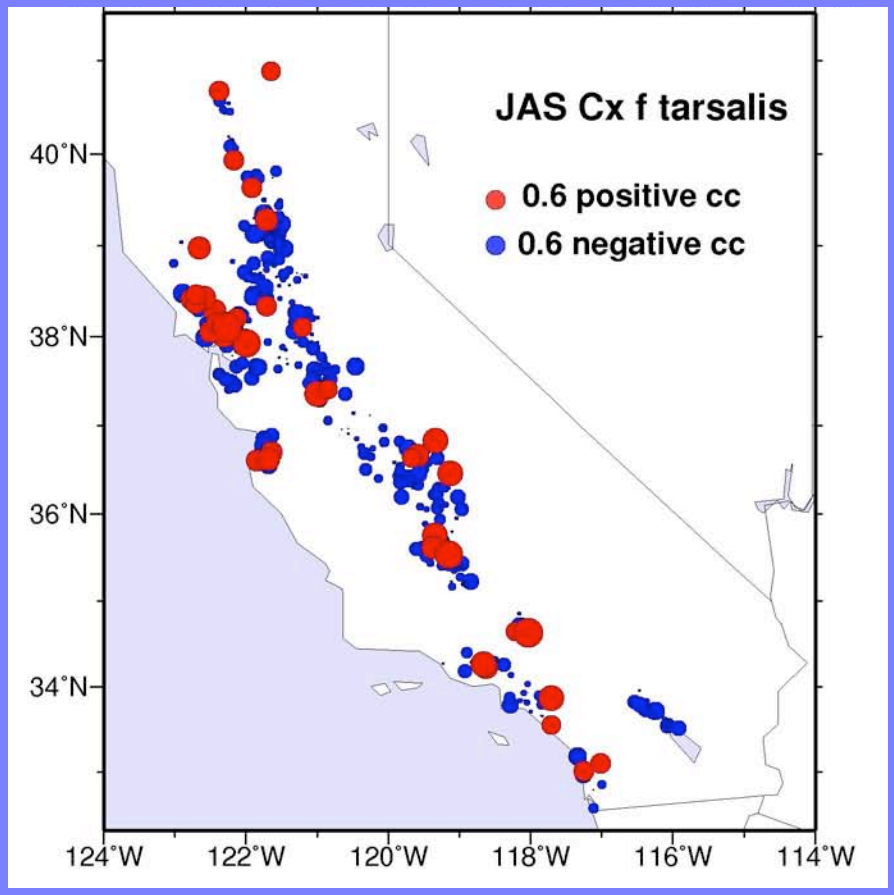
Picture of an adult female culex tarsalis

***the** mosquito catch picture*

Oct to March CA div precip cc Cx female tarsalis

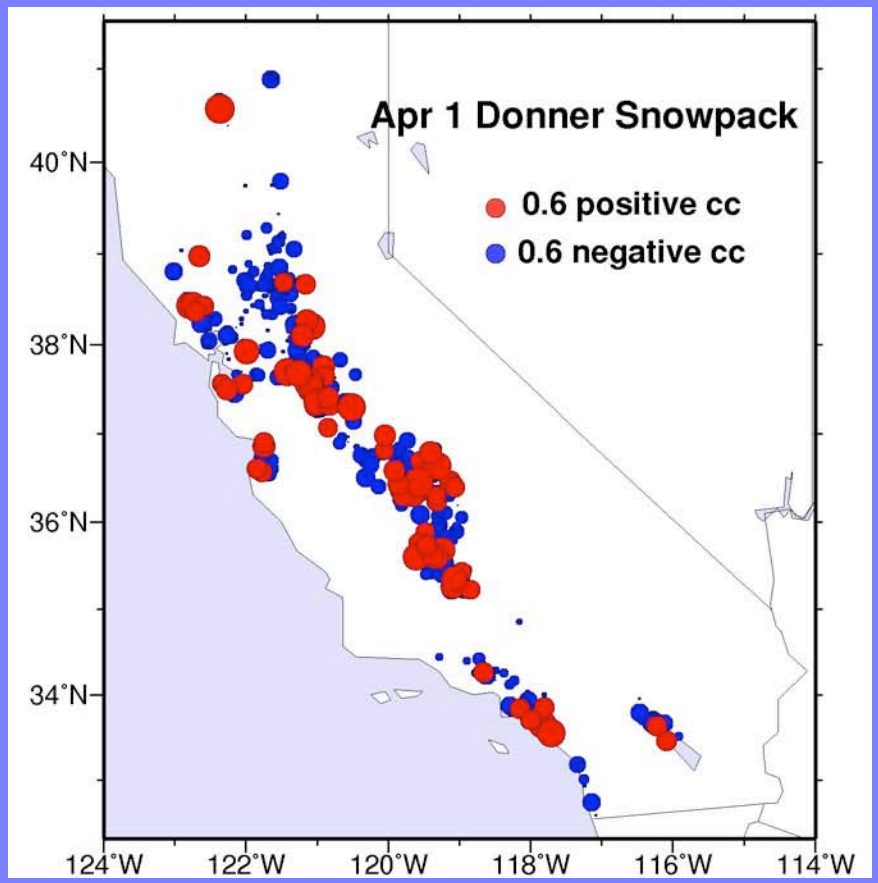
(detrended) female tarsalis; 34 districts (677 sites)

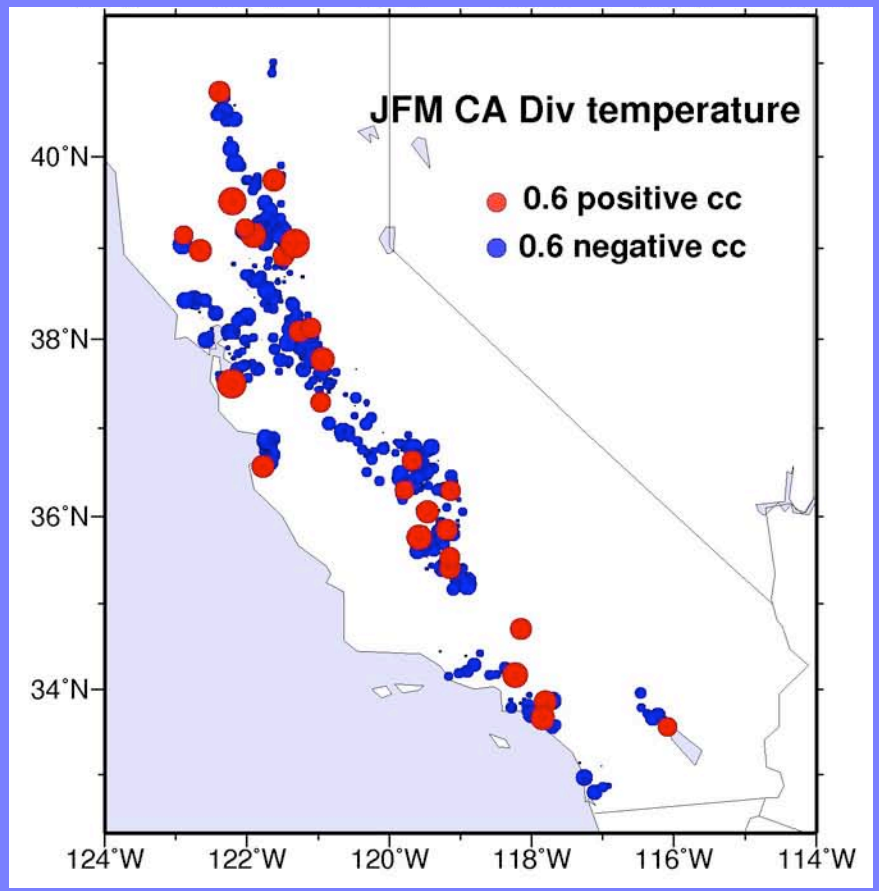


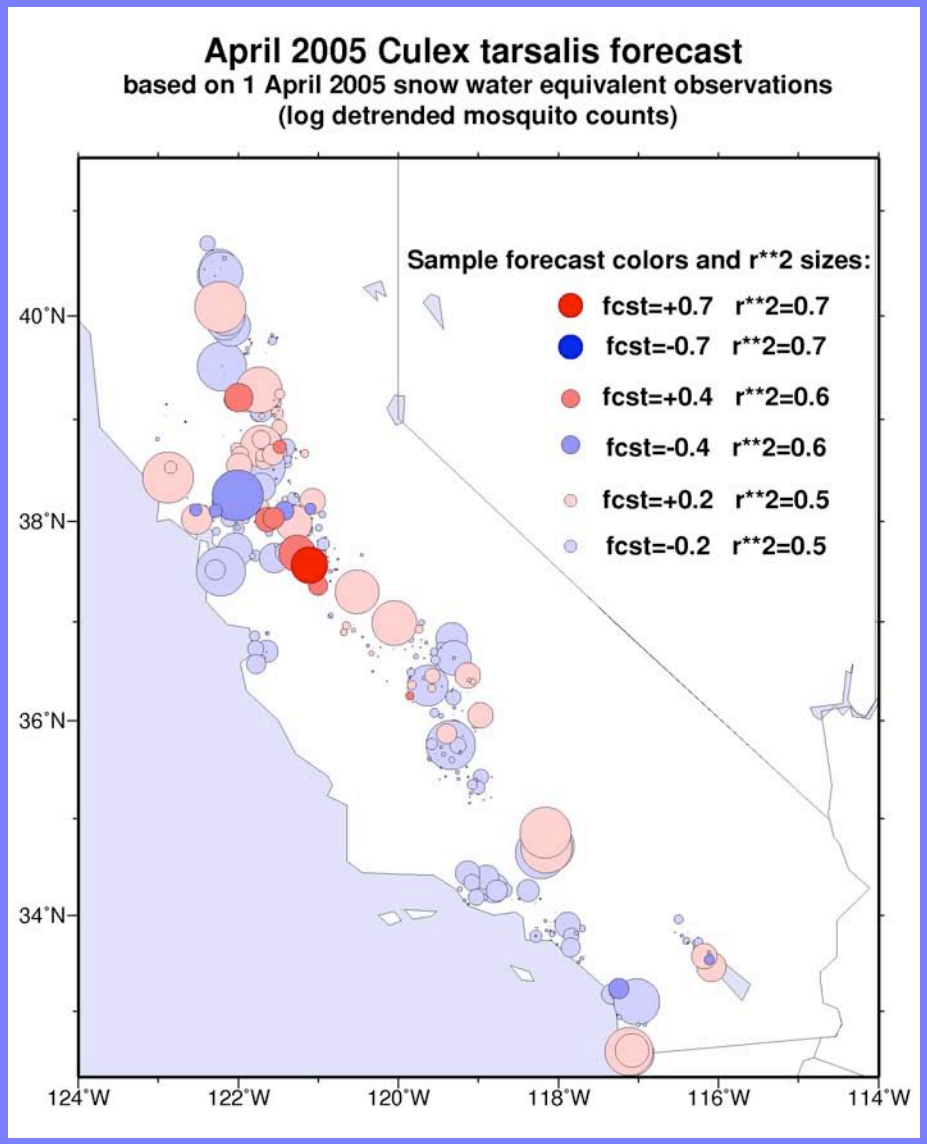


AMJ Cx female tarsalis cc

(detrended) female tarsalis; 34 districts (677 sites)






April 2005 Culex tarsalis forecast
based on 1 April 2005 snow water equivalent observations
(log detrended mosquito counts)
Sample forecast colors and r**2 sizes:
fcst=+0.7 r**2=0.7
fcst=-0.7 r**2=0.7
fcst=+0.4 r**2=0.6
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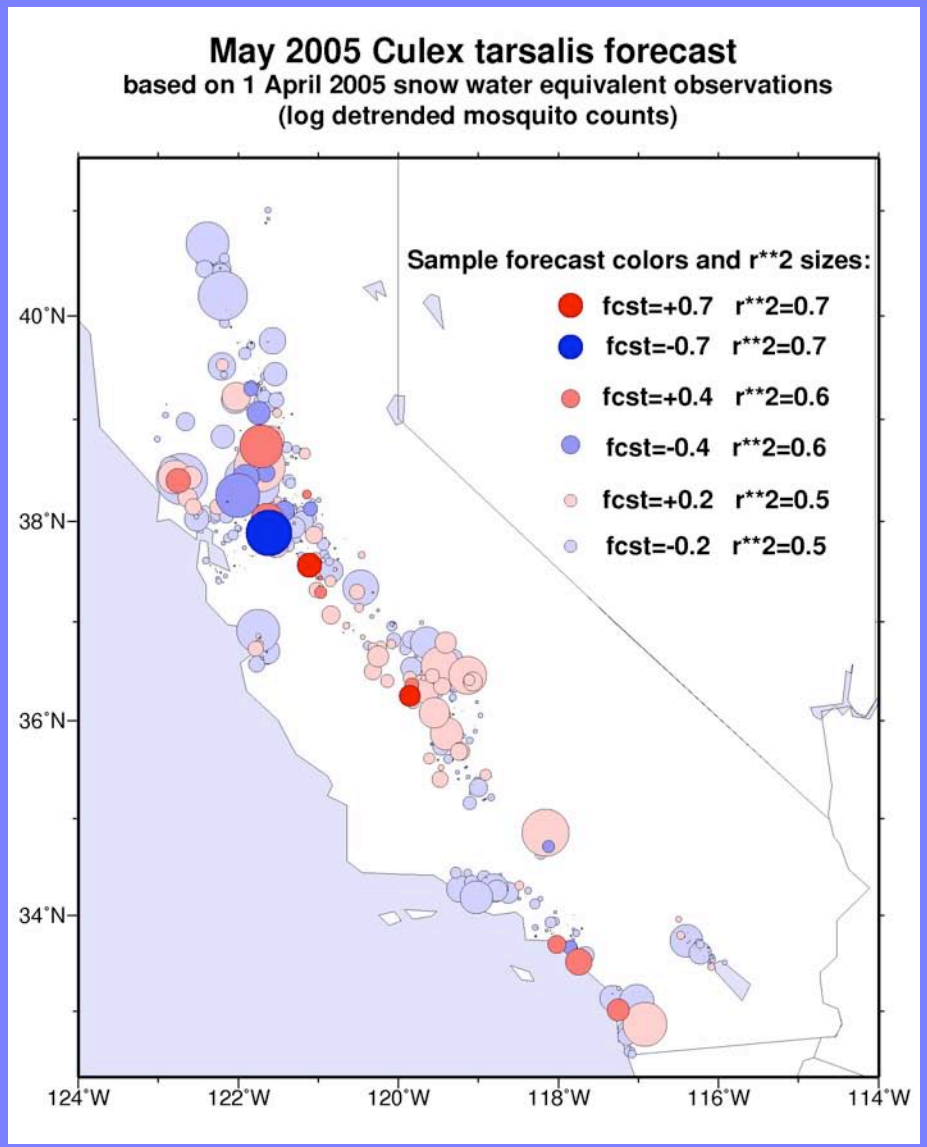
May 2005 Culex tarsalis forecast
based on 1 April 2005 snow water equivalent observations
(log detrended mosquito counts)
Sample forecast colors and r**2 sizes:
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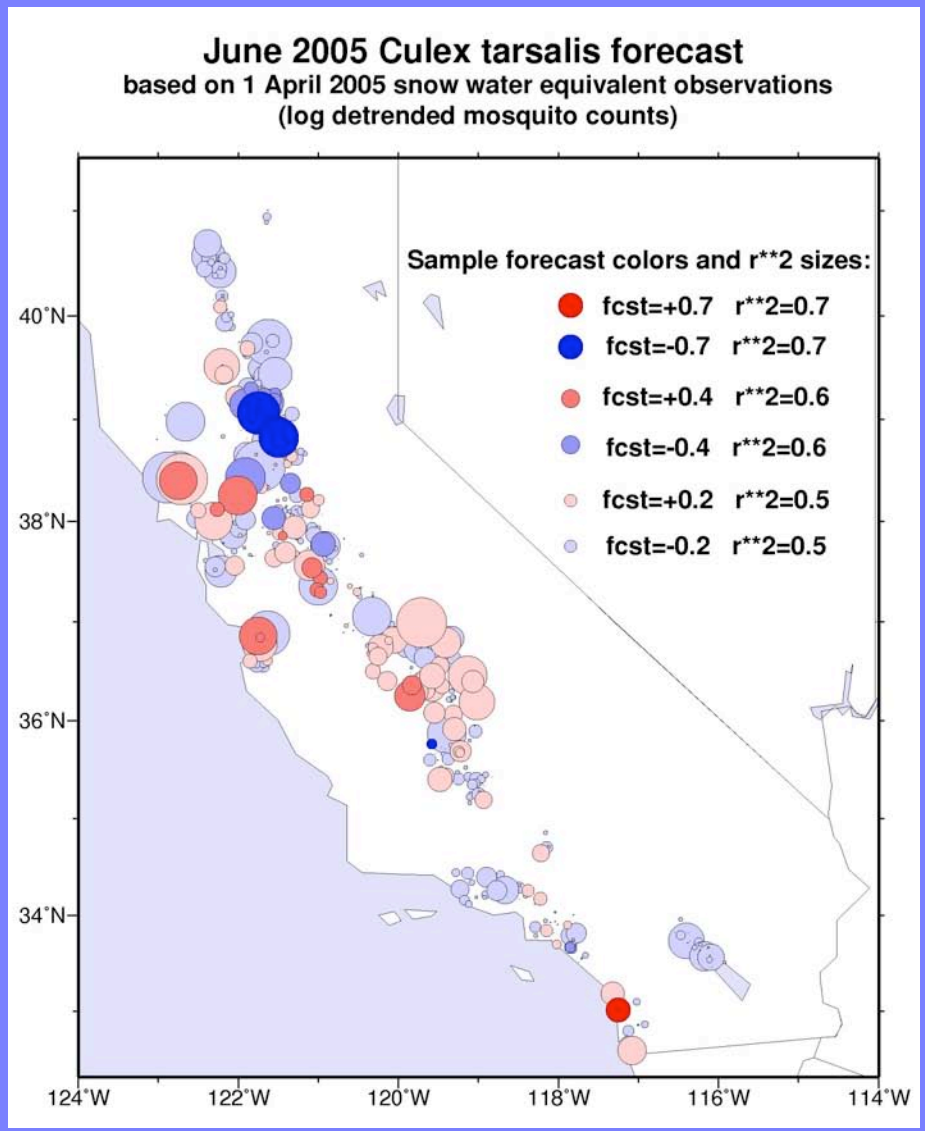
June 2005 Culex tarsalis forecast
based on 1 April 2005 snow water equivalent observations
(log detrended mosquito counts)
Sample forecast colors and r**2 sizes:
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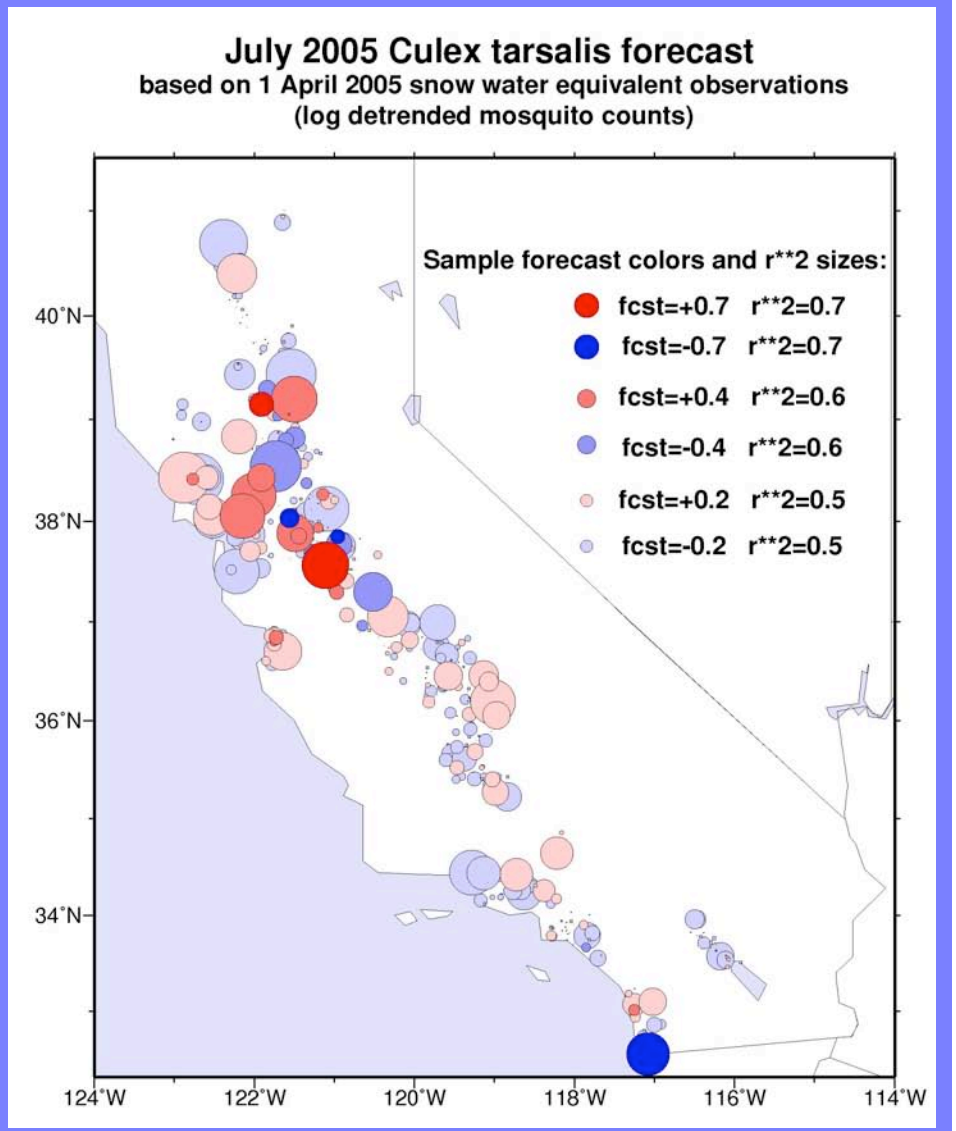
July 2005 Culex tarsalis forecast
based on 1 April 2005 snow water equivalent observations
(log detrended mosquito counts)
Sample forecast colors and r**2 sizes:
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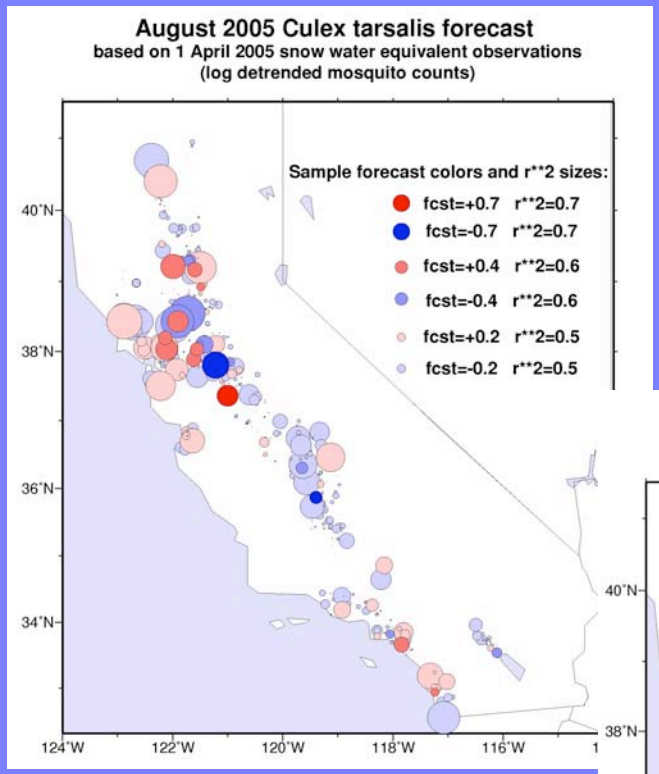
August 2005 Culex tarsalis forecast
based on 1 April 2005 snow water equivalent observations
(log detrended mosquito counts)
Sample forecast colors and r**2 sizes:
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fcst=+0.4 r**2=0.6
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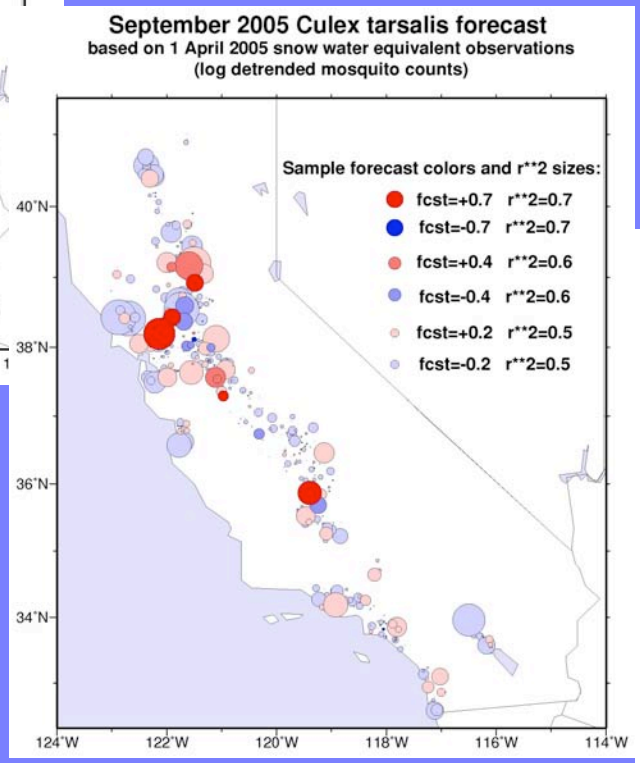
September 2005 Culex tarsalis forecast
based on 1 April 2005 snow water equivalent observations
(log detrended mosquito counts)
Sample forecast colors and r**2 sizes:
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fcst=+0.4 r**2=0.6
fcst=-0.4 r**2=0.6
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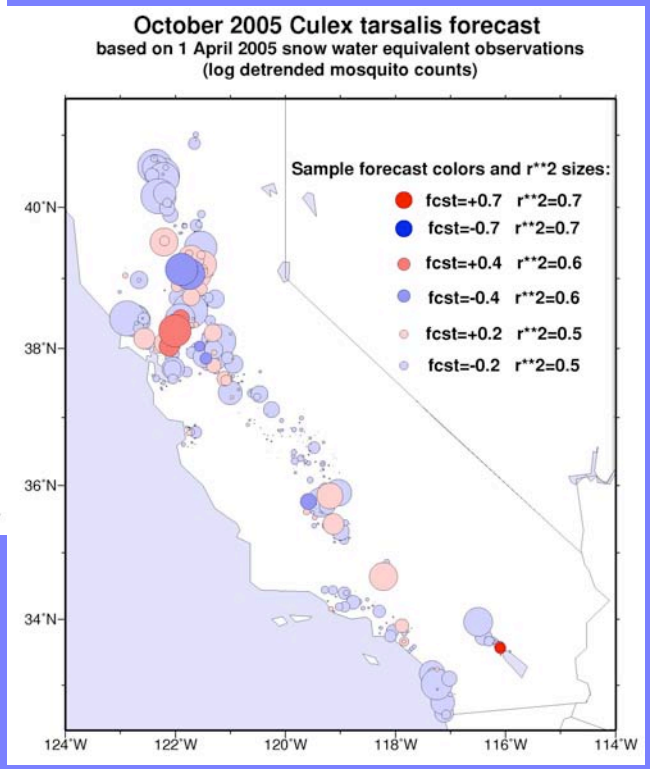
October 2005 Culex tarsalis forecast
based on 1 April 2005 snow water equivalent observations
(log detrended mosquito counts)
Sample forecast colors and r**2 sizes:
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fcst=+0.4 r**2=0.6
fcst=-0.4 r**2=0.6
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Cumulative Dead Bird Infections by County - California, 2005

Alameda County	1
Contra Costa County	3
El Dorado County	1
Fresno County	3
Humboldt County	2
Kern County	1
Kings County	1
Los Angeles County	2
Orange County	3
Placer County	1
Sacramento County	1

Santa Clara County	2
Santa Cruz County	1
Solano County	1
Sonoma County	5
Stanislaus County	2
Tulare County	2
Yolo County	1

From the USGS web site: http://westnilemaps.usgs.gov/ca_bird.html

California Applications Program (CAP) & The California Climate Change Center (CCCC)

Climate information for California decision makers

Funded by the NOAA Office of Global Programs and
California Energy Commission
CAP is a NOAA/OGP Regional Integrated Sciences and Assessments (RISA) member

Our partner site: California Climate Data Archive

2003 Annual Report
References
Conferences
Requests for Proposals
Contacts

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15 April 2005 *RISA Speaker's Series presents:* Dan Cayan and Tony Westerling of the California Applications Program (CAP), Scripps Institution of Oceanography: California's vulnerability to climate variability and change and CAP's efforts to assist decisionmakers on water resources, wildfire and human health issues
(see Conferences for more details).

Success Stories

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. By working directly with users, CAP and CCCC are working to evaluate climate information needs and utility from the user perspective.

Objectives

- Evaluate weather and climate forecasts for California
- Improve local models and forecasts of water resources and fire risks
- Tailor and disseminate forecasts to local users

Approach

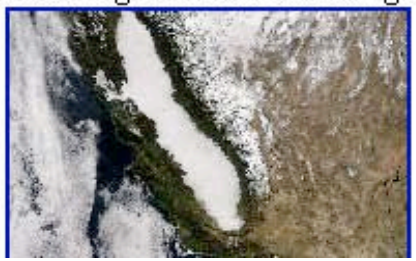
- Downscale climate forecasts and simulations from global to regional to local scales
- Provide a variety of forecasts in real time

Special CAP/CCCC Topics

Illilouette Adventure

Brian Huggett attempted to reach Illilouette Creek weekend of 19/20 March 2005

Winter image of the California region

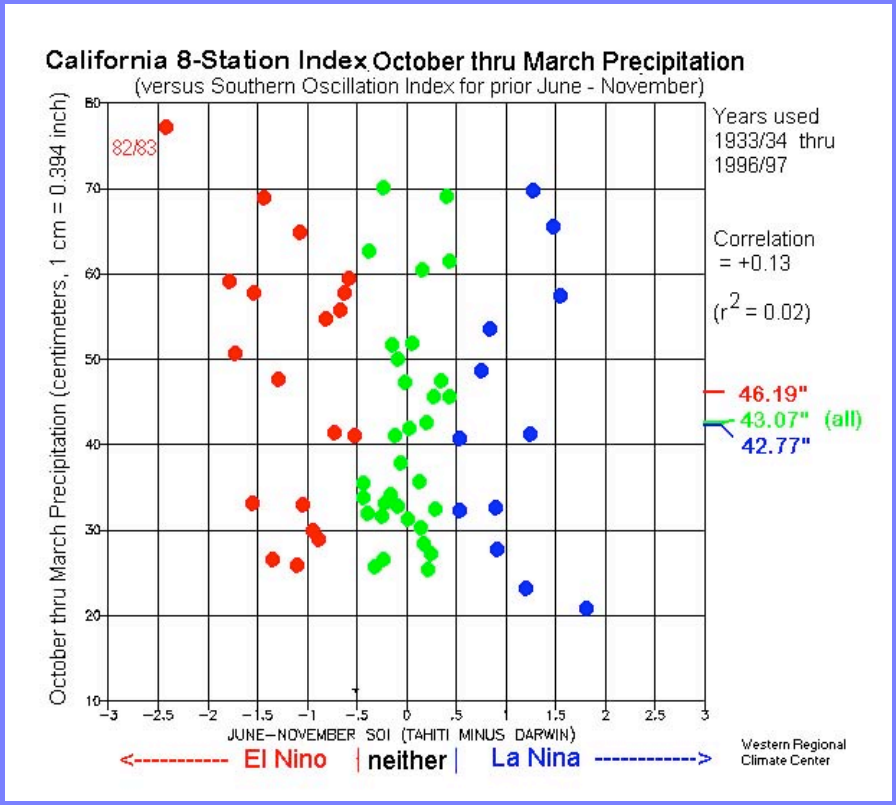


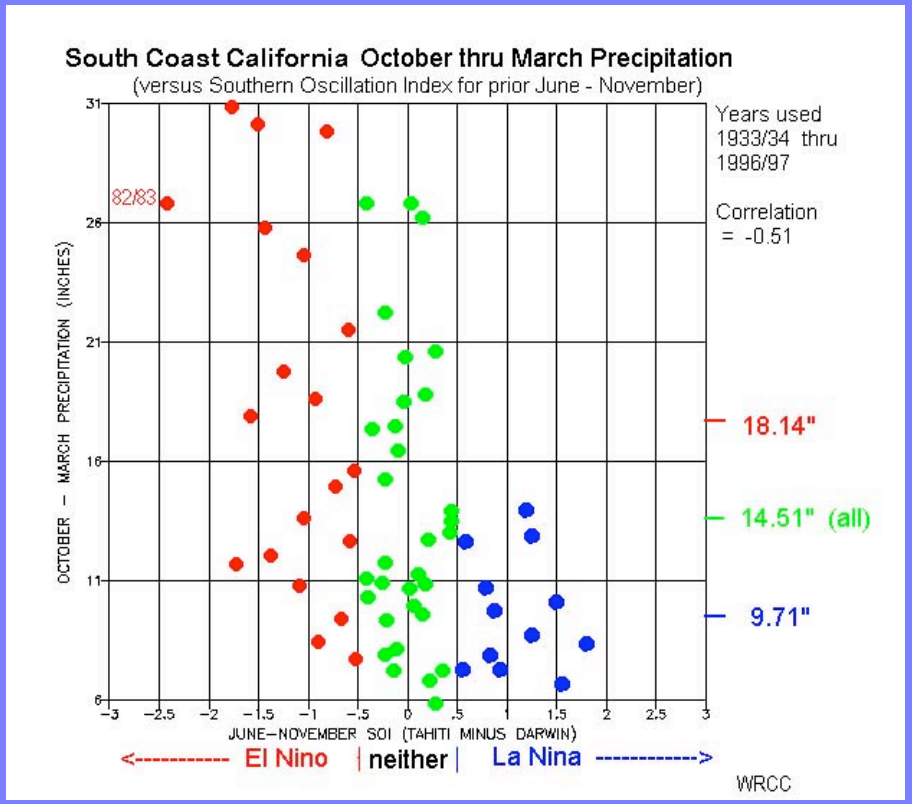
CAP/CCCC Research

- **From climate-change spaghetti to climate-change distributions for 21st Century California**
- *Updated daily*
  Medium-range Hetch Hetchy precipitation and Tuolumne Meadows temperature forecast
- **The CALFED Bay-Delta Program: Climate Science issues and needs of the CALFED Bay-Delta Program**
- **Climate Variability and CALFED -- CAP/CCCC Contributions to the 2003 CALFED Science Conference**
- **El Niño and California 2002-2003**
- **Potential Impacts of Global Warming on California's Hydrology**

But things don't always work out the way we expected:

ENSO vs. California Precipitation





CAP Challenges

Problems are tough—*forecasting is difficult; linkages are sometimes weak or complex.*

Necessary datasets may be limited or not exist, *esp* at the "applications" end (*e.g.* fire, ecosystems, health, economics)

"Users" interest is transient. Persistence (by the RISA) is needed to maintain connections and build confidence. Must be prepared to "strike when the iron is hot".

Tight funding

team members not able to focus on CAP thrusts
team is less cohesive
organization is loose
team only able to respond to selected problem issues;
growth into new areas is limited

Student involvement in interdisciplinary problems sometimes unrealistic.

NOAA Research - Office of Global Programs
Regional Integrated Sciences and Assessments (RISA)
Climate and Societal Interactions Division

California Applications Program Success Stories
May 2003

Highlights for advancing integrated multidisciplinary research and expanding decision maker's options in the face of climate change and variability

Contributions to Decision Support: Tools and Resource Forecasts

- **US Streamflow Forecasts:** Based on interannual and interdecadal predictors, CAP researchers create streamflow forecasts considering the variability of streamflow and the anticipated water year atmospheric conditions. Historical daily flow records from over 1200 streamgaging stations across the US were used to compute flood statistics and winter and spring seasonal averages for each stations period of record. Historical conditioning of flow terciles by ENSO and PDO status were analyzed and then used together with summertime predictions of the following years ENSO and PDO conditions to develop a streamflow forecast. *(http://meteora.ucsd.edu/cap/flow2003_fcast.html)*
- **Forecasts of temperature and precipitation extremes:** Using observed and model predictors, CAP researchers developed a statistical downscaling scheme to produce useful seasonal forecasts of climate extremes, such as temperature and precipitation. Energy, water and fire resource managers use the extreme forecasts in planning for critical or emergency situations, such as increased power demand or increased threat of flood or fire.
- **Western US seasonal snowpack forecasts:** Using summer and fall climate conditions, CAP researchers developed a principal component analysis method for predicting April 1 snowpack over the western US. Snowpack, as measured on April 1, is the primary source of warm-season streamflow for most of the western US and thus represents an important source of water supply. *(http://tenaya.ucsd.edu/~dettinge/pdosnow.pdf)*
- **Wildfire forecasts for the western US:** For lead times of a season to two years, CAP researchers have developed statistical forecasts of seasonal area burned based on drought severity indices. For the past two years, these forecasts have successfully predicted many features of the western US wildfire season. Fire managers use these early forecasts for requesting supplemental resources and making decisions about temporary fire suppression personnel. *(http://meteora.ucsd.edu/cap/fire_forecast2003.html)*

Engaging stakeholders

- **Northern California water resource prediction/management (Folsom):** Working with Staff of Central Valley Operations of the Bureau of Reclamation and NOAAs regional River Forecast Center in Sacramento, CAP researchers provide streamflow simulations for the operational management of the Folsom Lake Reservoir. Demonstration of the feasibility and utility of climate-hydrology forecasting and water resources management is accomplished by inter comparing retrospective reservoir operations under: (1) current operational practice, (2) integrated forecast-control operation using climate forecasts based on historical/climatological information and (3) integrated forecast-control operation using climate forecasts based on global climate model simulations. *(http://www.hrc-web.org/FOLSOM/)*
- **Medium Range Forecasts for city of San Francisco:** For the City of San Francisco / Hetch Hetchy water/power system, CAP researchers have averaged and scaled 12 individual 15-day forecasts of precipitation and temperature from the current NCEP medium-range forecast ensemble. The forecasts are rescaled from the globalgrid of the MRF weather model (roughly 2 degrees of latitude by 2 degrees of longitude), and from the 850 millibar pressure level in the atmosphere, to be equivalent to the temperatures routinely observed by the Tuolumne Meadows SNOWTEL site. Precipitation is scaled to have the same monthly means as the Hetch Hetchy precipitation station. These rescaled forecasts were designed to be suitable for input to statistical predictors of Hetch Hetchy inflows. *(http://tenaya.ucsd.edu/~dettinge/hetchy/)*
- **Web pages:** Public web pages communicate with stakeholders on issues of immediate interest such as drought, wildfire, snowfall, Santa Ana and May Gray/June gloom conditions. Web pages also provide data and forecast resources for stakeholders. CAP actively maintains and updates two main web informational sources: (1) the California Applications Program web site *(http://meteora.ucsd.edu/cap)* and (2) the California Assessment for the United States Global Change Research Program: Preparing for a Changing Climate *(http://tenaya.ucsd.edu/~meyer/calif_usgcrp.html)*
- **Stakeholder briefings:** CAP researchers respond to numerous requests for specific briefings on issues of climate conditions, forecasts and long-range planning. For example, a recent presentation was made for the USBR Yuma desalinization plant (Department of Water Resources) concerning flood and drought possibilities for the next 30 years. Also, a plenary talk briefed the 2003 Southwest Drought Summit on current and changing southwest climate conditions. In addition, the Mojave Water Agency requested information on the most suitable historic periods for testing its long-term water-resource management alternatives. Recently, many stakeholders, including Ventura and San Diego counties, have expressed interest in climatic periods suitable for analyzing total maximum daily loads, as this is important to water quality.

Significant additions to knowledge

- **Climate change impacts on California:** CAP research alerted the California hydrologic community that even modest climate changes could mean a significant decrease in snowmelt, which was unexpected. Simulated snowpack under warmed conditions depicts a severe loss of snow as indicated by changes in the snow water equivalent (SWE). By 2030, under the "business-as-usual" scenario, temperature is projected to rise about 0.6 degrees C, resulting in a minor decrease in April snowpack at lower elevations. However, by 2060 a temperature rise of 1.6 degrees C results in a loss of one-third of the total snowpack. This loss is focused in mid to lower elevations since the snowpack there is more sensitive to temperature changes than at higher, colder elevations. By 2090, a projected temperature increase of 2.1 degrees C results in a loss of about half of the average April snowpack storage, with greatest losses in the northern headwaters. Spring runoff is reduced by 5.6 cubic km, with associated increases in winter flood peaks. *(http://meteora.ucsd.edu/cap/hydro_glwarming.html)*
- **Mosquito abundance and seasonal moisture:** Working with a group led by Bill Reisen, Arbovirus Research Station, Bakersfield, CA, CAP researchers are finding links between seasonal moisture indices and mosquito abundance. With the expected near-future arrival of West Nile virus in California, the ability to anticipate mosquito abundances has taken on increased public interest. There has been considerable interannual variability in mosquito abundance, part of which is correlated across the entire state of California. Summer mosquito numbers correlate positively with moisture accumulation, as indicated by precipitation, streamflow and snow water content. Prediction of summer mosquito abundance from prior winter moisture variables may provide a useful look ahead at several months lead-time. *(http://meteora.ucsd.edu/cap/calif_health.html)*

Influencing operations and policy

- **CALFED and climate change in California:** CAP researchers engaged the interests of CALFED, a CALifornia FEDeration Program of more than 20 state and federal agencies working with local communities to develop and implement plans to restore ecological health and improve water management for the San Francisco Bay-Delta system over the next 30 years. This system provides water for 2/3 of the state of California (22 million people), irrigation supplies for $27 billion in agriculture (45% of the nations produce) and is a primary water source for California's trillion-dollar economy. The ecosystem and its freshwater supply are in jeopardy because of freshwater diversions. CAP is working with CALFED to integrate climate change and variability into its restoration plans so that they will be able to accommodate California's highly variable climate. *(http://meteora.ucsd.edu/cap/calfed_climate.html)*
- **Real-time climate monitoring for wildfire:** CAP's CEFA (Program for Climate, Ecosystem and Fire Applications), has developed a web-based near-real-time climate monitoring section that offers 10 and 30 day anomaly maps of remote automatic weather station and lightning strikes over the west. Developed for stakeholders, this site offers previously unavailable information to land managers and fire weather forecasters. *(http://cefa.dri.edu/Assessment_Products/ClimMon/RawsReanalanoms.html)*
- **Ventura Basin ground-water management:** Working with the United Water Agency, CAP researchers are developing a ground-water/surface-water model that incorporates long-range (seasonal) forecasts to address management issues. Ensembles of hindcast climate simulations from 1950 to 1998, by three different climate-prediction model runs, have been used to force a calibrated model of ground-water/surface-water conditions in the Santa Clara-Calleguas basin of southern California. *(http://meteora.ucsd.edu/cap/ventura.html)*

Significant additions to knowledge

- **Building a climate observational capacity:** CAP has initiated several projects towards building climate observational capacity in California and the western US.
  - CAP is part of a multi-disciplinary, multi-agency team installing an upgraded set of meteorological, snow and stream instruments in the Sierra Nevada. These instruments are critical tools for collecting information leading to further understanding of the large interannual and lower frequency climate variability in the Sierra and to learn more about potential large impacts due to climate change. Historical measurements of key physical elements in the mountain snow zone are sparse and not complete, so the nature of recent, and future, changes and the processes that drive them are not well understood. A real-time monitoring system will help greatly to improve this understanding and better observe climate variability and change as they occur. *(http://meteora.ucsd.edu/cap/snow_monitor.html)*
  - CAP is also part of an effort to use wireless communication to provide real-time detailed weather observations. This hydro-meteorological effort is located in the coastal sagebrush of the Santa Margarita Ecological Reserve (SMER), north of San Diego in southern California. Towers containing instruments have been established at strategic locations in SMER to allow for detailed monitoring of air and water mass transfer. *(http://tenaya.ucsd.edu/~meyer/smer_hydromet.pdf)*
  - CAP has assumed the role of maintaining the lilac and honeysuckle records from the Western Regional Phenological Network (WRPN). This network (established in 1957 for lilac and 1968 for honeysuckle), shows key phonological phases have fluctuated over the last 4-5 decades indicating warmer-than-normal springs which may be an expression of natural variability or a symptom of global warming. *(http://meteora.ucsd.edu/cap/lilac.html)*
- **Medium-range forecast (MRF) archive:** The CAP historical MRF ensemble project uses a single, unchanging, global atmospheric model to make a set of daily medium range (0-14 day) forecasts over a long historical period. This MRF history is needed to allow objective, quantitative assessments of forecast skill and the predictability of various kinds of weather events. For every day from 1979 to present, CAP is making an ensemble of 10 forecasts. The model employed is the National Centers for Environmental Prediction (NCEP)'s MRF model (Reanalysis II version). To produce an ensemble of 10 forecasts we have adopted the NCEP "breeding" procedure to make 5 pairs of positively and negatively perturbed initial conditions for each of the individual forecast runs. *(http://meteora.ucsd.edu/cap/hindcast.html)*