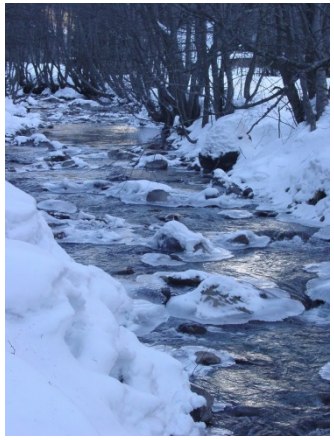
DWR Climate Change Program

Consideration of Climate Change in Water Resources Planning

Andrew Schwarz
DWR

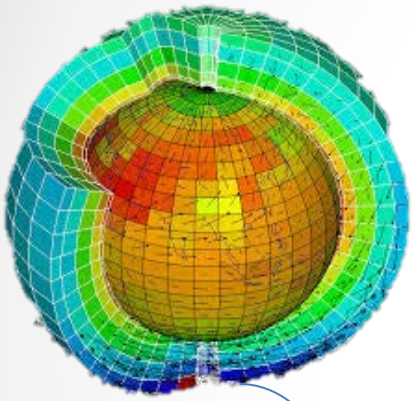


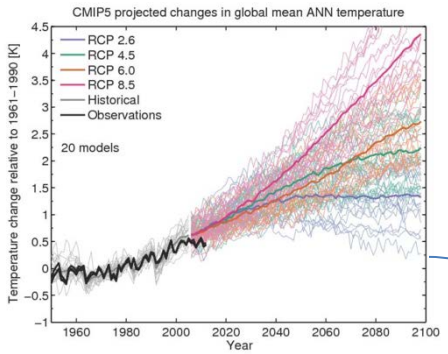
California Water Commission

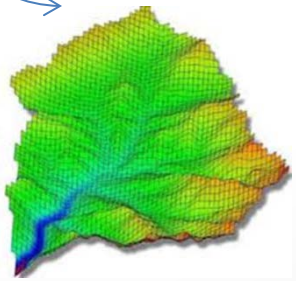
January 20, 2016

Tools and Tradeoffs

in Climate Change Analysis for Planning







CLIMATE CHANGE SPECIFIC ANALYSES

Regional/Statewide/
Watershed impacts

Existing system impacts

- Historical operational experience
- Observational records
- ***High level, no specific decision to be made***

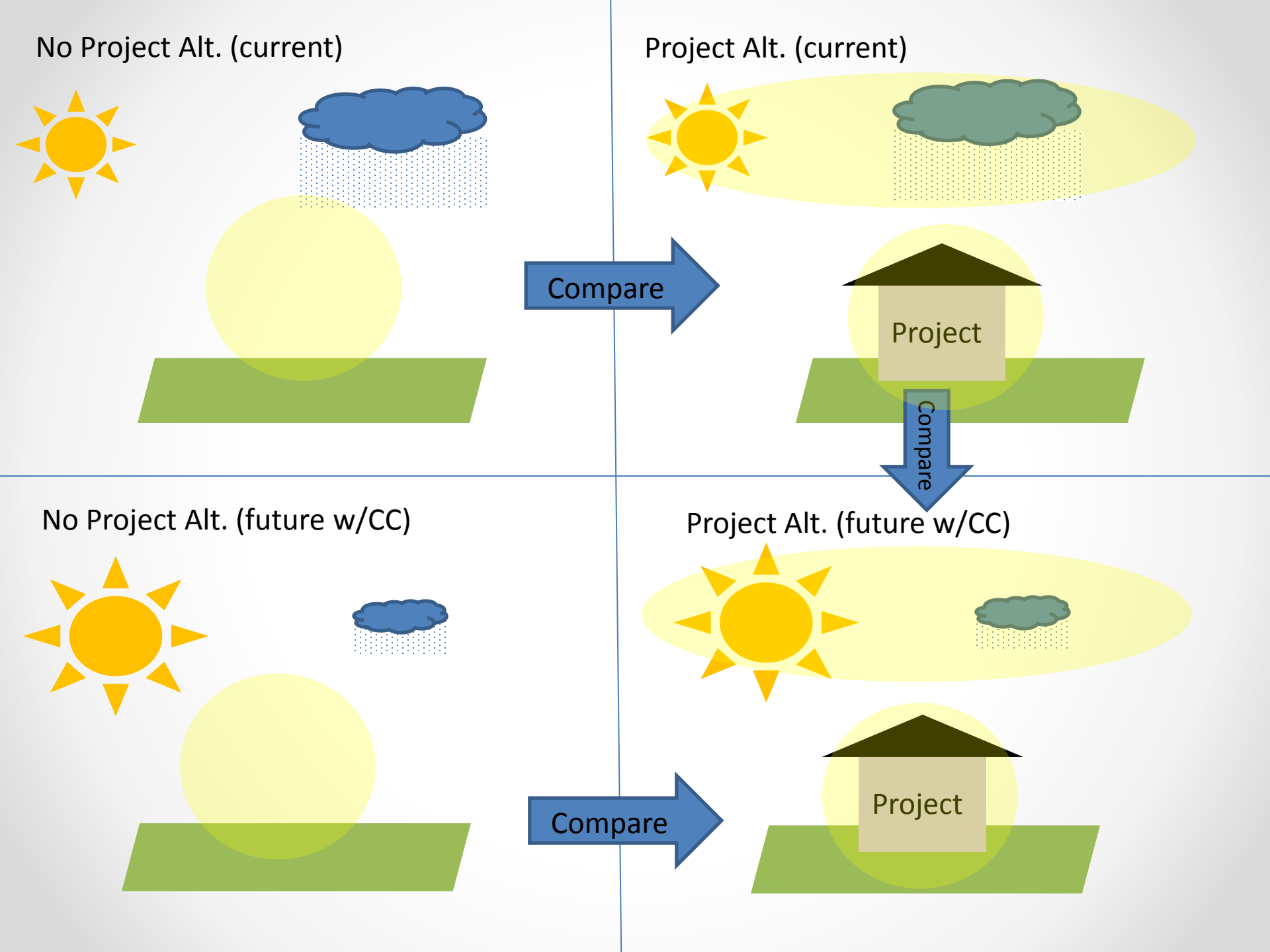
❖ California Water Plan
❖ SWP Delivery Capability Report
❖ Sac SJ Basin Study

PROJECT SPECIFIC ANALYSES

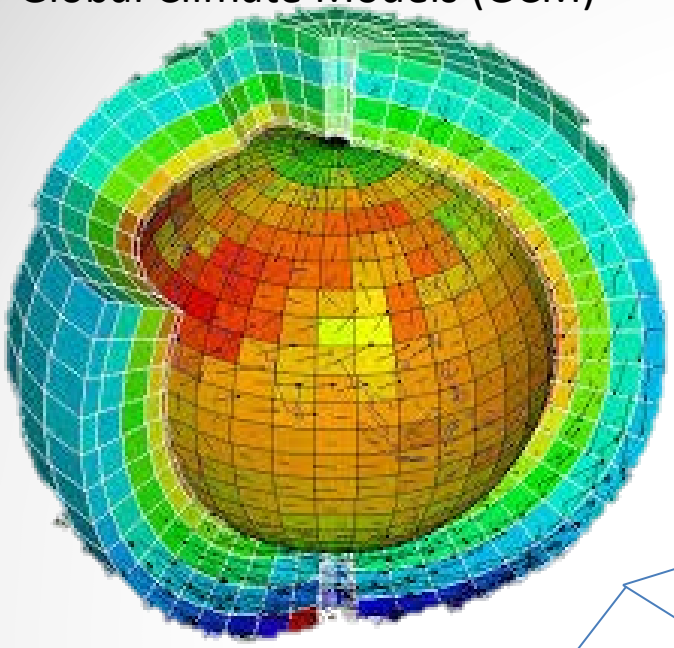
Proposed project or management plan performance

- No historical performance record
- Operational uncertainty
- Multiple alternatives/optimization schemes
- ***Highly detailed, go/no-go decision to be made***

❖ CEQA Projects
❖ WSIP
❖ SGMA Plans


No Project Alt. (current)
Project Alt. (current)
Compare
Project
Compare
No Project Alt. (future w/CC)
Project Alt. (future w/CC)
Compare
Project

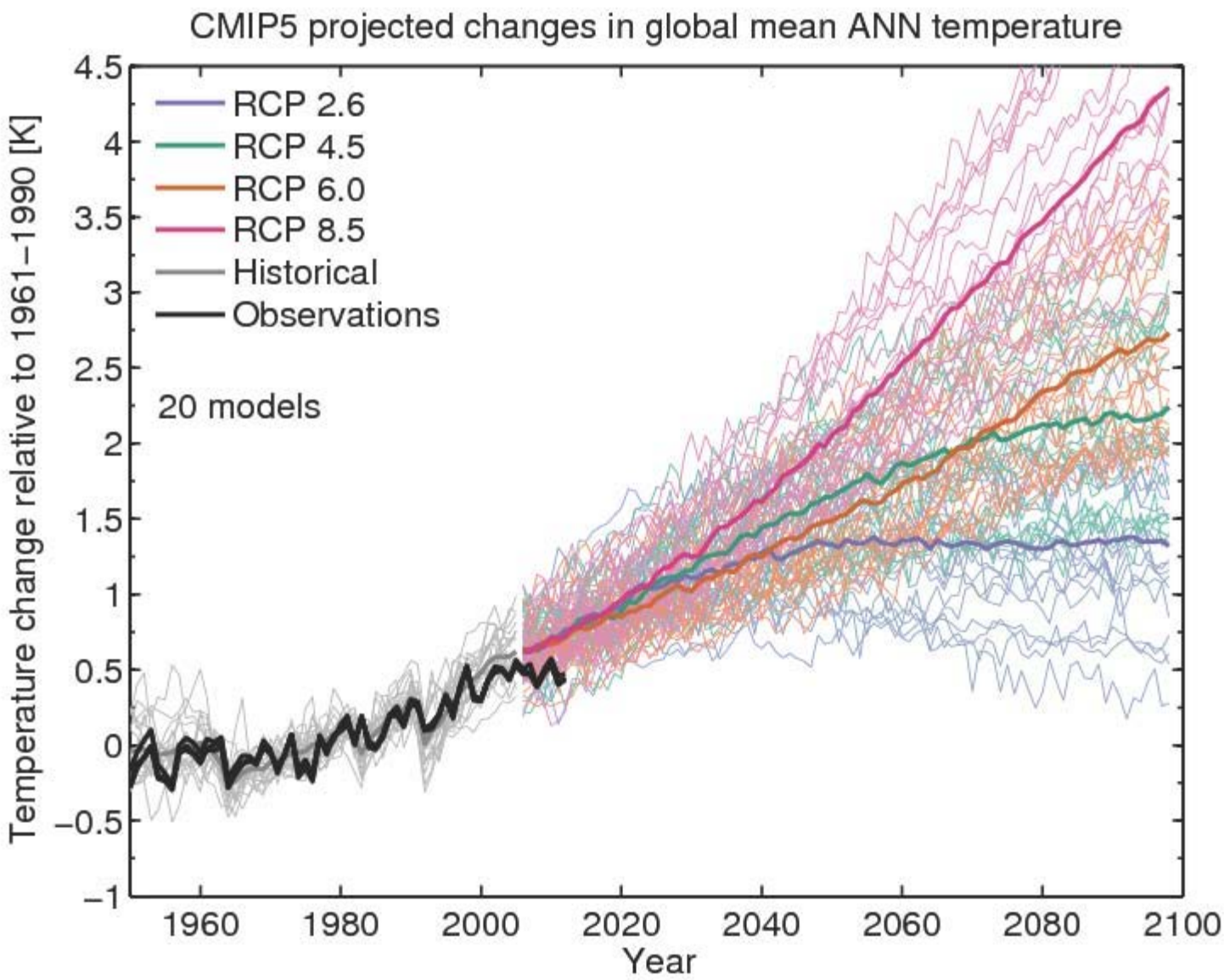
Global Climate Models (GCM)



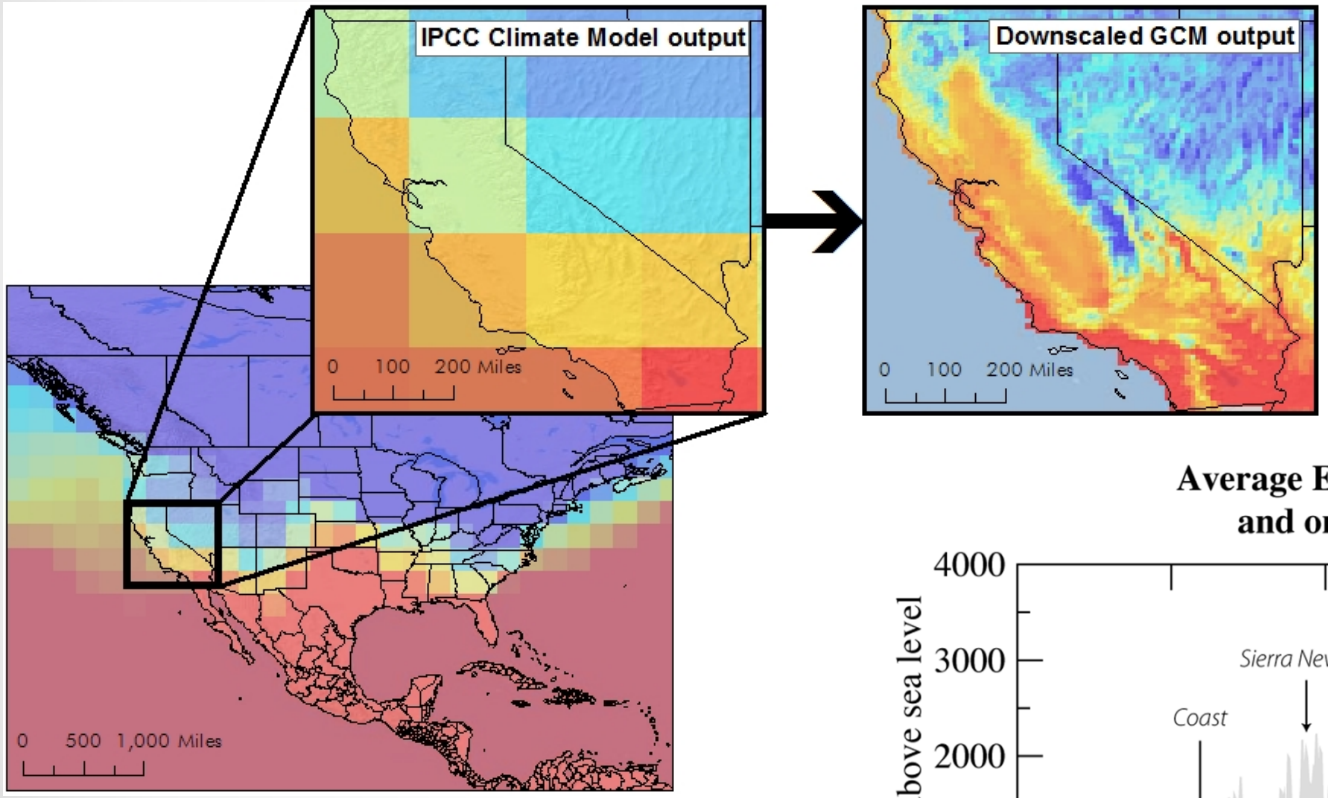
Regional/Statewide/
Watershed impacts

Proposed project or
management plan
performance

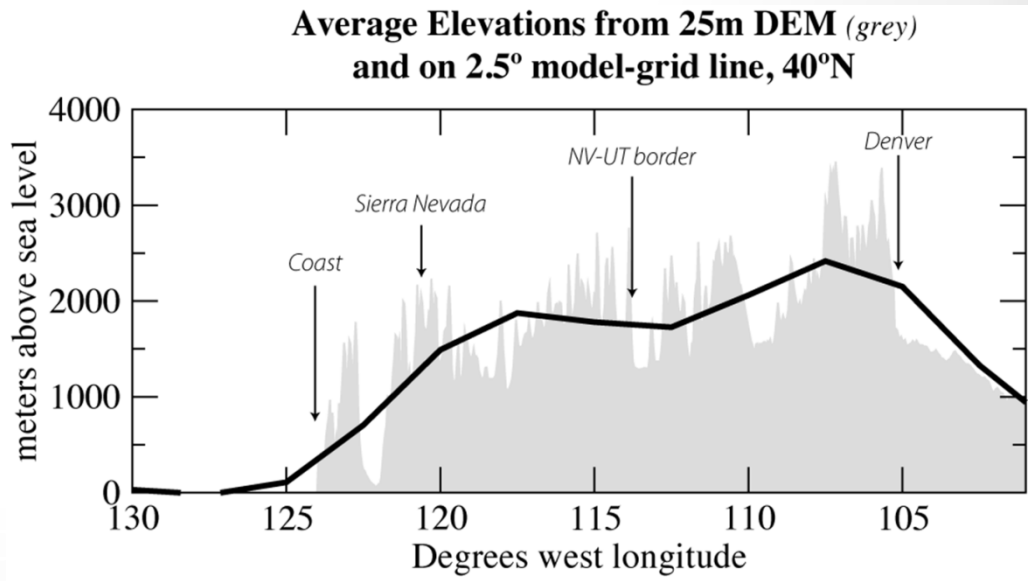
Existing system impacts


CMIP5 projected changes in global mean ANN temperature
RCP 2.6
RCP 4.5
RCP 6.0
RCP 8.5
Historical
Observations
20 models
Temperature change relative to 1961–1990 [K]
4.5
4
3.5
3
2.5
2
1.5
1
0.5
0
−0.5
−1
1960
1980
2000
2020
2040
2060
2080
2100
Year

From global to local "Downscaling"



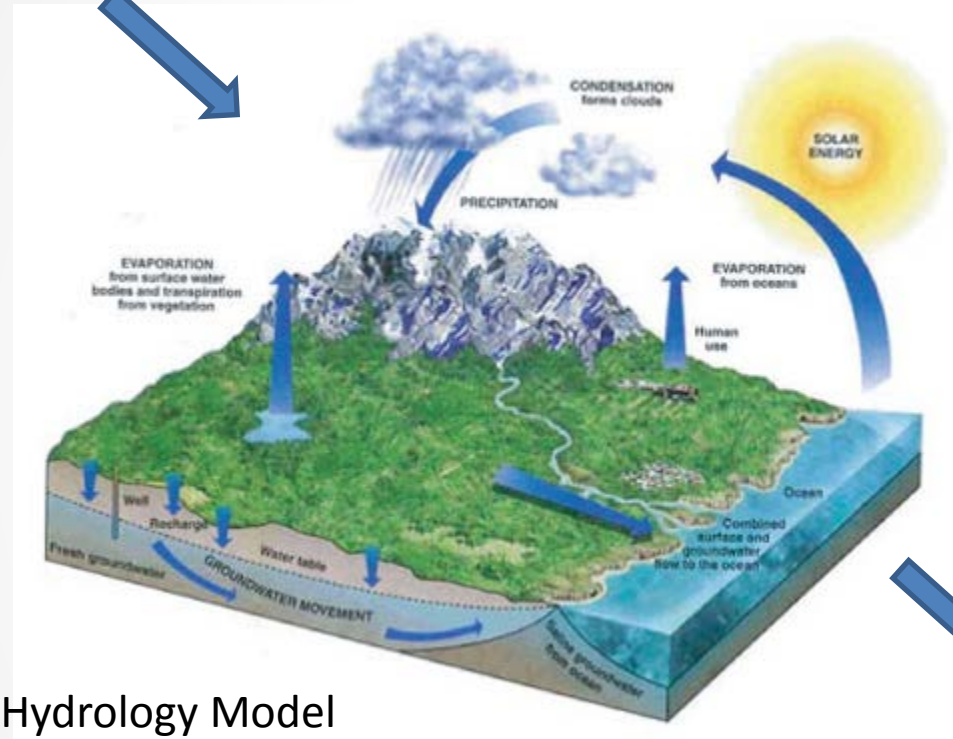
Regional features such as the Central Valley and Sierra Nevada are visible after downscaling



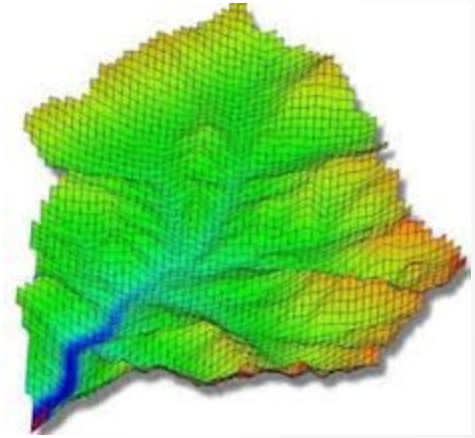
IPCC = Intergovernmental Panel on Climate C

From climate to hydrology

Temperature and Precipitation from downscaled climate model



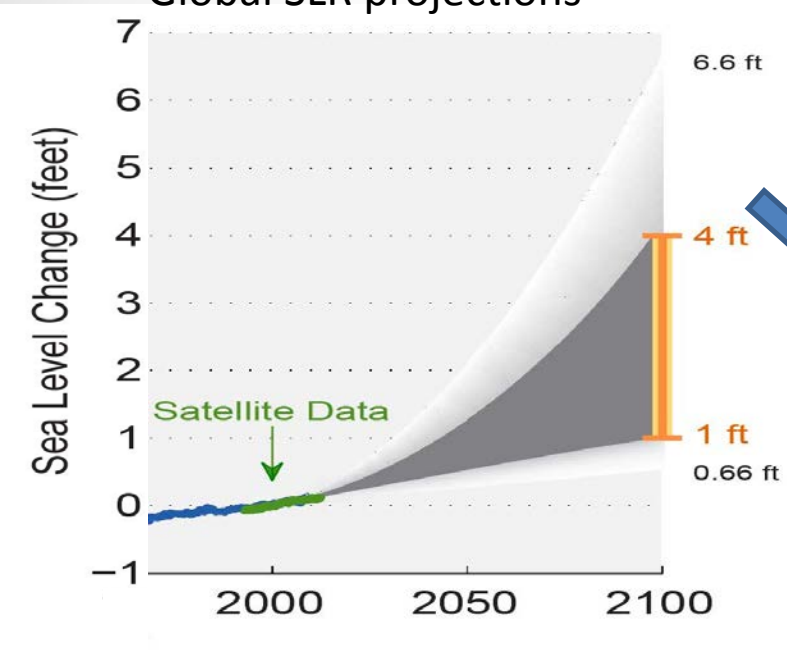
Hydrology Model
(VIC, SAC-SMA, IWFM, HEC-HMS)



Streamflow, soil moisture

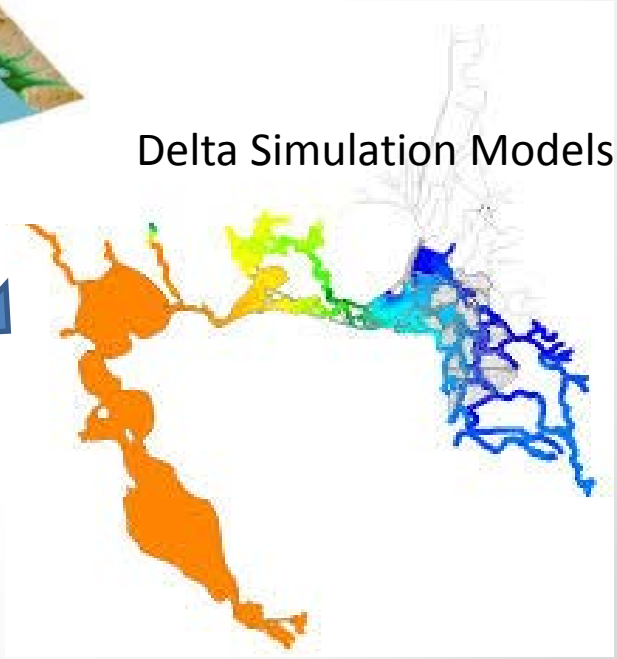
From climate to sea level

Global SLR projections

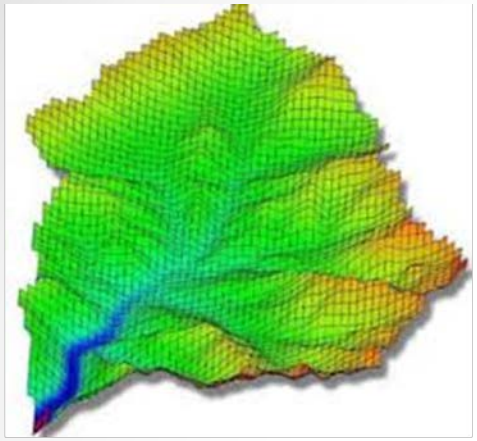


Local coastal characteristics

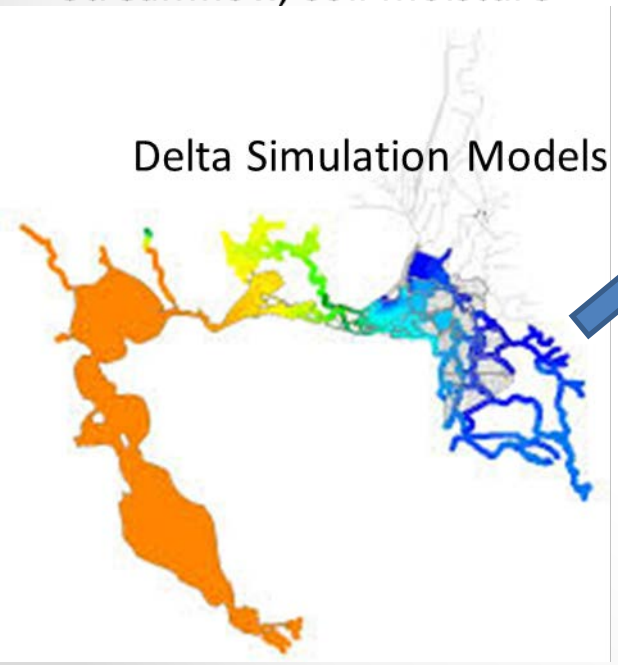
Delta Simulation Models



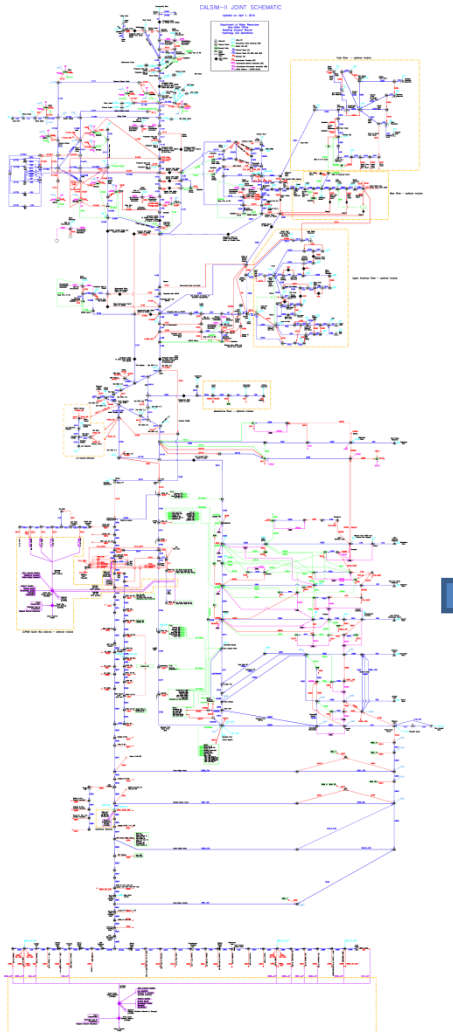
From hydrology to hydraulics



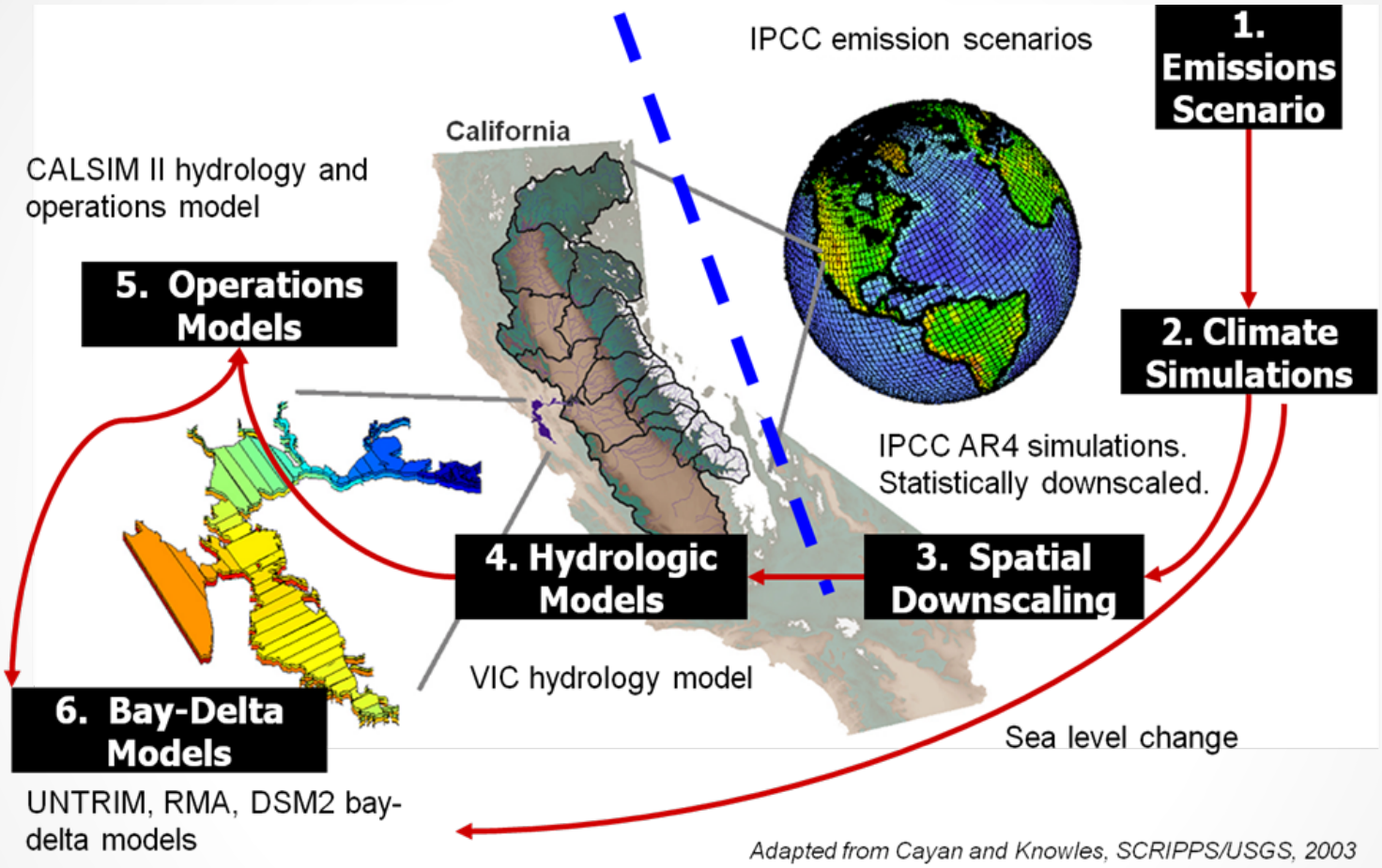
Streamflow, soil moisture



Delta Simulation Models



SWP Deliveries
CVP Deliveries
Reservoir Storage
Canal Flow
Delta Conditions



Adapted from Cayan and Knowles, SCRIPPS/USGS, 2003

For local or regional systems this process can be fractal

Other Impact or Economic Models

Deliveries
Reservoir Storage
Canal Flow
Delta Conditions

Aquatic Resource Impacts

Economic Analysis and Benefits

Primary Questions for Climate Change Analysis

- What future climate or climates should we be evaluating/how should we use GCM data?
- What are the best ways to downscale GCM data?
- What is the best way to go from changes in climatology to changes in hydrology?
- When should we use stress tests and how would those tests be constructed?

DWR Climate Change Technical Advisory Group (CCTAG)

Perspectives and Guidance for Climate Change Analysis

August 2015

California Department of Water Resources (DWR)

Climate Change Technical Advisory Group (CCTAG)

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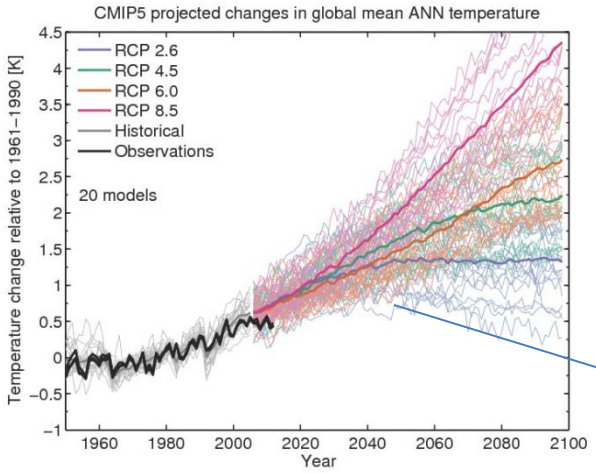
Technical Information Record
This report represents the preliminary findings from 2012-2015 by DWR's expert external advisory committee, the Climate Change Technical Advisory Group, on global climate model selection appropriate for California water resources, planning for extreme conditions, downscaling, and recommendations for future work.

ii



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

Start with 31[1] GCMs

Global

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.

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

Evaluate how each GCM represents California historical

- Dry and Wet Precipitation Extremes
- Heat Waves and Cold Snaps

Remove ~5 GCMs

10 GCMs to use for CA water planning

The remaining 10 GCM's are recommended for water resources planning because they represent important components of

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).

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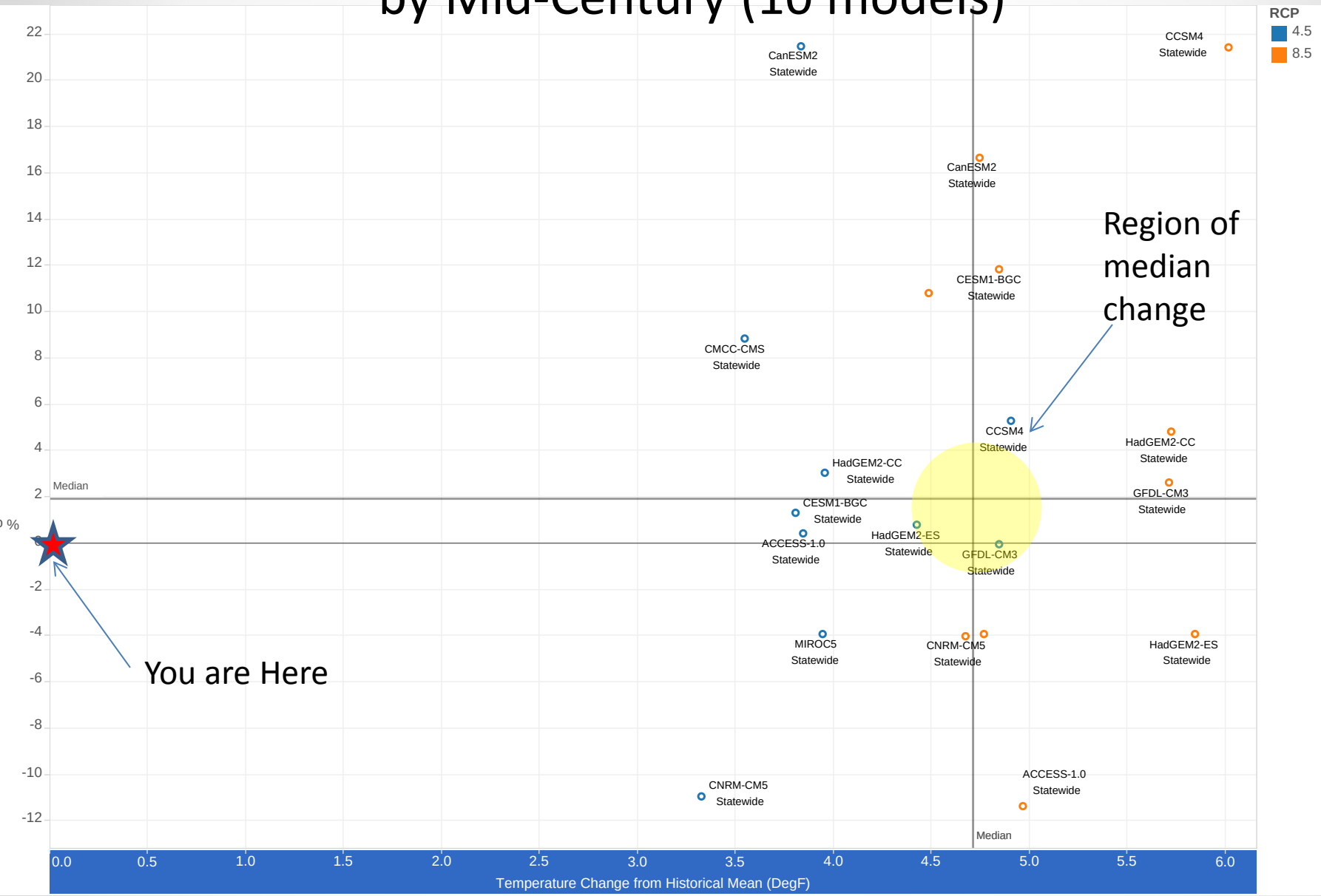
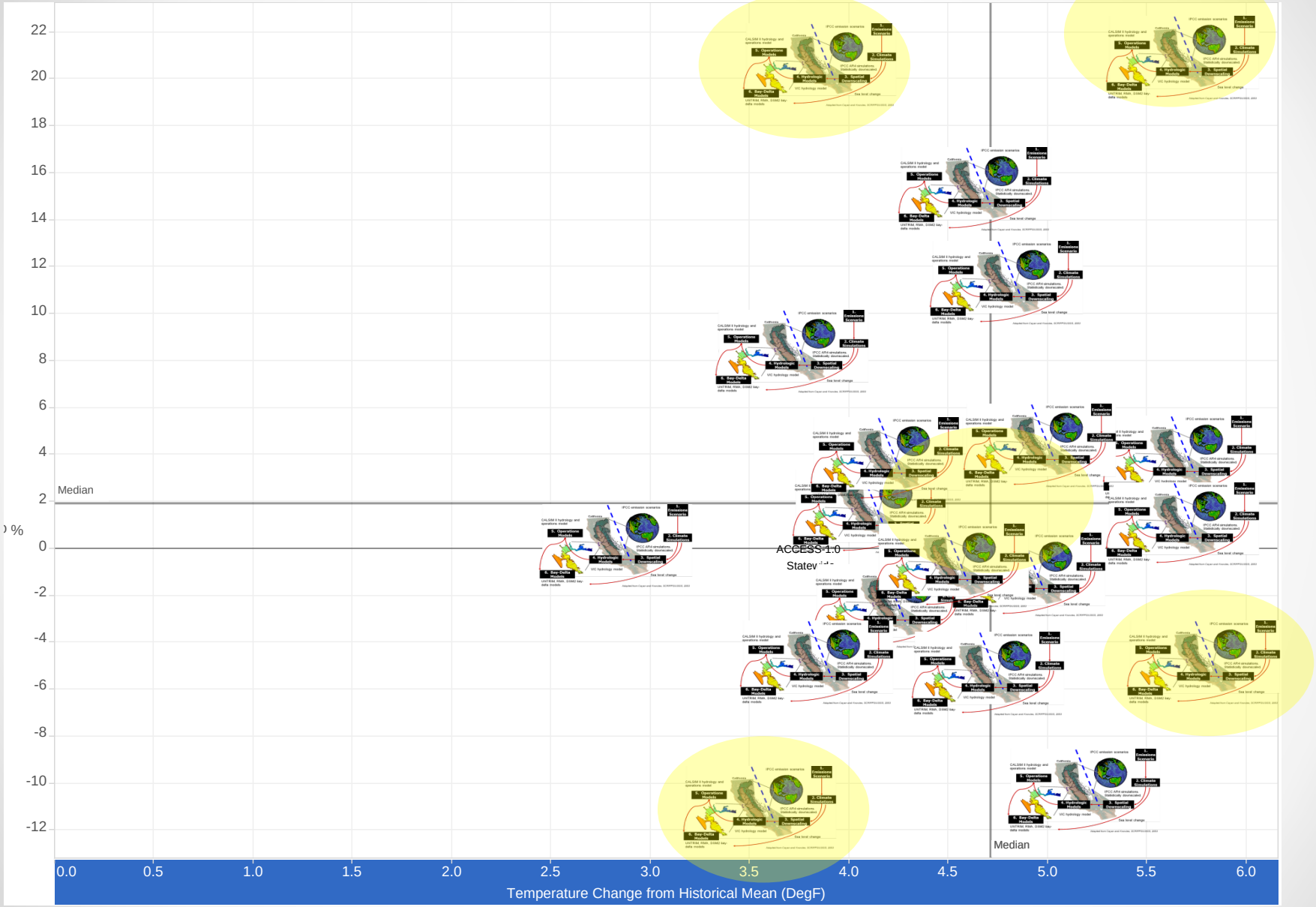
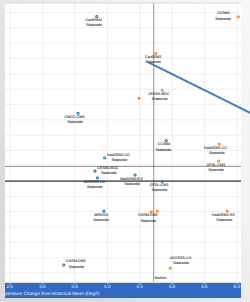
Statewide Temperature and Precipitation Change by Mid-Century (10 models)




22
20
18
16
14
12
10
8
6
4
2
0
-2
-4
-6
-8
-10
-12
Median
ACCESS-1.0
Median
0.0
0.5
1.0
1.5
2.0
2.5
3.0
3.5
4.0
4.5
5.0
5.5
6.0
Temperature Change from Historical Mean (DegF)

Seeing the Forest for the Trees



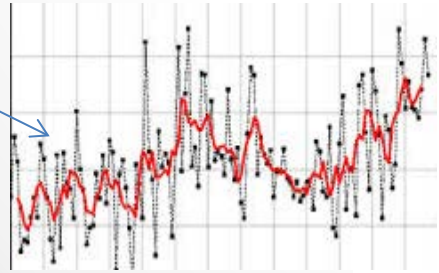


Table B2-3b Driest Periods Simulated by Ten Selected GCMs for the East of Sacramento Region for RCP8.5

Model Name	WY2006-WY2100					WY1851-WY2100	
	Dry 10-Year Period Start	# of Years	Driest Year	Driest Year % of Hist. Avg.	10-Year Period WY % of Hist. Avg.	Longest Run of Dry Years	Year Dry Run Begins
ACCESS-1.0	2056	6	2056	48.58	72.73	3	2070
CCSM4	2012	4	2013	48.58	85.56	3	2067
CESM1-BGC	2046	4	2049	63.94	92.09	4	1893
CMCC-CMS	2011	2	2017	62.33	85.03	2	2007
CNRM-CM5	2021	1	2021	75.61	103.49	3	1999
CanESM2	2034	6	2034	41.61	76.63	4	2034
GFDL-CM3	2014	4	2015	42.10	80.80	3	1976
HadGEM2-CC	2077	6	2085	38.55	76.93	4	1931
HadGEM2-ES	2060	5	2063	50.58	76.77	2	2062
MIROC5	2049	6	2049	64.90	79.37	3	2049
Observed: CA climate division 2	1923	4	1923	40.60	80.13	2	1990

Notes:

GCM = global climate model, WY = water year

Water year historical averages are for WY1961-WY1990. For GCM background information and affiliated research institutions, see the CMIP5 Coupled Model Intercomparison Project at http://cmip-pcmdi.llnl.gov/cmip5/availability.html.

More Questions to Ponder…

- How far out into the future should we be planning?

Uncertainty grows about everything: population, technology, climate, politics, land use, regulations as we move further into the future. What is the right balance between preparation and certainty?

More Questions to Ponder…

- When evaluating projects or plans throughout the state how do we handle regional differences in climate changes?

  There are clear benefits to having intercomparability across the state, but spatially consistent projections will not equally stress every region. What is our priority in evaluating projects?

More Questions to Ponder…

- What does stress test performance tell you about the decision you want to inform?

  If a project performs well under highly like circumstances but fails to perform under highly unlikely but stressful circumstances should we build it or not?