

Probabilistic forecasts for the energy sector

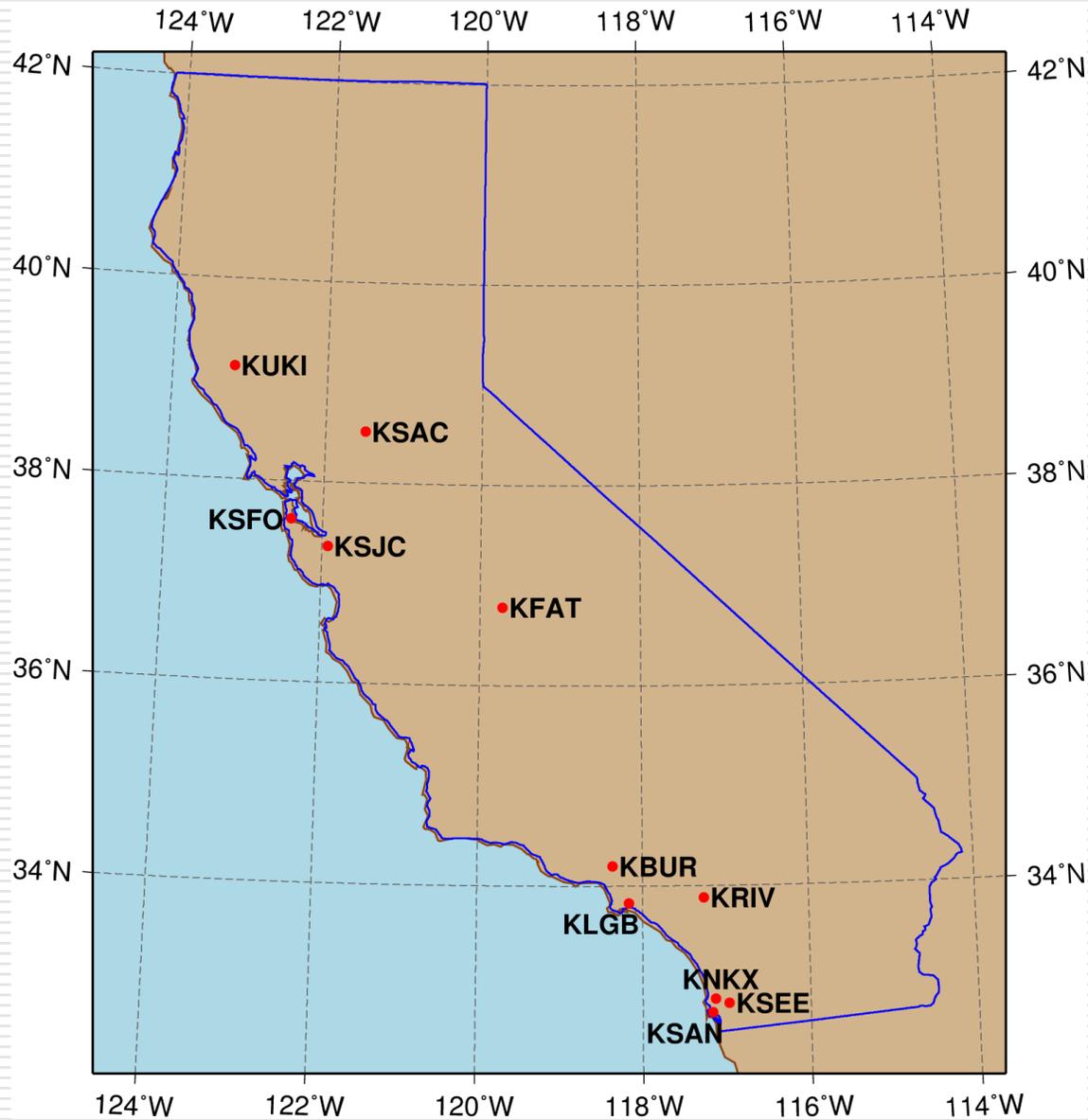
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Scripps Institution of Oceanography

4 June 2013

Stations used for utility load forecasting



Station weights:
from Tom Gorin

PG&E:

KFAT: 0.413
KSAC: 0.169
KSFO: 0.069
KSJC: 0.282
KUKI: 0.067

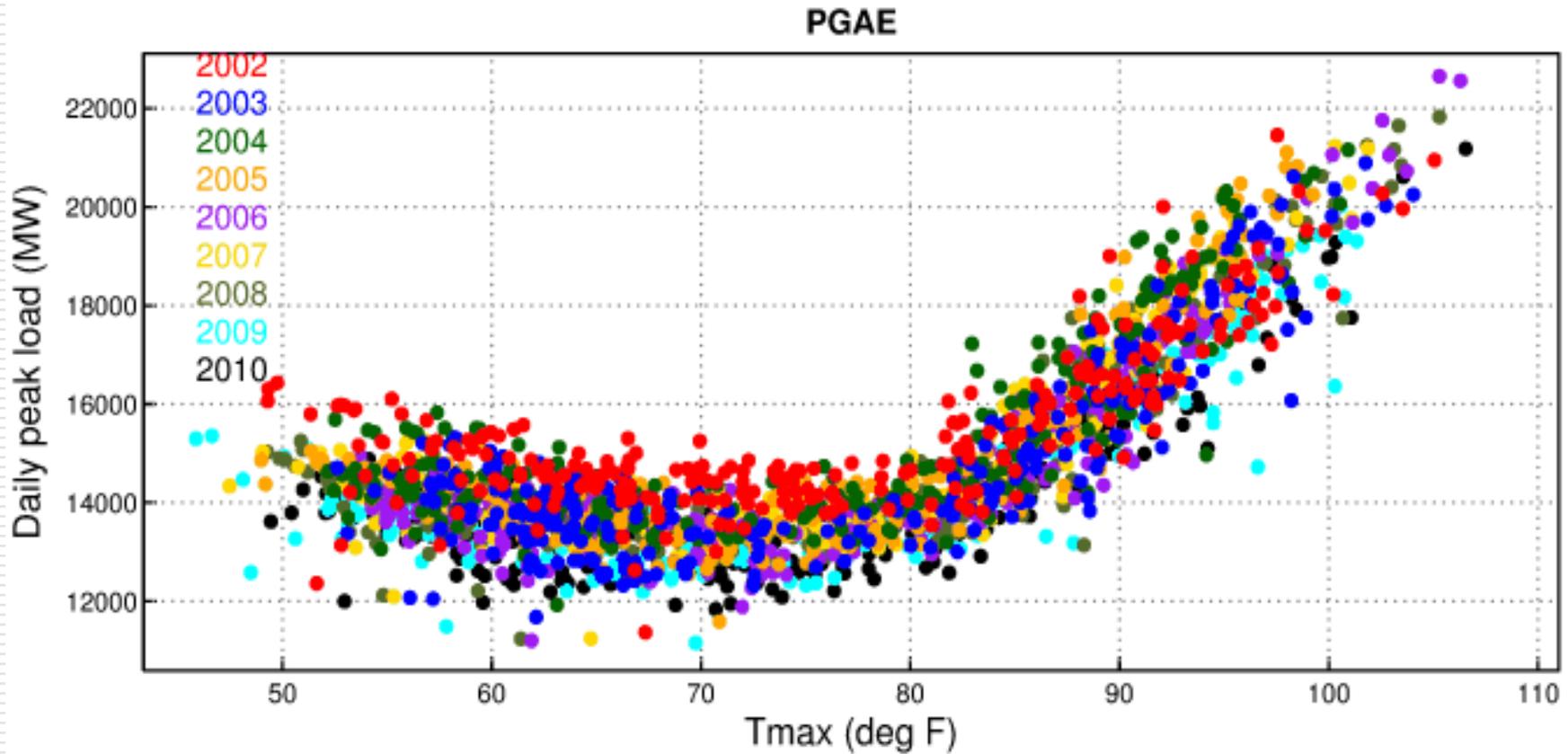
SCE:

KRIV: 0.371
KBUR: 0.243
KLGB: 0.324
KFAT: 0.062

SDGE:

KSAN: 0.333
KNKX: 0.333
KSEE: 0.333

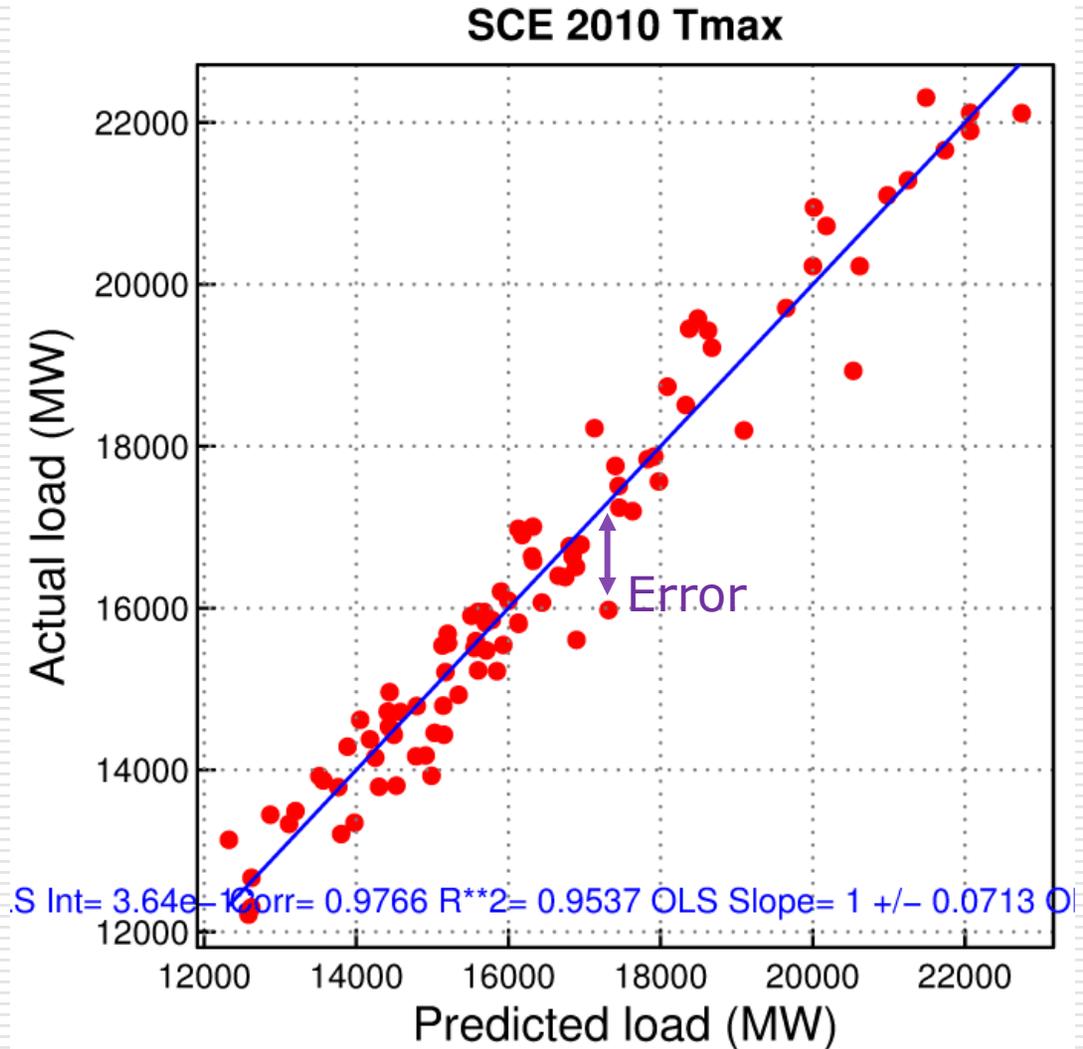
Load vs. max daily temperature, 2002-2010



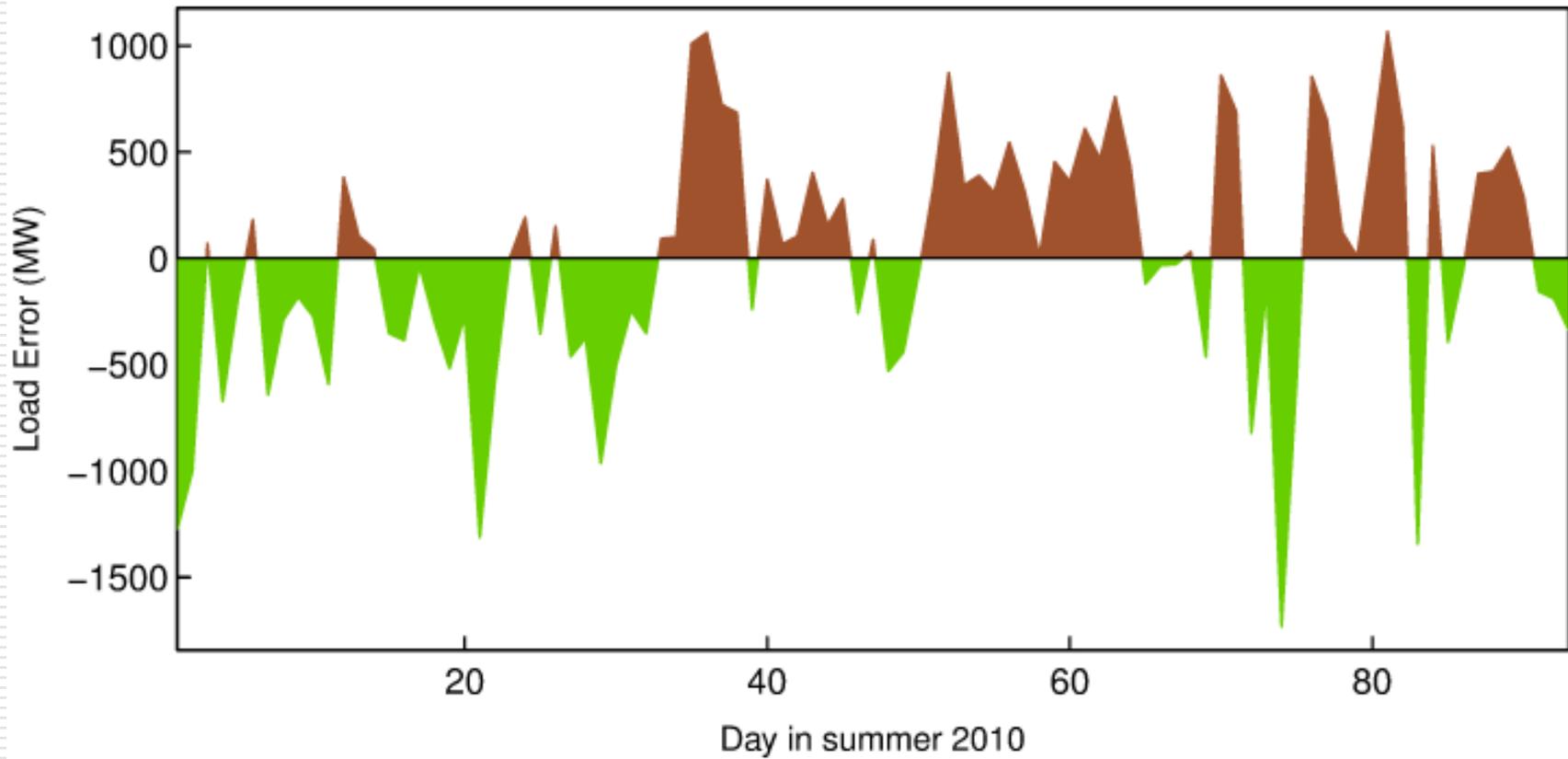
Have looked at PG&E, Southern California Edison, and SDG&E

Predict load from T_{max} , T_{min} , and weekend/holiday

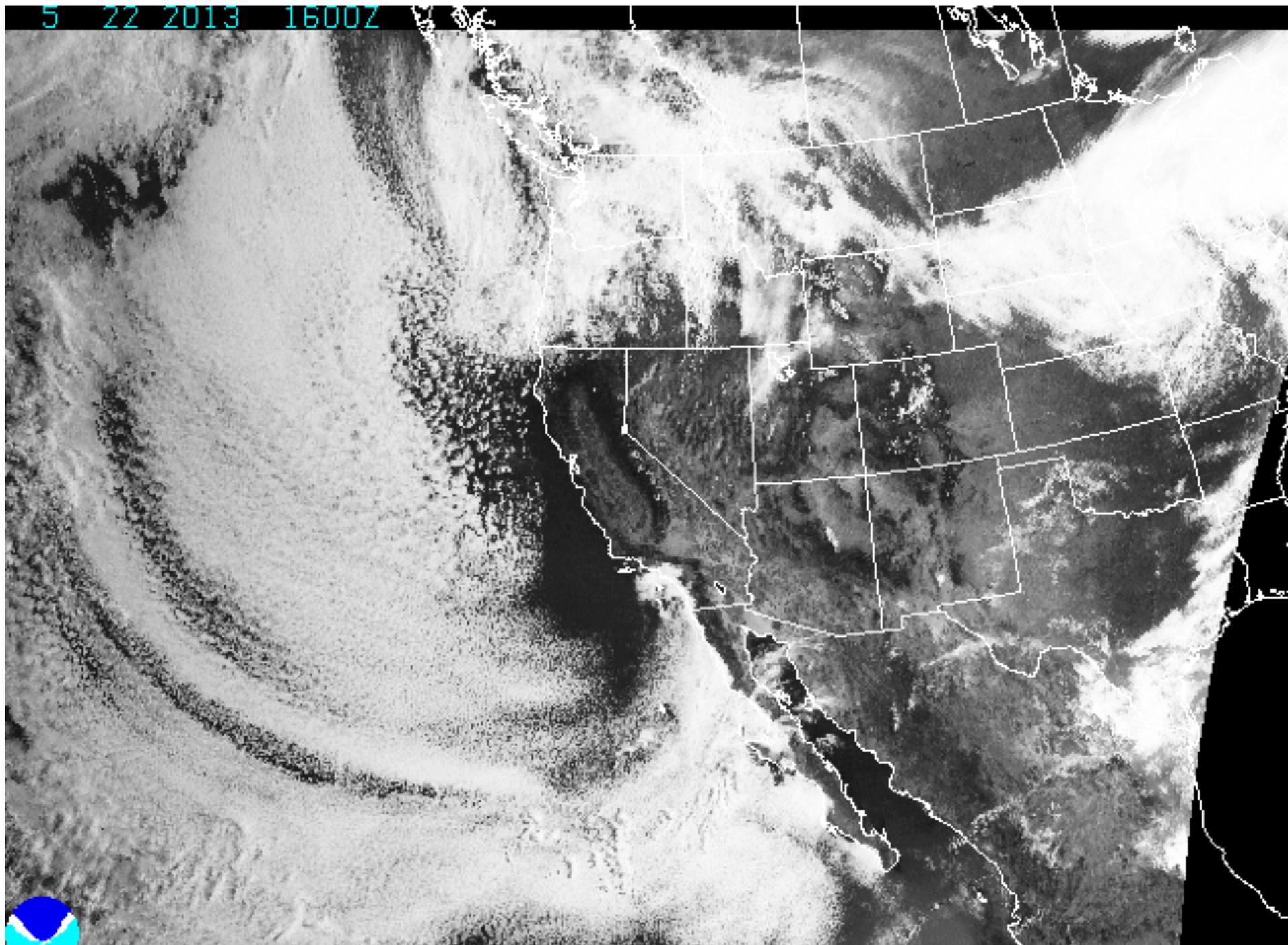
- Summer only
- Let "error" be (actual load) - (load expected from regression)



Load forecast "error" for Southern Cal. Edison



5 22 2013 1600Z



VISIBLE

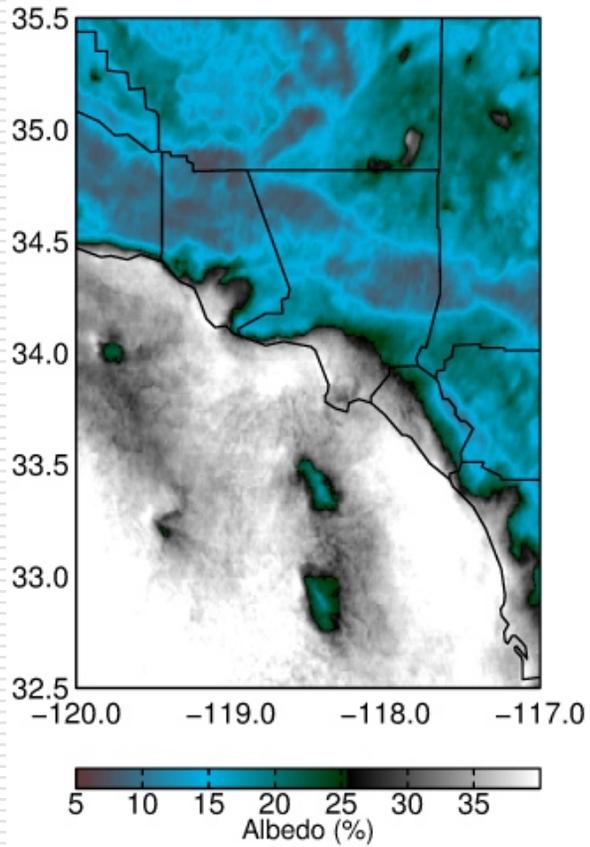
8 km

NOAA

[HTTP://WWW.GOES.NOAA.GOV](http://www.goes.noaa.gov)

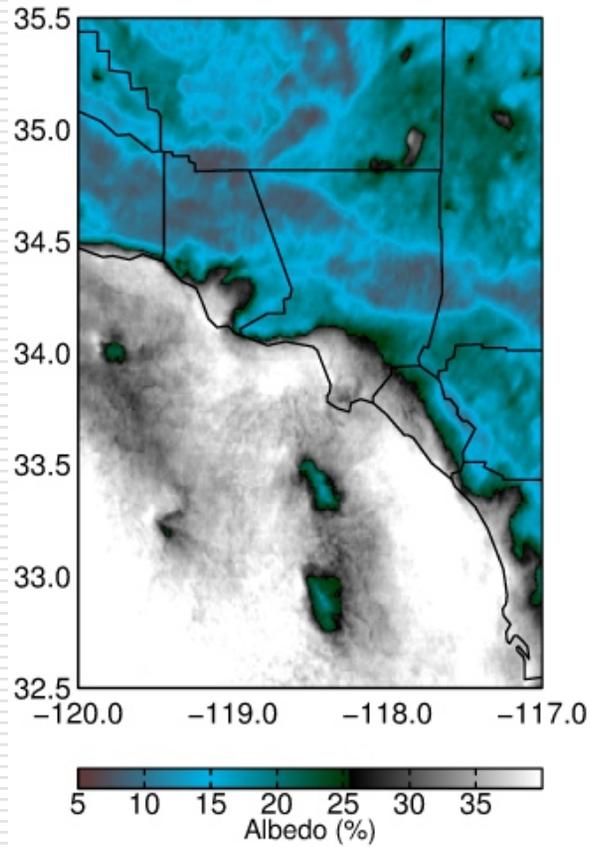
Effect of low stratus

Mean albedo at 9 AM LST (2010)

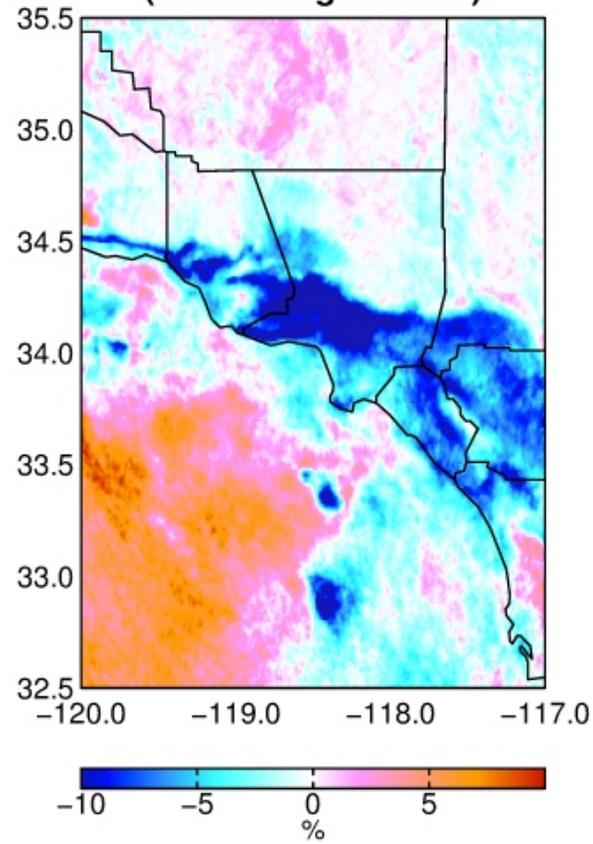


Effect of low stratus

Mean albedo at 9 AM LST (2010)



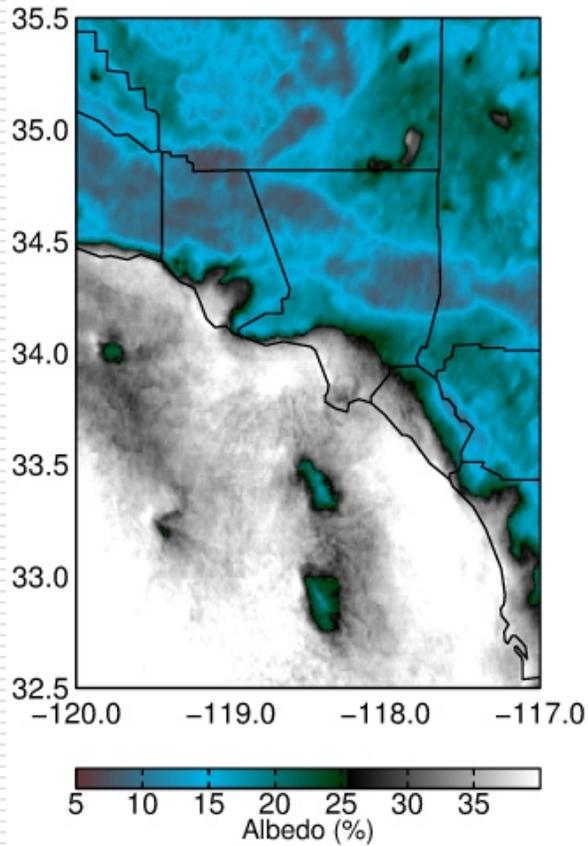
(albedo pos load err) –
(albedo neg load err)



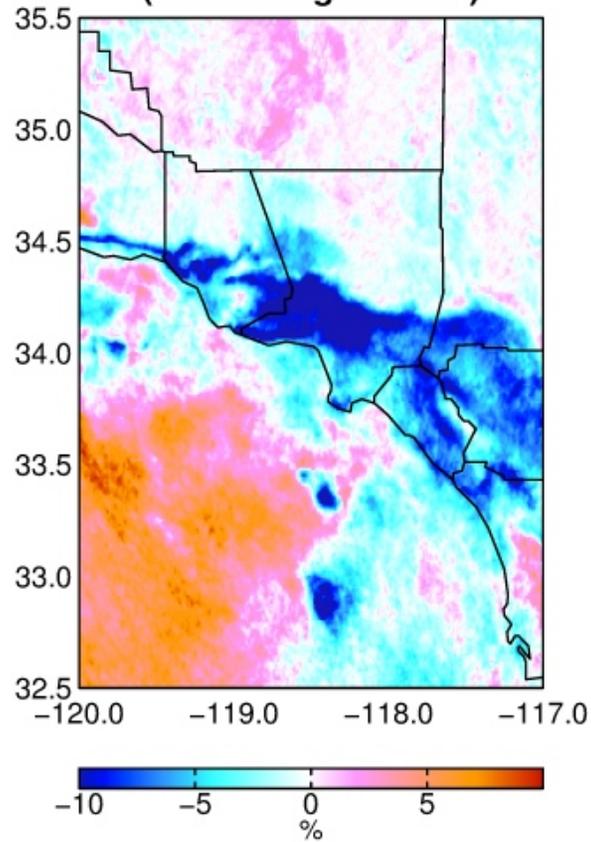
/home/pierce/projects/cec_heatwaves

Effect of low stratus

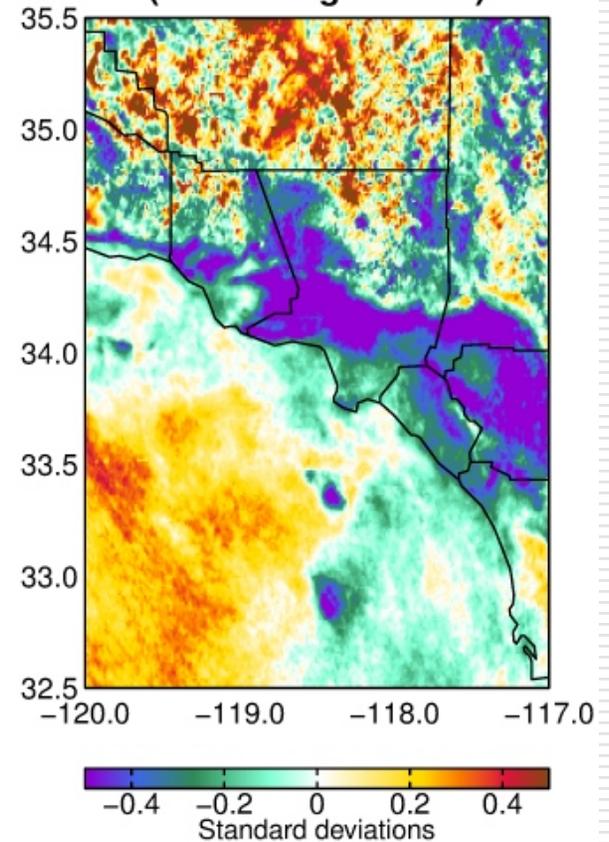
Mean albedo at 9 AM LST (2010)



(albedo pos load err) –
(albedo neg load err)

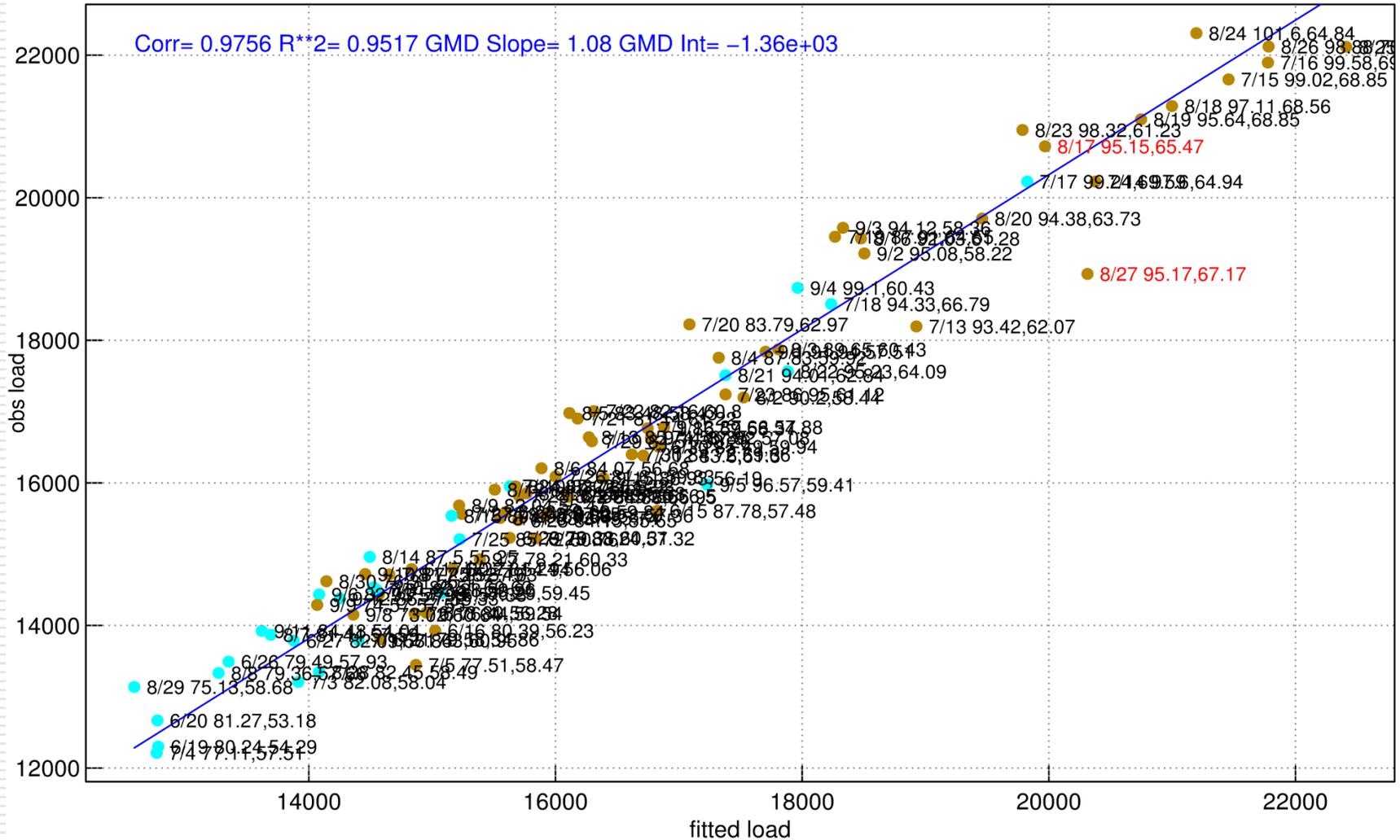


(albedo pos load err) –
(albedo neg load err)



/home/pierce/projects/cec_heatwaves/analyze_load_fcst_err_vs_clouds_v3.R Thu Feb 14 13:12:59 2013

Fitted vs. actual loads, SCE, summer 2010

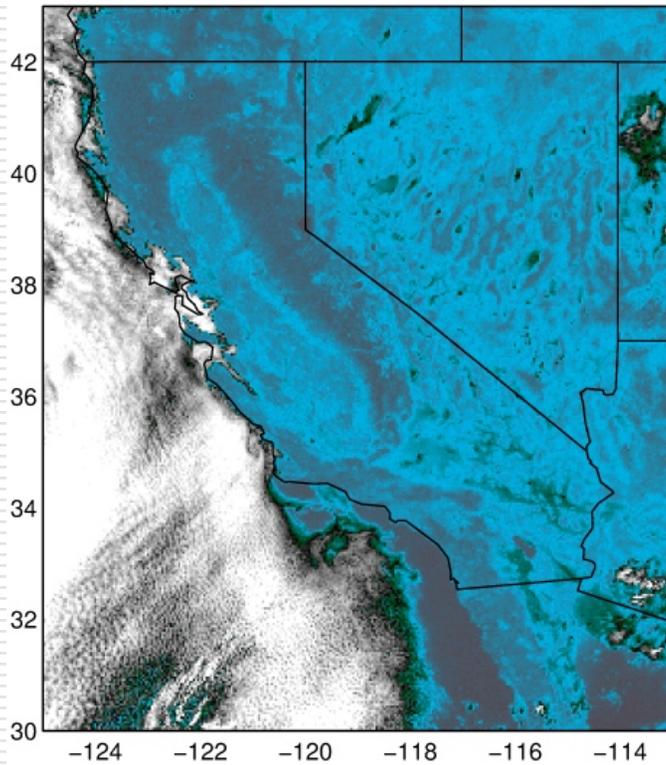


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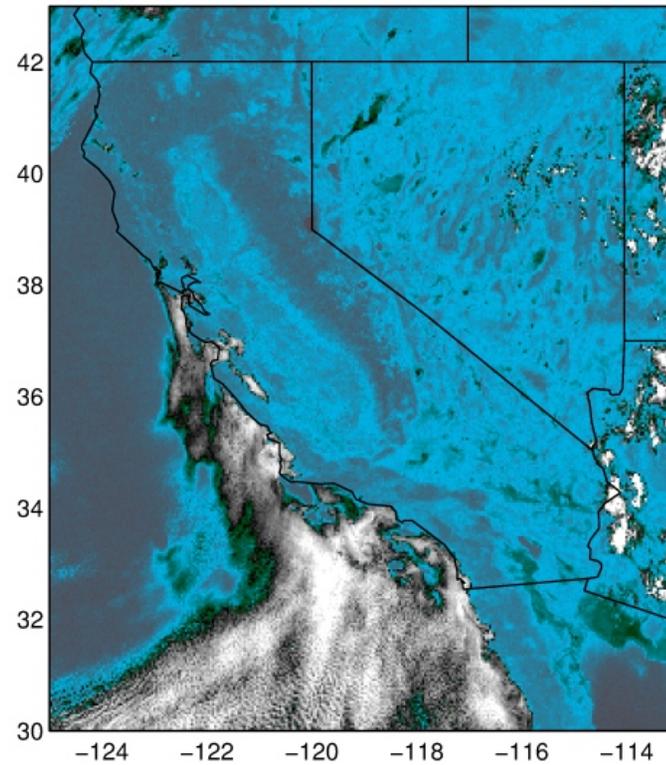
Example: 2 weekdays with same temperature

Tmax:	95.15 F	95.17 F
Tmin:	65.47 F	67.17 F
SCE Load:	20,700 MW	18,900 MW

17 Aug 2010



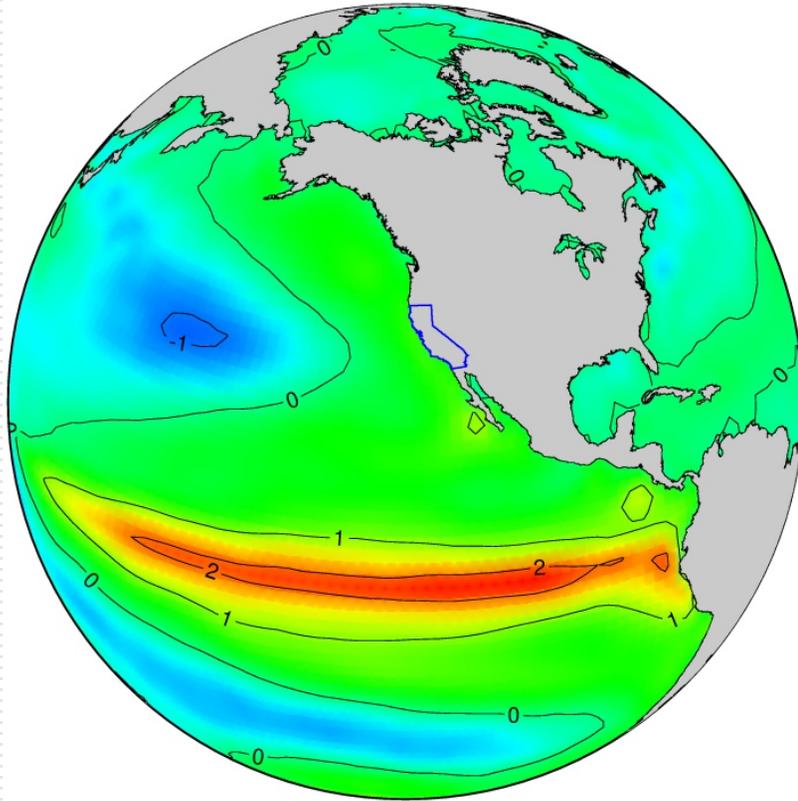
27 Aug 2010



Albedo
(%) at
9 AM

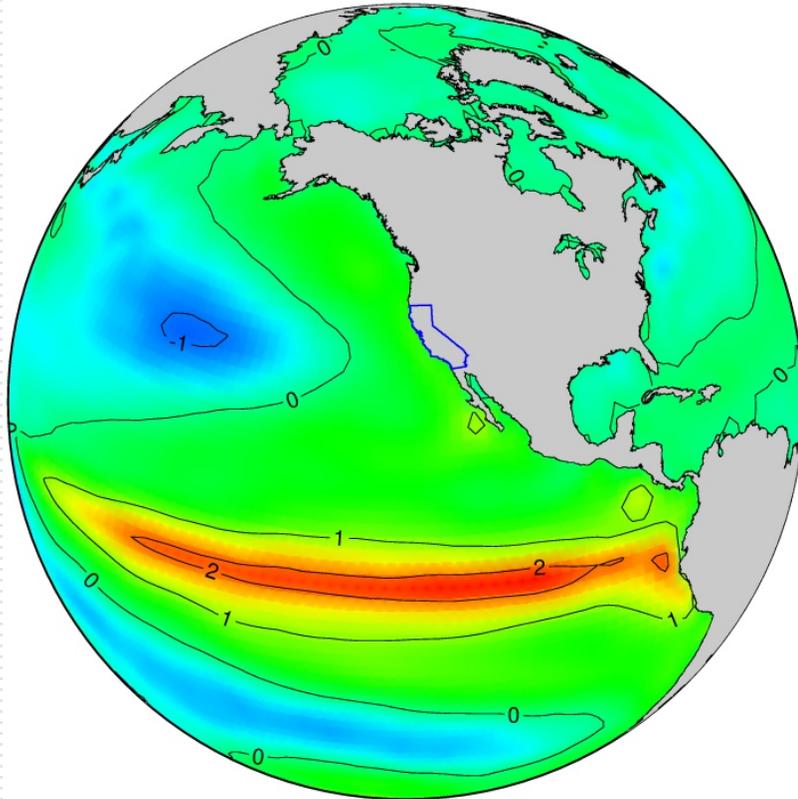
Sources of seasonal predictability

El Nino/Southern Oscillation (ENSO)

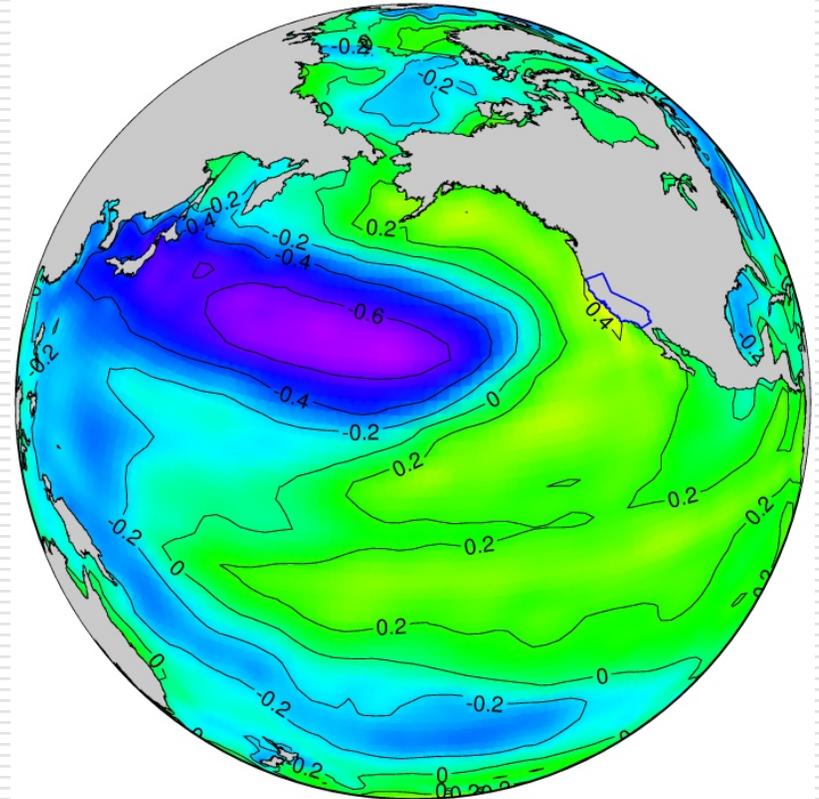


Sources of seasonal predictability

El Nino/Southern Oscillation (ENSO)

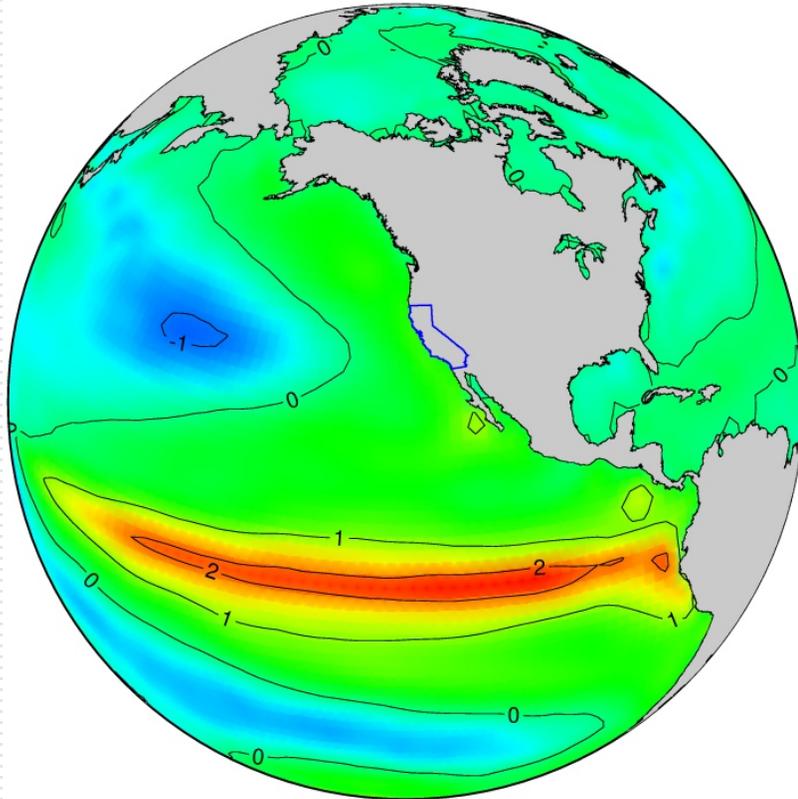


Pacific Decadal Oscillation (PDO)

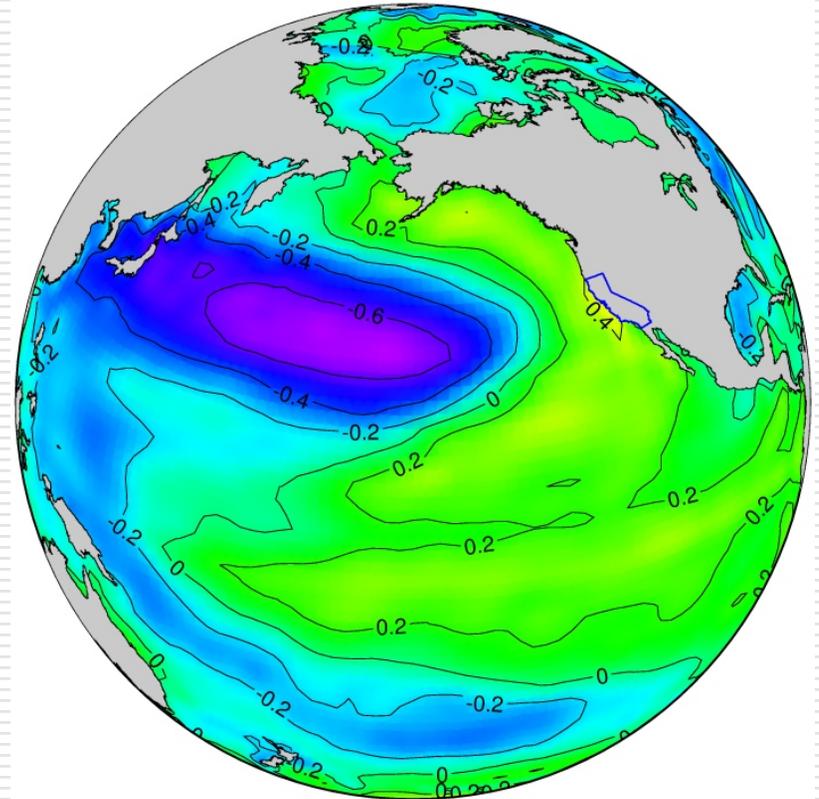


Sources of seasonal predictability

El Nino/Southern Oscillation (ENSO)



Pacific Decadal Oscillation (PDO)



- Soil moist or dry

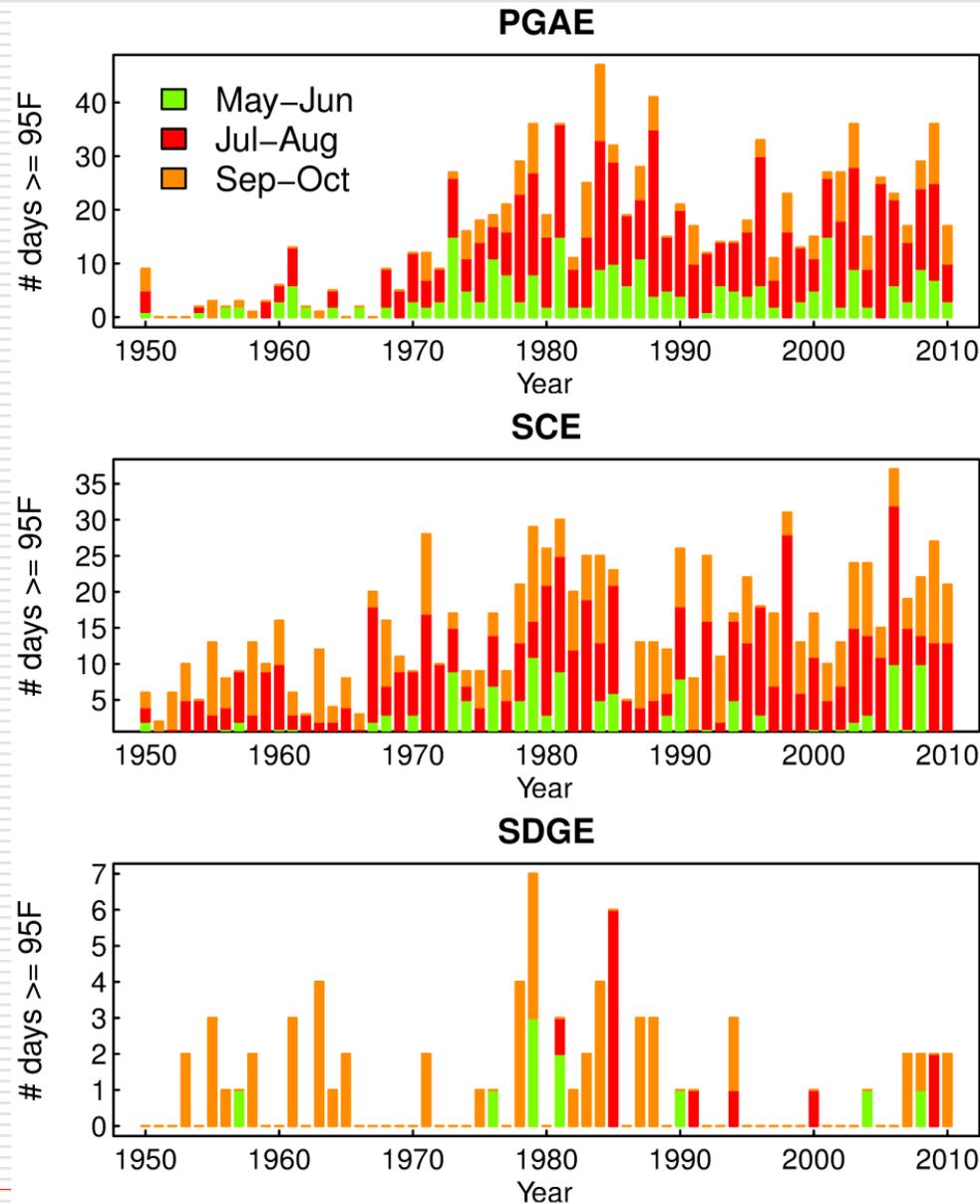
What we're trying to predict

- For each utility (PG&E, SCE, SDGE):
 - Number of hot days (≥ 95 F)
 - Cooling degree days
 - Tavg, Tmax, Tmin

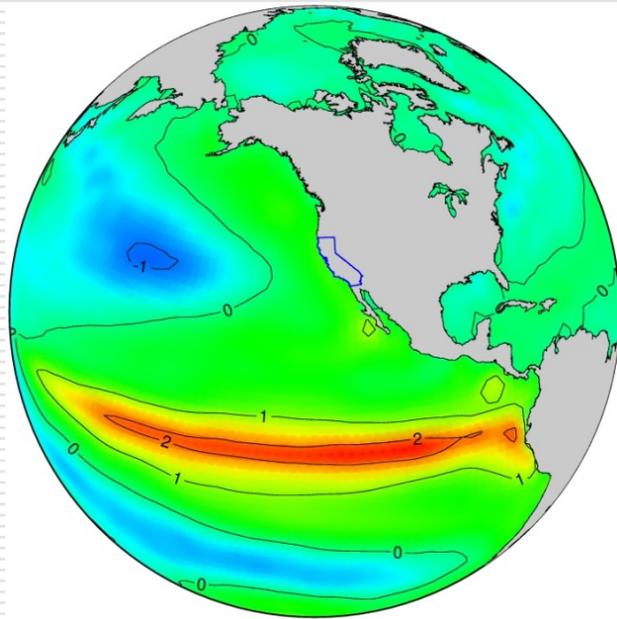
- Details
 - 1950-2010
 - Using terciles (lowest third, middle third, top third)
 - Seasons:
 - spring (Mar-Apr-May) and summer (Jun-Jul-Aug)
 - Warm season (May-Oct)
 - A *posteriori* significance values:
 - ≥ 11 or ≤ 3 : 10%
 - ≥ 12 or ≤ 2 : 5% and 1%
 - ≥ 13 or ≤ 1 : better than 1%

 - 17% relationships significant at 5-10% level or better (89 of 528)
 - 7% significant at 1-5% level or better (37 of 528)

Number of hot (≥ 95 F) days per year

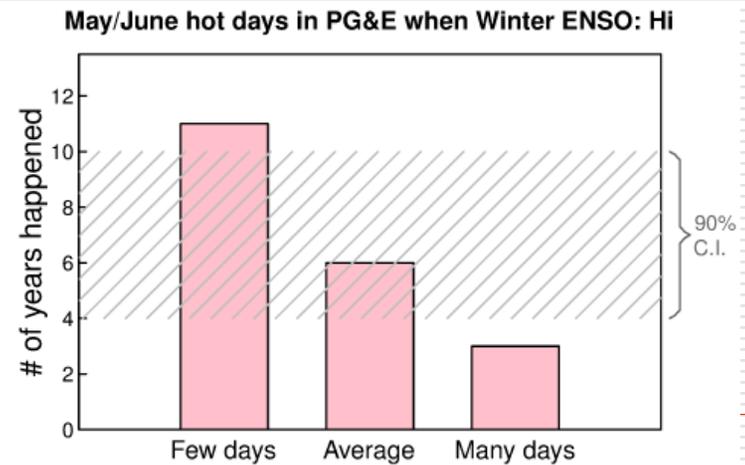
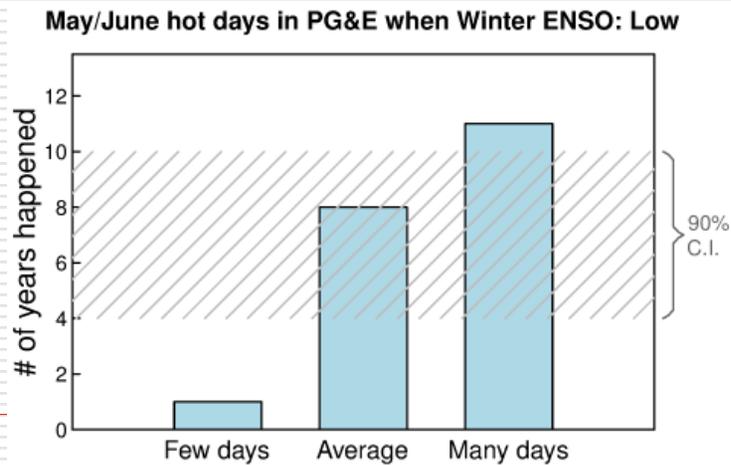


El Nino/Southern Oscillation

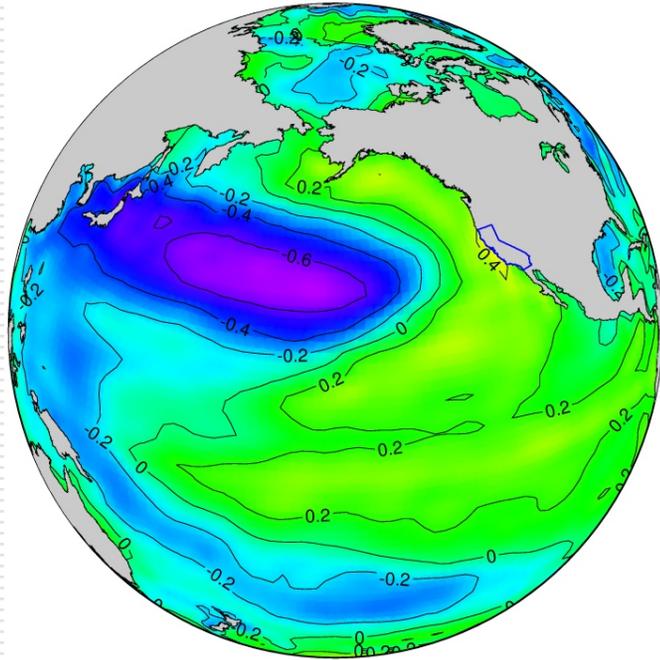


ENSO summary:

- Strongest relation is to PGAE:
 - 95 F days in early season only (May-June)
 - Weak relationships to Tmin, Tmax
- SCE:
 - 95 F days relationship in early season (May-Jun)
- SDGE:
 - 95 F days weak relationship in May-Jun

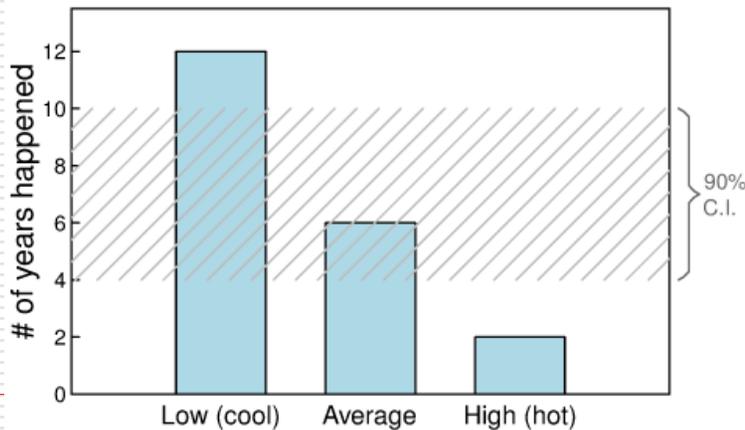


Pacific Decadal Oscillation

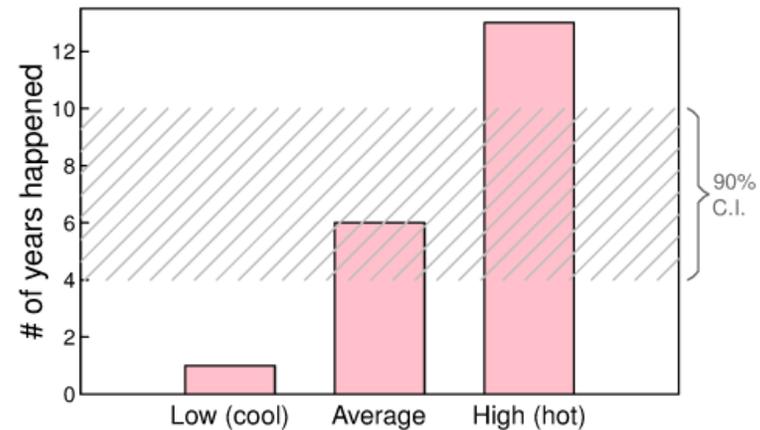


- PDO summary:
 - 31 significant relationships, mostly to *seasonal* quantities
 - Few relationships with hot days (only 4)
 - Warm PDO goes with a warm season, cool PDO goes with a cool season

SDG&E Avg. Tmax, Spring when PDO: Low



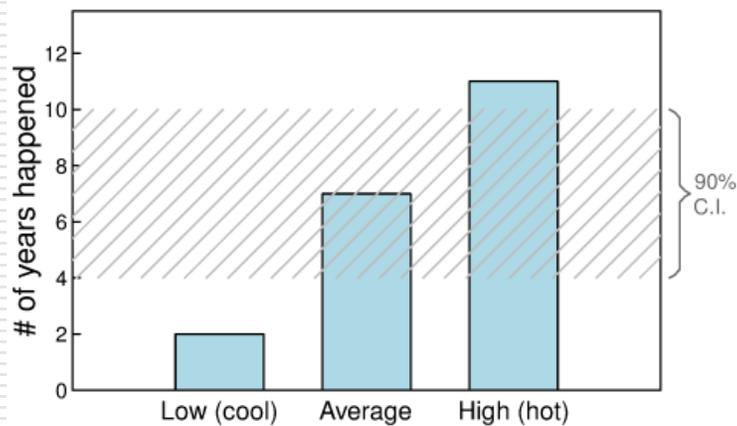
SDG&E Avg. Tmax, Spring when PDO: Hi



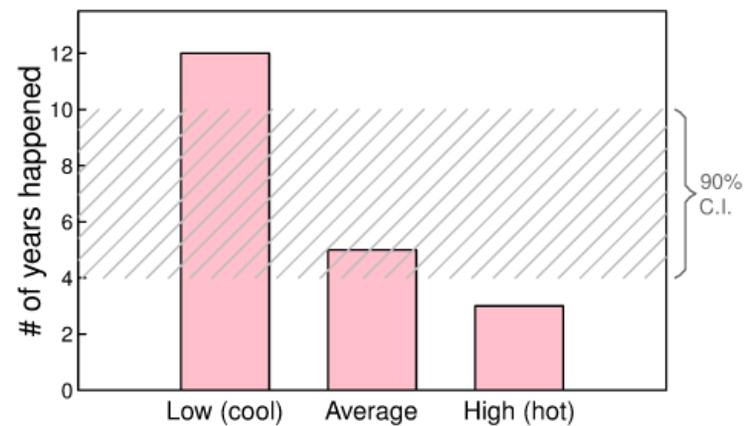
Soil moisture

- Summary:
 - 33 significant relationships, mostly to *seasonal* quantities
 - Few relationships with hot days (only 3)
 - Mostly spring coincident – signal falls off by summer
 - Strongest effect seems to be on below average temperatures; enhanced in wet years, suppressed in dry years

Avg. daily Tmax, SCE (MAM) when Soil moist (MAM): Low

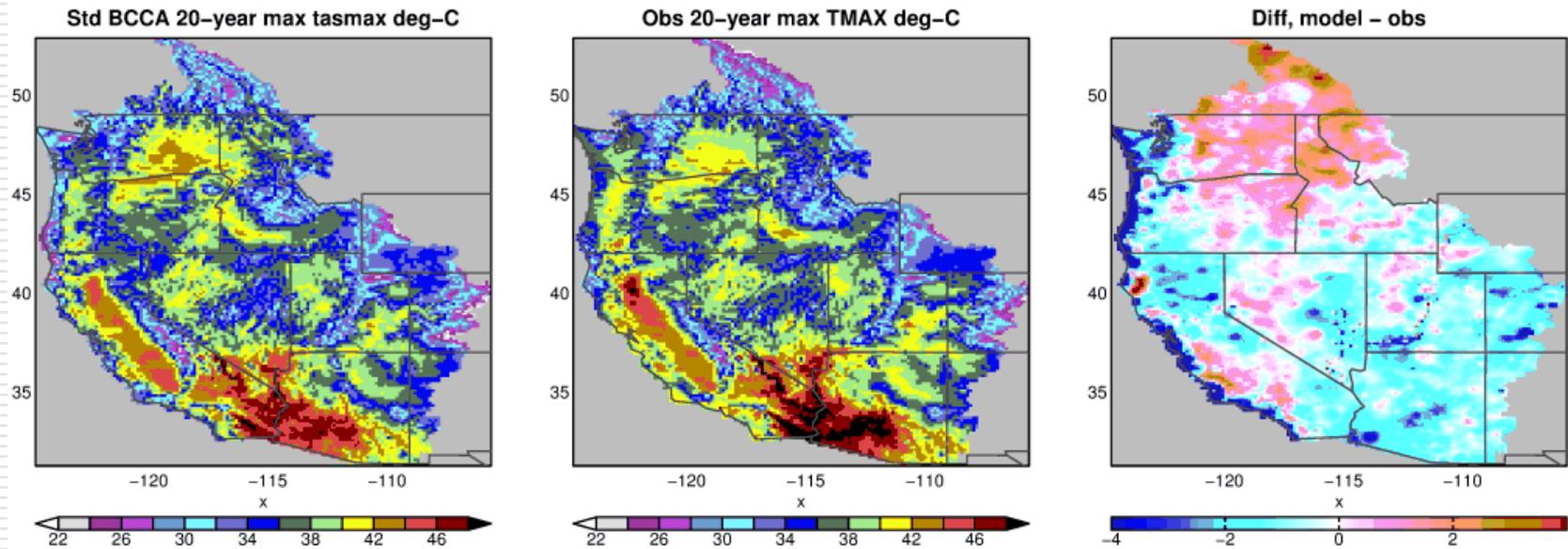


Avg. daily Tmax, SCE (MAM) when Soil moist (MAM): Hi

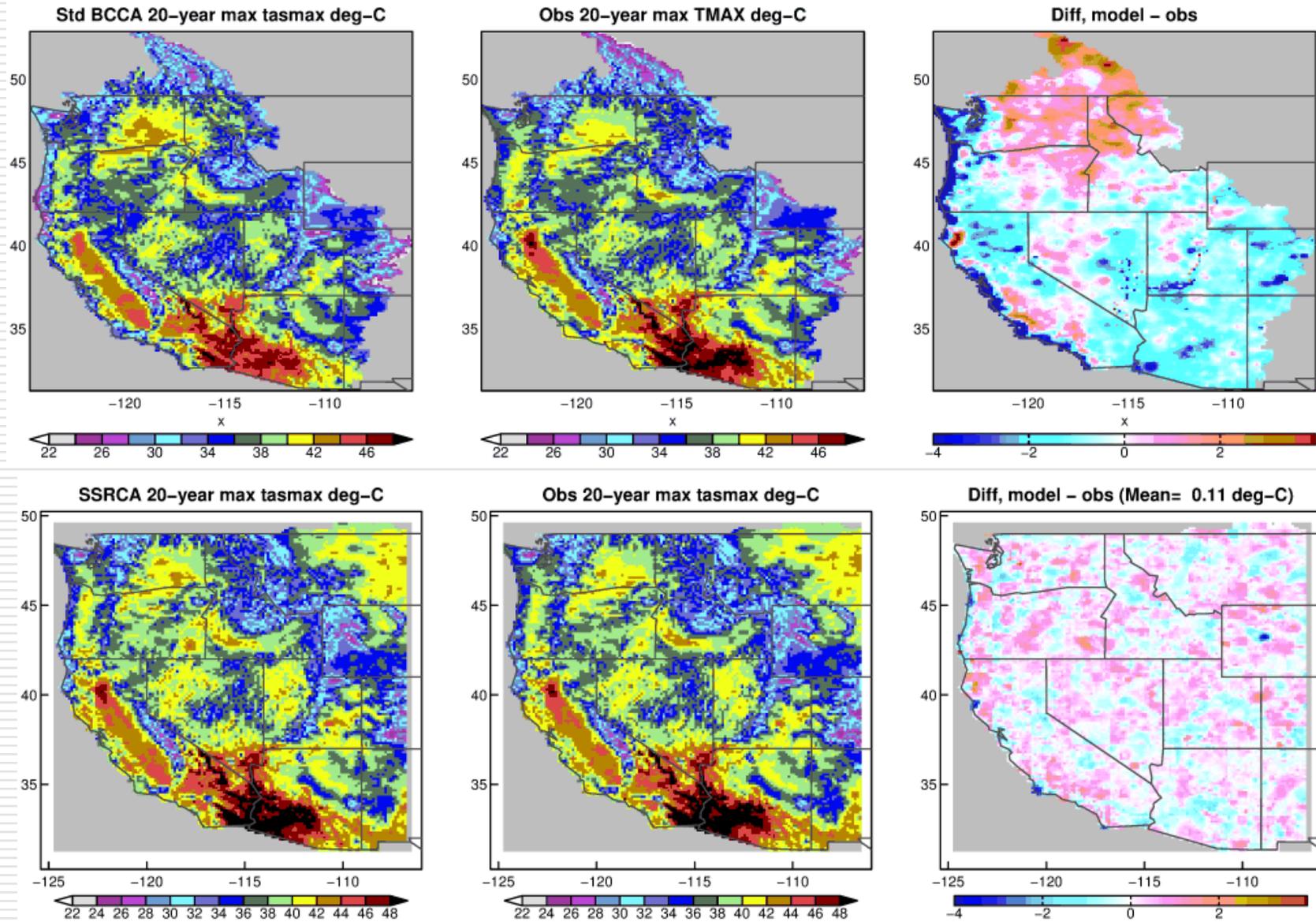


Hottest day in 1 and 20 years

Hottest day in 1 and 20 years (existing method)

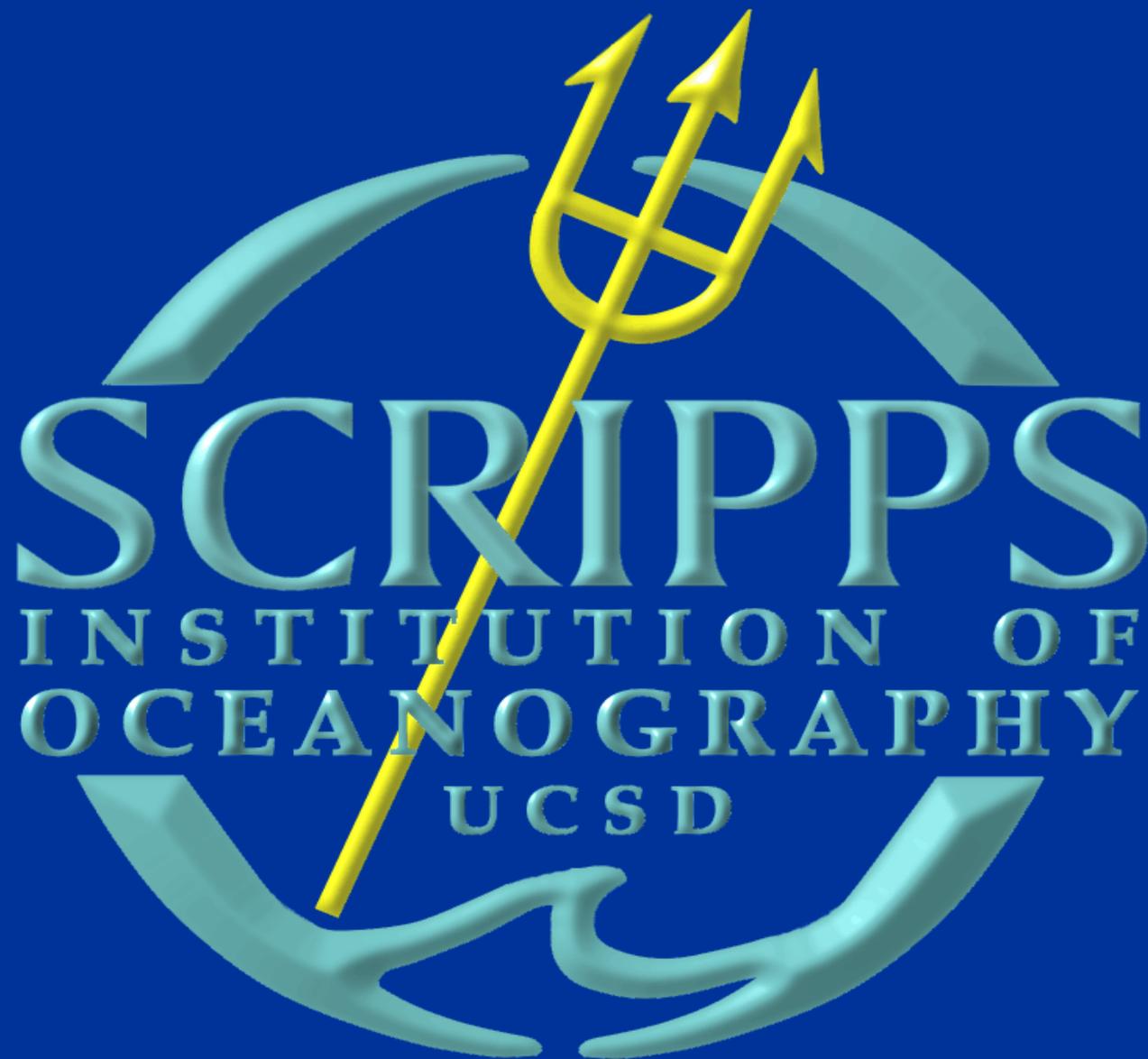


Hottest day in 1 and 20 years (new method)



Key Points

- ❑ Marine layer cloud cover is implicated in load forecast “errors” in the LA basin
- ❑ Probabilistic seasonal outlooks are possible
 - ENSO has some relationships to 95 F days
 - PDO relates more strongly than ENSO, but to seasonal averages
 - Dry conditions influence spring conditions, but not later in summer
- ❑ Hottest day in 1 and 20 years not well captured by current models
 - New methods we’re working on may help



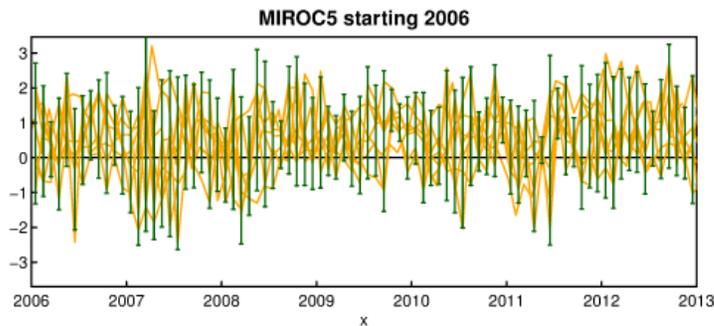
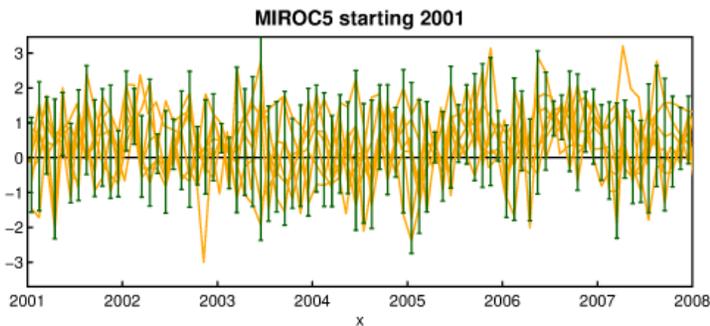
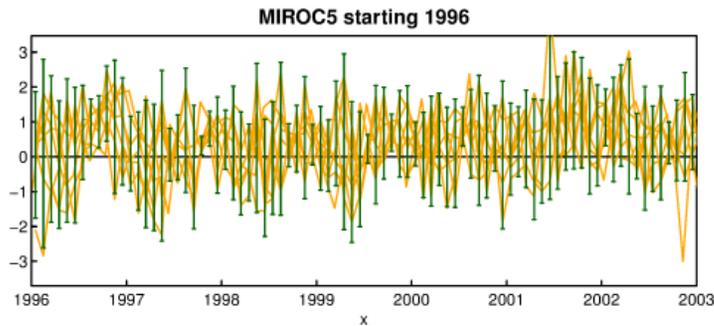
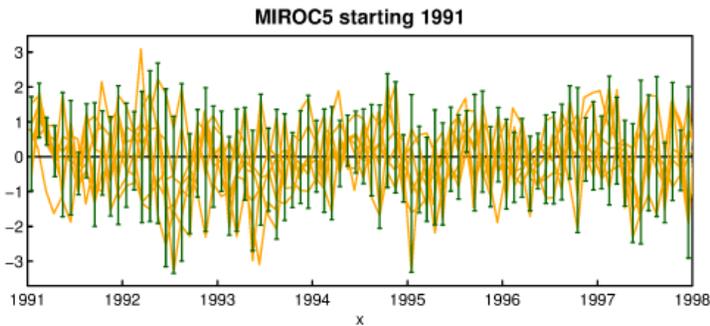
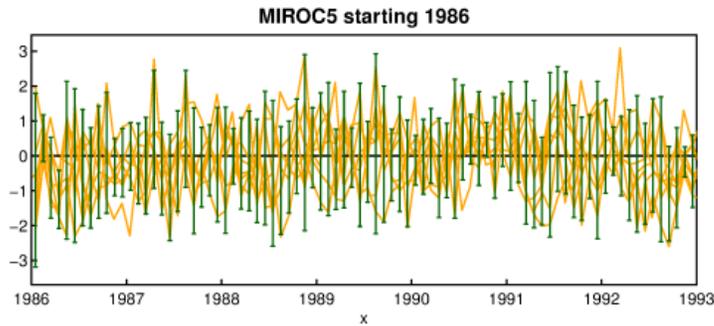
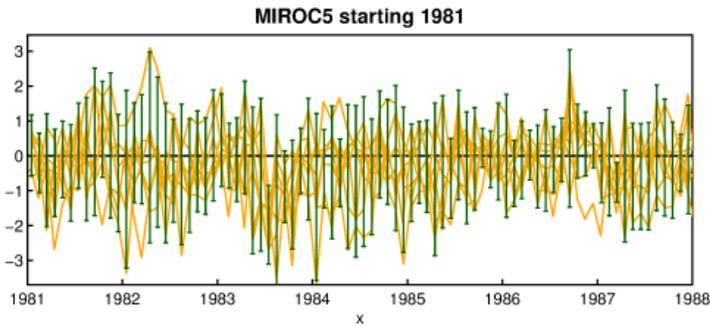
SCRIPPS

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Decadal prediction?

MIROC5



CA coastal
temperature
anoms

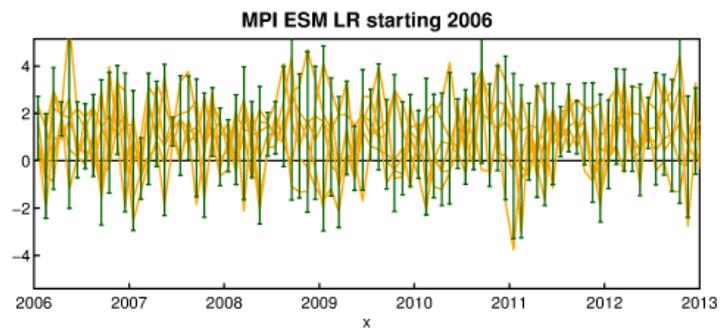
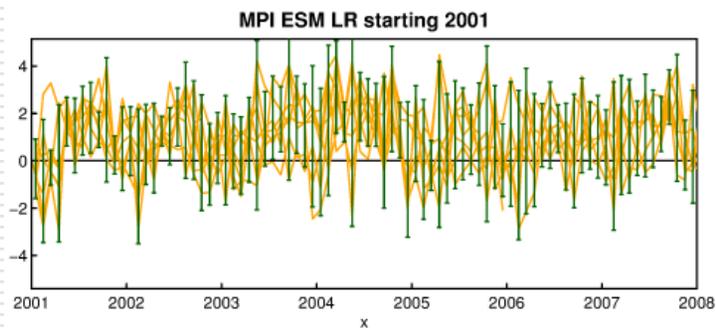
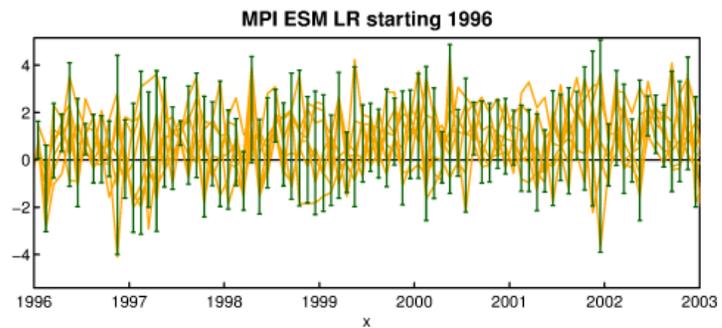
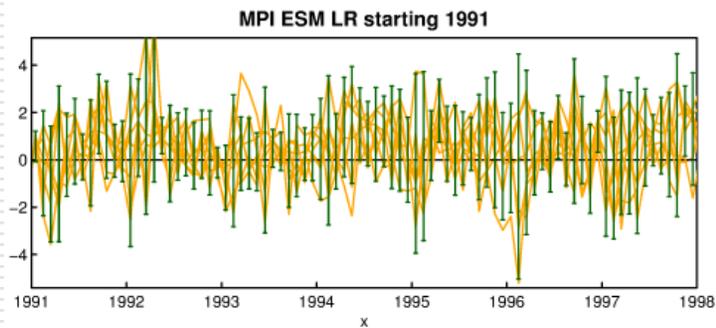
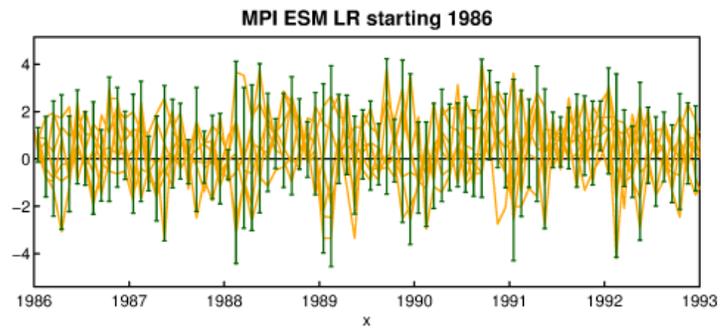
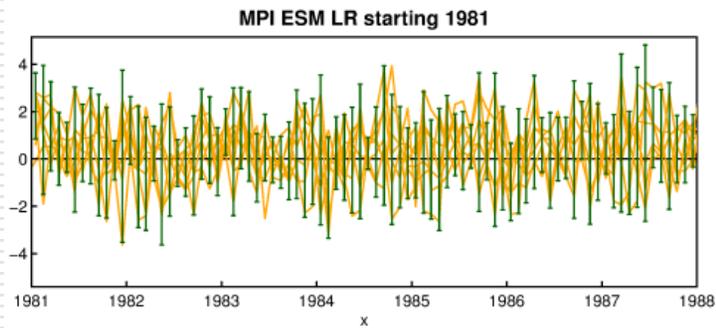
7 realizations

90% conf. int

/data/misc/cmip5/decadal/miroc5/plot_tser_coast_v2.R Fri Feb 15 13:13:53 2013

Decadal prediction?

MPI ESM LR



CA coastal
temperature
anoms

7 realizations

90% conf. int

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