Probabilistic forecasts for the energy sector

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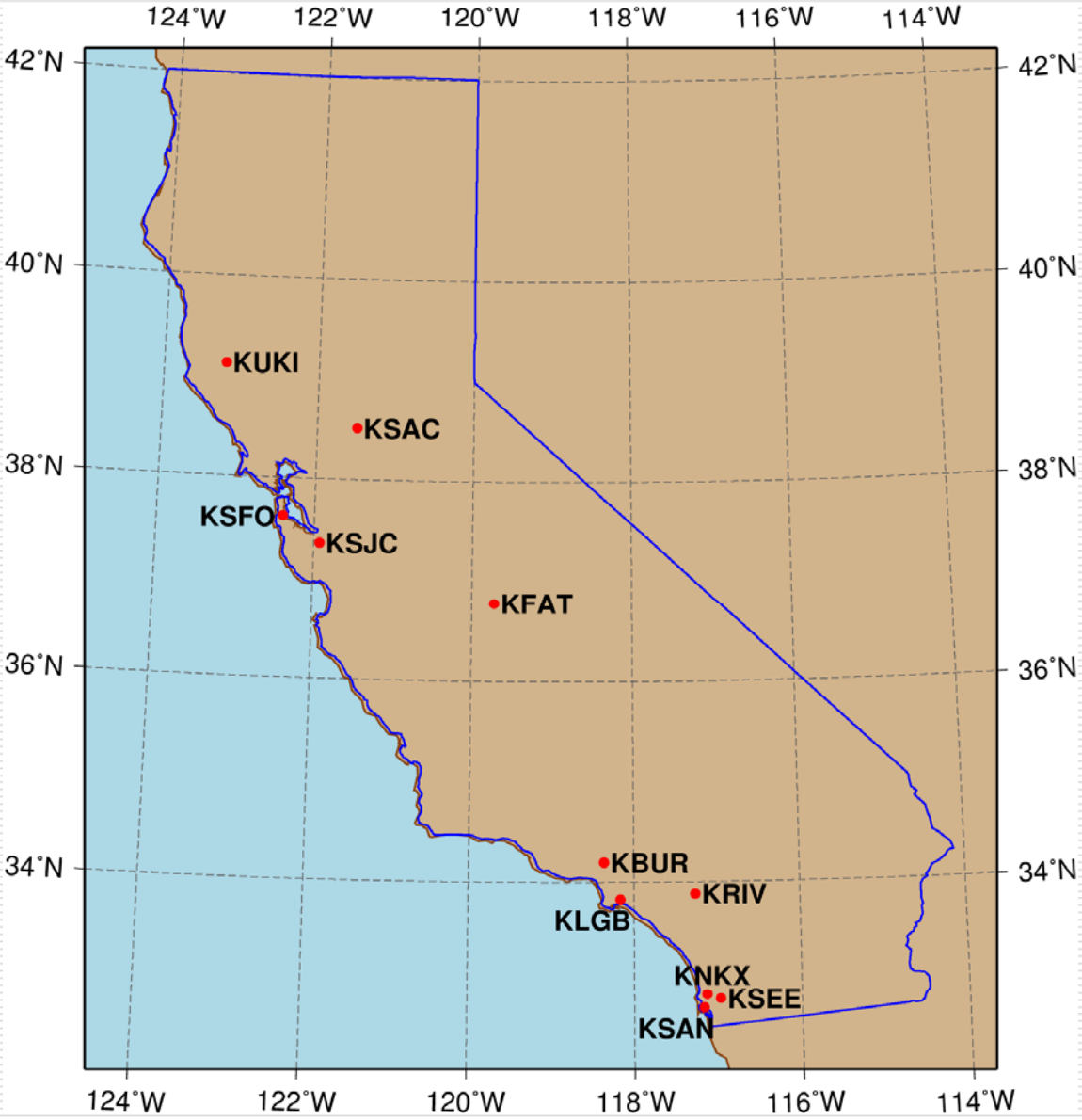
Stations used for utility load forecasting



Station weights: from Tom Gorin

PGAE:

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

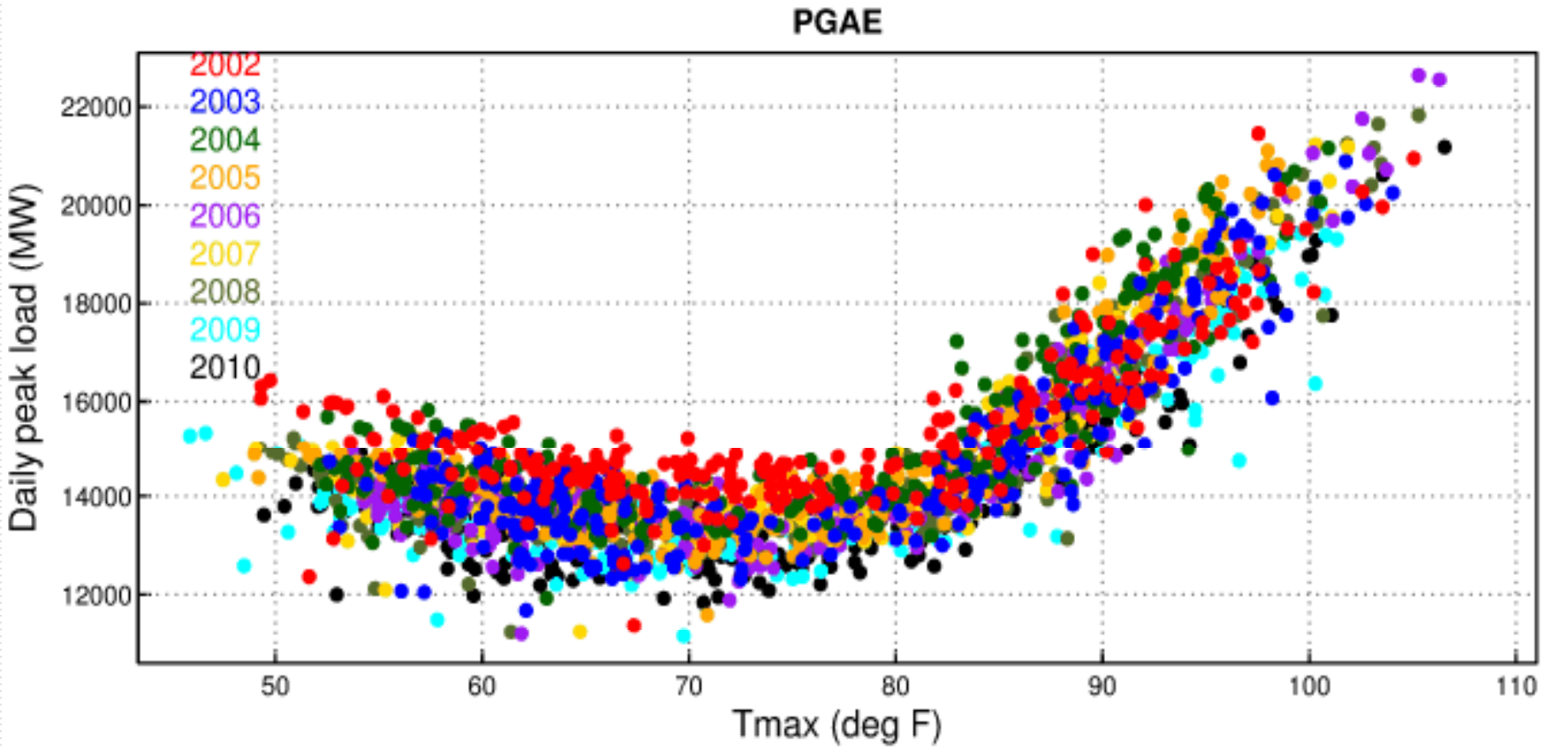
SCE:

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

SDGE:

KSAN: 0.333
KNKX: 0.333
KSEE: 0.333

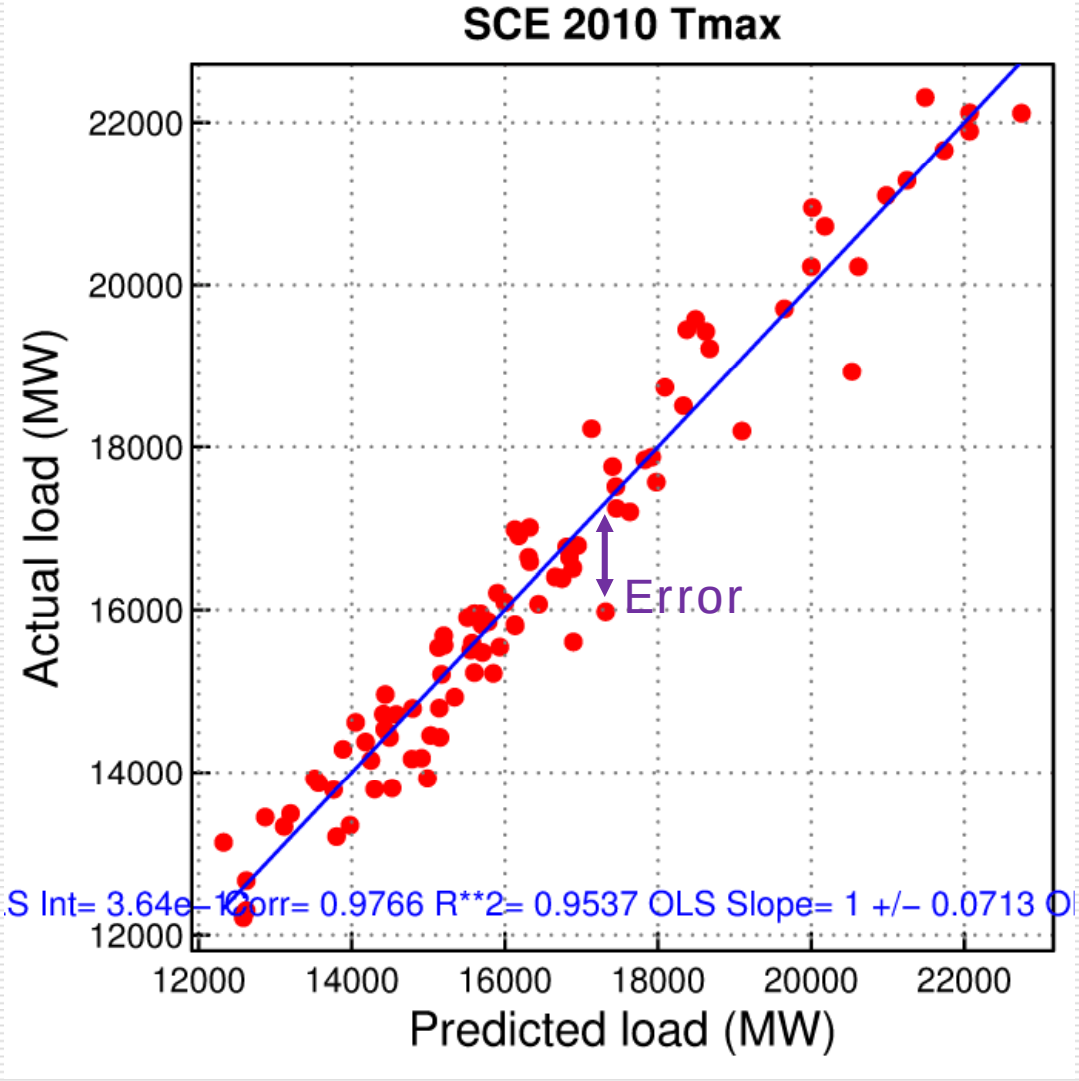
Load vs. max daily temperature, 2002-2010



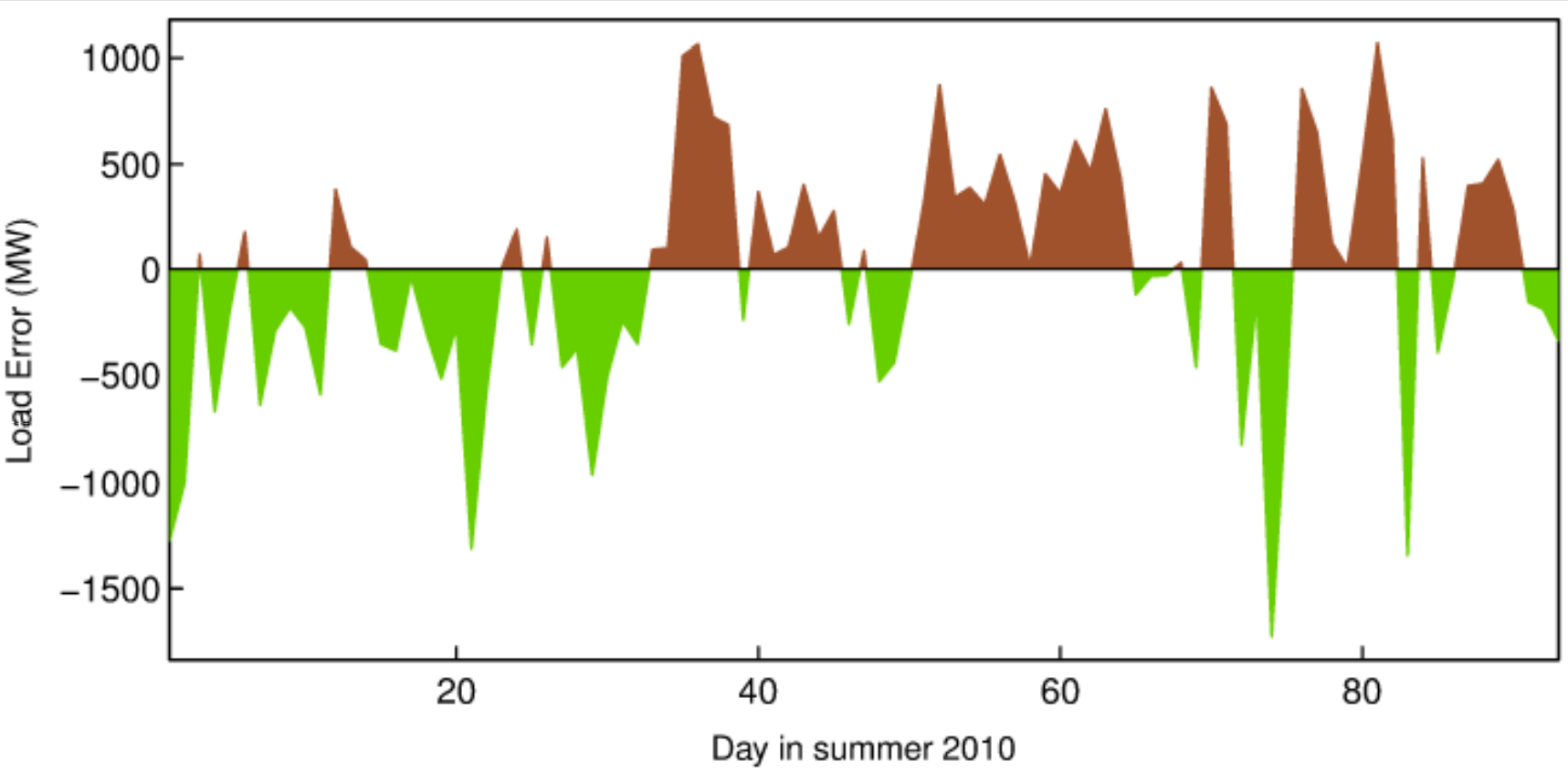
Have looked at PG&E, Southern California Edison, and SDG&E

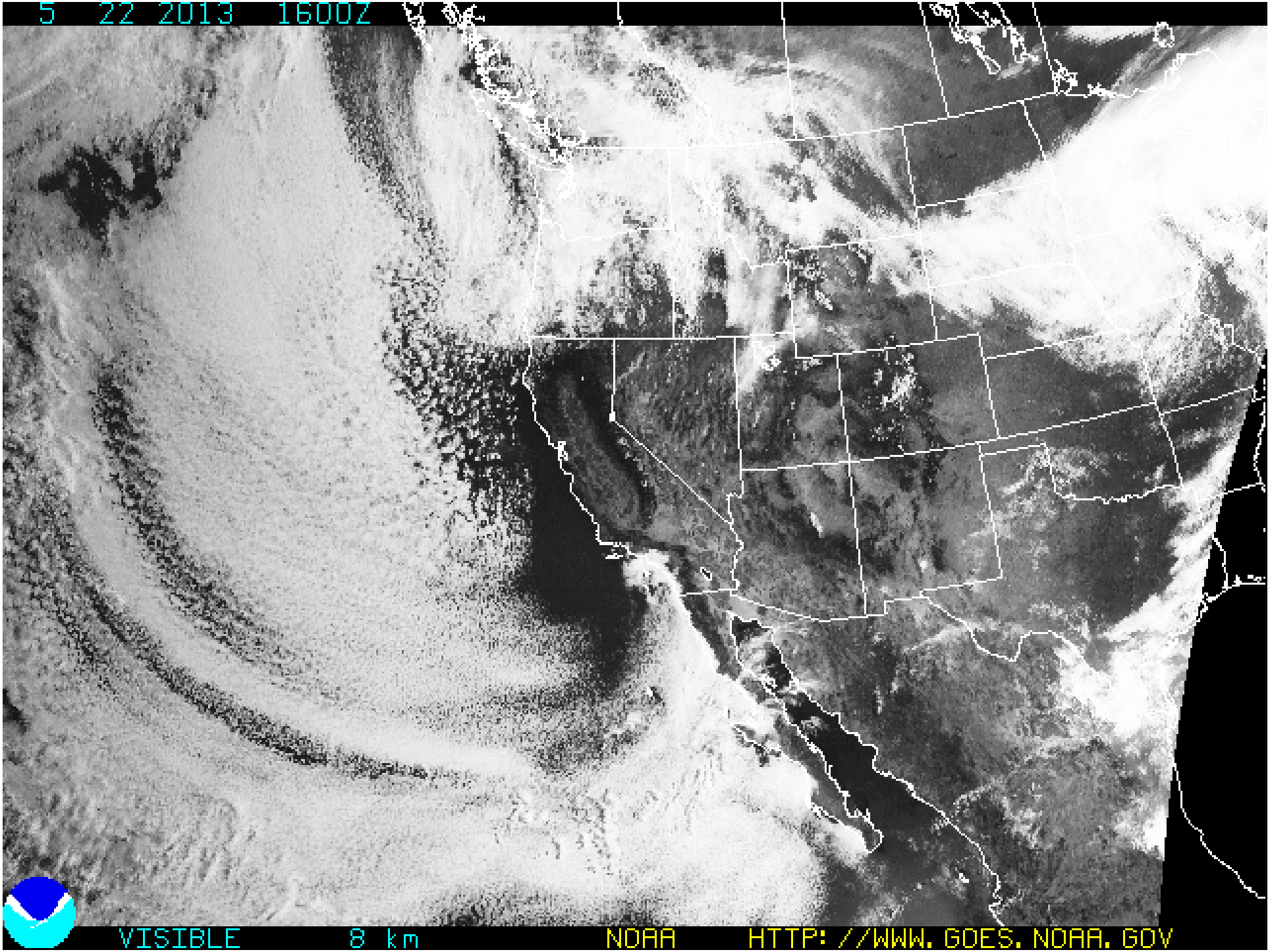
Predict load from T_{max}, T_{min}, and weekend/holiday

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

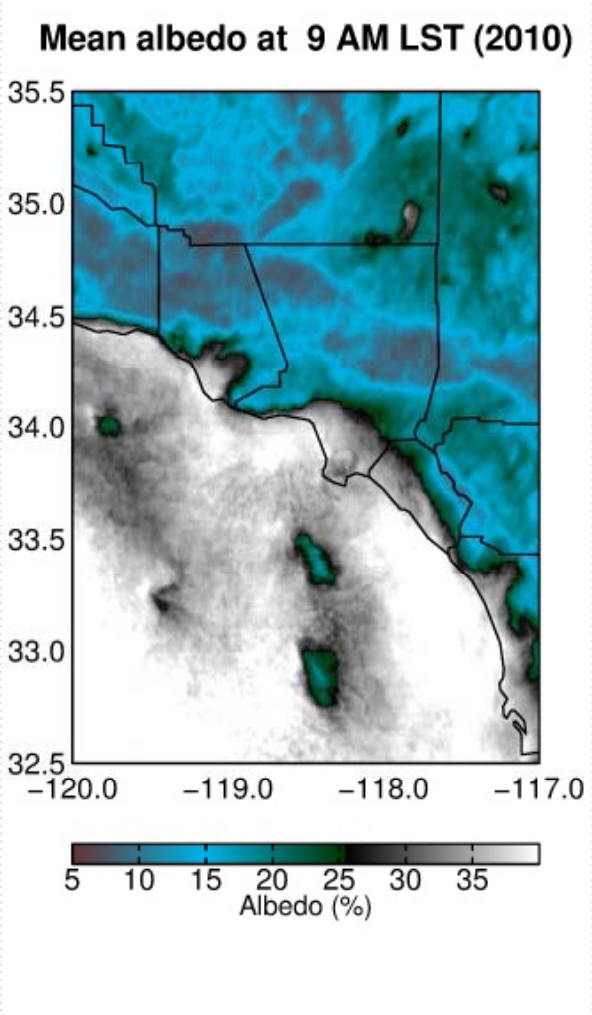


Load forecast “error” for Southern Cal. Edison




5 22 2013 1600Z
VISIBLE 8 km
NOAA HTTP://WWW.GOES.NOAA.GOV

Effect of low stratus



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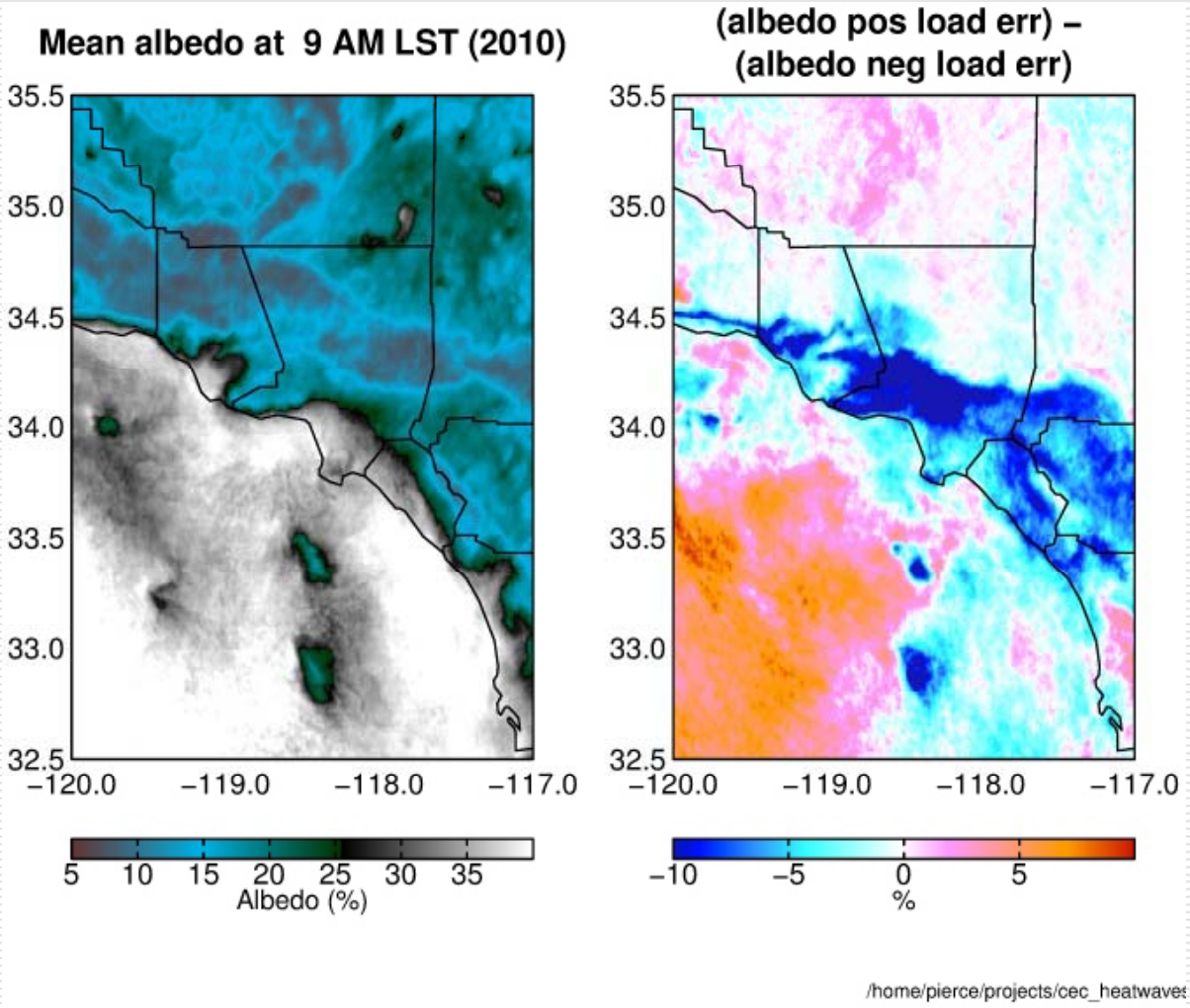

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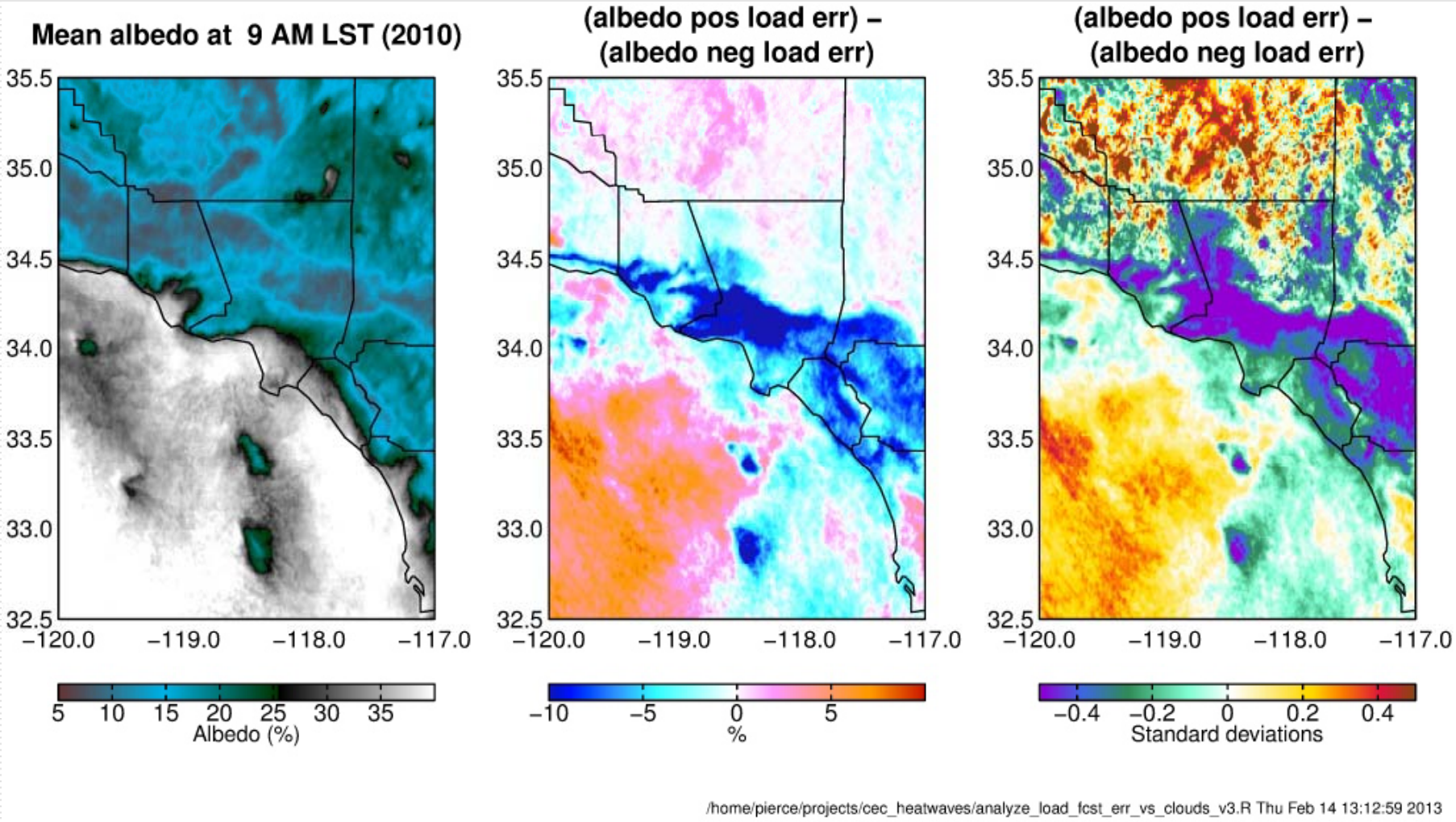
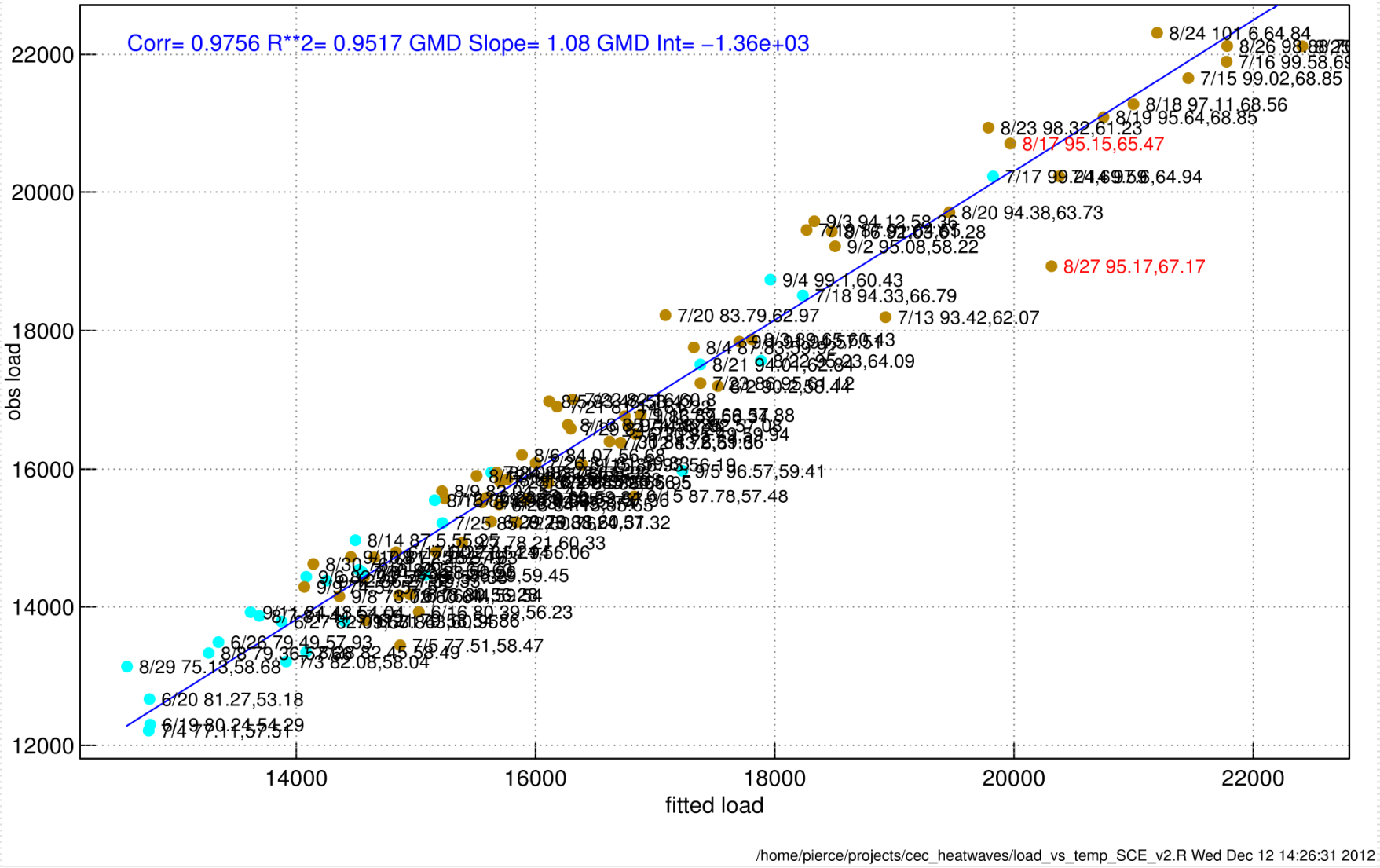
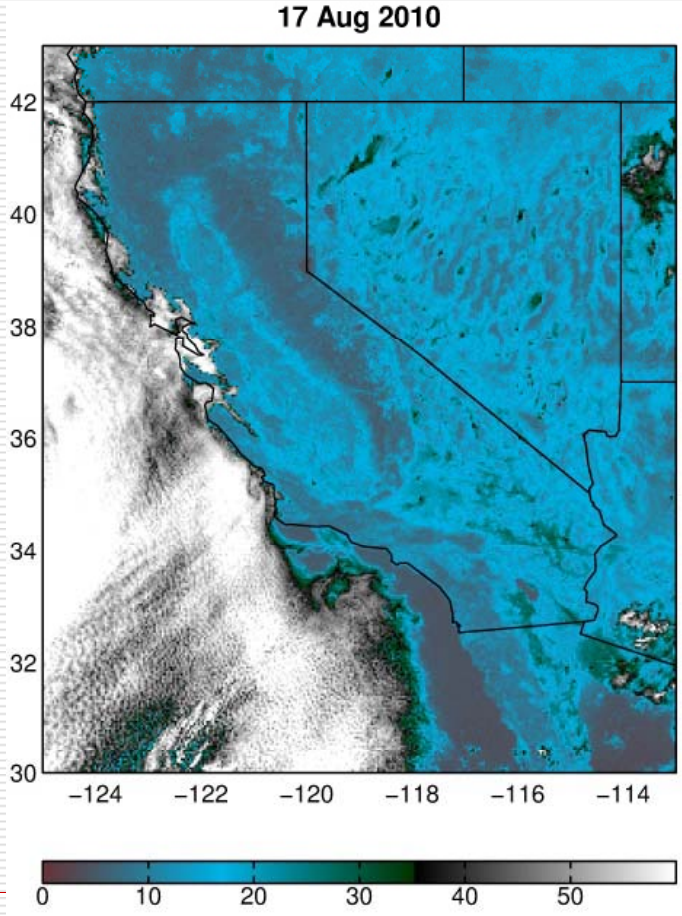


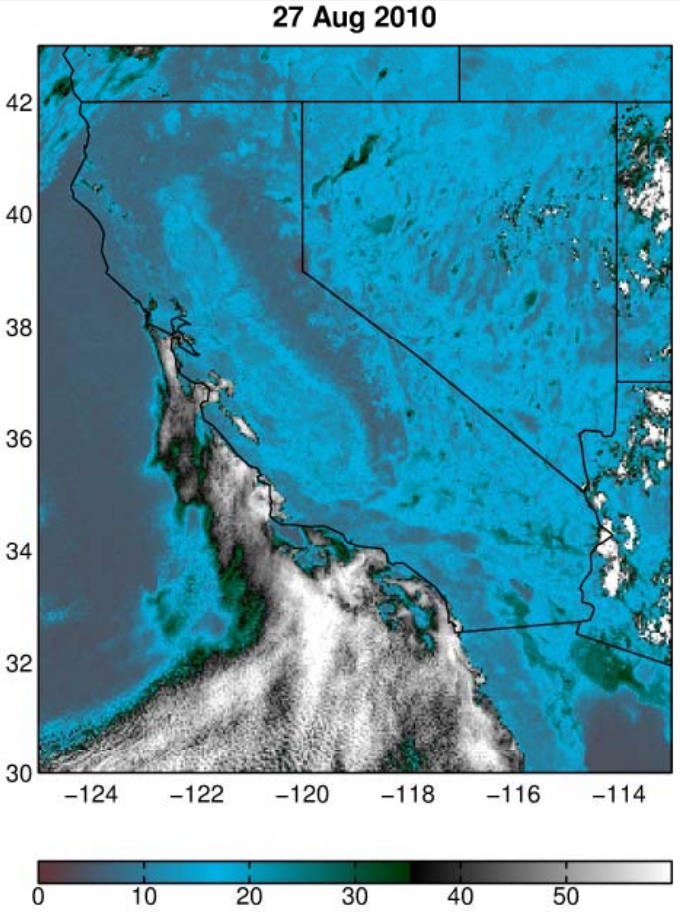
Fitted vs. actual loads, SCE, summer 2010



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

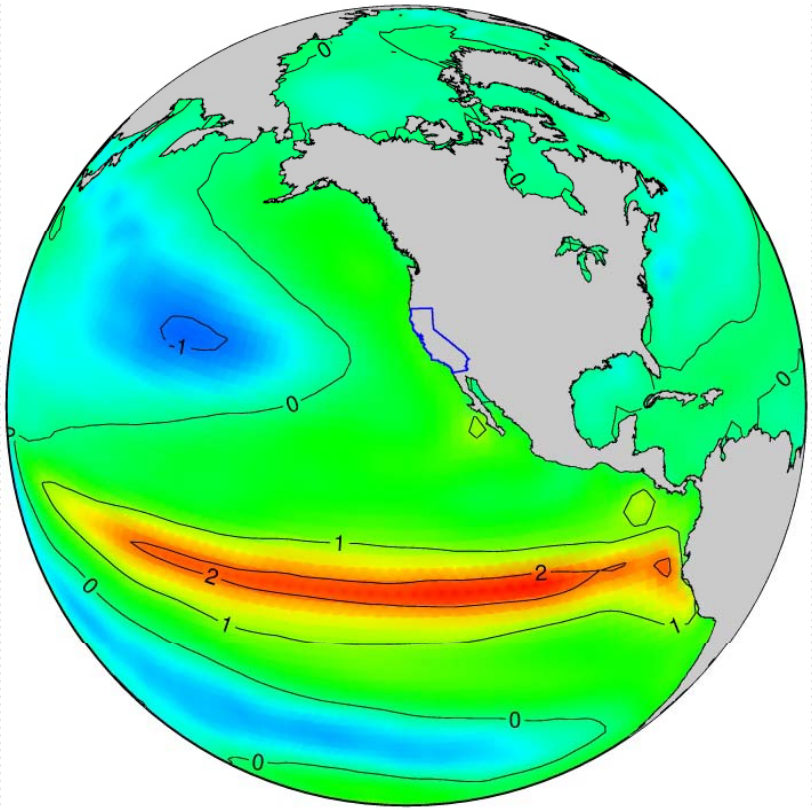




Albedo (%) at 9 AM

Sources of seasonal predictability

El Nino/Southern Oscillation (ENSO)



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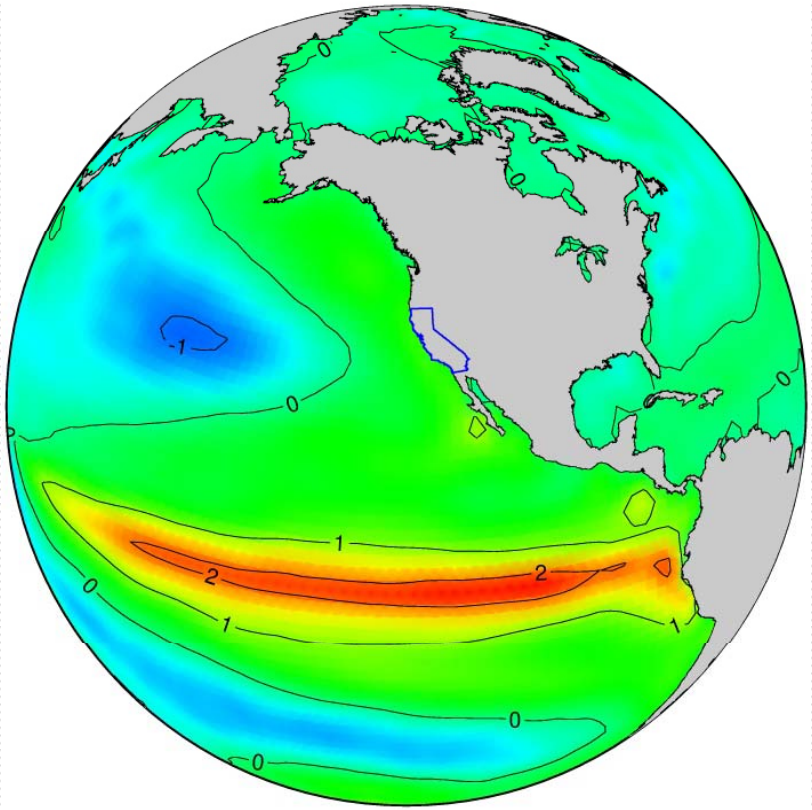
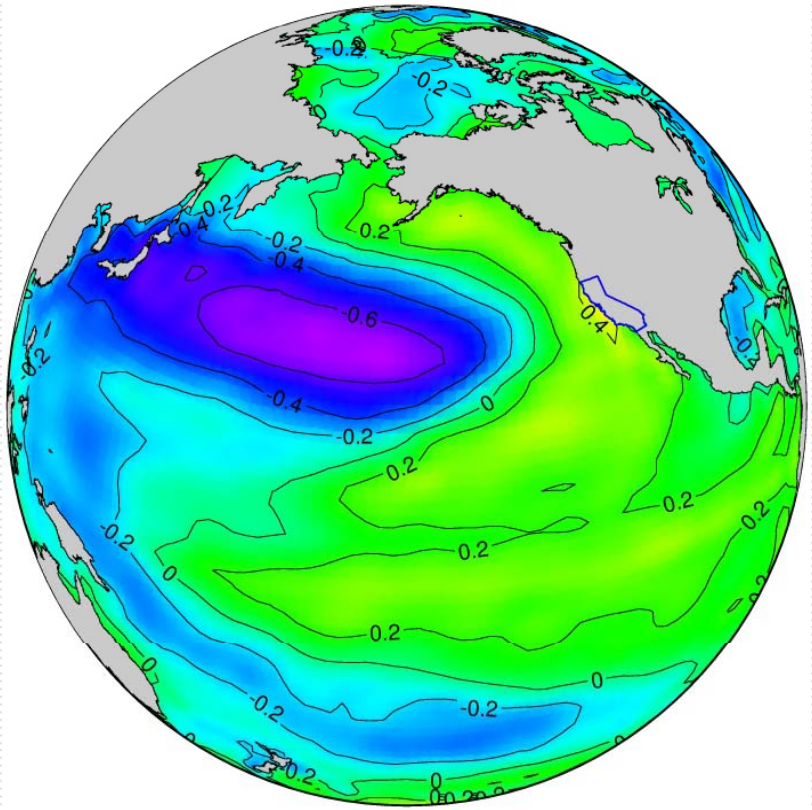


Pacific Decadal Oscillation (PDO)



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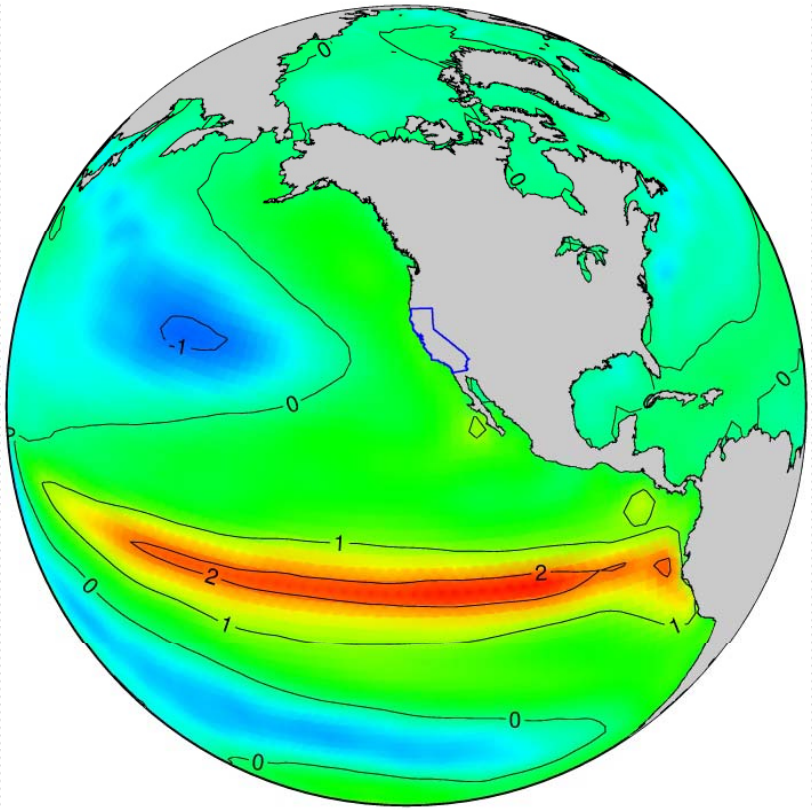

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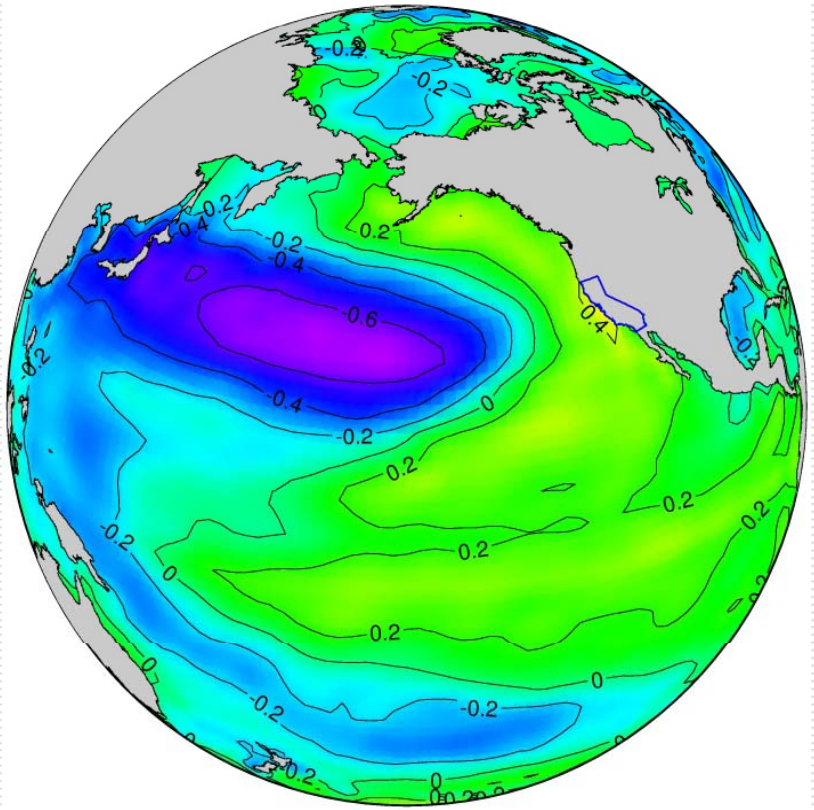


- Soil moist or dry

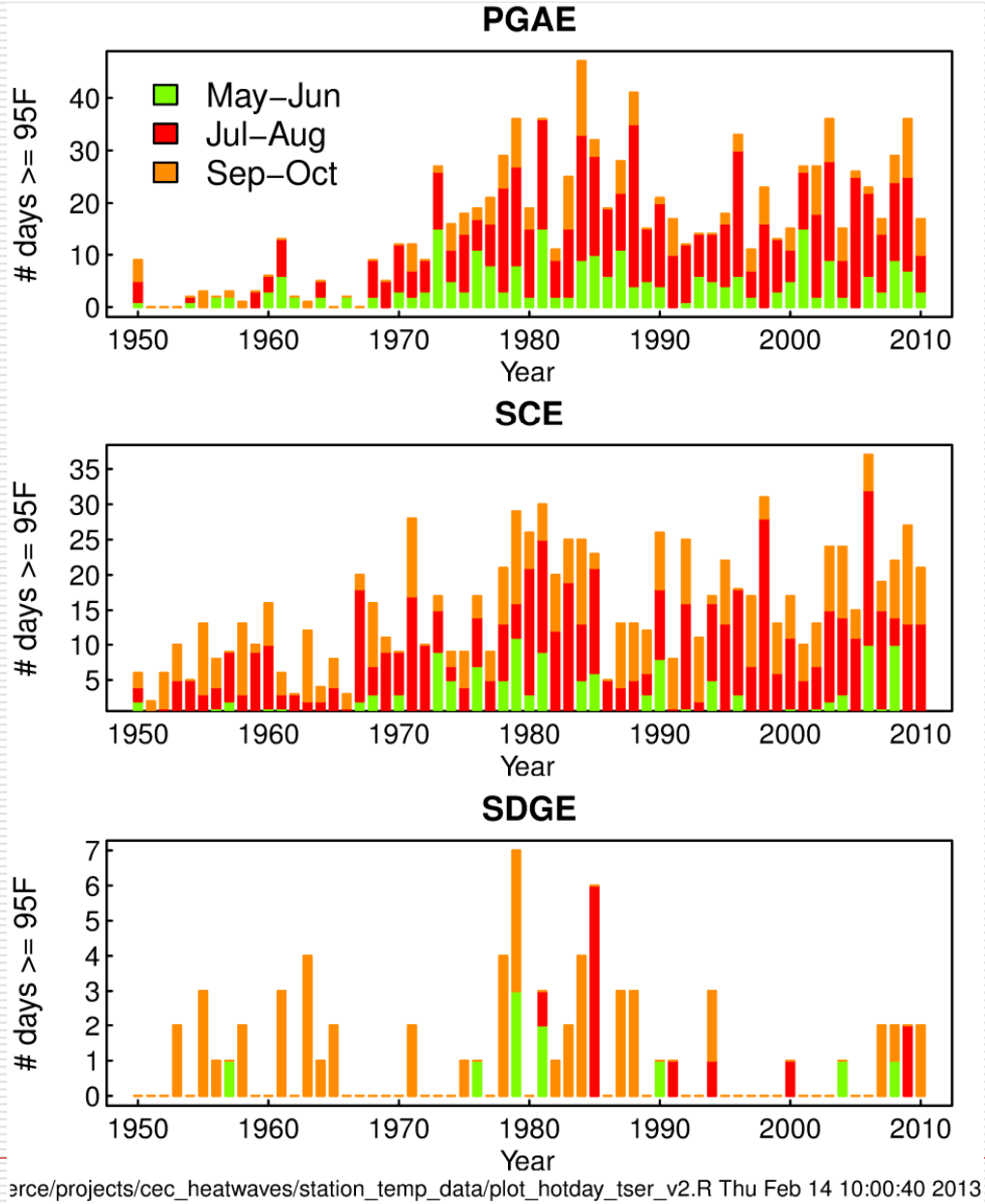
What we're trying to predict

- For each utility (PGAE, SCE, SDGE):
  - Number of hot days (>= 95 F)
  - Cooling degree days
  - Tavg, Tmax, Tmin

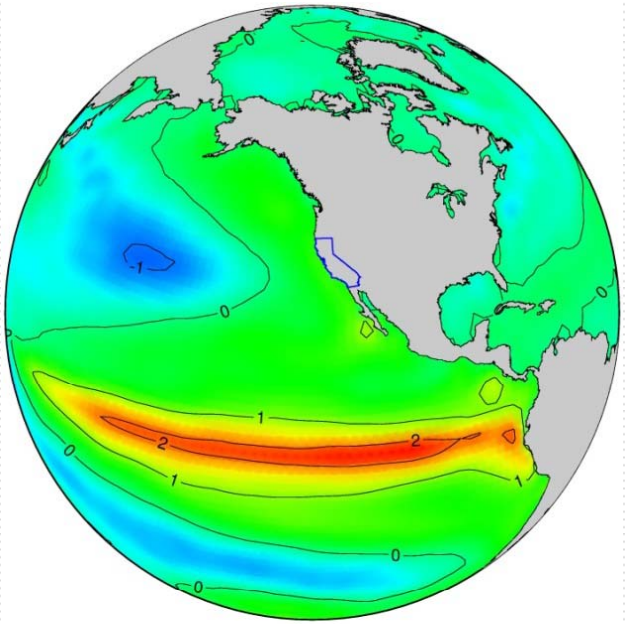
- Details
  - 1950-2010
  - Using terciles (lowest third, middle third, top third)
  - Seasons:
    - spring (Mar-Apr-May) and summer (Jun-Jul-Aug)
    - Warm season (May-Oct)
  - *A posteriori* significance values:
    - >= 11 or <= 3: 10%
    - >= 12 or <= 2: 5% *and* 1%
    - >= 13 or <= 1: better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

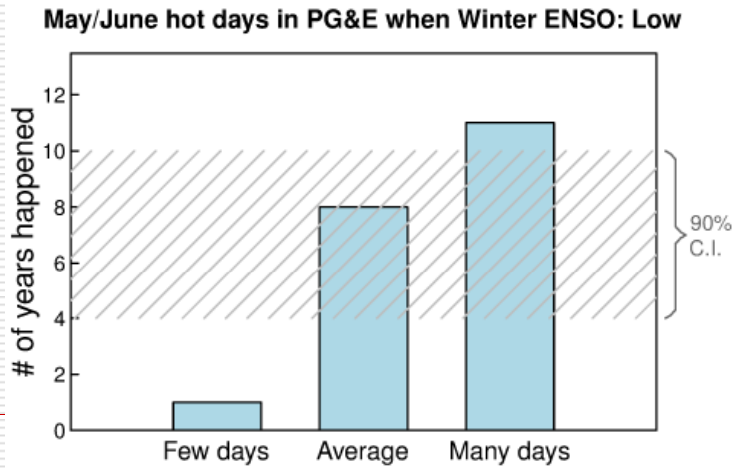


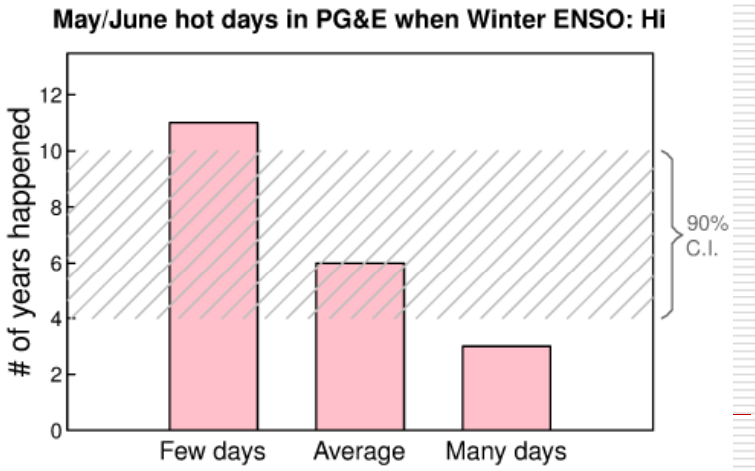
El Nino/Southern Oscillation



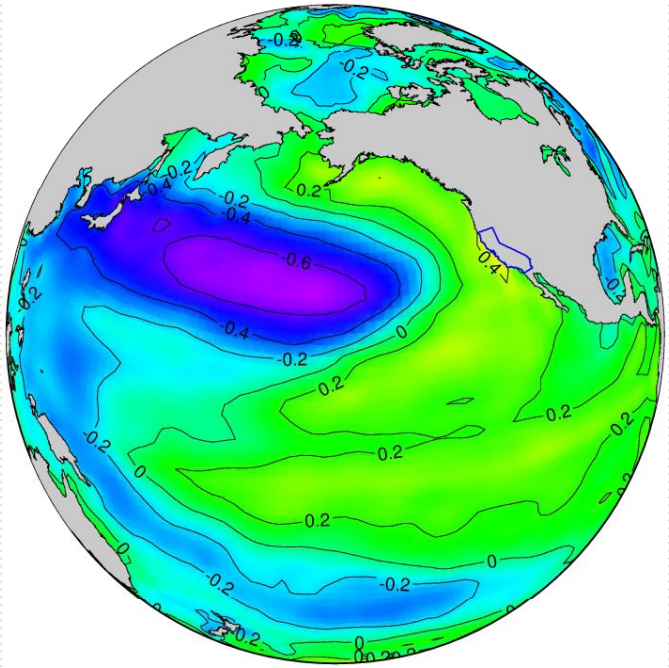
ENSO summary:

- 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

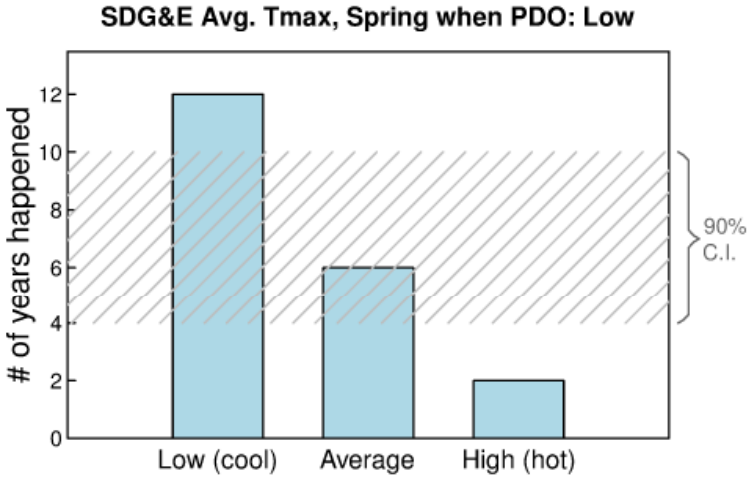


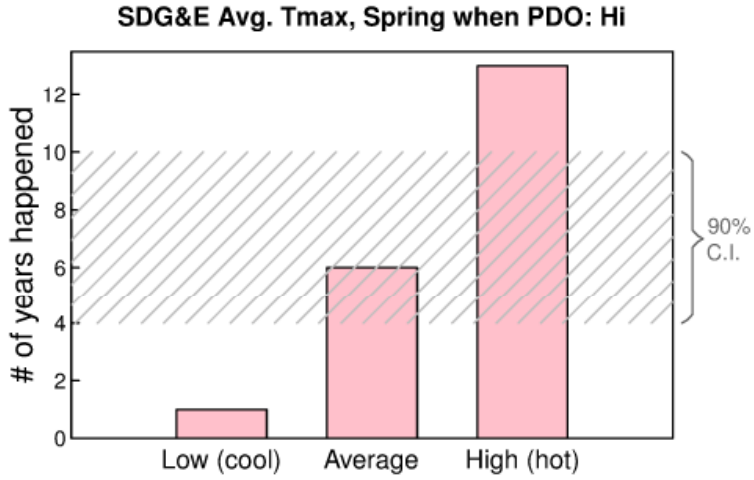


Pacific Decadal Oscillation



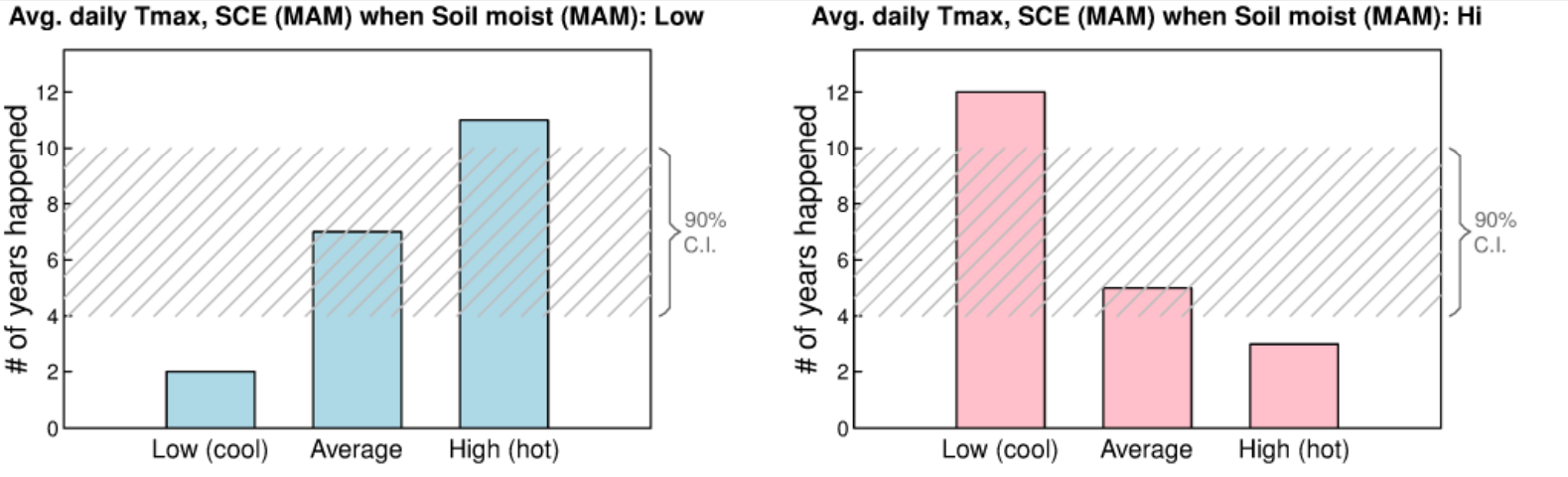
- PDO summary:
  - 31 significant relationships, mostly to *seasonal* quantities
  - Few relationships with hot days (only 4)
  - Warm PDO goes with a warm season, cool PDO goes with a cool season





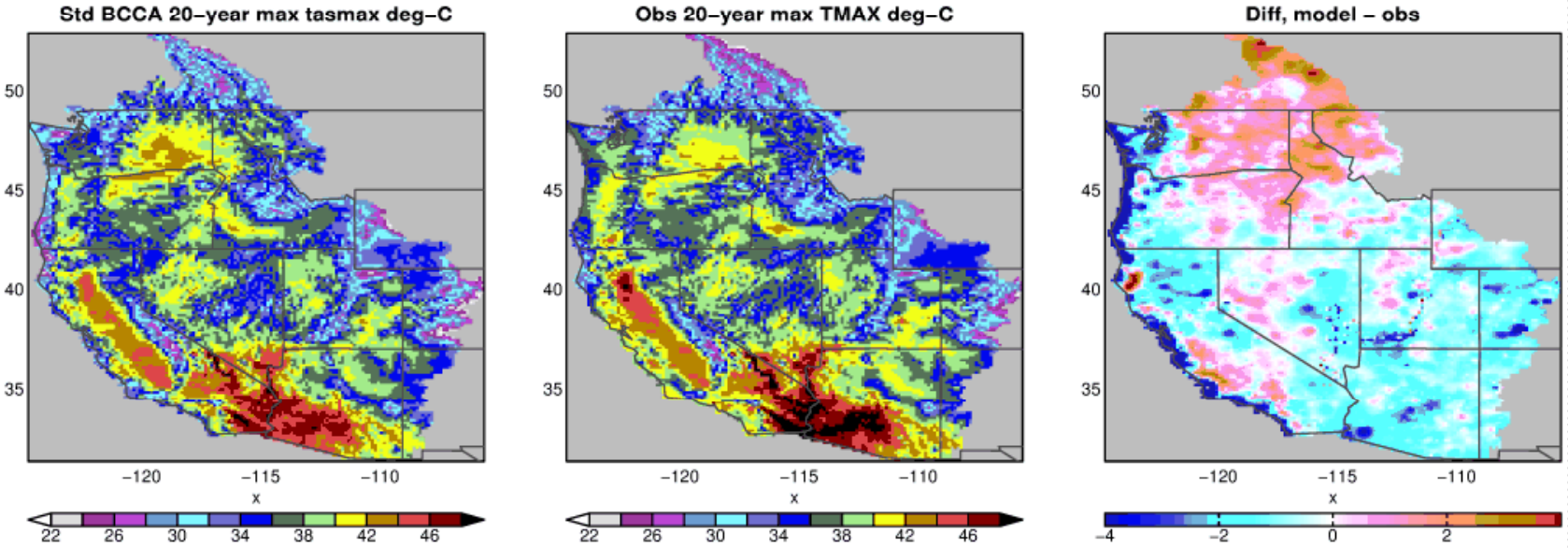
Soil moisture

- 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

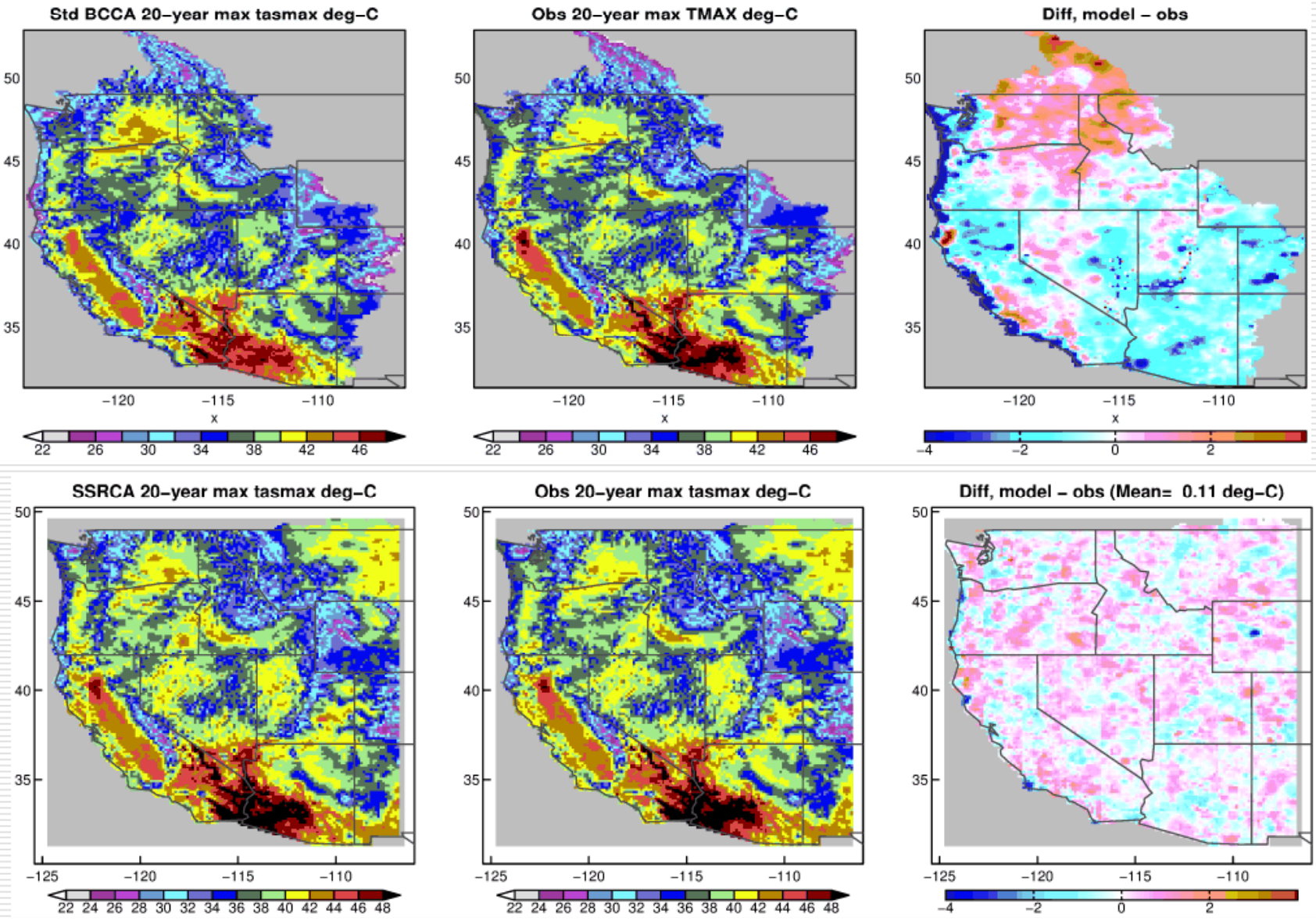


Hottest day in 1 and 20 years

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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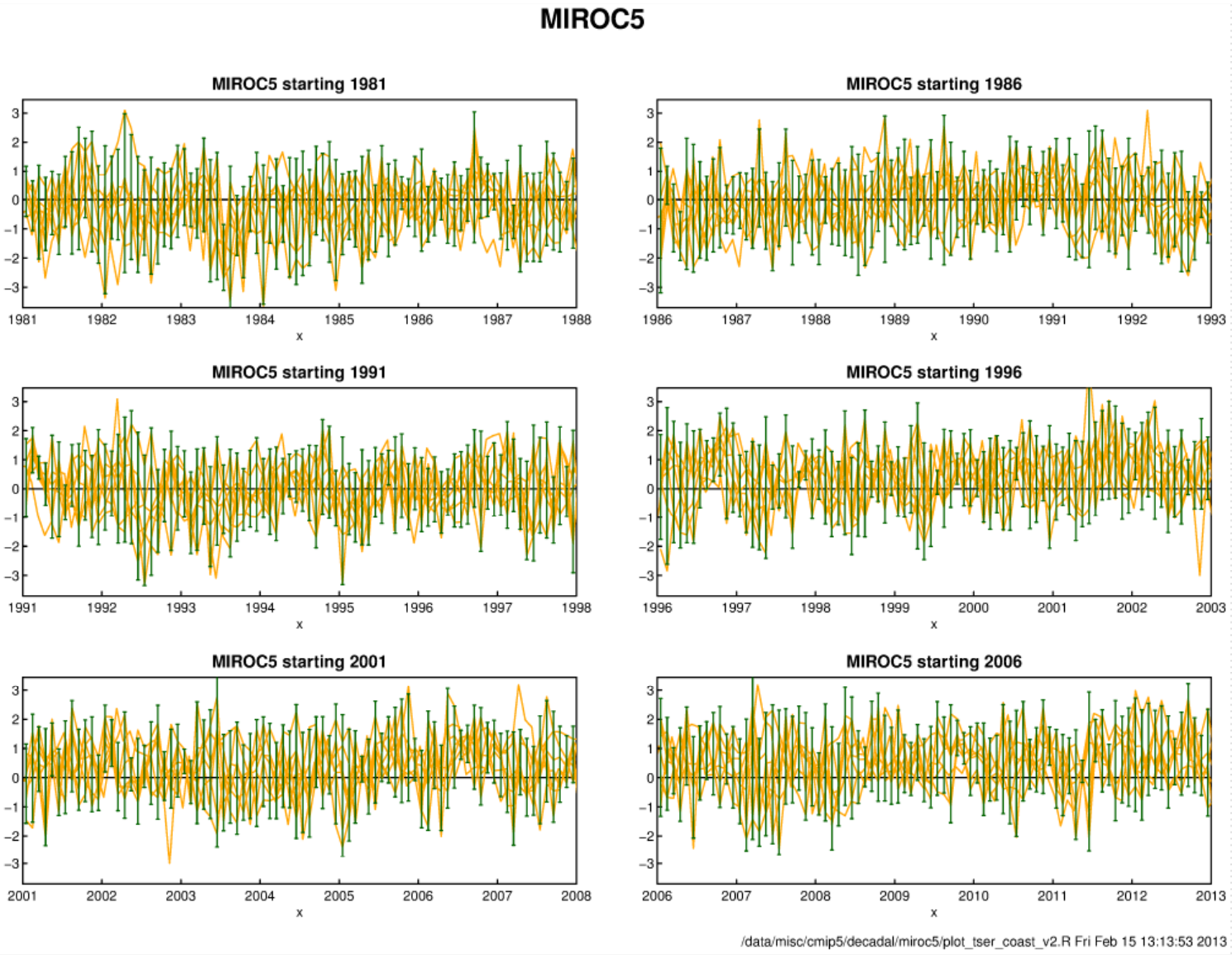
Decadal prediction?

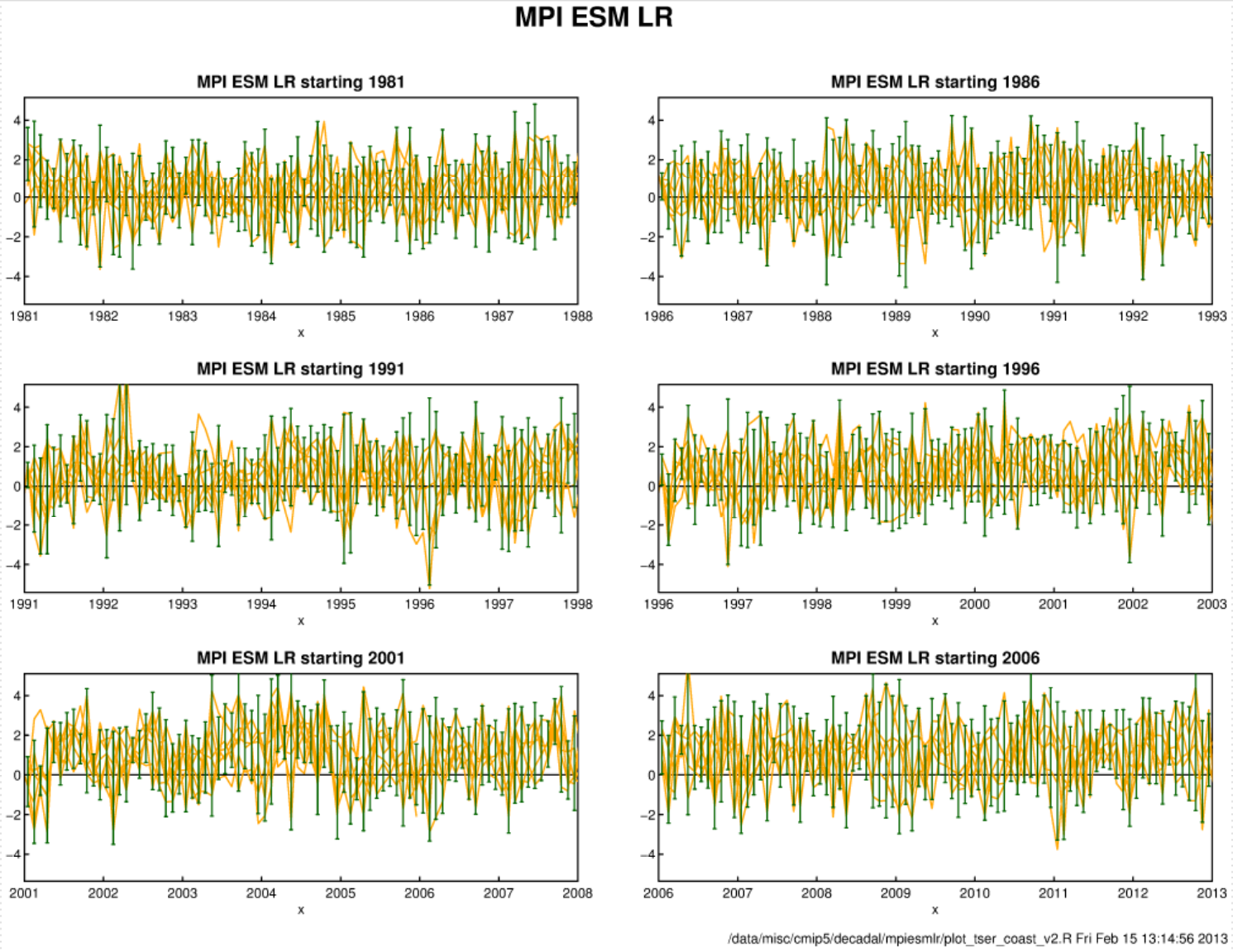


CA coastal temperature anoms

7 realizations

90% conf. int

Decadal prediction?



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