Using Future Climate Projections to Support Water Resources Decision Making in California

DSM2 User Group Meeting
April 22, 2009

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Modeling Support Branch
Bay-Delta Office

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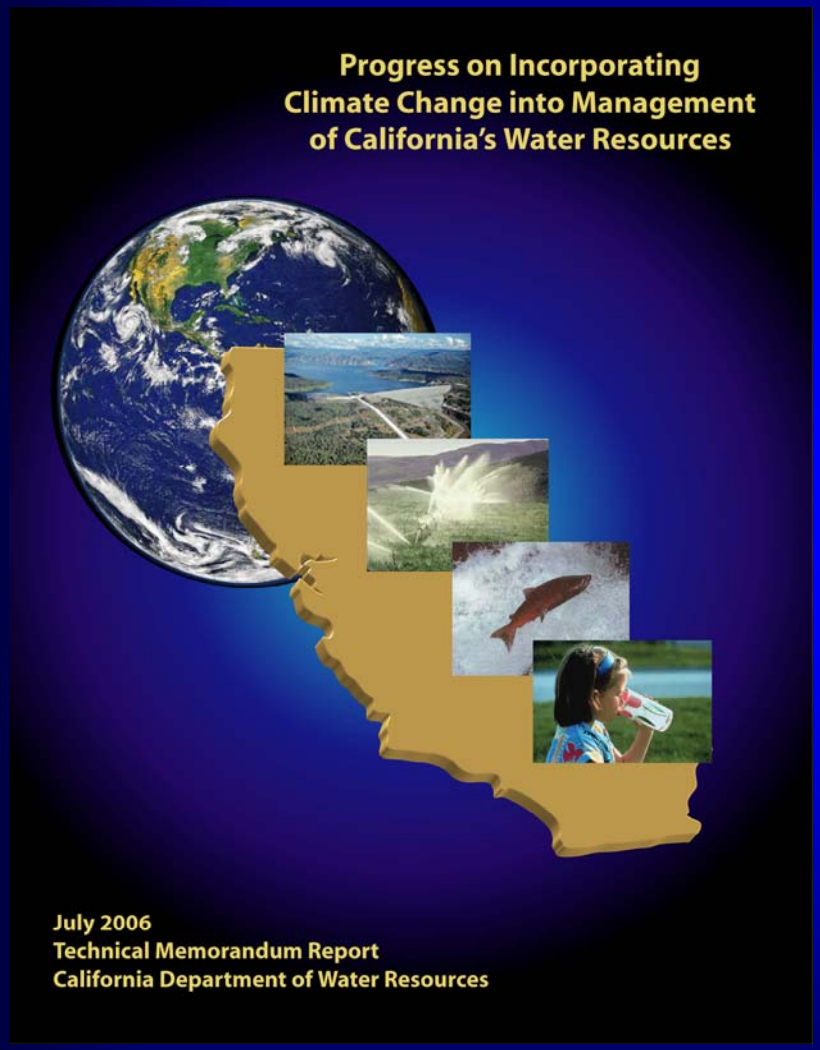
- Maury Roos
- Sanjaya Seneviratne
- Jianzhong Wang
- Hongbing Yin
- Nikki Blomquist

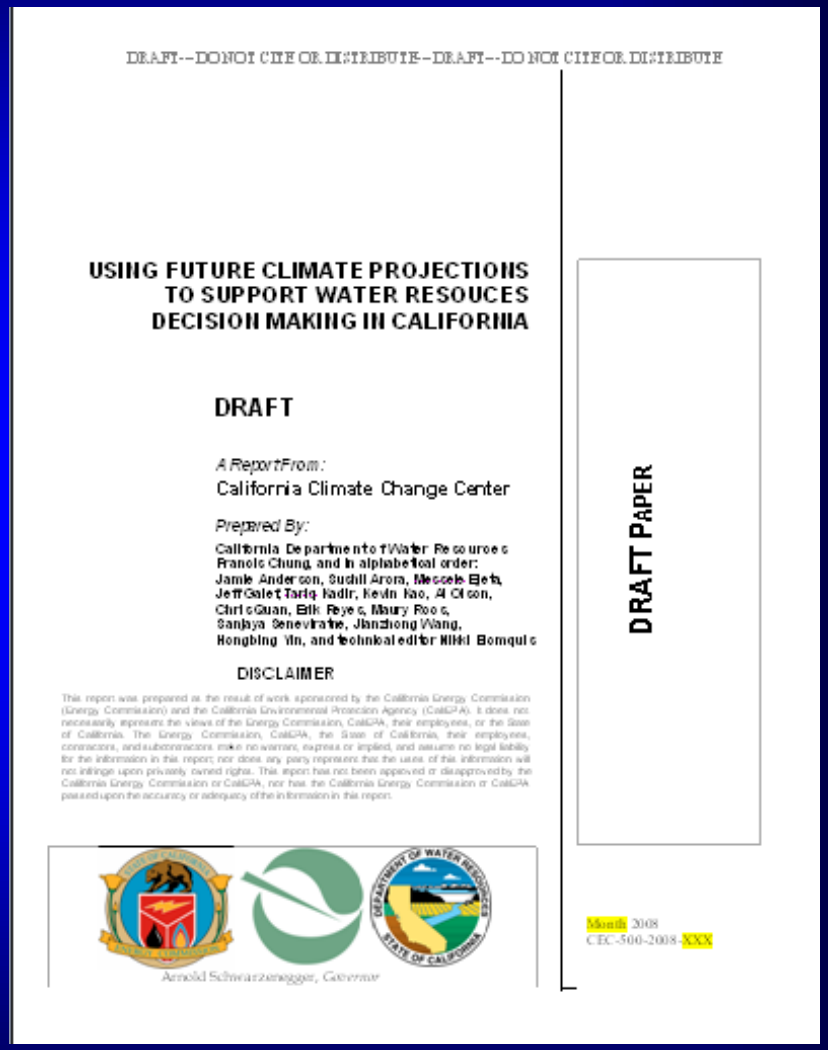
2006 Report

4 Scenarios (2 GCM x2 GHG)



2009 Report

12 Scenarios (6 GCM x2 GHG)



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USING FUTURE CLIMATE PROJECTIONS
TO SUPPORT WATER RESOUCES
DECISION MAKING IN CALIFORNIA

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A Report From:
California Climate Change Center

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Hongbing Yin, and technical editor Nikki Elomquis

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Arnold Schwarzenegger, Governor

DRAFT PAPER

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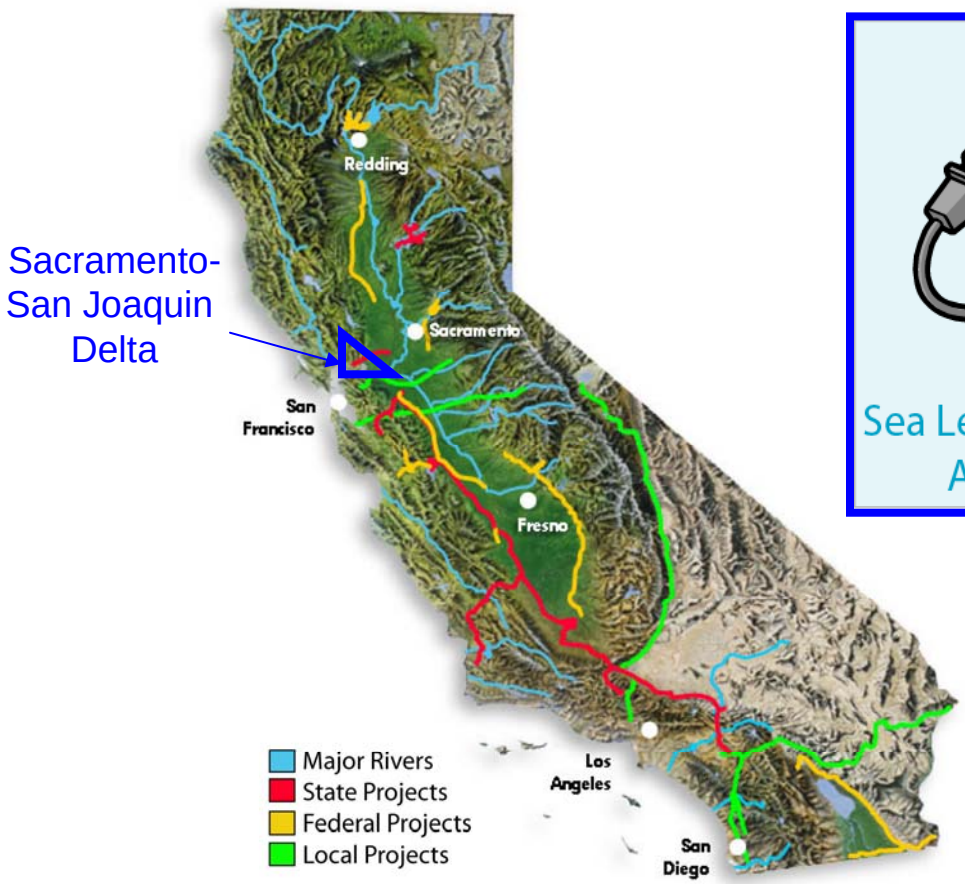
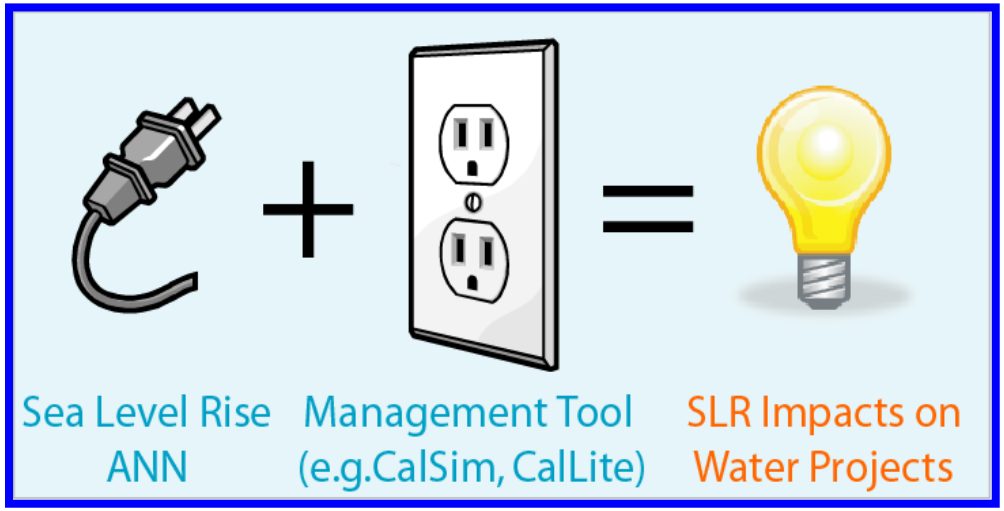
What's New for 2009 DWR CAT Report

- More future climate scenarios
  - 4 in 2006, 12 in 2009
- Comparison of GCM and historical data
- Updated methods for creating data series that reflect possible future climate conditions
  - Sea level rise
  - Reservoir inflows
  - Outdoor urban and agricultural water demands
- Incorporating sea level rise in SWP-CVP impacts assessments
  - Mid-century and end of the century impacts

Models of SWP and CVP Operations
Need a Way to Quickly Represent
Delta Water Quality Standard Compliance



Sea Level Rise Artificial Neural Networks

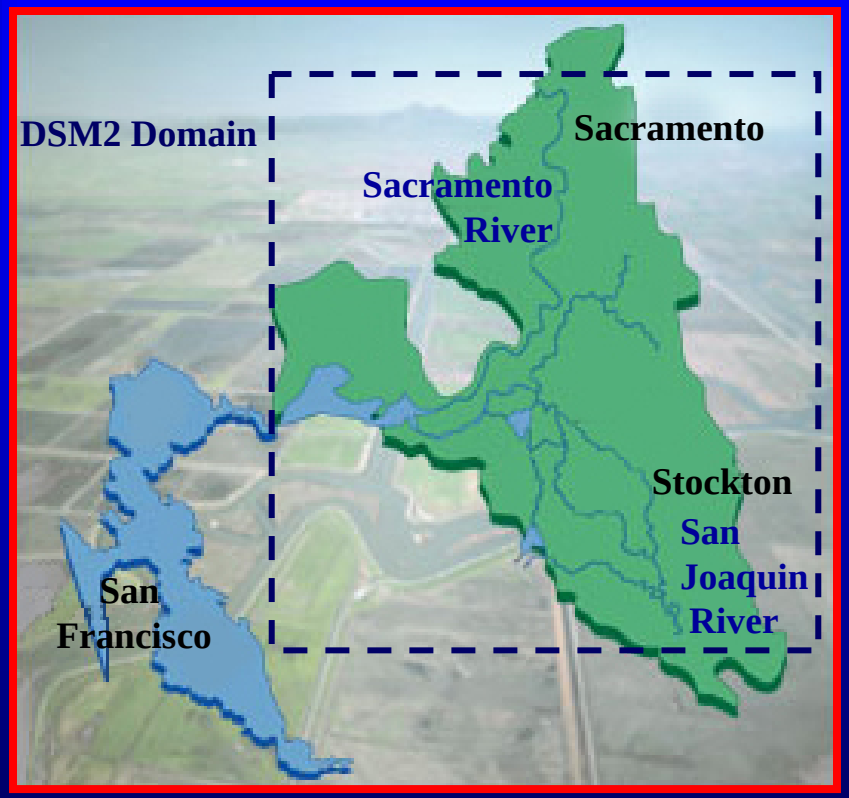


A Delta salinity ANN is a computer program that quickly estimates Delta salinity based on inflows and exports

An ANN can be used in management tools such as CalSim and CalLite to estimate sea level rise impacts

Developing Delta Salinity ANNs

1. Use DSM2 to simulate Delta Salinity for SLR scenarios



- Increase water level at Martinez
- Increase salinity at Martinez based on DRMS study by Ed Gross

2. Using DSM2 results, "train" SLR ANN to replicate Delta salinity

INPUT
- Northern Delta inflows
- San Joaquin River flows
- Delta exports
- Delta consumptive use
- Cross Channel gate operations
- Tidal energy

↓

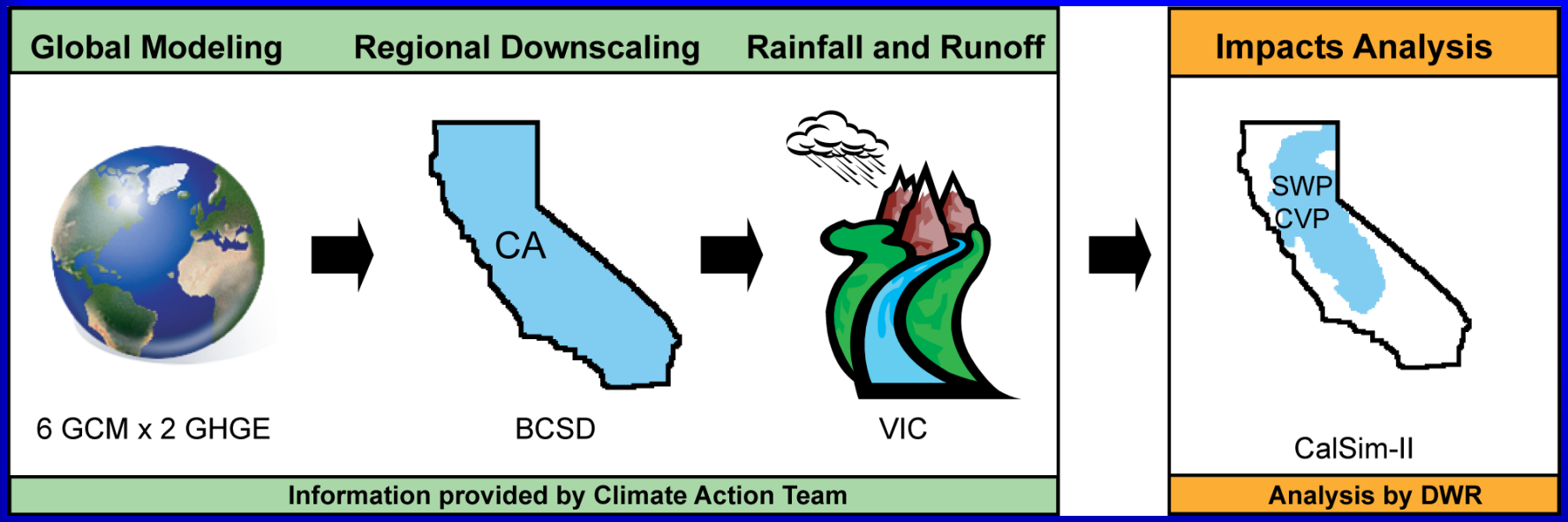
Sea Level Rise ANN

↓

OUTPUT Salinity at:
- Collinsville
- Emmaton
- Jersey Pt
- Antioch
- Chipps Is.
- Old R at Rock Sl.
- Los Vaqueros
- Victoria Canal (center)
- Victoria Canal-Middle R
- Clifton Court Forebay (SWP)
- Jones Pumping Plant (CVP)

ANN=Artificial Neural Network

SWP-CVP Impact Assessment Methodology



- Delta exports
- Carryover storage
- Groundwater pumping
- Power Supply
- X2 location
- Vulnerability to System Interruption

BCSD= Bias Corrected Spatial Downscaling VIC= Variable Infiltration Capacity Model
SWP= State Water Project CVP=Central Valley Project DWR= Dept. of Water Resources

SWP and CVP Water Supply Impacts

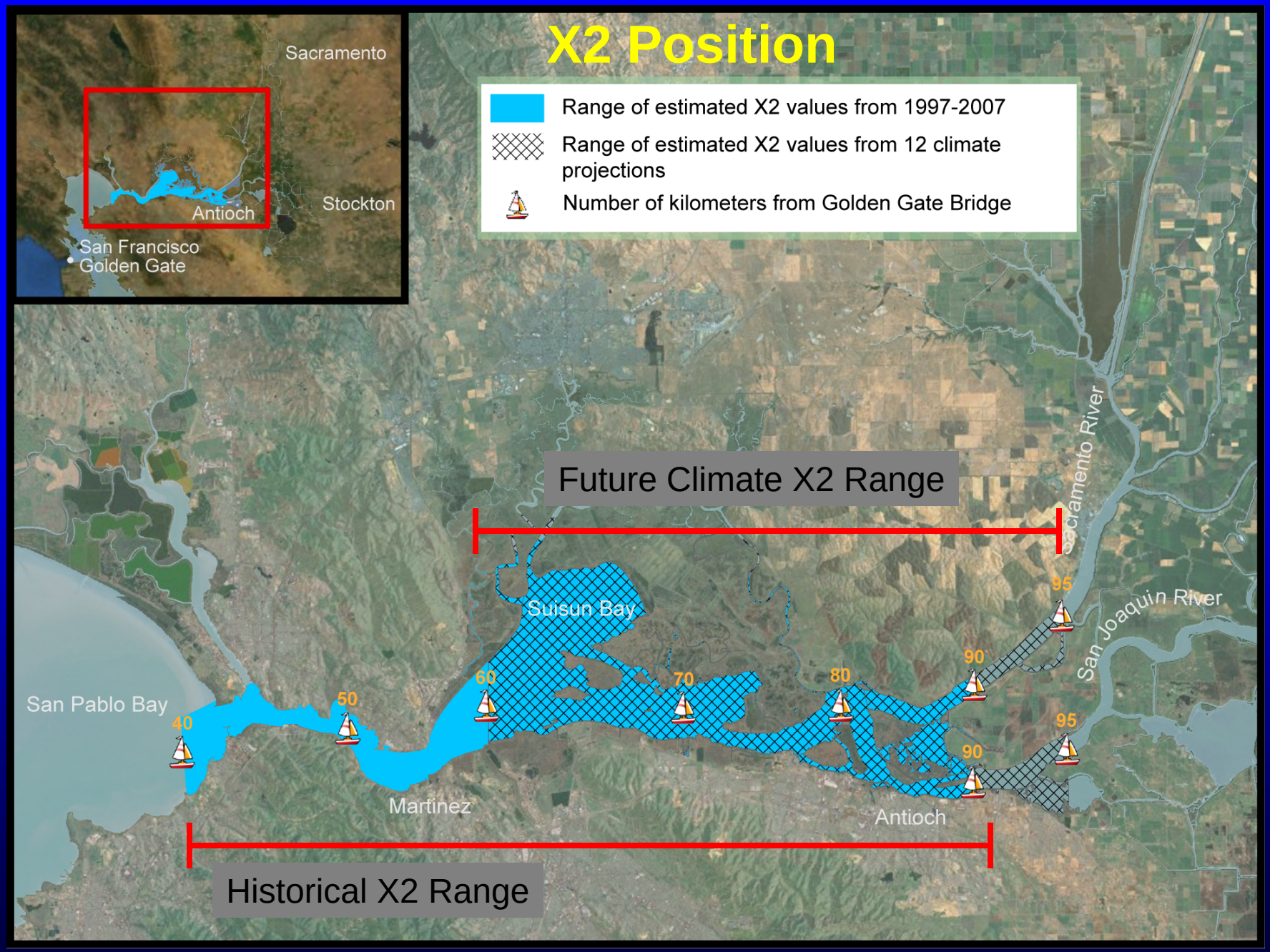
- Delta exports ↓
  - Mid-century: -7 to -10%
  - End of century: -21% to -25%

- Reservoir carryover storage ↓
  - Mid-century: -15 to -19%
  - End of century: -33% to -38%

- Sac Valley Groundwater Pumping ↑
  - Mid-century: +5 to +9%
  - End of century: +13% to +17%

SWP=State Water Project CVP=Central Valley Project

X2 Position


Sacramento
Antioch
Stockton
San Francisco
Golden Gate
Range of estimated X2 values from 1997-2007
Range of estimated X2 values from 12 climate projections
Number of kilometers from Golden Gate Bridge
Future Climate X2 Range
Suisun Bay
Sacramento River
San Joaquin River
San Pablo Bay
40
50
60
70
80
90
95
90
95
Martinez
Antioch
Historical X2 Range

System Vulnerability to Interruption

- Water levels go below the lowest outlets (dead storage) in at least one of the main storage reservoirs
- System is vulnerable to interruption
  - Mid-century: 1 in every 6-8 years
  - End of century: 1 in every 3-4 years
- Water needed to avoid interruption in years of shortage
  - Mid-century: 575-750 TAF
  - End of century: 750-850 TAF
- Assuming $470/acre-ft willingness to pay, cost of extra water to avoid interruption
  - Mid-century: $270-$350 million/year
  - End of century: $350-$400 million/year

www.climatechange.ca.gov
www.water.ca.gov/climatechange/

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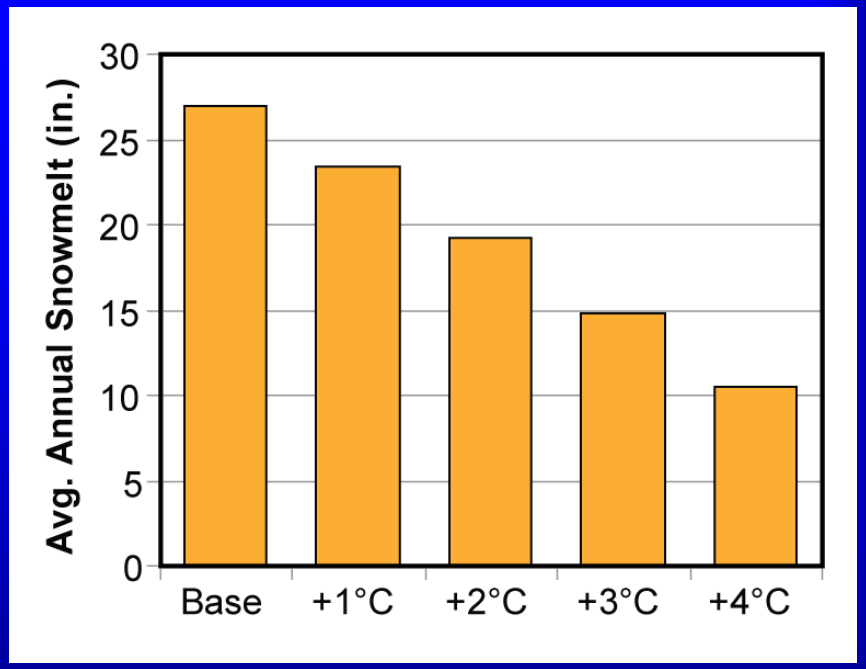
Take Home Message

- Effects of increasing air temp on Feather basin
  - ↓ April snowpack, ↓ runoff in April-July
  - ←50% inflow to Oroville up to a month earlier
- Effects of climate change on SWP and CVP
  - ↓ annual Delta exports, ↓ reservoir carryover storage
  - ↑ annual groundwater pumping
  - → X2 range moves upstream, standard still met
  - ↓ Power supply
  - ↑ vulnerability to operational interruption

Effect of Increasing Temperature on Upper Feather River Basin Runoff

- Watershed for SWP main reservoir, Lake Oroville
  - Low elevation, so rain/snow sensitive to temp. changes
- Effects of increasing air temperature by
  - +1°C, +2°C, +3°C, +4°C
- Snowmelt decreased
  - 15% for +1°C
  - 60% for +4°C
- Runoff shifts earlier in year
  - Flood control vs. water supply
  - For +4°C, mean runoff shifts from mid-April to mid-March



SWP=State Water Project

SWP and CVP Power Impacts

- Power Use ↓
  - Lower water deliveries reduces energy needs
  - Mid-century: -14%
  - End of century: -17%

- Power Generation ↓
  - Lower water deliveries reduces hydro power generation
  - Mid-century: -4% to -11%
  - End of century: -4% to -9%

SWP=State Water Project CVP=Central Valley Project

Governor's Executive Order S-3-05

- Signed June 1, 2005
- Targets to reduce emission levels of greenhouse gases
- Required biennial reports starting January 2006
  - Water supply
  - Public health
  - Agriculture
  - CA coastline
  - Forestry
- Formed Climate Action Team

2009 CAT Future Climate Scenarios

6 Global Climate Models

- GFDL-CM2.1 (USA)
- NCAR-PCM1 (USA)
- CNRM-CM3 (France)
- MPI-ECHAM5 (Germany)
- MIROC3.2med (Japan)
- NCAR-CCSM3 (USA)

2 GHG Emissions Scenarios

- A2 (higher GHG emissions)
  - high population growth
  - regional economic growth
  - fragmented technological changes
- B1 (lower GHG emissions)
  - low population growth
  - rapid economic growth
  - sustainable technology

12 Total Scenarios = 6 GCM x 2 GHG Emissions Scenarios