

Uncertainties in Assessments of Climate Change impact on SWP/CVP

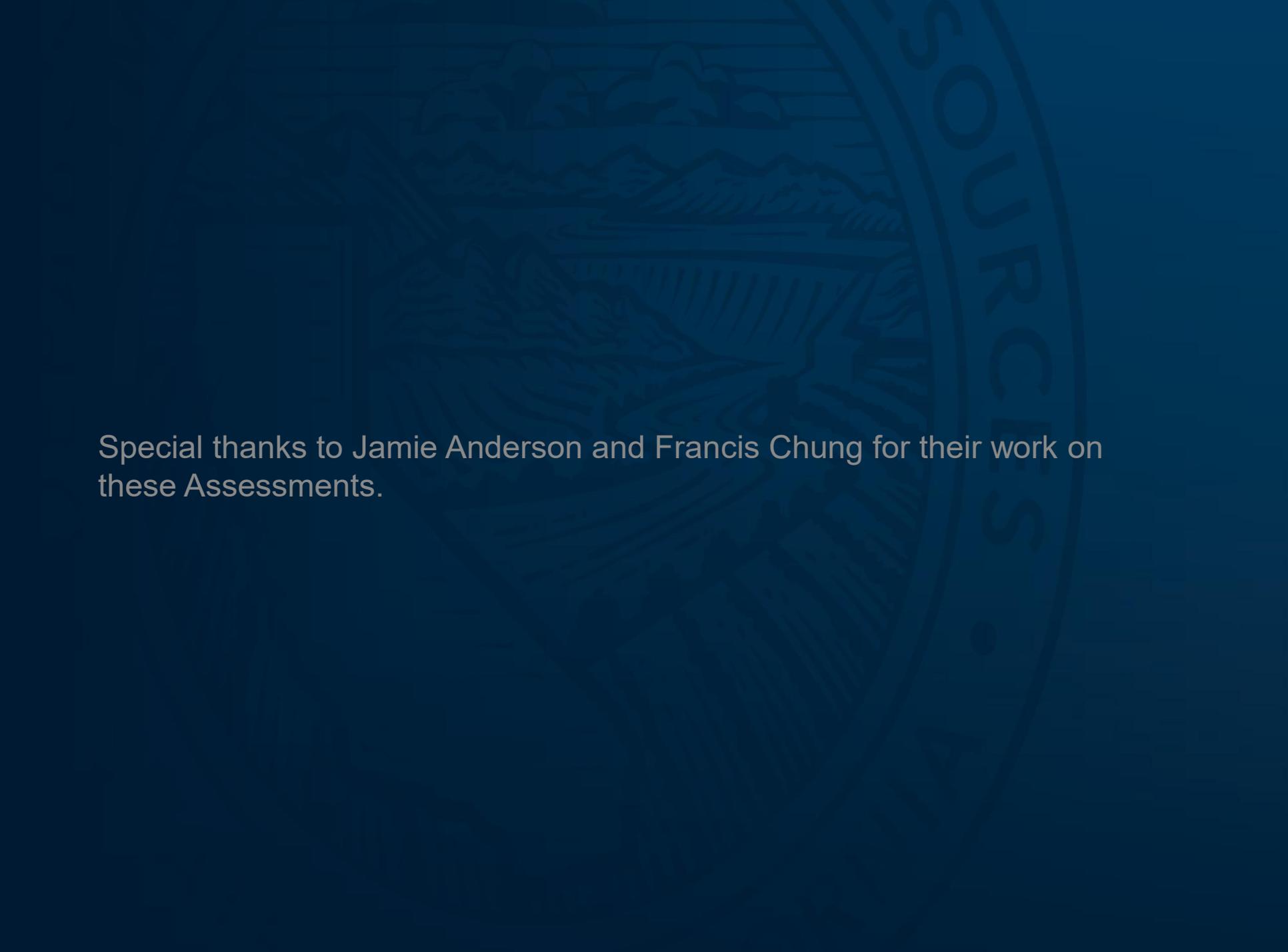
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CWEMF 2025



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Outline

- Background
- Uncertainty Sources
- GCM Projections and Emission Scenarios
- Selection and Resampling of GCM Projections
- Downscaling of GCMs: Dynamic vs Statistical
- Transferring of GCM's CC Signal into CalSim3: Flow
- Transferring of GCM's CC Signal into CalSim3: Demand
- Transferring of GCM's CC Signal into CalSim3: SLR ANN
- Strategy for Reducing Uncertainties

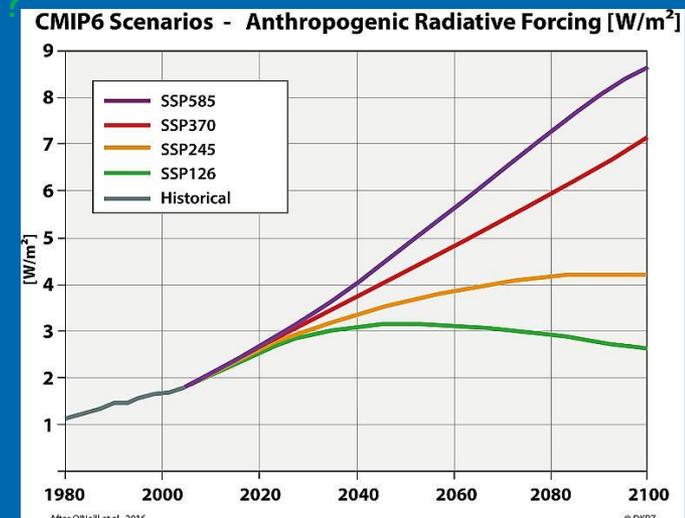
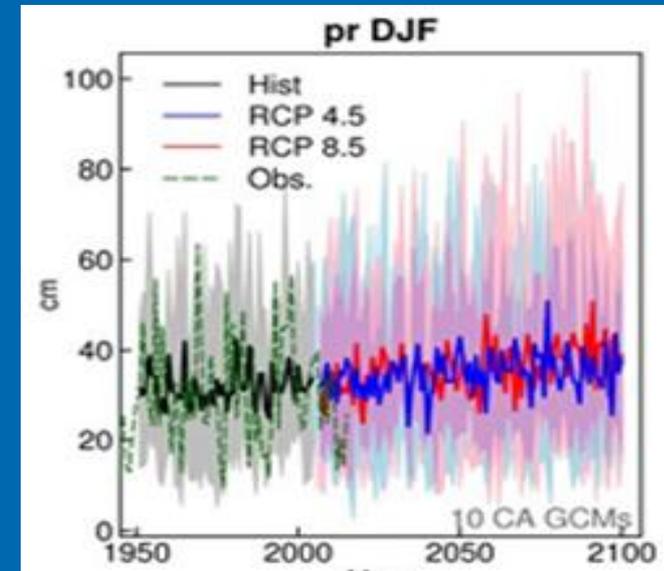
Background

- First, Second, and Fourth California Climate Change Assessment from MSO (former BDO) & DCR Report
 - 2006: Progress on Incorporating Climate Change into Management of California's Water Resources.
 - 2009: Using Future Climate Projections to Support Water Resources Decision Making in California.
 - 2018: Mean and Extreme Climate Change Impacts on the State Water Project
 - 2024: The State Water Project Delivery Capability Report 2023
- Uncertainty in Climate Change Impact on SWP/CVP

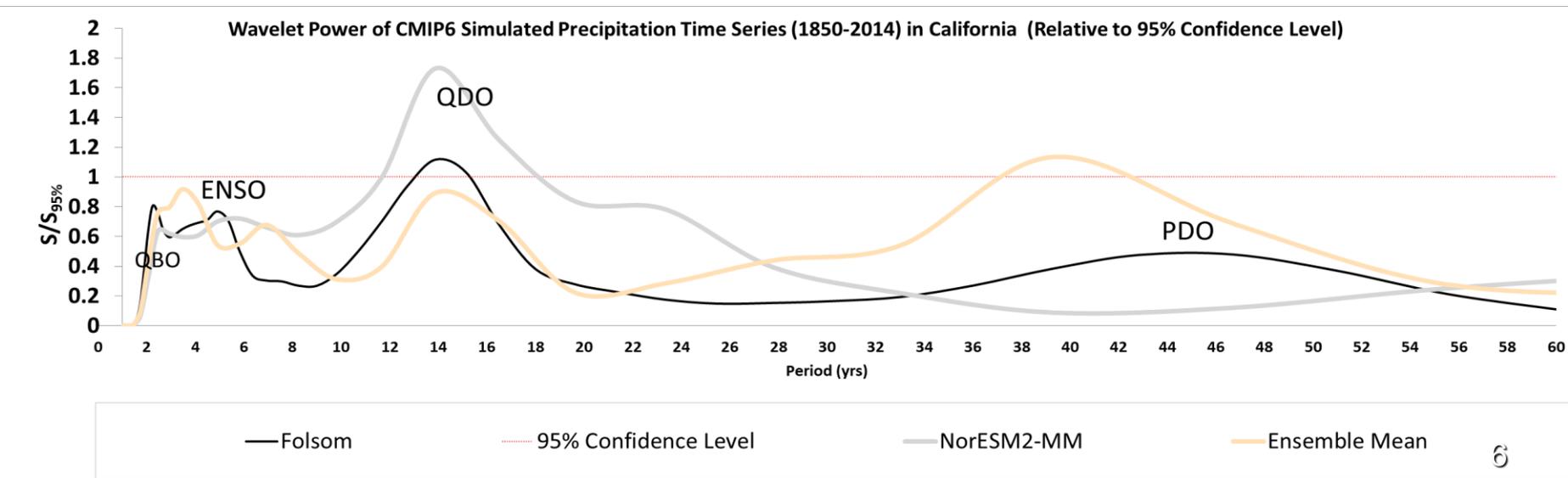
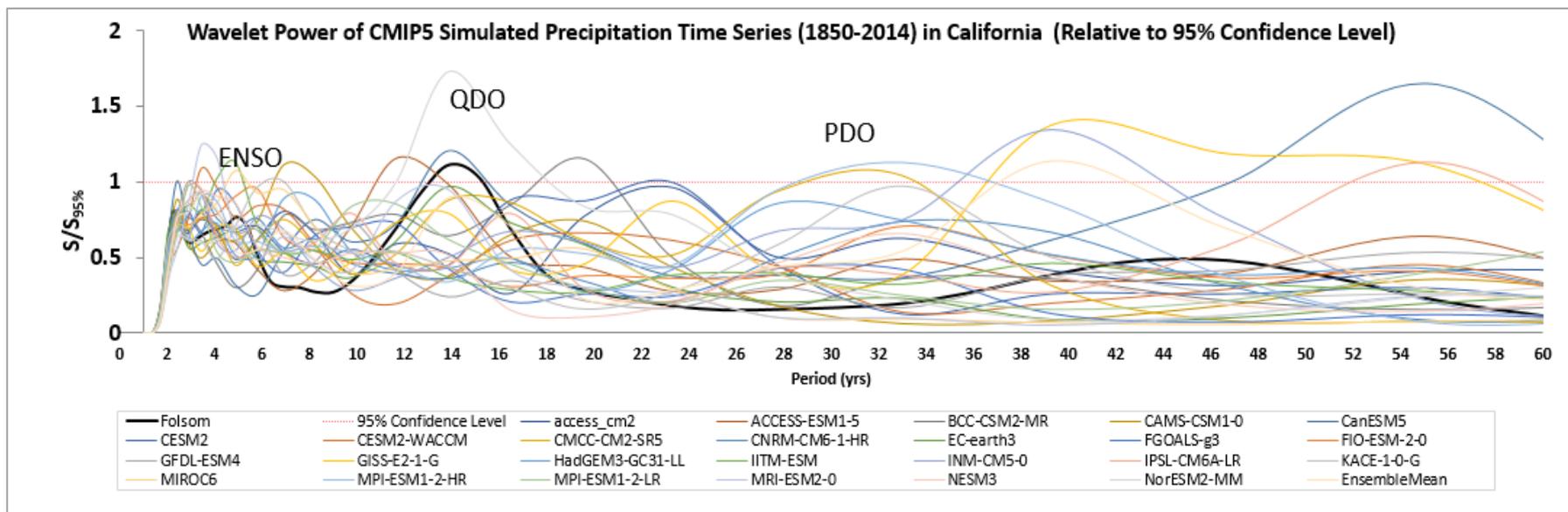
Project Year	GCM Projection	Emission Scenarios	Future Period	Down-scaling	Delta Export Change
2006	2, CMIP3	A2&B1	2050	BCSD	-15.6% & -0.5%
2009	10, CMIP3	A2&B1	2045	BCSD	-10% & -7%
2018	20, CMIP5	RCP85 & RCP45	2060	LOCA	-13% % -8%
2024	197, CMIP6	SSP245, 370, 585	2043	LOCA2	-12.7% (50% LOC)

GCM Models and Emission Scenarios

- CMIP3, CMP5 and CMP6's Projection
 - Temperature, Precipitation, Wind and Humidity
 - Interannual Variability
 - Sources of Uncertainties
 - Imperfect model physics and model grids
 - Chaotic nature of general (atmospheric) circulation
 - Emission Scenarios
 - Pessimistic (SSP585) or Optimistic (SSP126) ?
 - Strategy for reducing these uncertainties
 - Ensemble run with slightly different initial conditions vs Poorman ensemble
 - Benefit of ensemble mean method

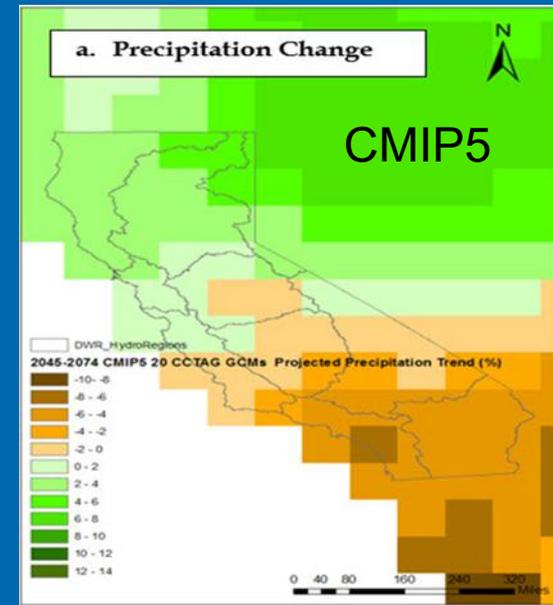
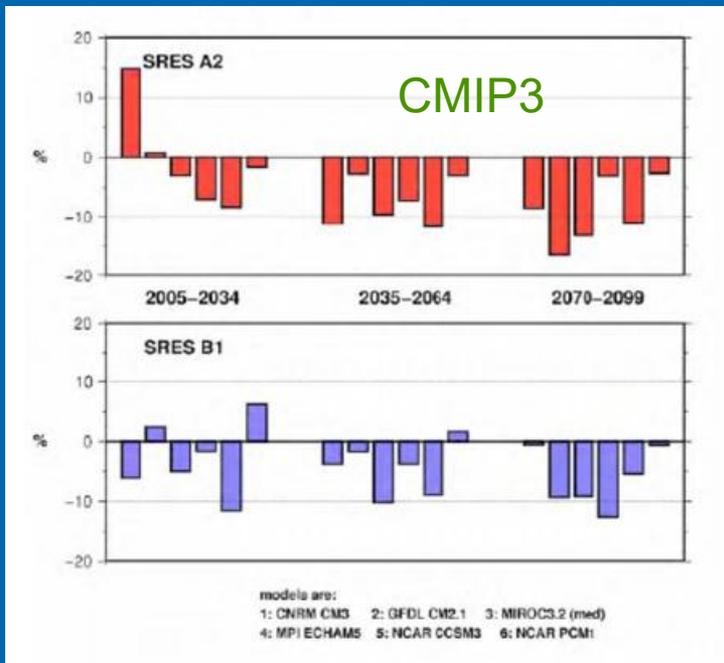


Wavelet Analysis of CMIP6 Simulated Precipitation (1850 – 2014)

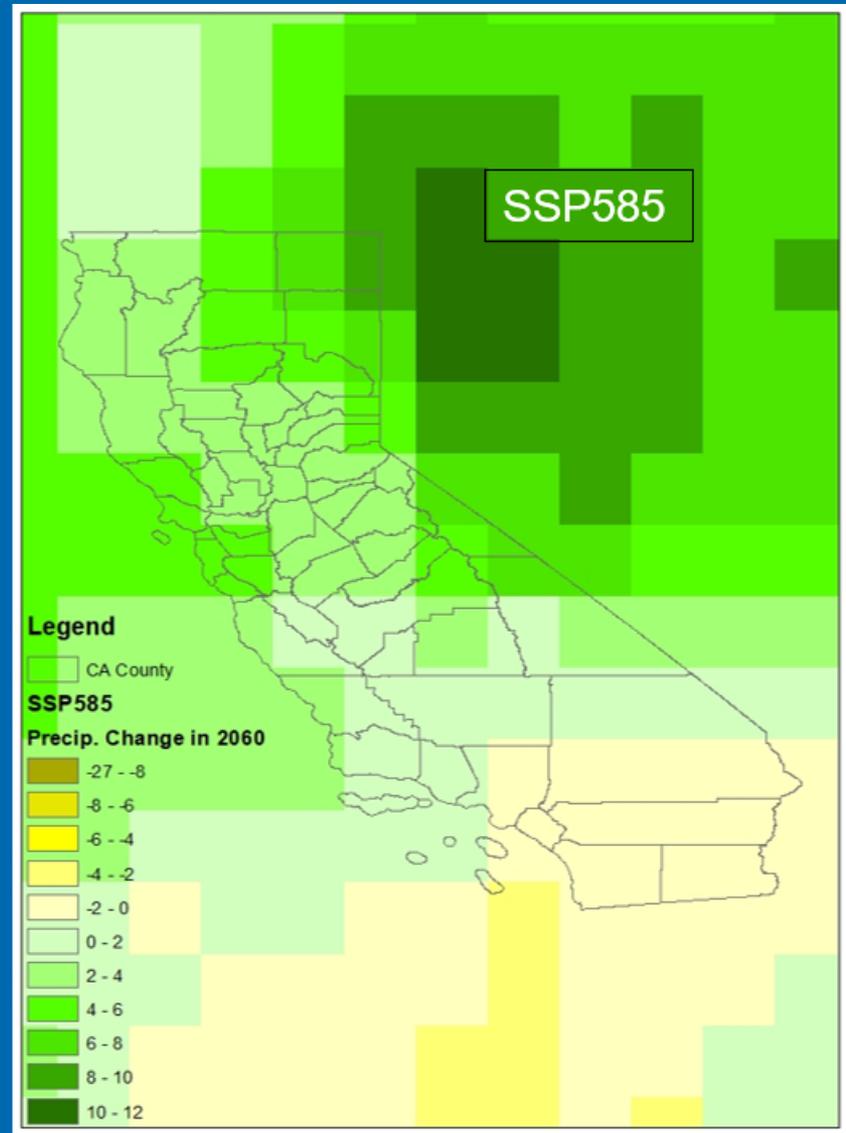
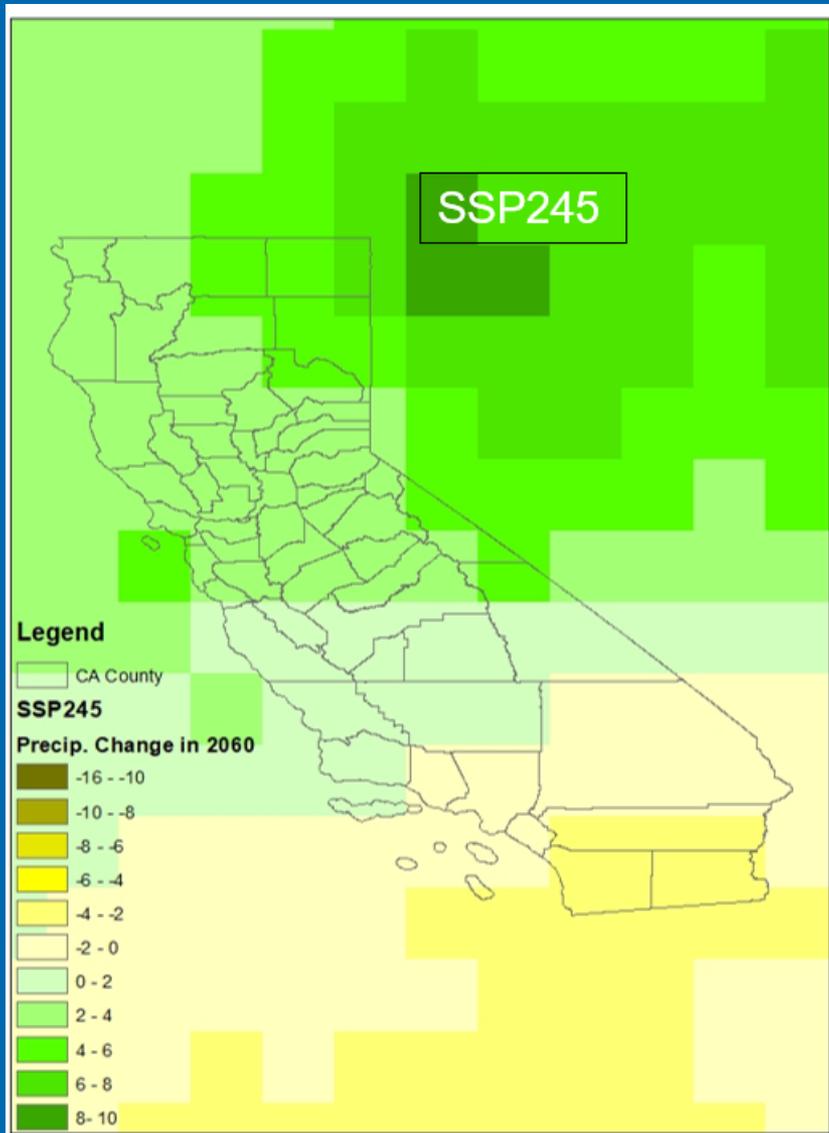


Selection of GCM Projections

- GCM Selection for the Assessments
 - CAT's selection of CMIP3 GCMs for Assessment II
 - CCTAG's Selection of CMIP5 GCMs for Assessment IV
 - Precipitation Trend of Selected GCM Projections
 - On the average, CAT's 10 CMIP3 projections tends to dry in 2045
 - CCTAG's 20 CMIP5 projections tends to wet in the future in 2060•

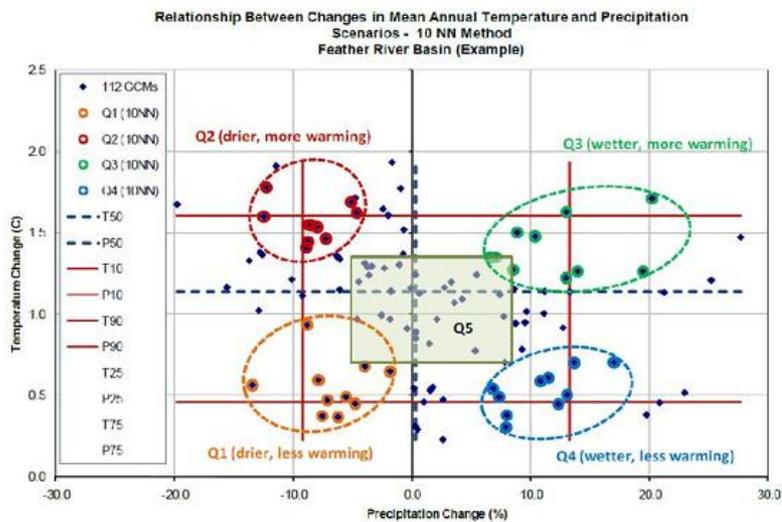


- CMIP6 Projection (Ensemble mean of 28 GCM Projections)

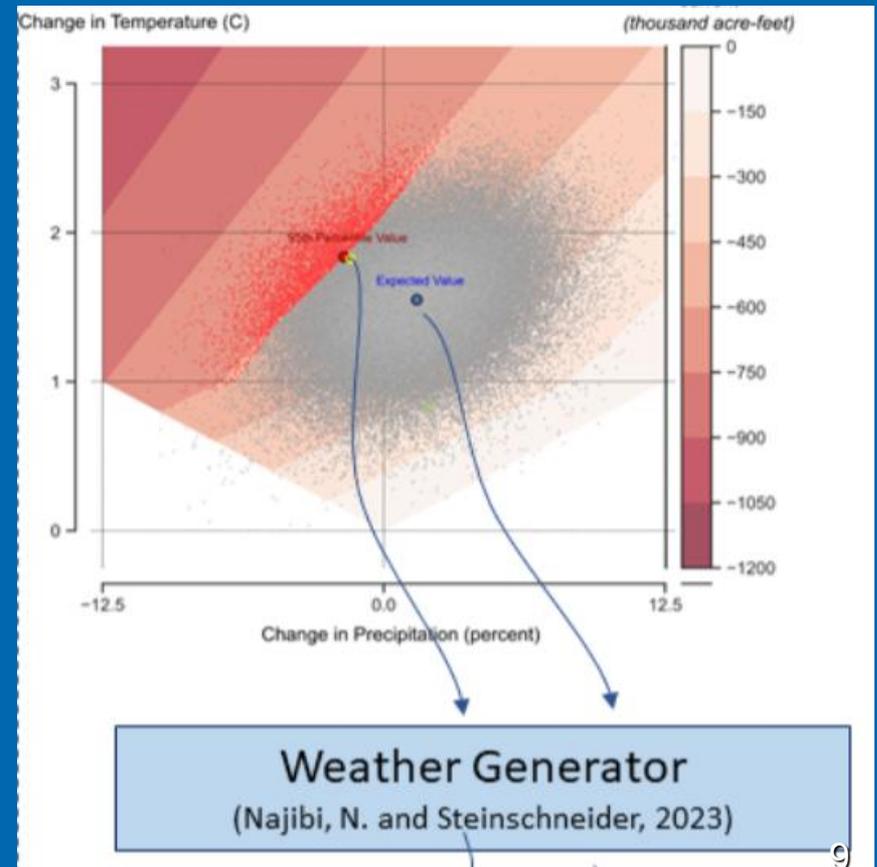


Resampling of GCM Projections

1. BR's Past Bookending Method



2. DWR's Current Risk Informed and WGEN Method



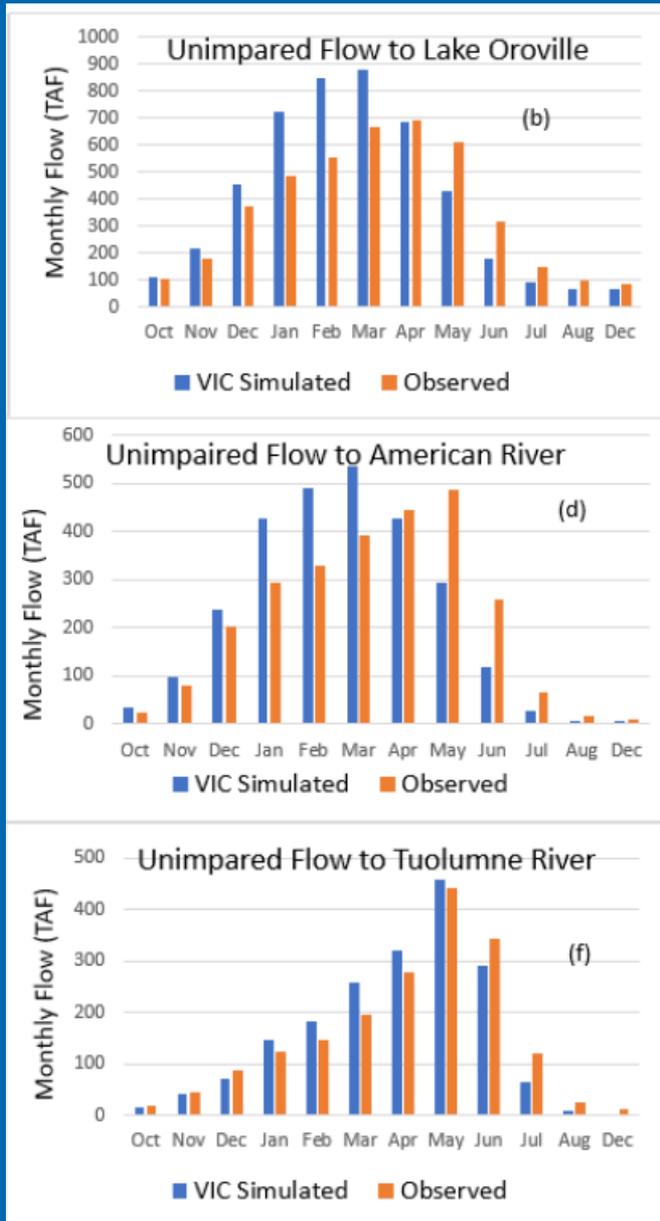
Downscaling

- Necessity for Downscaling
 - Current highest GCM models (~ 50 km) are still too coarse
 - Precipitation-runoff models need high resolution data to generate flow
 - Need bias correction
- Uncertainty in Statistical Downscaling
 - BCSD, CA, LOCA,...
 - Observed P-T interdependency is not kept well
 - Based on high resolution of historical data and have stationarity issues
 - GCM's projected trends are modified
- Uncertainty in Dynamic Downscaling
 - Regional Atmospheric Model (WRF ...)
 - GCM's projected trends are modified or even flipped

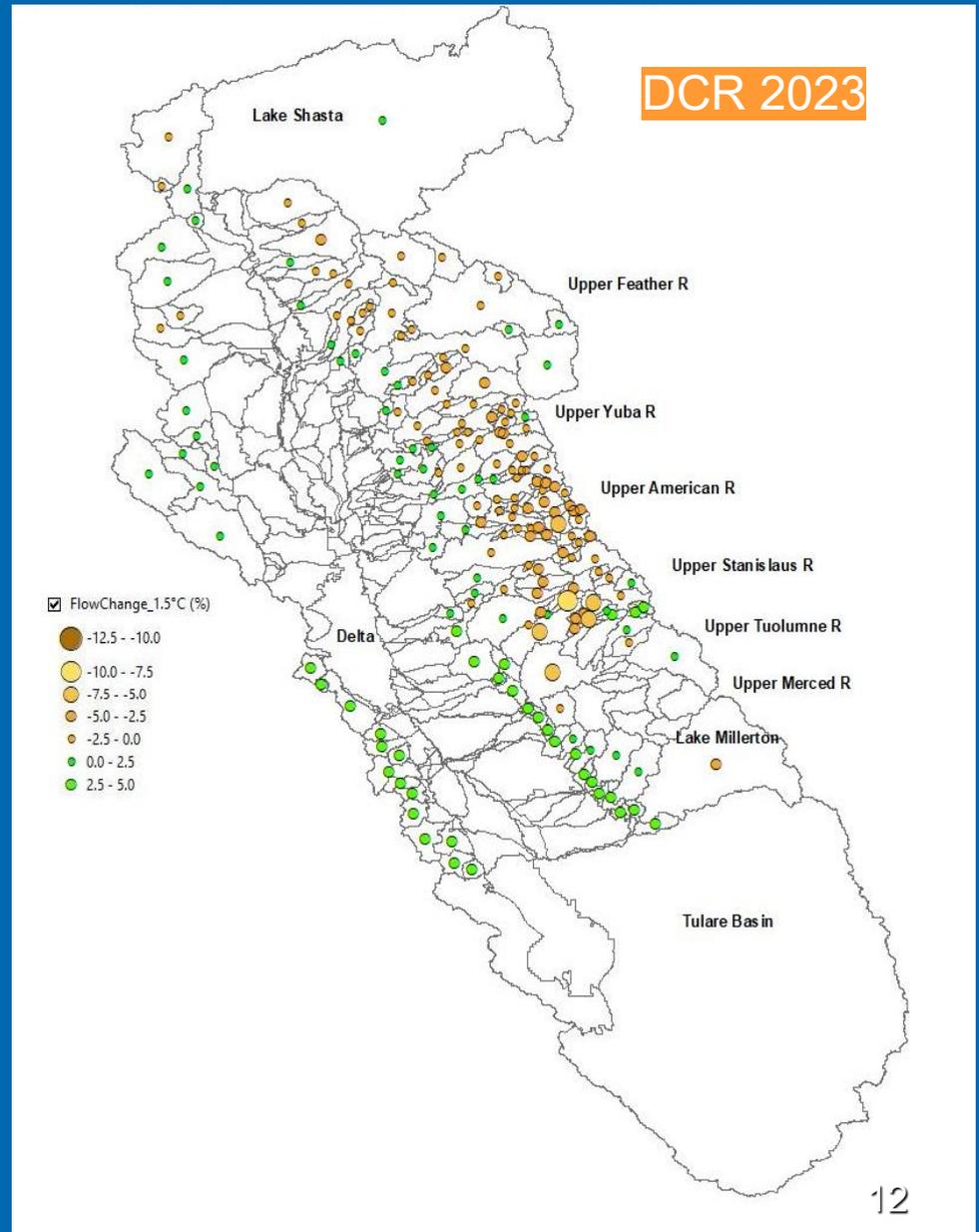
Transferring of CC Signal into CalSim: Flow

- Steps for CC signal transfer in Three Assessments
 - VIC model run to generate future flow
 - Perturbation ratio approach to perturb historical flow to have climate change flow
- Uncertainty in VIC's historical flow simulation
 - Simulated seasonal flow pattern
 - Inconsistent flow change among neighboring watersheds
- Uncertainty in Perturbation Ratio Approach
 - Perturbation Ratio could bias correct systematic errors
 - Perturbation Ratio does keep CC signal well
 - But Perturbation Ratio “creates” future flow mechanically
 - Directly use VIC flow into CalSim3 is not still mature yet

VIC Simulated Seasonal Flow Pattern

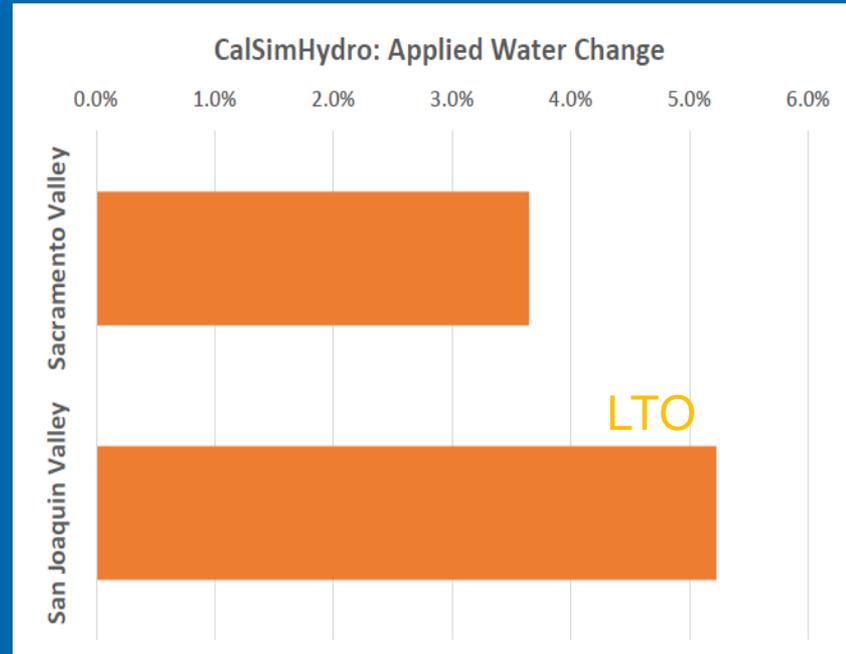
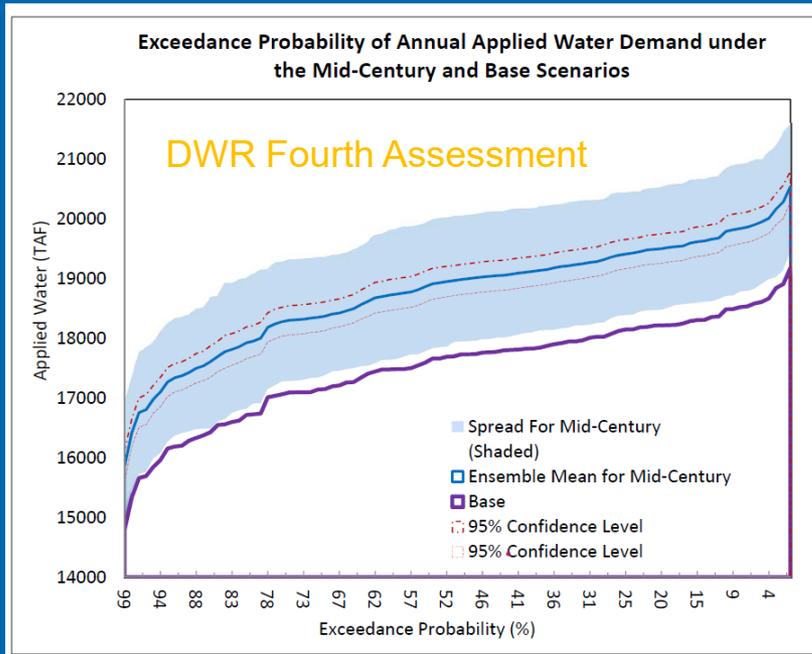


VIC Simulated Flow Change in 2043 with 1.8% Precipitation Increase



Transferring of CC Signal into CalSim: Demand

- Climate Changed (CC) Demand based on H-S or P-M eq.
 - Increase by 6.5 % in 2060 in the Fourth Assessment based on H-S
 - Increase by 4-5% in 2040 in BR's LTO study based on P-M



- But these demand all based on the increase of PET in the future. Future PET might not increase due to the wind stilling issue.

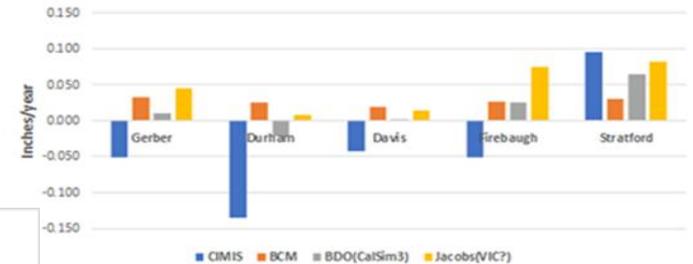
Uncertainty in CC demand

- Wind stilling issue and the use of mean daily wind in VIC
- Crop growth period assumes not changing with CC

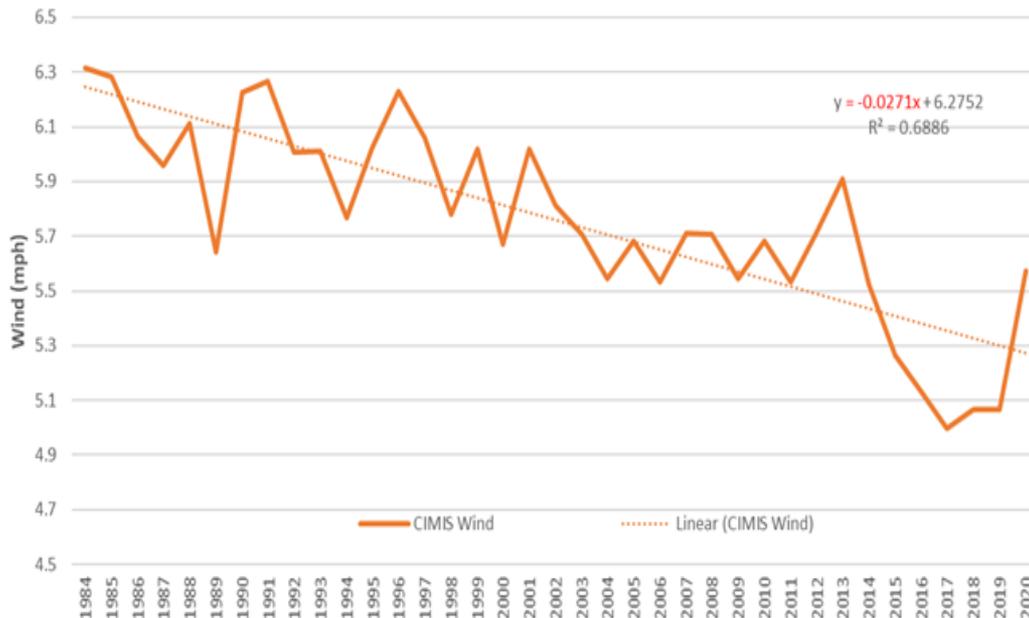
Trend from 1983 to 2020 (inches/year)

	Gerber	Durham	Davis	Firebaugh	Stratford
CIMIS	-0.052	-0.135	-0.043	-0.051	0.095
BCM	0.032	0.026	0.018	0.027	0.030
BDO(CalSim3)	0.010	-0.022	0.002	0.025	0.065
Jacobs(VIC?)	0.044	0.008	0.014	0.075	0.081

Trend from 1983 to 2020



CIMIS Wind at Davis



Transferring of CC Signal into CalSim: SLR

- Uncertainty in Projection of Global Mean SLR
 - If Global greenhouse gas emissions are not significantly reduced, GMSL is projected to rise by 0.61 to 1.10 meters by 2100 (IPCC)
 - Global SLR caused by
 - ~ Thermal Expansion
 - ~ Melting of Ice Sheets in Antarctic and Greenland
- SLR in Three Assessments
 - Assum SLR in San Francisco Bay same as global mean SLR

SLR	2006	2009	2018	2023 DCR
Mid of Century	N/A	1ft (2045)	~ 1ft (2060)	0.5 ft to 1ft (2043)
End of Century	N/A	2ft (2085)	N/A	N/A

Uncertainty in SLR Impact

- Assessment 2018 for 2060
 - Mean SLR of 1.0 ft
 - Delta export reduced by 229 TAF
- Assessment 2009 for 2045
 - SLR of 1.0 ft in 2045
 - Delta export reduced by 147 TAF (-2%)

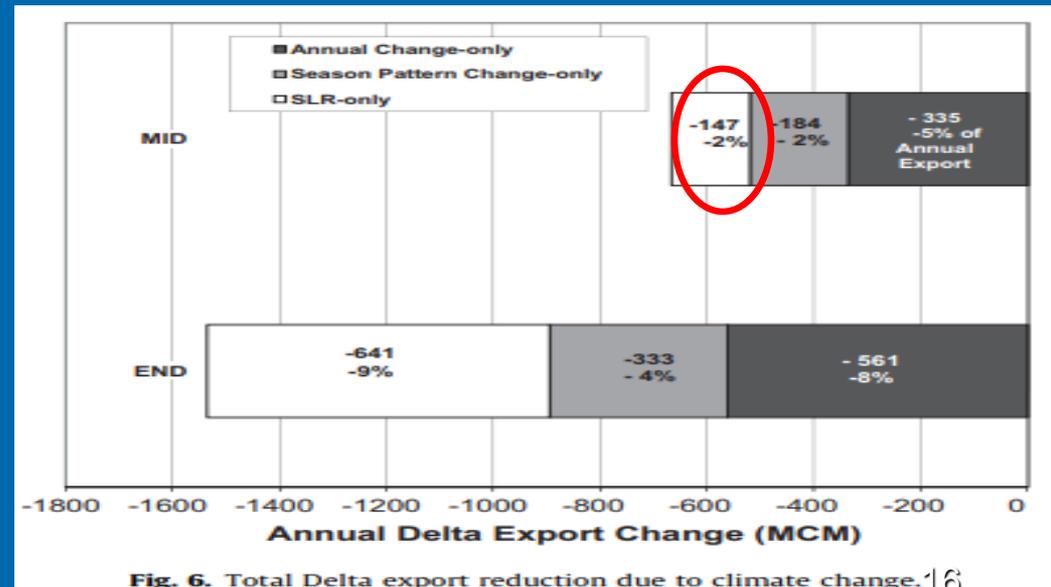
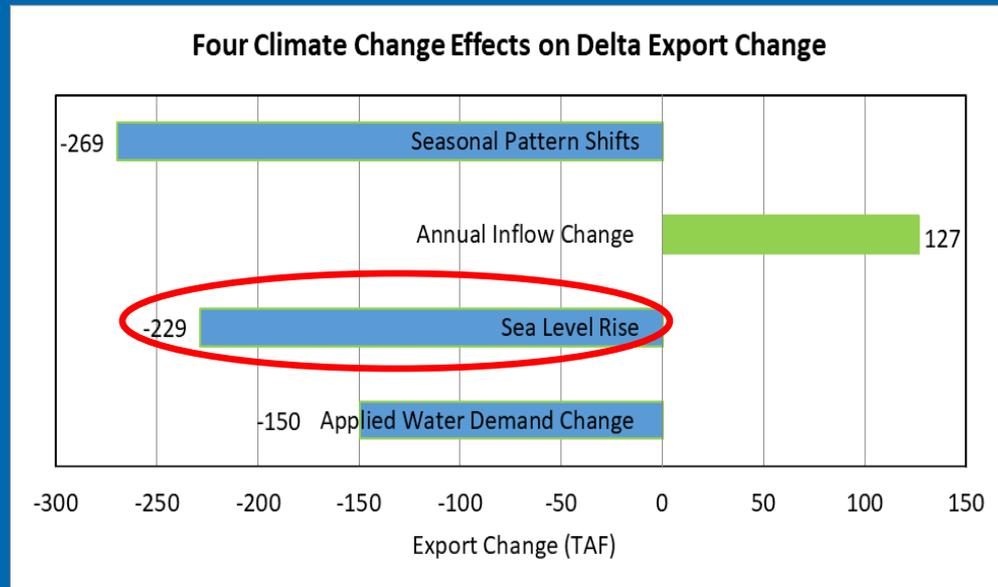


Fig. 6. Total Delta export reduction due to climate change. 16

Conclusions

- Uncertain!!!

Question?