# Producing Scientific and Strategic Guidance for California's Department of Water Resources:
# The Climate Change Technical Advisory Group

## Collaboration Overview

The California Department of Water Resources (DWR) runs the State Water Project (SWP), which provides drinking water for more than 25 million people, water for agriculture, flood control, power generation, recreation, fish and wildlife protection, and water quality improvements. Hydrologic impacts under a changing climate include reduced snowpack, increasing ratio of rain to snow, earlier snowmelt, higher temperatures, and rising seas; all of which impact the state's water supply. (See SWP and regional climate change vulnerabilities figure, below).

To improve the scientific basis for decisions and enhance the consistency of climate change approaches, DWR empaneled a Climate Change Technical Advisory Group (CCTAG) for guidance on the scientific aspects of climate change, its impacts on water resources, the use and creation of planning approaches and analytical tools for both DWR and for local water management supported by DWR, and the development of adaptation responses.

Diverse areas of expertise are needed to describe and assess the changing climate of California. Members were selected from multiple disciplines, including atmospheric science; hydrology; civil engineering/infrastructure; environmental science; climate data and statistics; social science; resource economics; land use planning; and climate modeling. DWR selected professional representatives from these disciplines by assessing applicants' knowledge, skills and experience. Membership was announced in February, 2012.

Meetings were held quarterly, with additional conference calls as needed, to discuss incorporating climate change into planning for DWR, as well as how DWR can best support the local water management community with climate change planning.

### California Climate Change Vulnerabilities

**Because of the economic, geographical, and biological diversity of California, vulnerabilities and risks due to current and anticipated future changes are best assessed on a regional basis. A few of the key climate vulnerabilities for each hydrologic region are indicated.**


**North Coast** 1 Sea level rise may make tidal marshland susceptible to more frequent, longer and deeper flooding. • Longer drought periods would impact local fractured rock groundwater supplies.

**San Francisco Bay** 4 Sea level rise may increase the susceptibility of tidal wetlands to more frequent, longer and deeper flooding.

**Sacramento-San Joaquin Delta** • Sea level rise may increase stress on Delta levees and change water quality.

**Central Coast** 6 Coastal infrastructure and nearshore ecosystems are vulnerable to increasing sea level and storm surges, while coastal aquifers could be affected by increasing salinity intrusion.

**South Coast** 9 Magnitude and frequency of extreme precipitation events may increase, resulting in greater flood risk, debris flows, and degradation of habitat for special-status species. • Higher temperatures and longer dry seasons would increase wildfire risk and impair water quality in local streams and lakes.

**North Lahontan** 3 Increased air and water temperatures would place additional stress on sensitive ecosystems and species. • Higher temperatures and longer dry seasons would increase wildfire risk.

**Sacramento River** 2 Increased air and water temperatures would place additional stress on sensitive ecosystems and species. • Loss of snowpack storage may reduce reliability of surface water supplies and result in greater demand on groundwater resources.

**Tulare Lake** 7 Loss of snowpack storage may reduce reliability of surface imported water supplies and replenishment of local supplies, and result in greater demand on groundwater resources. • Increased air and water temperatures would place additional stress on sensitive ecosystems and species.

**Mountain Counties** • Loss of snowpack storage may reduce reliability of surface water supplies • Snowpack reduction may have significant impacts on the water-related tourism industry.

**San Joaquin River** 5 Increasing temperatures and variable precipitation patterns would affect agricultural crops by reducing winter chill-hours, increasing extreme heat days and increasing evapotranspiration.

**South Lahontan** 8 Higher temperatures and longer dry seasons would increase wildfire risk and impair water quality in local streams and lakes. • Reduced snowpack and changes in runoff timing would impact the winter-dependent economy supporting disadvantaged communities.

**Colorado River** 10 More frequent and longer droughts would reduce imported water supply reliability and decrease local water quality and habitat.


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## Process Overview:

**DWR: CALL FOR**
**Applications**

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**REVIEWED BY**
**Management Team**

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**USING**
**Criteria**

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**SELECT**
**Advisory Group (14 members)**

*First CCTAG meeting, in Sacramento, California, May 11, 2012.*

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**ATTEND**
**Meeting Program**

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**PRODUCING**
- Charter
- Guidance
- Methodology
- Models
- Understanding
- Collaboration

## Lessons Learned

- Climate change must be incorporated into DWR's planning and projects in a dynamic manner that is commensurate with updates to science and policy.
- Drafting DWR-specific recommendations for incorporating science was challenging both due to time constraints and understanding DWR business needs.
- Technical capacity to ingest climate data varies greatly among water managers and across DWR.
- The climate model selection process developed was more important in some ways than the actual list of models identified. Since the science is changing so rapidly, the process will likely have to be repeated every few years or so.
- Seeing the impact of assumptions made (e.g., through some type of appropriate integrative software or case studies and pilot projects on various scales, where such impacts have been studied or demonstrated) might achieve more useful and realistic guidance.
- Large-scale water distribution projects influence effective approaches to climate change adaptation, and depend more on the local characteristics (including institutional issues), demands and conditions, and less on the large-scale climate forcing.
- More time should be invested early in the process to develop a work plan for completing the final products and identify critical path items.
- Statewide adaptation can be hindered by a lack of mandating authority by DWR to influence planning at the local level. Providing incentives or technical assistance to increase water agencies' capacity to apply climate models for water resources planning would benefit statewide adaptation.
- Next steps should include implementation of the guidance and perspectives both scientifically and regarding support to local water management.

## Positive Outcomes

The diverse professional team of scientists and practitioners tackled complicated water management issues regarding climate change impacts on California's water supply in *Perspectives and Guidance for Climate Change Analysis*, http://www.water. ca.gov/climatechange/ docs/2015/ Perspectives_Guidance_ Climate_Change_Analysis. pdf. This Technical Information Record represents the preliminary findings of the Advisory Group, on global climate model selection appropriate for California water resources, planning for extreme conditions, downscaling, and recommendations for future work.

### A Dynamic Team with Diversity of Expertise

- The diversity of opinions and perspectives from technical fields, policy and practitioners from various local, regional, state and international affiliations was noted as a very positive aspect of this effort.
- External perspective was helpful as a counterbalance to DWR's internal perspective.
- The team effectively worked through challenging technical issues by holding frequent discussions, allowing DWR to advance its programs by incorporating the best science available.
- Effort showed that convergence to a practical planning guide for using climate information can be achieved even for complex multidisciplinary issues such as those tackled (see "Choosing Global Climate Models" figure to the right).
- The group conducted effective collaboration without many ground rules, fostering open, inclusive, and transparent discussion.
- A dynamic team brought expertise, energy and passion to the table, but had different communication styles, which could also be a challenge.
- DWR's longstanding engagement with the science community was broadened by the CCTAG process.
- The CCTAG offered members continuous learning opportunities and a venue for presenting and hearing differing views.

## Choosing Global Climate Models to use for California Water Resources Planning

**Criteria**
- Scientists recommend using information from several Global Climate Models
- Using information from all available GCMs isn't practical
- Remove GCMs that fall short in representing historical climate and hydrologic processes important for California's water resources planning

**Method**

Global

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Western U.S.

↓

California

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10 GCMs to use for CA water planning

Start with 31[1] GCMs

**Global Climatology Filter**[2,3]
Evaluate how each GCM represents global historical
- Solar Radiation
- Air Temperature
- Atmospheric Pressure, Wind

Remove ~10 GCMs

**Western U.S. Climate & Hydrology Filter**[4]
Evaluate how each GCM represents Western US historical
- Air Temperature
- Precipitation
- Atmospheric Pressure Patterns
- El Niño Southern Oscillation Patterns

Remove ~5 GCMs

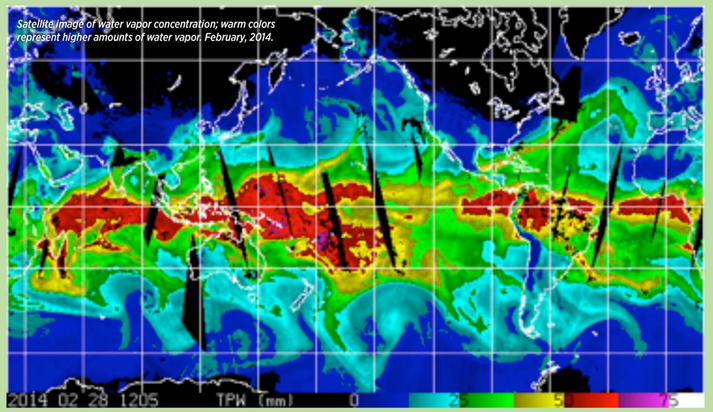
**California Hydrology & Extremes Filter**
Evaluate how each GCM represents California historical
- Dry and Wet Precipitation Extremes
- Heat Waves and Cold Snaps
- El Niño Spatial and Temporal Patterns

Remove ~5 GCMs

**GCM Recommendations for California**
The remaining 10 GCMs are recommended for water resources planning because they represent important components of historical climate at global, regional, and statewide scales


References:
[1] CA-DWR Climate Change Technical Advisory Group analysis used GCMs available at the start of the investigation that met certain data requirements (2013).
[2] Gleckler, P. J., Taylor, K. E., and Doutriaux, C.: Performance metrics for climate models, J. Geophys. Res.-Atmos. (2008).
[3] IPCC, Climate Change 2013: The Physical Science Basis, Cambridge University Press, Cambridge, UK and New York (2013).
[4] Rupp, D. E., J. T. Abatzoglou, K. C. Hegewisch, P. W. Mote: Evaluation of CMIP5 20th century climate simulations for the Pacific Northwest USA, J. Geophys. Res.-Atmos. (2013).


California's water supply is dependent upon annual and interannual weather and climate conditions. Determining the impact of climate change onto regular climate variability will be a challenge. The multi-disciplinary CCTAG members met regularly over the course of 3 years; in person and via webex, to discuss these important matters. The wide variety of perspectives allowed for the transfer of information and understanding between the science community and practitioners.




*Satellite image of water vapor concentration; warm colors represent higher amounts of water vapor. February, 2014.*

### Model Selection

CCTAG provided guidance on a methodology to choose global climate models (GCMs), downscaling techniques, scenarios for extreme events, and further work needed to apply these elements. Specific unique work resulting from the CCTAG effort was related to GCMs:

- A 3-step evaluation approach was used to identify a tractable set of GCMs for California water resources planning.
- The identified GCMs will provide consistency for DWR planning projects.
- This methodology will inform the State's 4th Assessment Report, anticipated in 2018.

## In Conclusion

- Substantial hydrologic climate changes will challenge current and future generations of Californians.
- CCTAG guidance and perspectives will help DWR improve the scientific basis for decisions and enhance the consistency of climate change approaches.
- DWR will be better able to provide guidance to local water managers on incorporating climate change into their planning.
- DWR and CCTAG members increased their understanding of climate change issues facing California, which will benefit the greater water management community.