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

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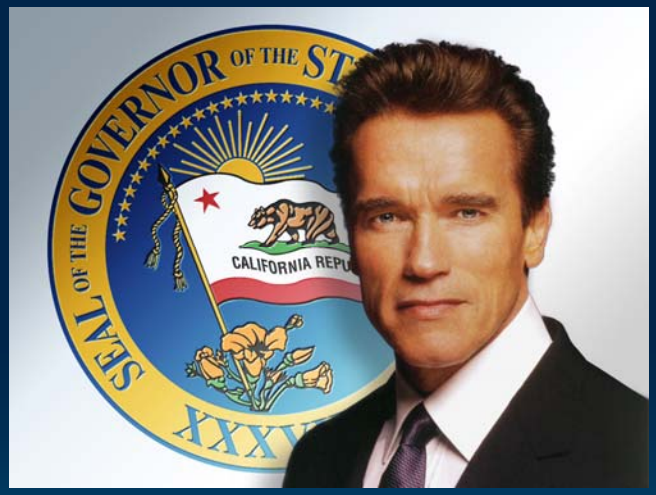
IEP-CWEMF Joint Modeling Session

March 1, 2006

Modeling Support Branch
Bay Delta Office

Governor Arnold Schwarzenegger on Global Warming…….



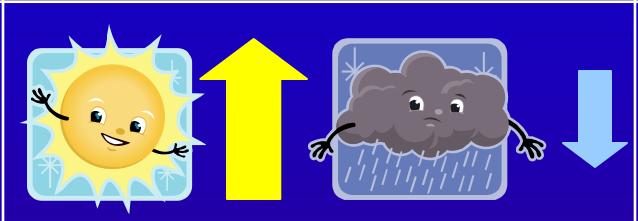
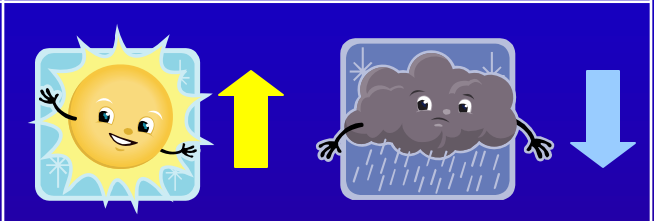
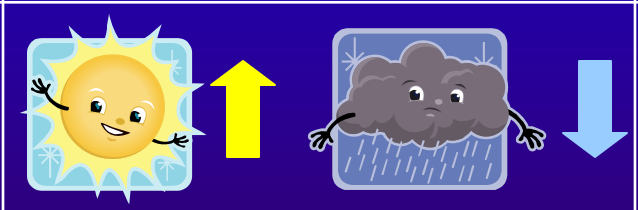
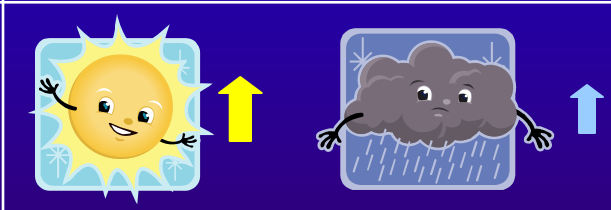
“ I say the debate is over. We know the science. We see the threat. And we know the time for action is now.”

United Nations World Environment Day Conference, June 1,2005, San Francisco

Governor's Executive Order

- EO S-3-05 June 1, 2005
- Targets to reduce emission levels of Green House Gases
- Biennial reports starting Jan06
  - Water supply
  - Public health
  - Agriculture
  - CA coastline
  - Forestry
- Formed Climate Action Team

Precipitation and Air Temperature Projections

Scenario/ Model	A2	B1
GFDL		
PCM		

Climate Action Team selected four scenarios

2 models x 2 emissions scenarios

Climate Change Work Team

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Sanjaya Seneviratne

Francis Chung

Levi Brekke

Messele Ejeta

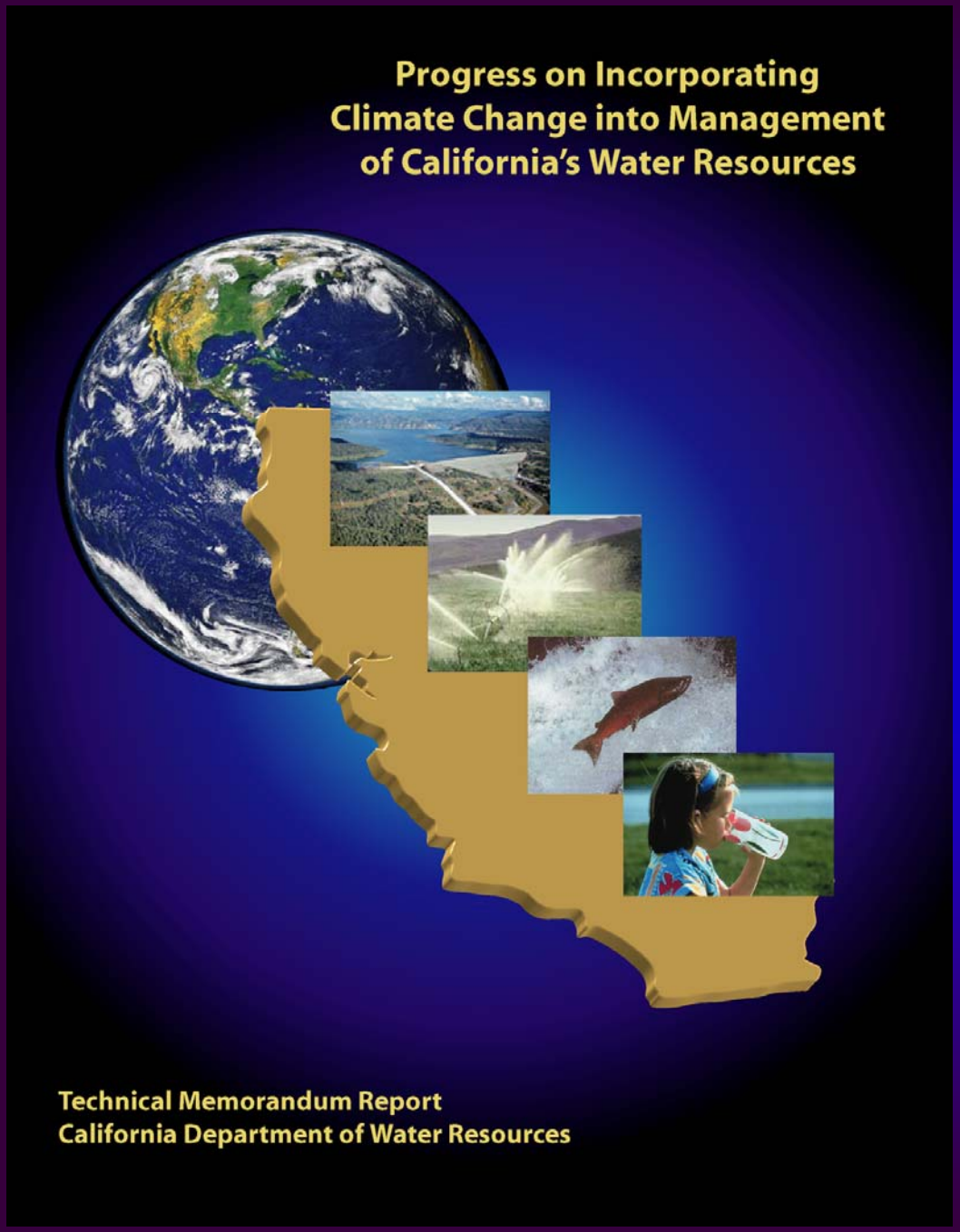
Dan Easton

Hongbing Yin

Mike Floyd

Roy Peterson

Mike Anderson



CH1 Introduction

CH2 Background

CH3 DWR Studies

CH4 SWP-CVP Impacts

CH5 Delta Impacts

CH6 Flood Management

CH7 Evapotranspiration

CH8 Future Directions

Peer reviewed chapters

Analysis Process

Global Modeling	Regional Downscaling	SWP & CVP Operations	Delta Flow & Water Quality
GFDL or PCM	VIC	CALSIM	DSM2
Air Temperature Precipitation Humidity Radiation	Streamflow Snowpack Snow melt Soil Moisture	Reservoir Ops Deliveries Storage Delta Outflow	Flow Salinity

Conducted by work team

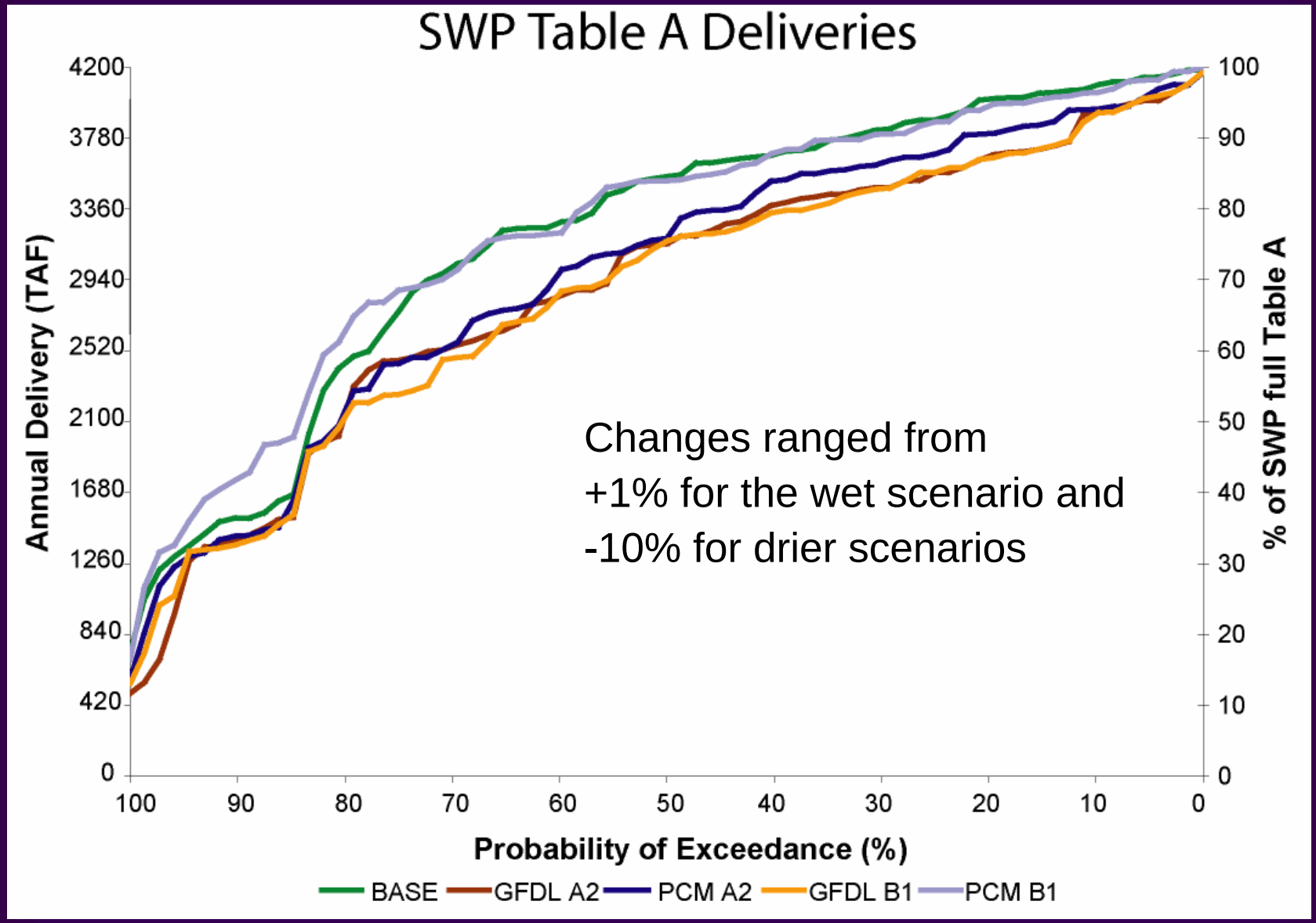
SWP and CVP Operations

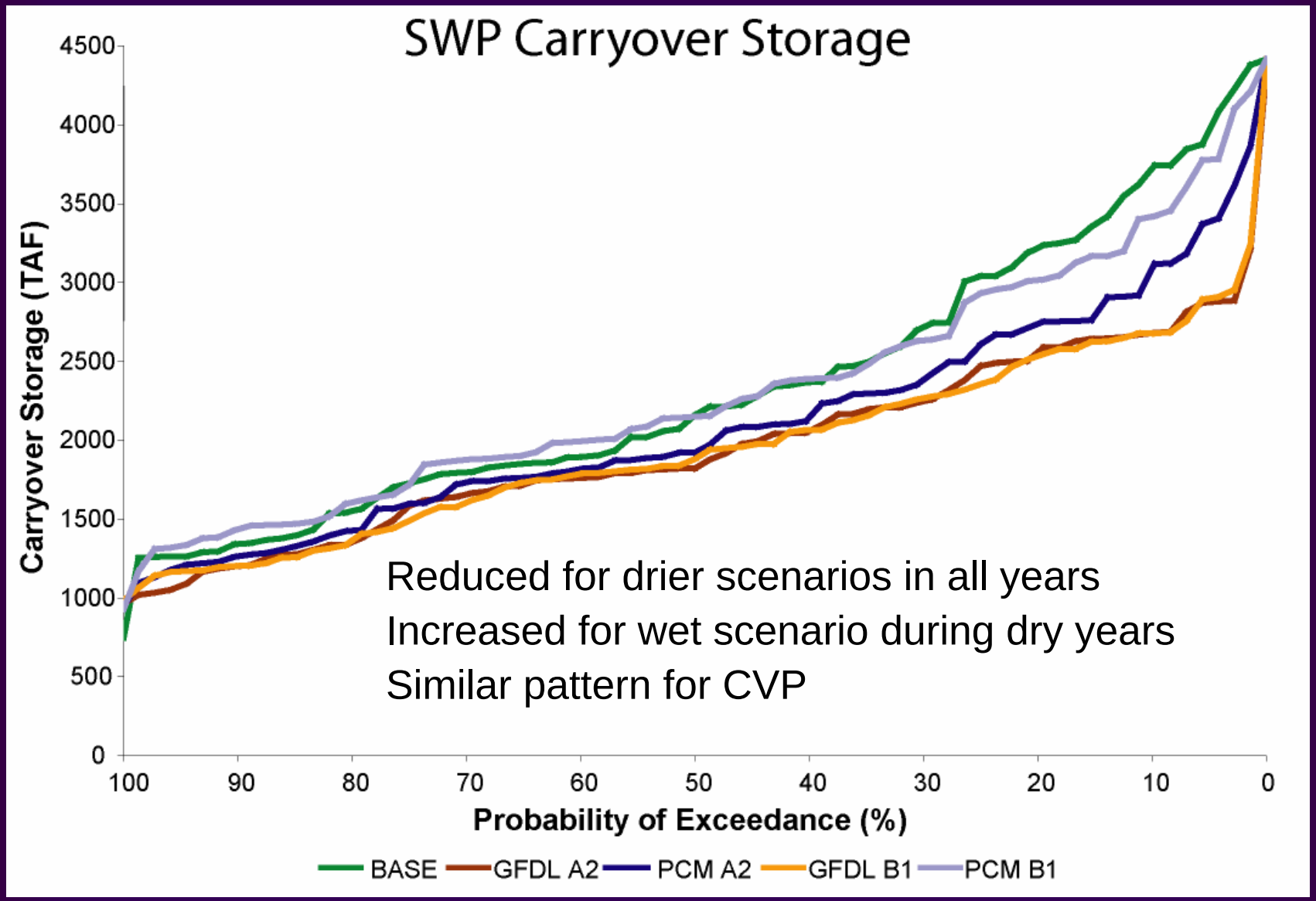
Preliminary Impacts to SWP and CVP Operations

- Use CalSim-II model
- 2050 projections of runoff into reservoirs
- 2020 estimates of land use
- Modify historical reservoir inflows to reflect climate change
- Use current operating rules
- No operation changes for sea level rise

Preliminary Results

- CVP reservoir shortages during droughts; Modified operations may be required
- Stream temperature changes were similar to air temperature changes
- Power generation was negatively impacted in drier scenarios


SWP Table A Deliveries
Annual Delivery (TAF)
4200
3780
3360
2940
2520
2100
1680
1260
840
420
0
% of SWP full Table A
100
90
80
70
60
50
40
30
20
10
0
Probability of Exceedance (%)
Changes ranged from
+1% for the wet scenario and
-10% for drier scenarios
BASE
GFDL A2
PCM A2
GFDL B1
PCM B1


SWP Carryover Storage
Carryover Storage (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
100
90
80
70
60
50
40
30
20
10
0
Probability of Exceedance (%)
BASE
GFDL A2
PCM A2
GFDL B1
PCM B1
Reduced for drier scenarios in all years
Increased for wet scenario during dry years
Similar pattern for CVP

Delta Water Quality

Delta Simulations

- Base case and 4 climate change scenarios
  - Present sea level
  - 1ft sea level rise
- Inflows and exports provided by CalSim-II
  - 2020 level of land use
  - 2050 projected runoff
  - No operations changes for sea level rise

Chloride Standard Compliance

Compliance with 250 mg/l Chloride Standard at Old R at Rock Sl

Scenario	BASE	1ft SLR	GFDL A2	PCM A2	GFDL B1	PCM B1
Present sea level	97.2%	-	98.0%	98.0%	98.2%	97.4%
1-ft sea level rise	97.2%	89.9%	89.6%	90.3%	90.1%	90.9%

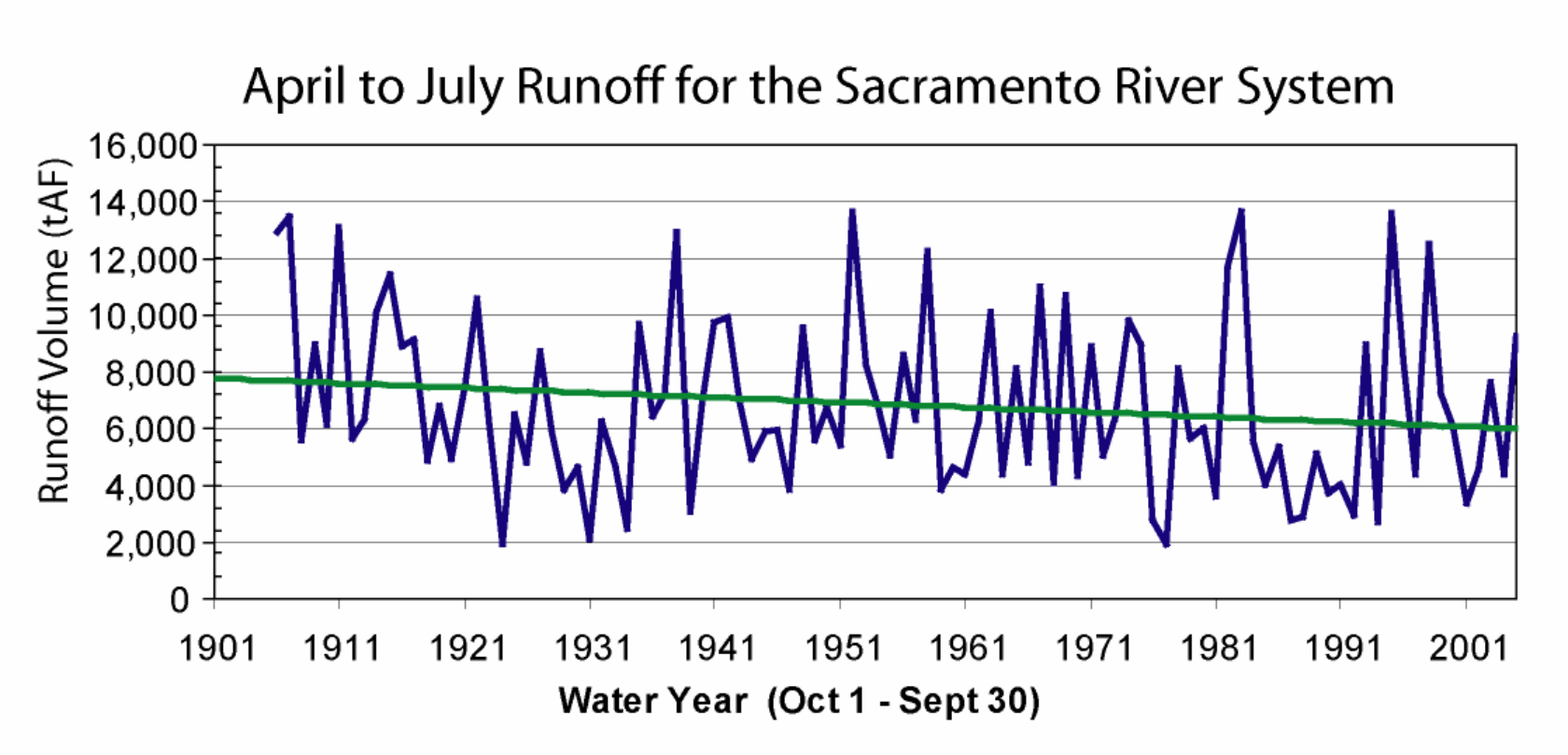
- 100% compliance at SWP and CVP intakes for all scenarios
- Operations changes for climate change maintain similar compliance to base case
- A 1-ft sea level rise with no changes in operations increases violations at Old River at Rock Slough by ~8%

Flood Management

Climate Change in Field Data

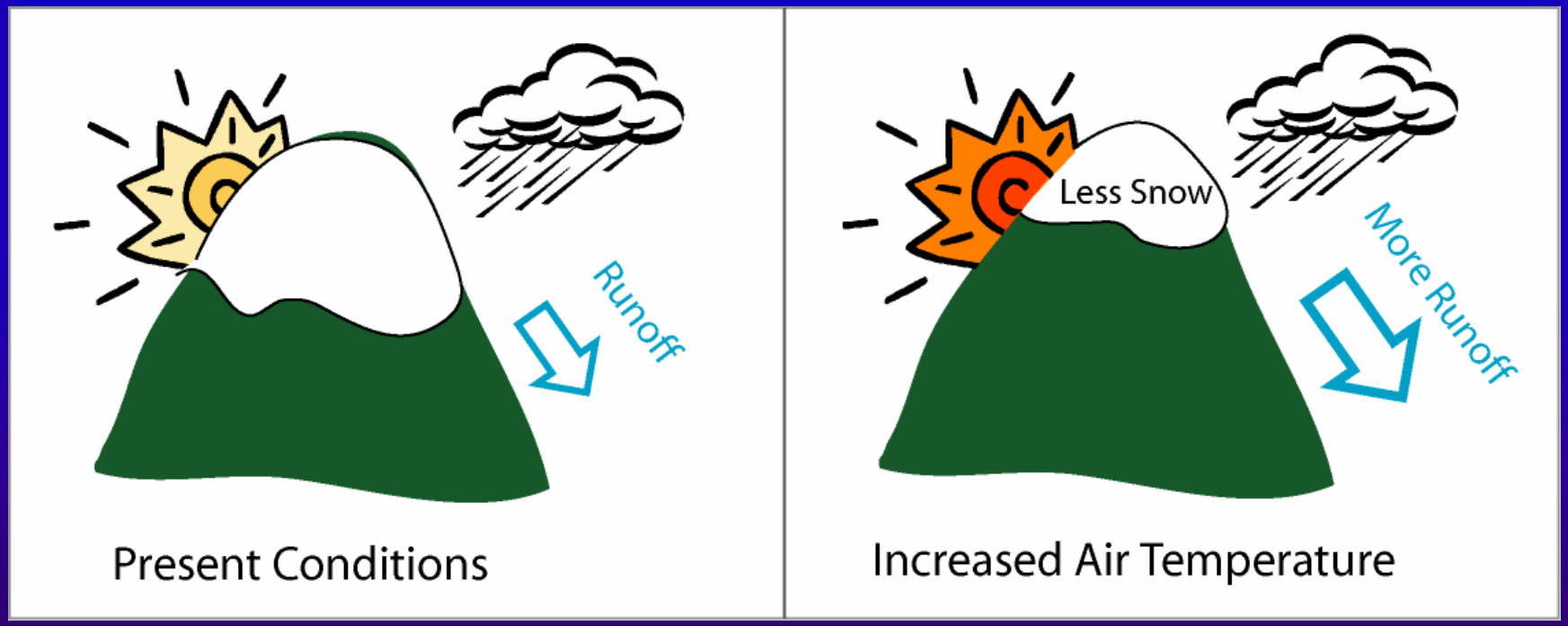
- Increasing air temperatures
- Precipitation
  - Increasing in northern CA
  - Decreasing in southern CA
  - Increasing inter-annual variablity
- Flood peaks increasing in mean and variance

Observed Changes in Runoff



- Runoff increasing in winter (Oct-Mar)
- Runoff decreasing in spring/summer (Apr-Jul)

Climate Change Impacts on Snowpack and Runoff



Future Climate Change and Flood Management

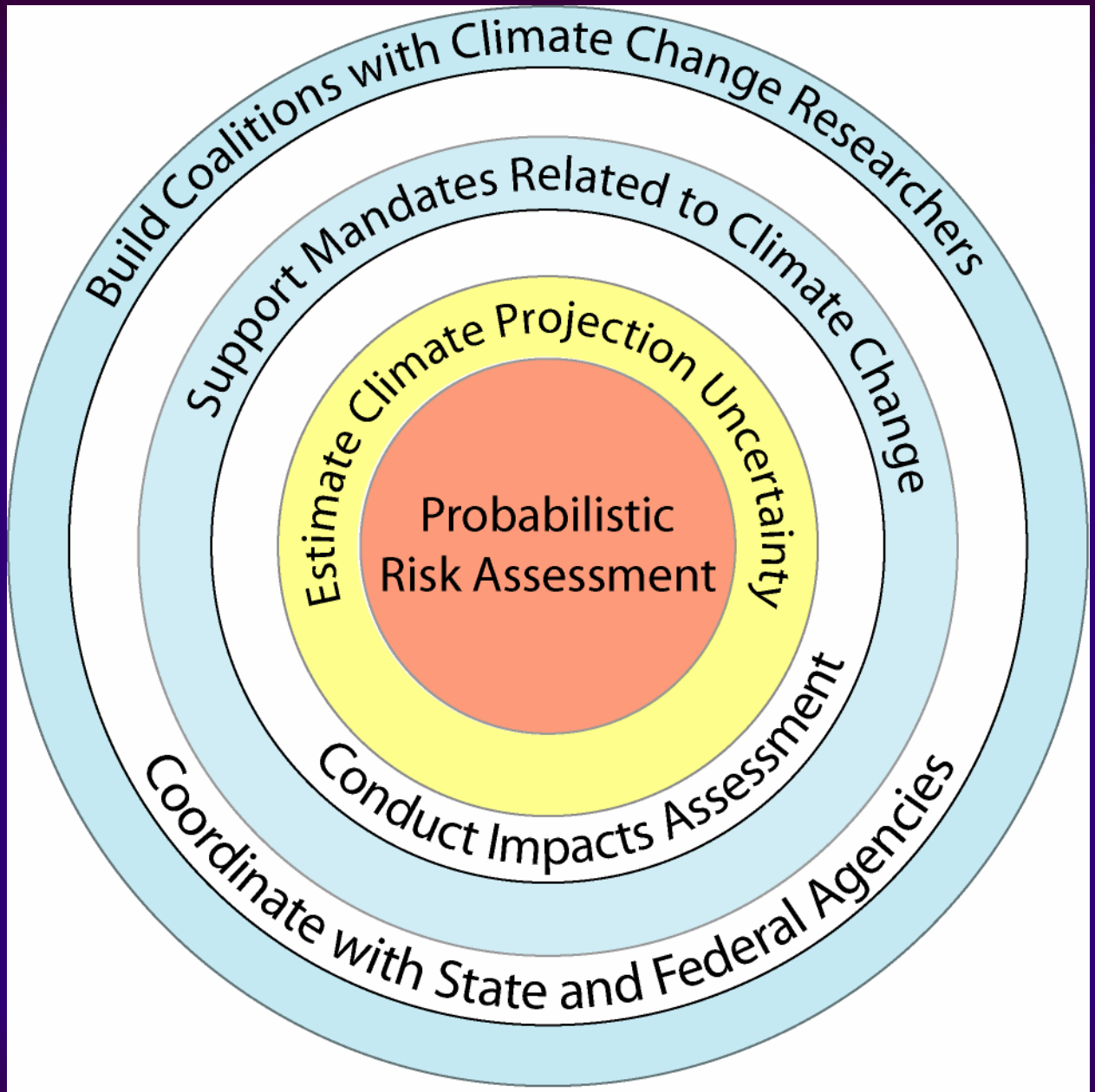
- Projections are for long term averages
- Individual weather events may vary greatly
- Changes in variability of extreme events are important and are not well represented in climate models

Evapotranspiration

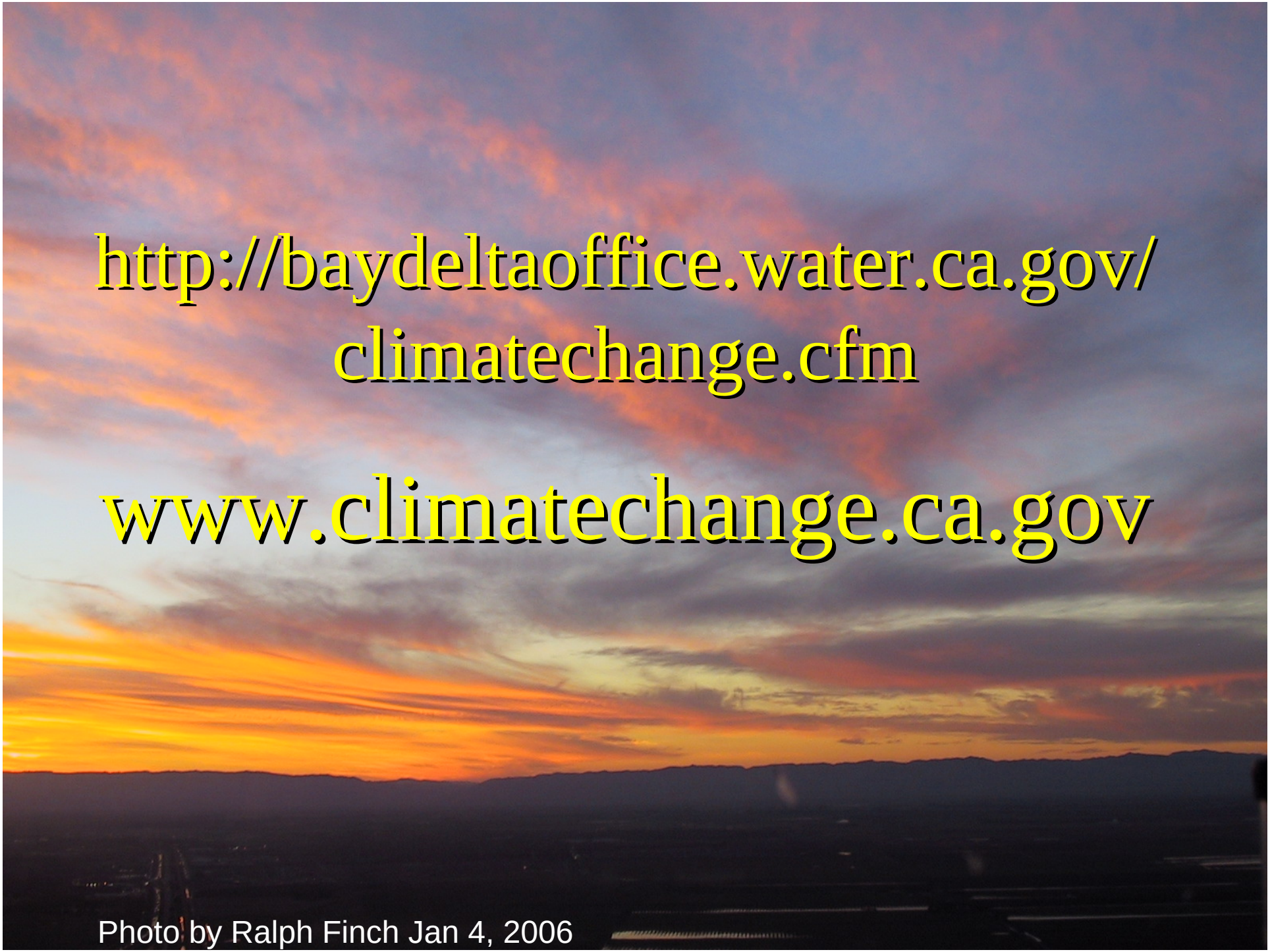
Climate Change Effects on ET

- Climate change can affect both ET processes
  - Evaporation
  - Transpiration
- + 3ºC air temperature ⇨ ET +3%-6%
  - correlates to a large volume of water statewide
- Higher water demands could be offset by increased water use efficiency

Future Directions



Climate Change Work Team Goals


http://baydeltaoffice.water.ca.gov/climatechange.cfm
www.climatechange.ca.gov
Photo by Ralph Finch Jan 4, 2006