Adaptation of the energy sector to climate variability and change using seasonal/mid-term climate forecasts

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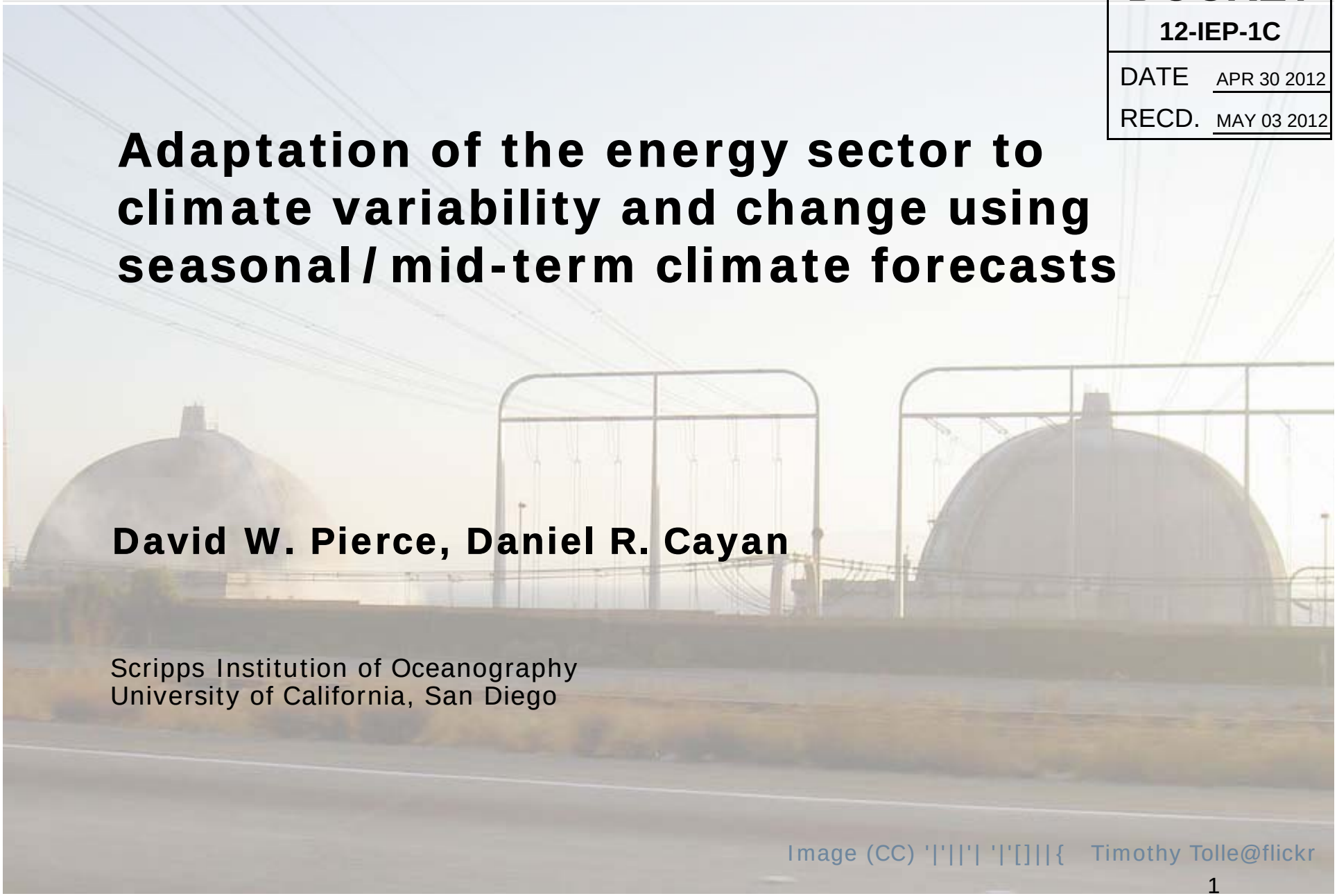

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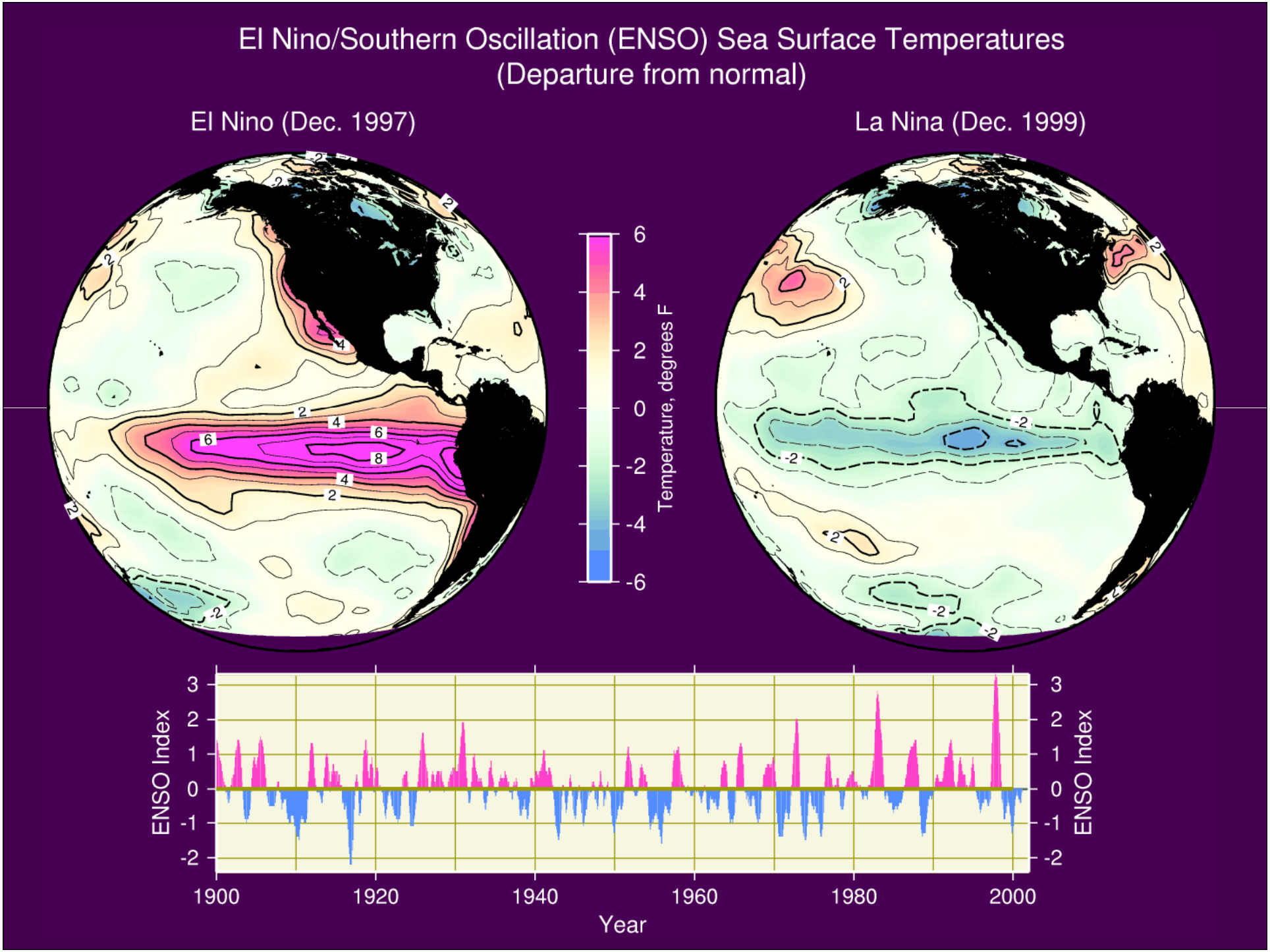
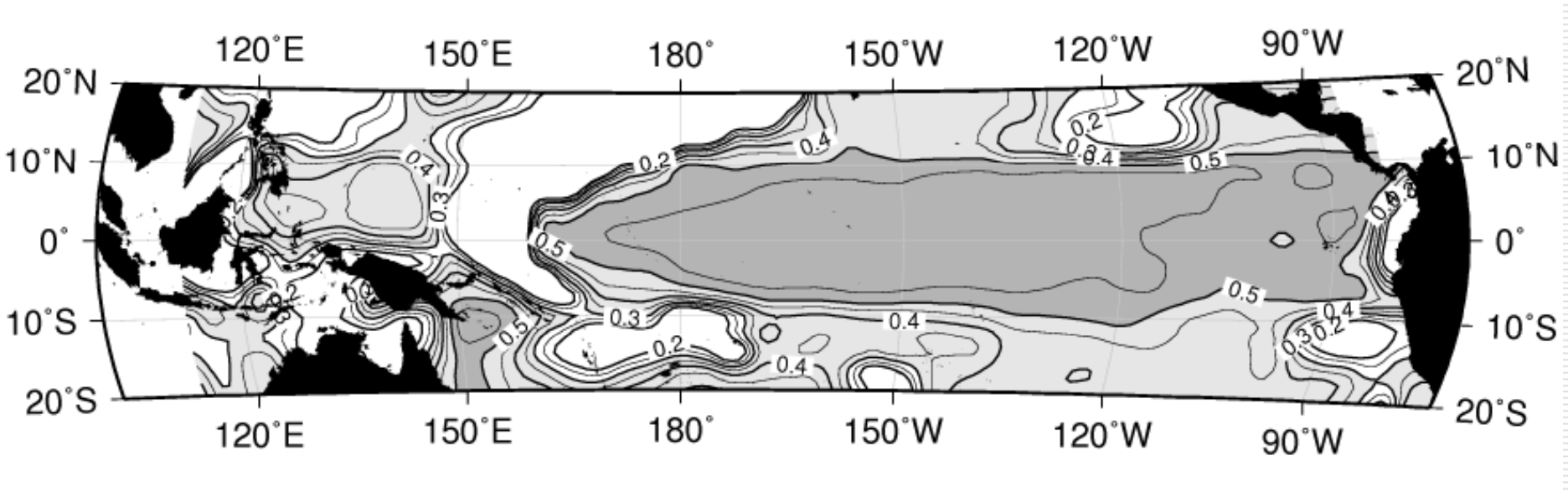

El Nino/Southern Oscillation (ENSO) Sea Surface Temperatures
(Departure from normal)
El Nino (Dec. 1997)
La Nina (Dec. 1999)
Temperature, degrees F
6
4
2
0
-2
-4
-6
ENSO Index
3
2
1
0
-1
-2
1900
1920
1940
1960
1980
2000
Year

El Nino/La Nina forecast

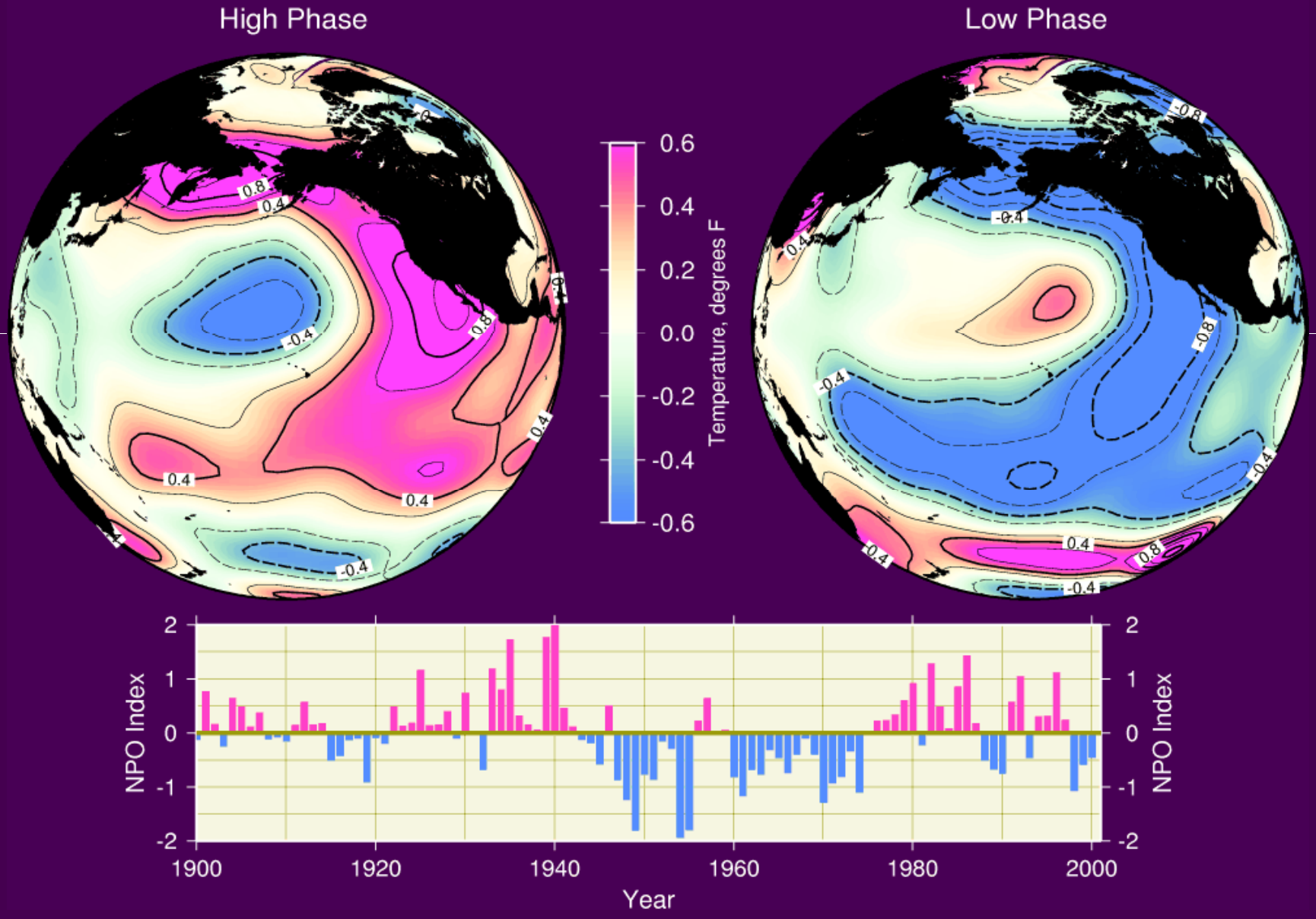
1-year lead time



Correlation, forecast to observed SST anomalies, over verification period (1965-93)

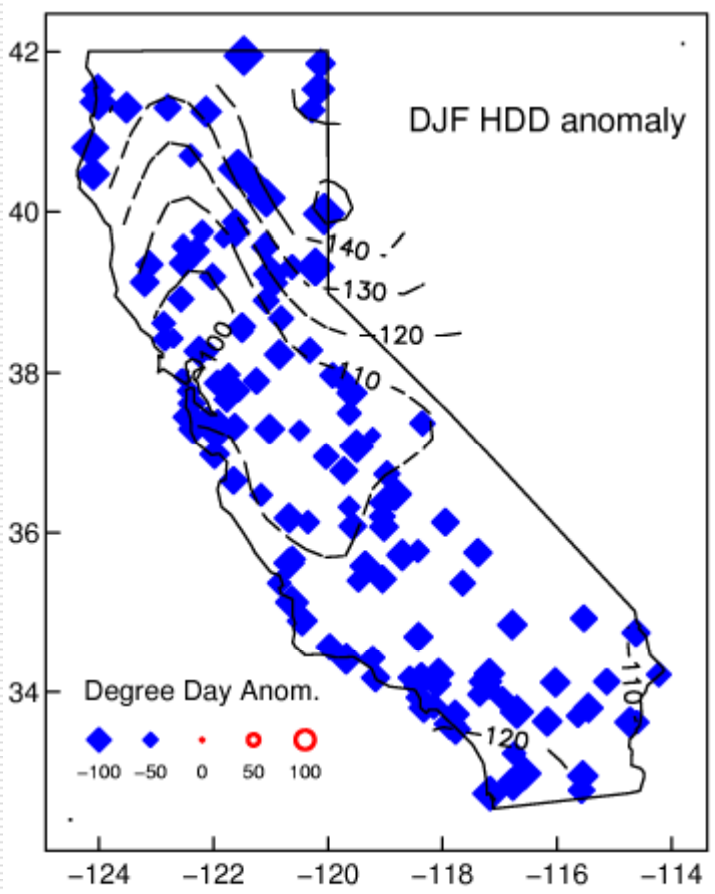
Pacific Decadal Oscillation (PDO) Sea Surface Temperatures

(Departure from normal)

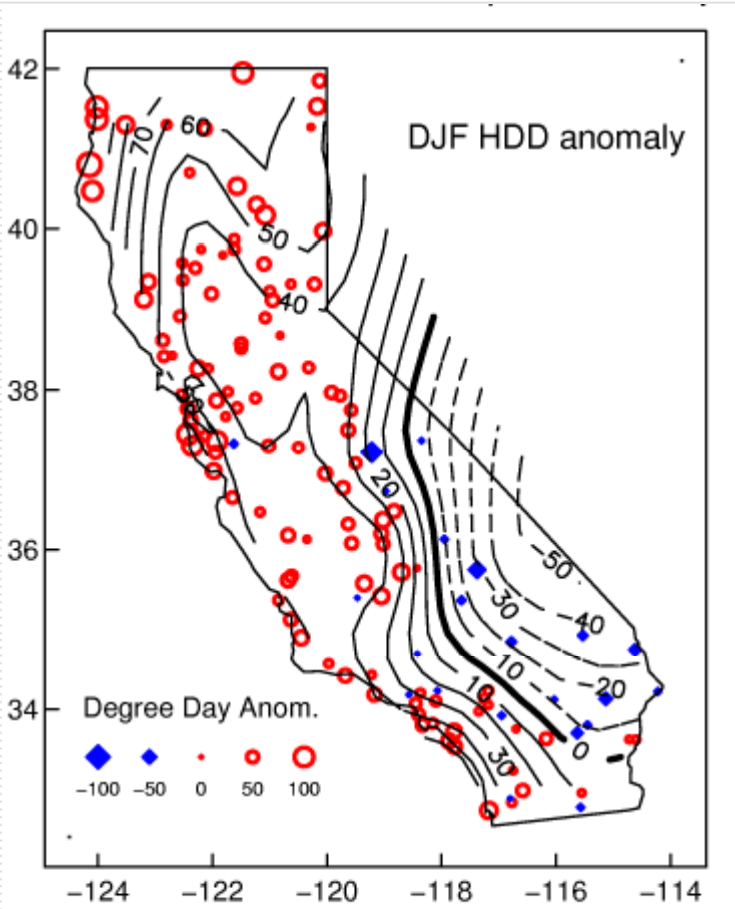


PDO and heating degree days (HDD)

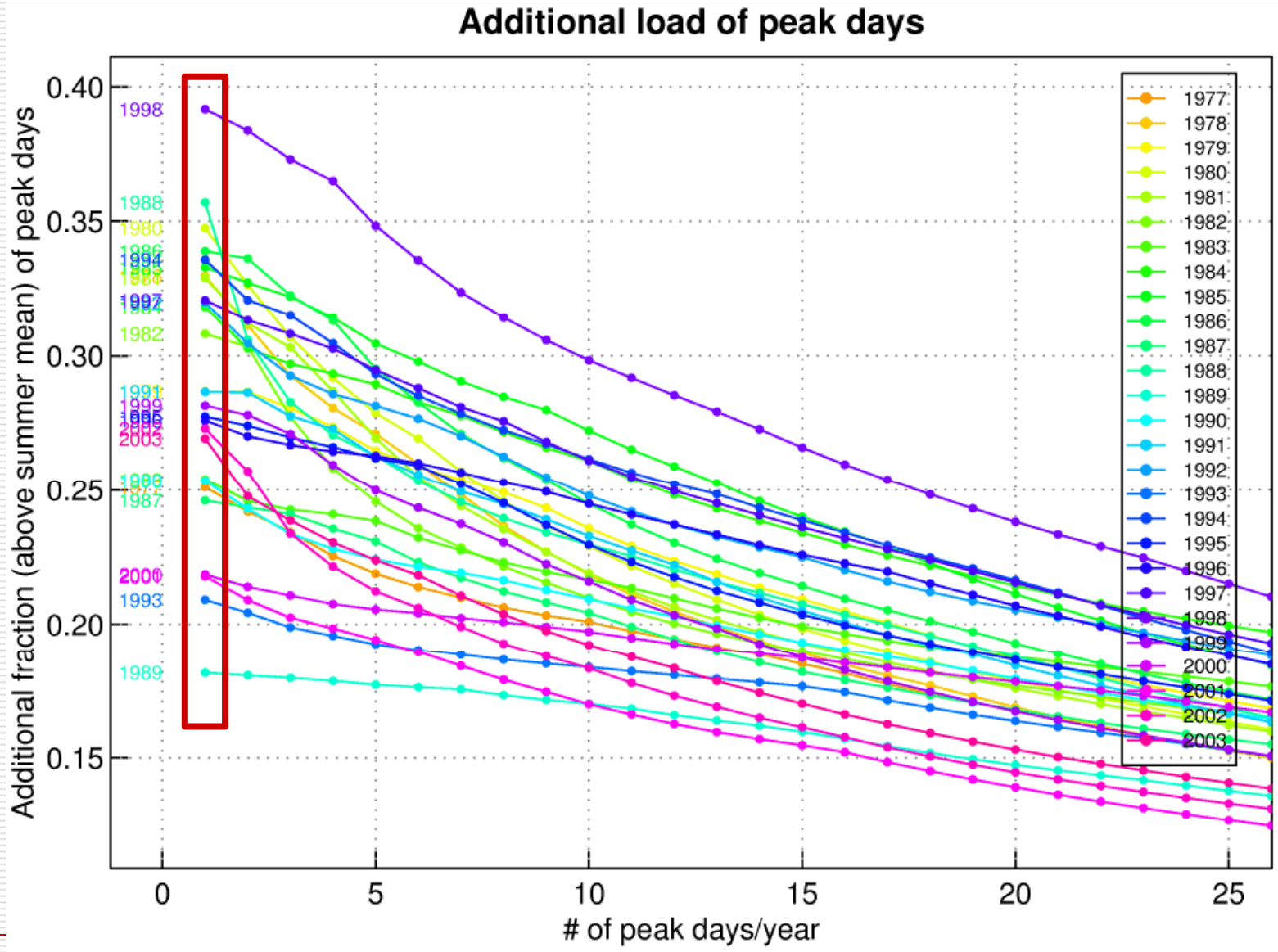
Positive PDO

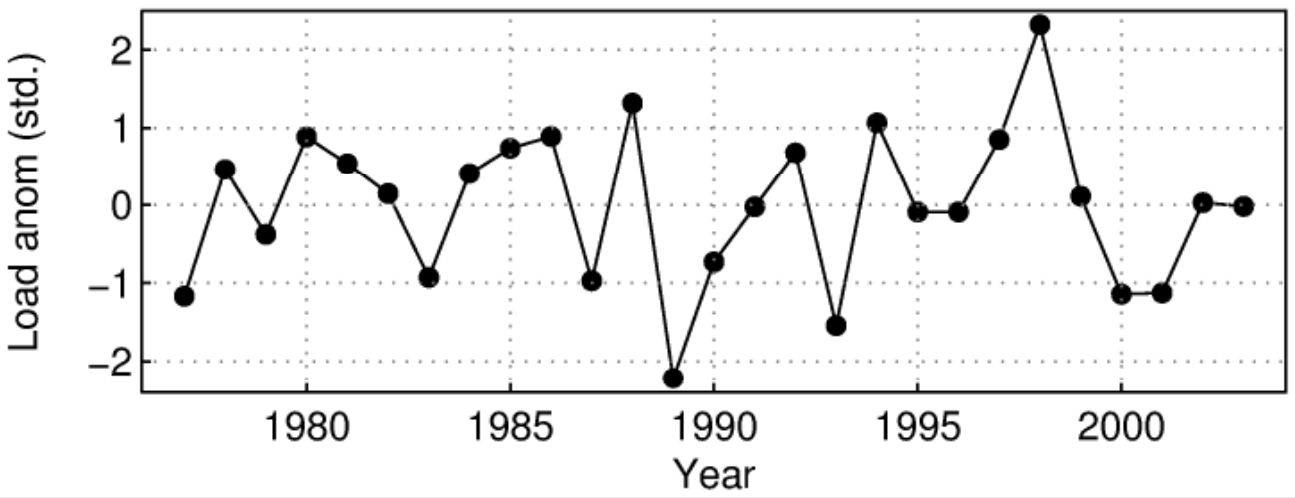


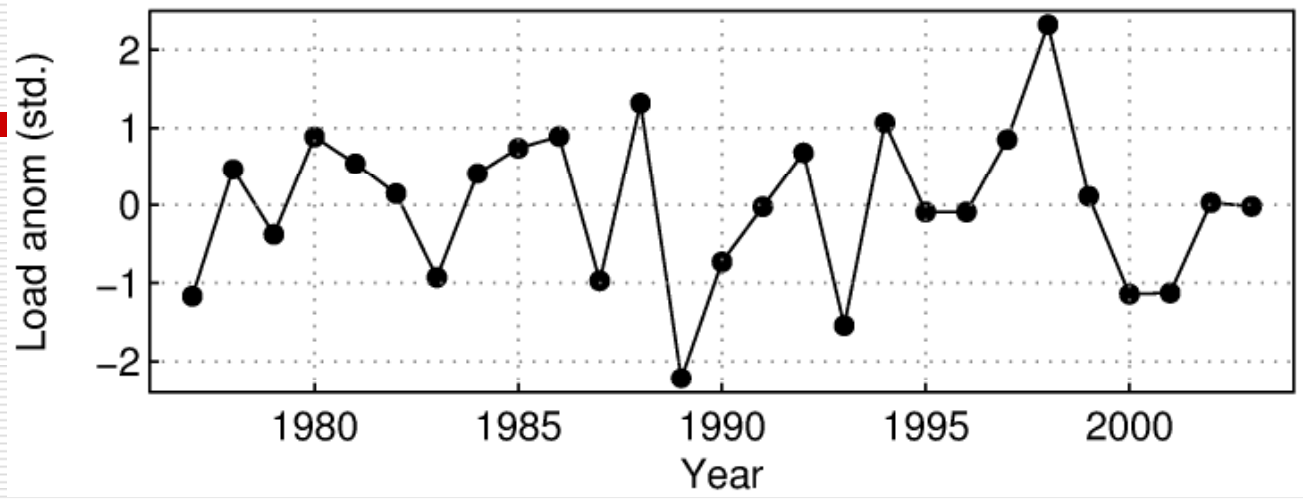
Negative PDO



Peak electrical load




Load anom (std.)
2
1
0
−1
−2
1980
1985
1990
1995
2000
Year


Load anom (std.)
2
1
0
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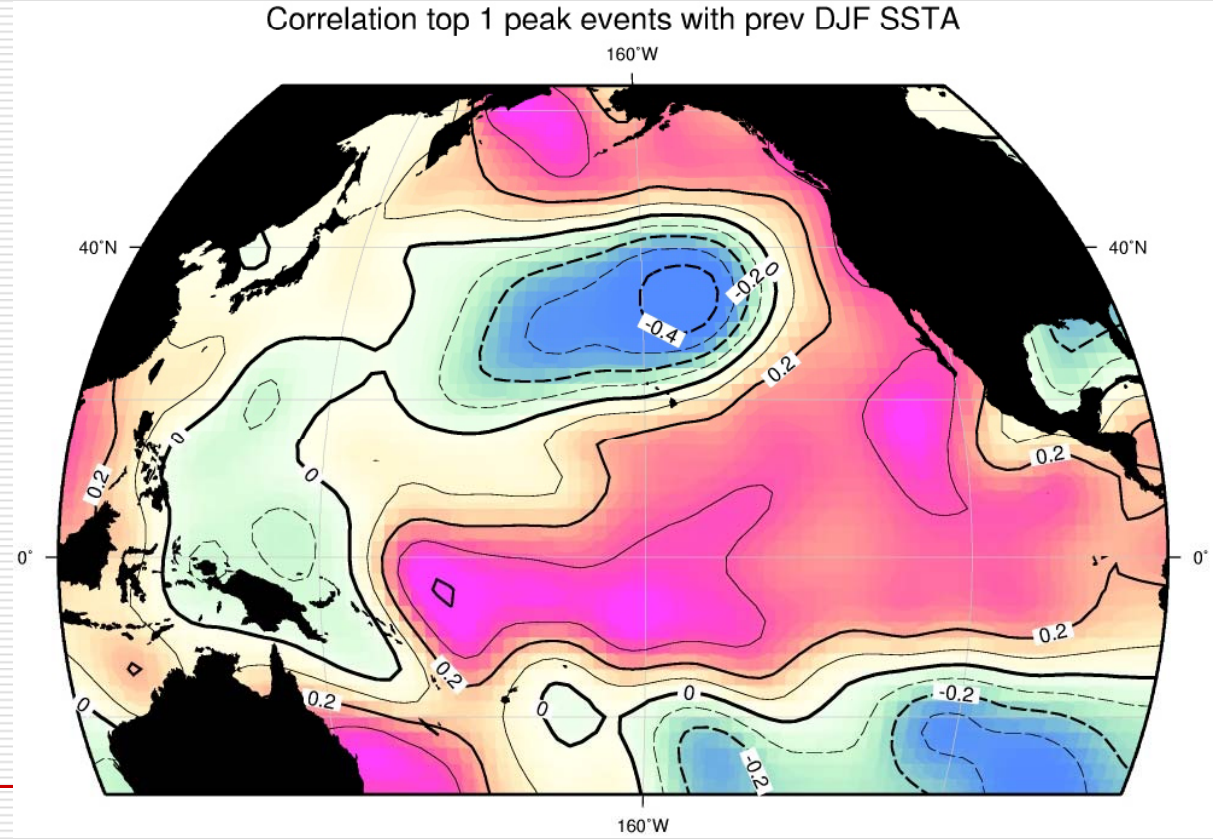
1980
1985
1990
1995
2000
Year


Correlation top 1 peak events with prev DJF SSTA
160°W
40°N
40°N
0°
0°
160°W
-0.4
-0.2
0
0.2
-0.2
-0.2

Spring PDO predicting summertime temperatures

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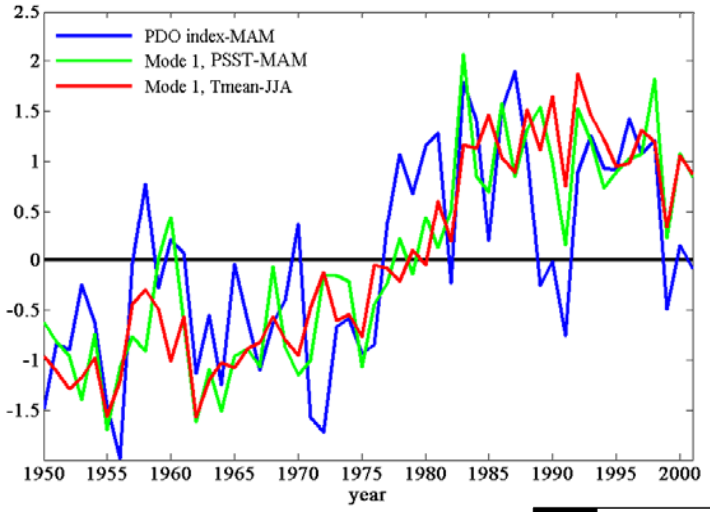
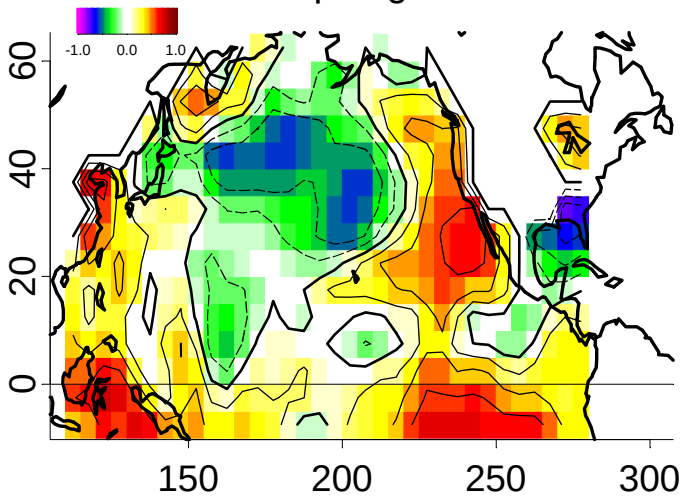
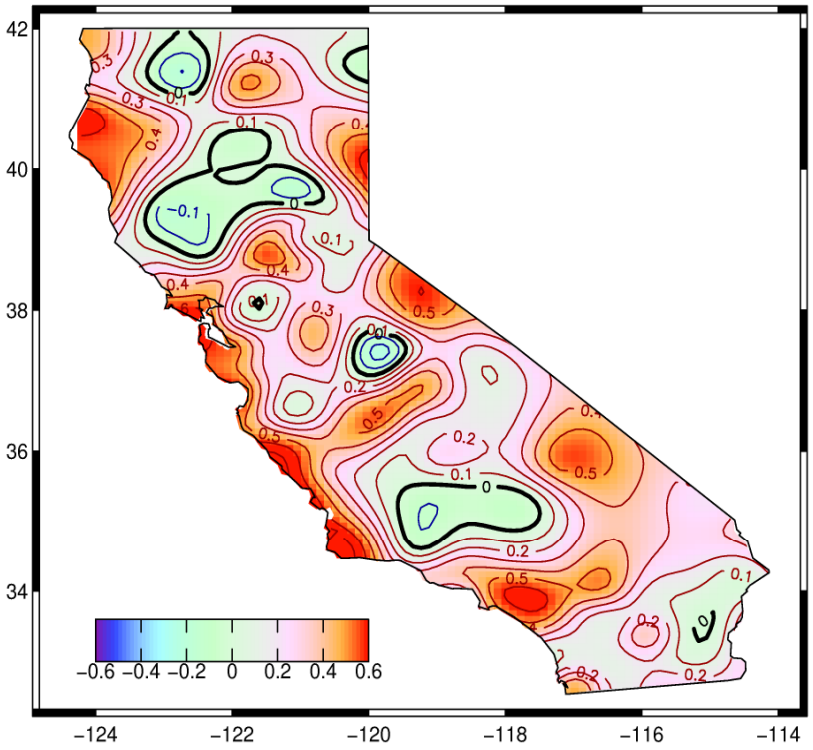


Correlation with spring Sea Surface Temp.



Correlation with summer (JJA) Tavg



Alfaro et al. JCLIM

San Jose

			Summer CDD	
		Below normal	Normal	Above normal
	Below normal	53%	35%	12%
PDO spring	Normal	35%	36%	29%
	Above normal	12%	29%	59%

Significance:	0.01	0.05	0.10

Dynamical predictability over a few years?

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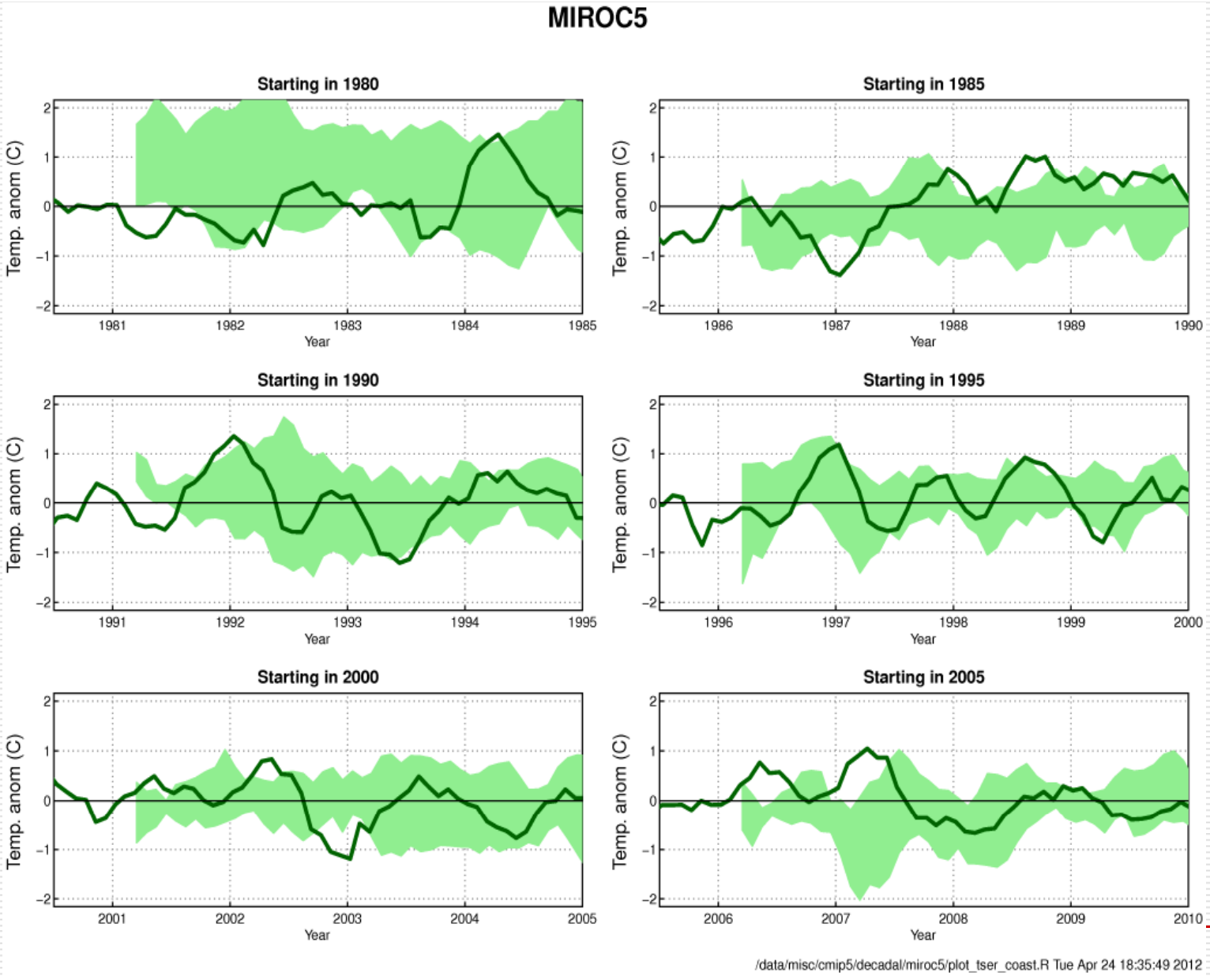

6-member ensembles; envelope shown

Future of California heat waves

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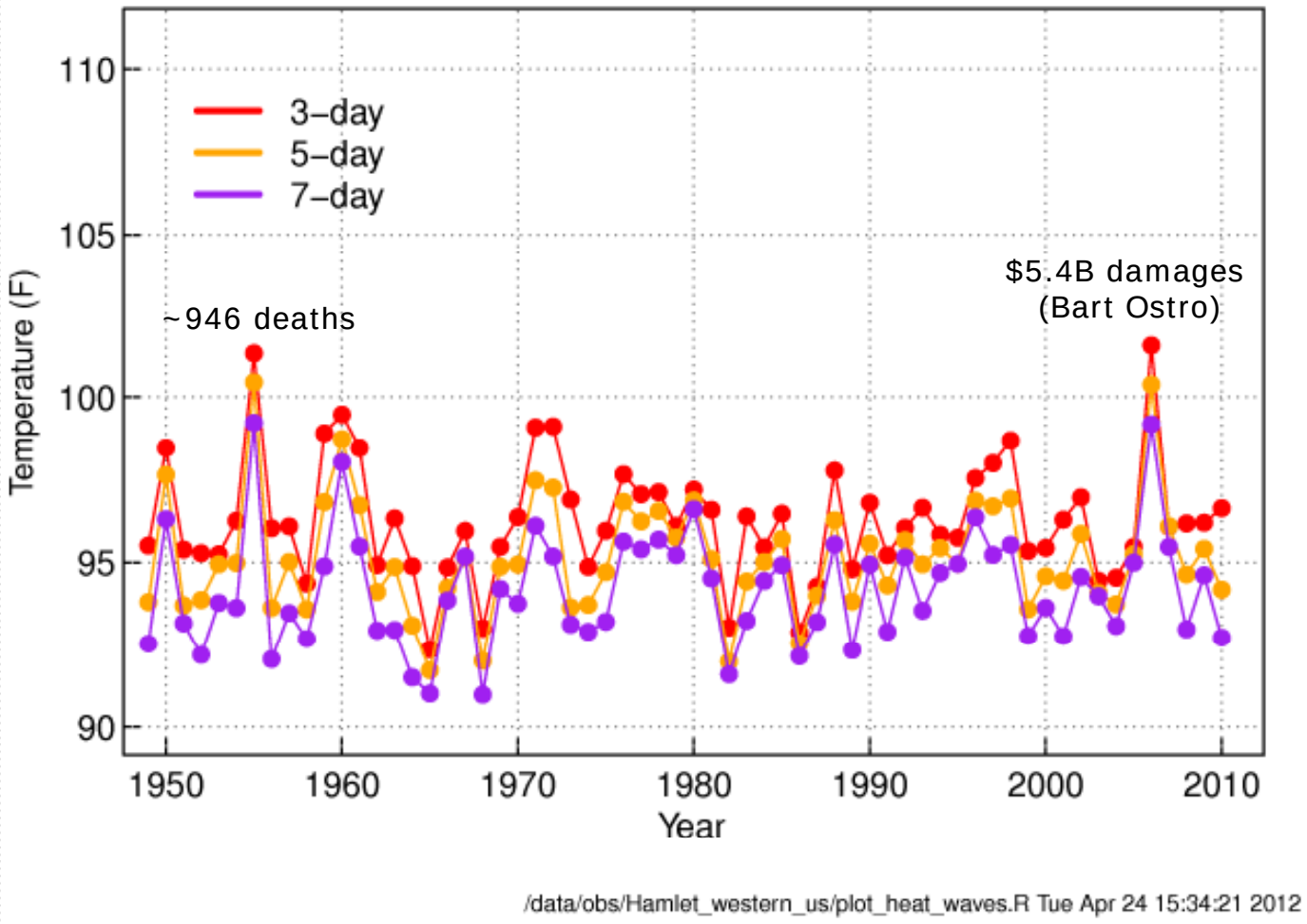
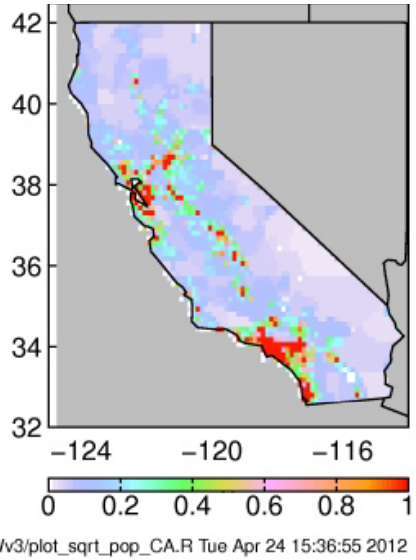
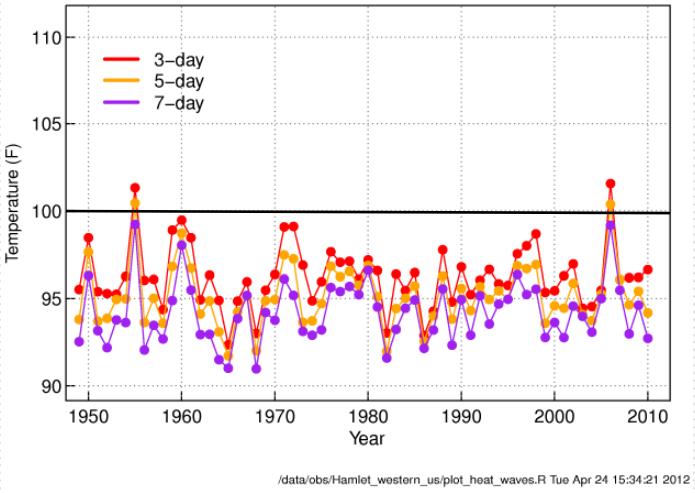
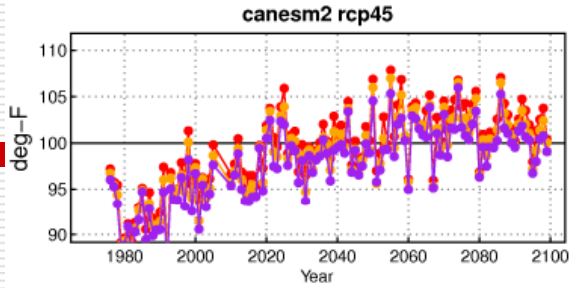


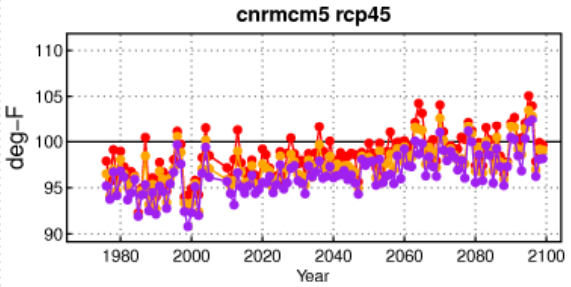
Weighted by population

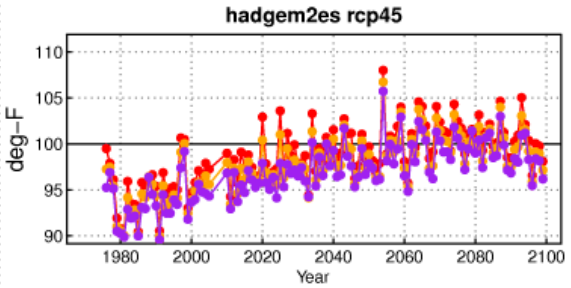


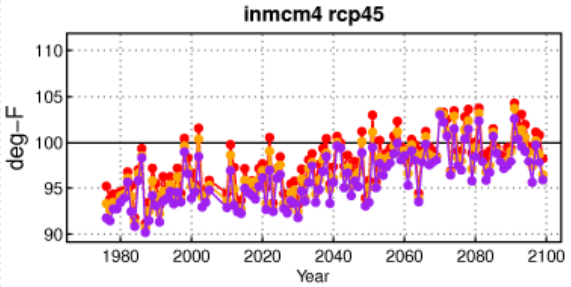
CMIP5 models

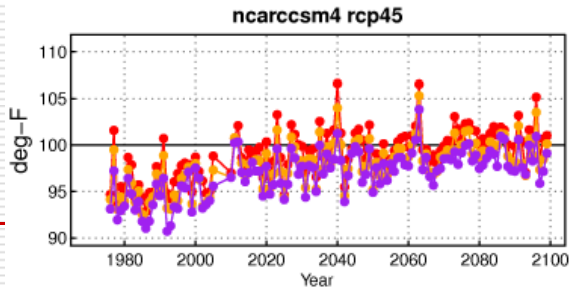






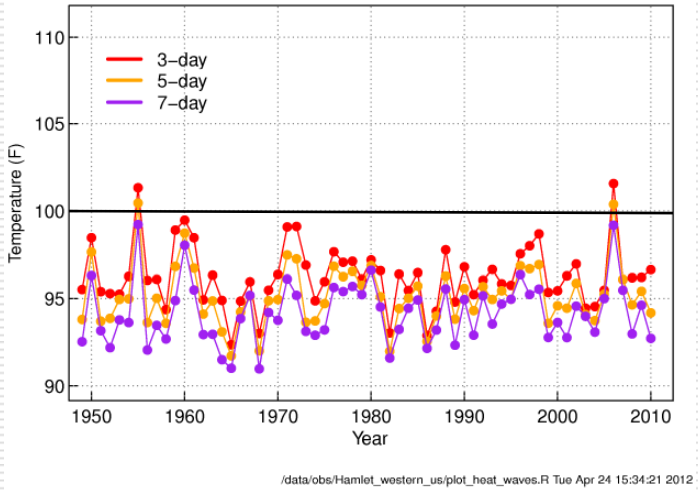




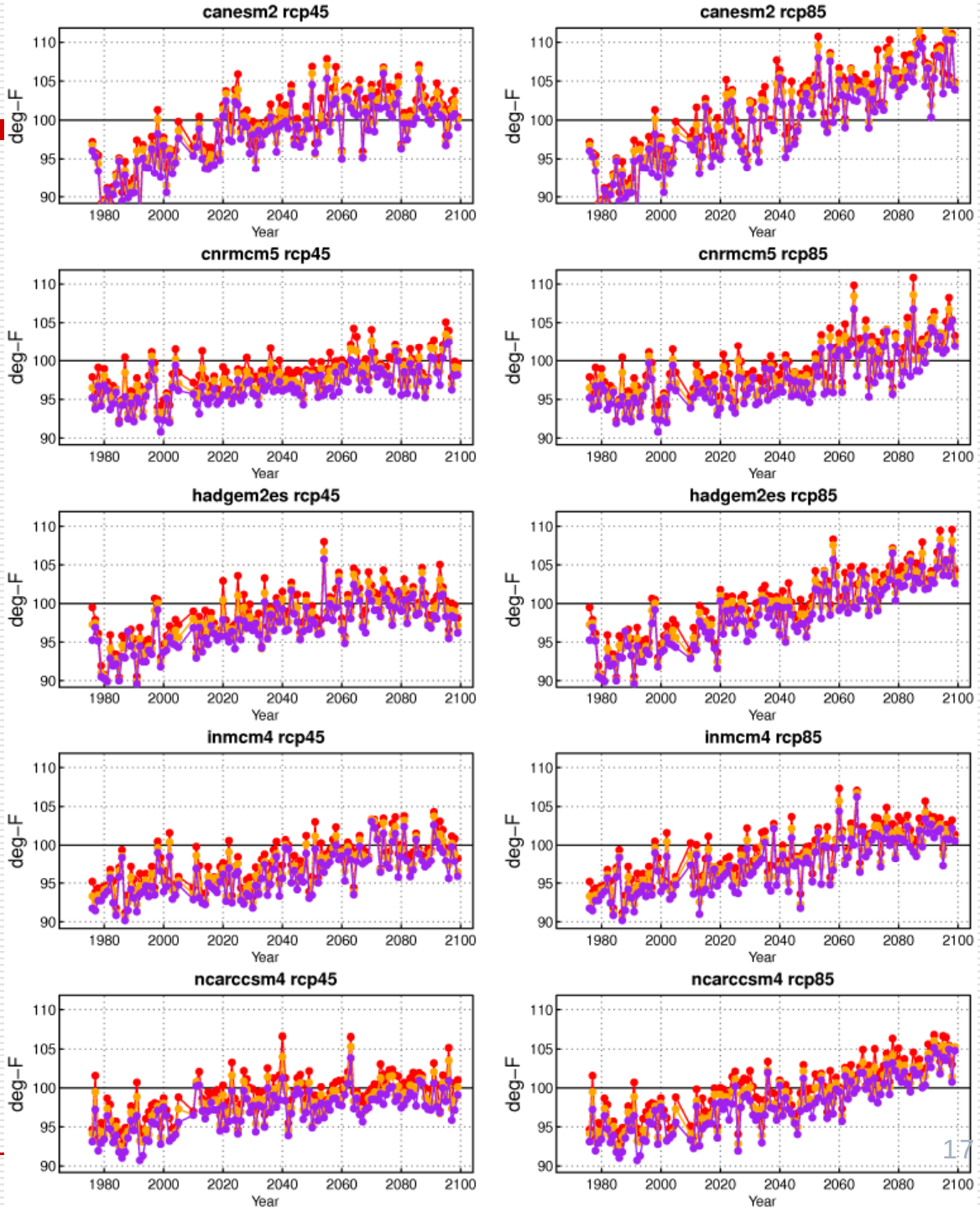


Bias-corrected
BCCA downscaling

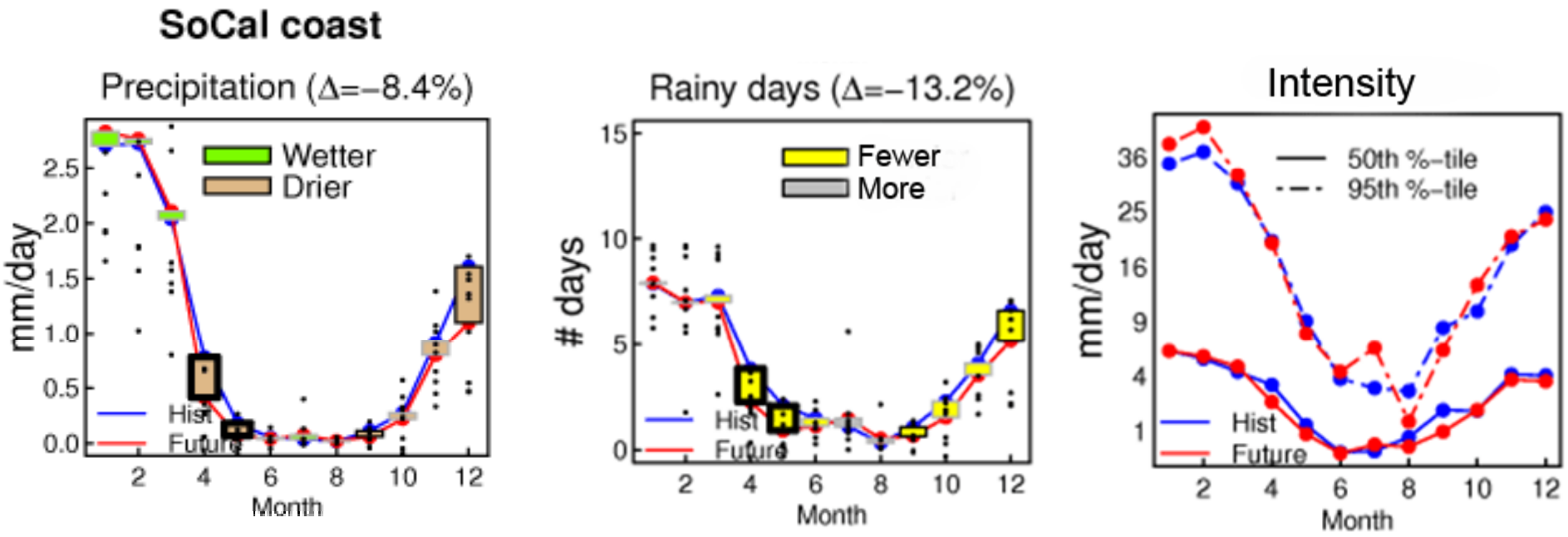
CMIP5 models



Bias-corrected
BCCA downscaling



Change in number of rainy days by 2060s



Pierce et al., CEC Scenarios project

Summary

- Operational El Nino/La Nina forecast (9-12 mos)
- Pacific Decadal Oscillation (PDO) important for energy use
  - Affects winter heating degree days, and Tmax in summer
  - Some ability to predict statistically the summer ahead (3 mos.)
- Dynamical prediction of PDO not encouraging > 1 season
- Damaging heat waves increase by 2020-2040
- Emission scenarios make a difference after 2070
- Changes in precipitation are complex combination of frequency and intensity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