

## Climate Change Impacts on the Sacramento-San Joaquin Delta

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Modeling Support Branch  
Bay Delta Office

## Acknowledgements

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## Climate Change

**“I say the debate is over. We know the science. We see the threat. And we know the time for action is now.”**

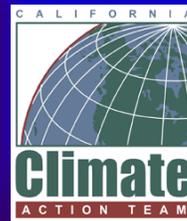
– Governor Schwarzenegger  
June 1, 2005  
World Environment Day



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## Governor's Executive Order

- EO S-3-05 June 1, 2005
- Reduce emission levels of Green House Gases
  - By 2010 to 2000 levels
  - By 2020 to 1990 levels
  - By 2050 to 80% below 1990 levels
- Biannual reports starting Jan06
  - Water supply
  - Public health
  - Agriculture
  - CA coastline
  - Forestry
- Formed Climate Action Team



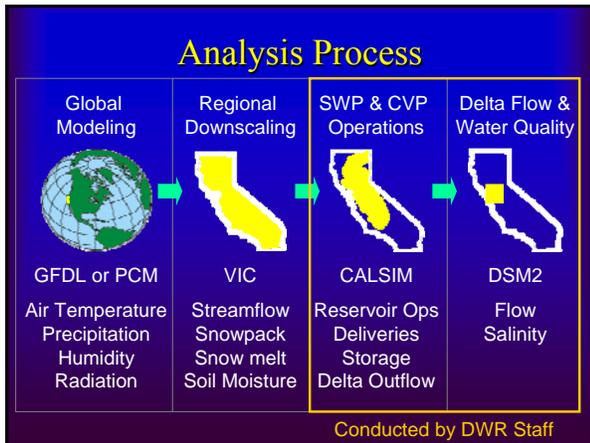
## Climate Action Team selected 4 Climate Change Scenarios

2 Models x 2 Emissions Scenarios

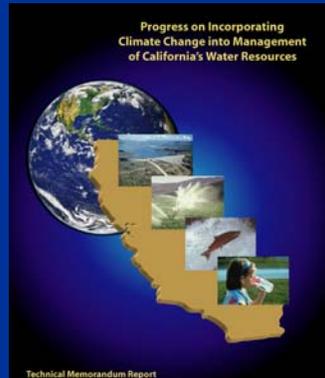
## Precipitation and Air Temperature Projections

Scenario/Model	A2	B1
<b>GFDL</b>	Relatively strong warming Modest drying	Modest warming, Modest drying
<b>PCM</b>	Modest warming Modest drying	Weak warming Weak precipitation increase in CA

GCMs all show increasing air temperatures for the next century  
There is no consistent trend in precipitation projections.



### Progress on Incorporating Climate Change into Management of California's Water Resources



Peer Reviewed

Undergoing Final Review

Target Release Jan 2006

Technical Memorandum Report  
California Department of Water Resources

- ### DWR Climate Change Report ~Jan06
- CH1: Introduction
  - CH2: Potential Impacts of Climate Change
  - CH3: DWR Climate Change Studies
  - CH4: Impacts of SWP and CVP
  - CH5: Impacts on Delta Water Quality
  - CH6: Impacts on Flood Management
  - CH7: Impacts on Evapotranspiration
  - CH8: Future Directions



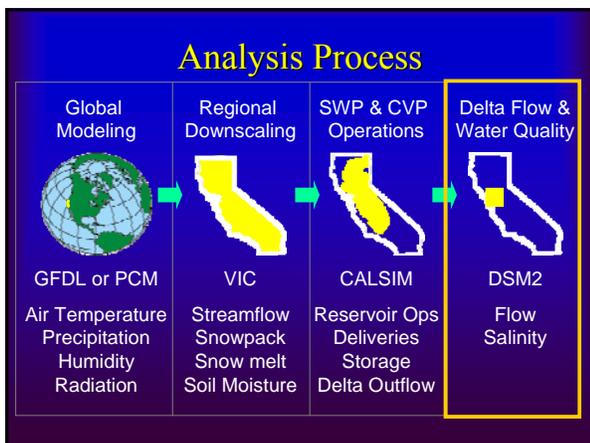
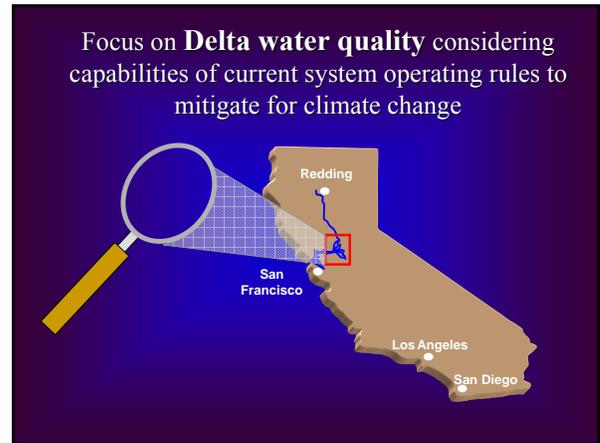
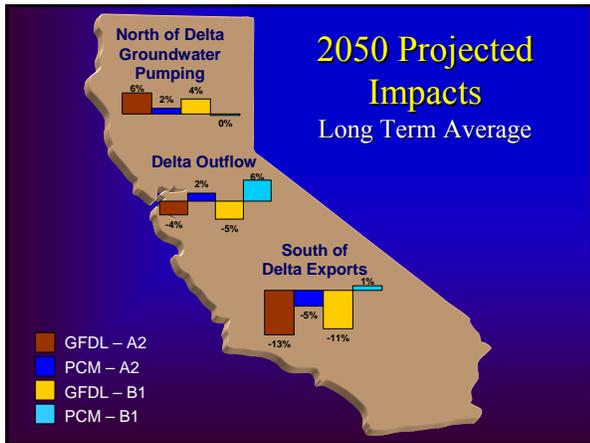
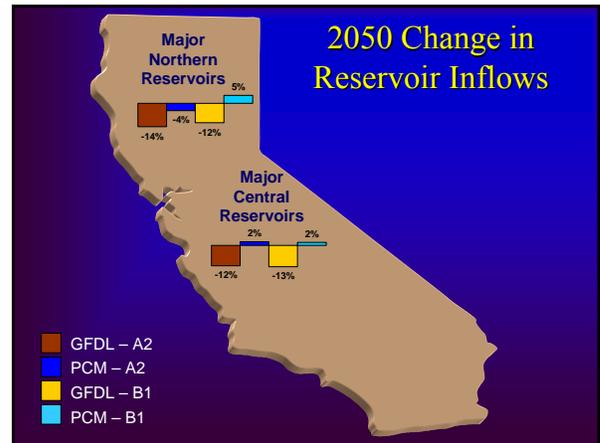
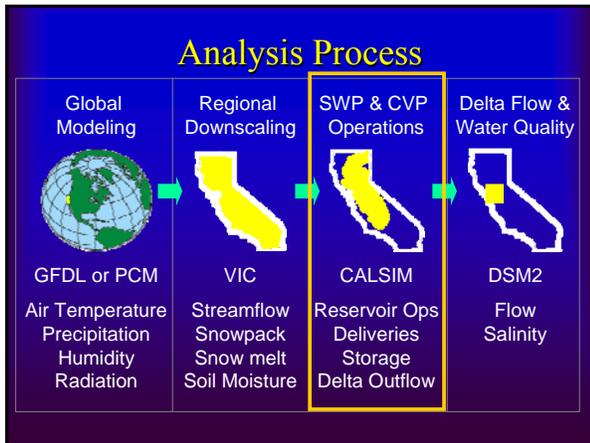
### CWEMF Annual Meeting Feb 28-Mar 2, 2006

2 Climate Change Sessions

- Tues Feb 28 4:15pm
  - SWP-CVP Impacts
  - Delta Impacts
  - Flood Management
  - Agricultural Impacts
- Wed Mar 1 10:15am
  - Mountain Hydrology
  - Extreme Droughts
  - Probabilities
  - Risk Assessment

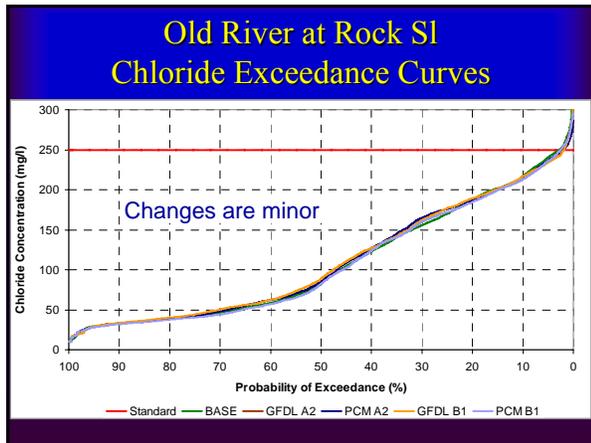


## CalSim Results in a Nutshell



- ### Delta Simulations
- 16-year DSM2 planning studies wy1976-1991
    - Flows and water levels
    - Salinity
  - Base case and 4 climate change scenarios
    - Present sea level
    - 1ft sea level rise
  - Inflows and exports provided by CalSim
    - 2020 level of land use
    - 2050 projected runoff
  - No additional modifications to operations





### 250 mg/l Chloride Standard Compliance

Scenario/ Location	BASE	GFDL A2	PCM A2	GFDL B1	PCM B1
Contra Costa-Old R at Rock Sl.	97.2%	98.0%	98.0%	98.2%	97.4%
Contra Costa-Los Vaqueros	99.9%	100%	100%	100%	100%
SWP-Clifton Court	100%	100%	100%	100%	100%
CVP-Tracy	100%	100%	100%	100%	100%

Operational flexibility is able to mitigate for changes in runoff and still meet Delta water quality standards most of the time

### 150 mg/l Chloride Standard Violations Old River at Rock Slough

	Year	Year Type	Standard: Min Days Cl≤150 mg/l	Number of Days Cl≤150 mg/l	
				GFDL B1	PCM B1
# Days with Cl≤150 mg/l	1989	Dry	165	153	139

### D1641 EC Standard Compliance for Agricultural Diversions

Scenario/ Location	BASE	GFDL A2	PCM A2	GFDL B1	PCM B1
SJR at Vernalis	86.5%	83.9%	85.9%	81.8%	85.4%
SJR at Brandt Bridge	90.1%	85.9%	89.1%	84.4%	90.1%
Old River at Middle River	88.0%	84.4%	88.0%	81.8%	87.5%
Old River at Tracy Bridge	88.0%	82.3%	85.4%	80.7%	87.5%

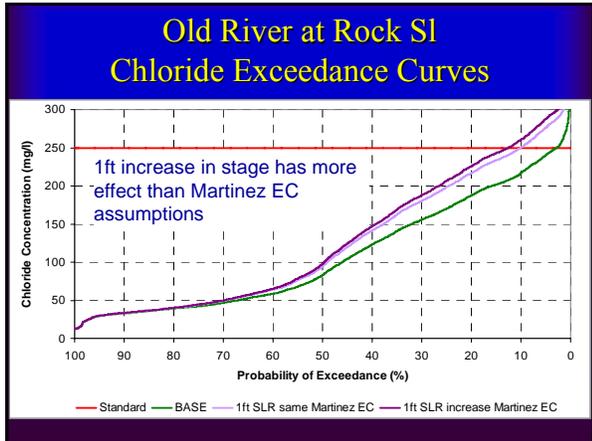
Vernalis compliance is key to meeting the standard at other locations  
Minor impacts from climate change

### Average Chloride Mass Loadings metric tons/day

	CCC	SWP	CVP
Base	54	711	686
GFDL A2	54	646	648
PCM A2	54	667	663
GFDL B1	55	670	686
PCM B1	54	685	688

Reduced exports lead to reduced chloride mass loadings

## 1ft Sea Level Rise Only



### 250 mg/l Chloride Standard Compliance

Scenario/ Location	BASE	1ft Sea Level Rise same Martinez EC	1ft Sea Level Rise increase Martinez EC
CCWD-Old River at Rock Sl	97.2%	89.9%	87.5%
CCWD-Old River at Hwy 4*	99.9%	99.7%	99.4%
SWP-Clifton Court	100%	100%	100%
CVP-Tracy	100%	100%	100%

Salt intrusion from a 1ft sea level rise and no changes in operations reduces compliance at Old R at Rock Sl by about 8%-10%

### 150 mg/l Chloride Standard Violations Old River at Rock Slough

Year	Yr. Type	Min Days Cl ≤ 150 mg/l	Base	1ft SLR same Martinez EC	1ft SLR increase Martinez EC
1976	Critical	155	177	126	118
1977	Critical	155	161	102	94
1989	Dry	165	184	166	162

### Average Chloride Mass Loadings 1ft SLR, metric tons/day

	CCC	SWP	CVP
Base	54	711	686
1ft SLR	61	786	734
GFDL A2	62	718	695
PCM A2	62	740	710
GFDL B1	63	744	735
PCM B1	61	758	736

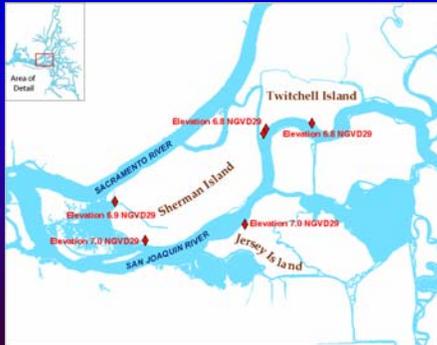
Increased salinity intrusion increases chloride mass loadings

## Climate Change and 1ft Sea Level Rise

Results are similar to those for sea level rise only



## Minimum Levee Crest Elevations



## Levee Overtopping Potential

Location	Min Crest Elev., ft	# of Potential Overtopping Events in 16 yrs			
		Base	4 Climate Change Scenarios	1 ft SLR	4 Climate Change Scenarios 1ft SLR
NW Sherman Is	6.9	0	0	2	2
SW Sherman Is	7.0	0	0	2	2
SW Twitchell Is	6.8	0	0	2	2
SE Twitchell Is	6.8	0	0	2	2
W Jersey Is	7.0	0	0	2	2

Climate change scenarios reflect historical variability

## Summary of Climate Change Impacts on the Delta

- Existing system flexibility adapted to shifts in runoff with water quality standard compliance similar to the base case
- Without adjusting system operations, a 1ft increase in sea level increased chloride violations at Rock SI by about 10%
- A 1ft sea level rise lead to two potential levee overtopping events in 16-years

## Future Directions

- Investigate mitigation measures including further system operational flexibility, especially for SLR
- Characterize salinity intrusion for SLR
  - Develop relationship for models, e.g. ANN, G-model
  - DSM2 boundary condition at Martinez
  - Delta WQ standards in CALSIM
- Extend impacts assessments to risk assessments  
*What is the likelihood that climate change and/or sea level rise scenarios will happen?*

[www.climatechange.ca.gov](http://www.climatechange.ca.gov)

Photo by Ralph Finch Jan 4, 2006