Trends in CCSM4 simulated California heat waves from large scale patterns

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1. Introduction
What do the CCSM4 weather patterns associated with extreme hottest days for the California Central Valley (CV) predict for the future? Grotjahn and Faure (2008) show Large Scale Meteorological Patterns (LSMPs) during extreme CV heat; Grotjahn (2011) used parts of selected LSMPs to predict extreme CV heat. Grotjahn (2013) compared observation-based data to LSMPs in a 20 year historical simulation by CCSM4. A longer historical period and two future climate scenarios simulations by CESM1 for the latter half of this century are now considered.

5. LSMPs index (CI) calculation
1. Project 850 hPa daily T anomalies and 700 hPa ω anomalies on parts of respective target ensemble mean patterns (fig 3a,b) to obtain daily circulation index (CI) as in Grotjahn (2011). Ensemble dates are hottest 1% of surface max T values (1979-88 period).
2. High CI implies hot surface max T, values
3. CI calculated for NNRA1 & model data

6. LSMPs comparison
1. Ensemble means for NDRA2 shown in fig 3a, b.
2. Ensemble means for CCSM4 (fig 3c,d) similar to observed but: i) weaker and ii) peak T anomaly is onshore, not off shore.

7. Results
1. Historical CCSM4: range, standard deviation (0.75 Std. Dev. vs 0.91) & skew all smaller than NNRA1. (fig. 4)
2. Historical CCSM4: too few of highest CI
3. RCP8 shifts median by 1 std. dev. (NNRA1 basis); RCP4 shift half that.
4. RCP cases: range increases as max values increase more than mins.
5. Model PDFs: RCP cases skew increases doubles historical period values. Historical CCSM skew 33% < NNRA1 skew, but CESM RCP 4 is 25% less.
6. Largest increases in durations above 1 std. dev. (1979-88 basis) due to shifts of medians. (fig. 5)
7. 20-yr return values increase ~25% (2.2 \rightarrow 2.8 (RCP4); \rightarrow 3.1 std. dev. ~40% (RCP8)
8. Inter-decade variation (fig 6). Standard deviation varies +/- 2-7%
9. Surface station trend unclear, but weak

8. Conclusions
1. CV unresolved so use LSMPs-based index as proxy for surface max temperatures
2. Model LSMPs similar to reanalysis-based LSMPs but too weak in CCSM; CCSM would not generate the hottest days adequately or often enough in historical runs.
3. In RCP scenarios, median shifts (0.5 – 1. std. dev.) skew doubles as min shifts less. Durations above 1 std. dev. increase greatly.
4. Return values (RV) increase greatly. In both RCP cases 20yr RVs exceed historical asymptote, i.e. unprecedented values.
5. RCP cases have PDF trend. For RCP8 trend exceeds inter-decadal variability.

9. Acknowledgment & References
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