On CCSM4 Versus Reanalysis Dynamics of Western North America hot spells

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1. Prior work & Motivation
Previous work (Grotjahn and Faure, 2008; Grotjahn 2011, 2013, 2014) find: Large Scale Meteorological Patterns (LSMPs) that amplify extreme heat in California Central Valley (CCV) on a regional scale. The LSMPs are an equivalent barotropic, nearly-stationary wave train (ridge-trough-ridge) across N. Pacific and western N. America. Model LSMPs are weaker and occur less frequently in CCSM4. LSMPs in the model do not incorporate unresolved topography and missing local circulations. A motivation is to uncover the dynamics of the hot spells LSMPs in reanalysis and model data. Emphasis here is on Wave Activity Flux (WAF, Takaya & Nakamura, 2001, form), backwards trajectories, & diabatic heating.

2. JIAS Data
“NNRA1” = NCEP/NCAR reanalysis 12 GMT daily data at 2.5x2.5 LatLon. 17 P levels, 6 hr resolution: 1981-2010. CCSM4 interpolated to corresponding resolution (1970-1999).

3. Hot spells identification
1. Remove long term daily means: LTDM
2. Normalize by LTDM standard deviation: SD
3. Apply to 15 CCV surface stations (5 model grid points) exceed their hottest 5%
4. Extend time period at least 6 stations (3 model grid points) exceed their hottest 5%
5. These dates define target ensemble for WAF, trajectories, other Calculations.
6. 22 NNRA1 events, 24 CCSM4 events over 30 years

4. Synoptics
Thermal anomaly max near coast, SLP low at coast, strong offshore (downslope) flow; enhanced sinking. Patterns in T, vertical motion, SLP gradient, and northerlies extend further north in CCSM than NNRA1.

5. Backwards trajectories
Most NNRA1 tracks from west, CCSM tracks from south; further north CCSM has west tracks; all sink over region

6. WAF and diabatic heating evolution NNRA1 & CCSM4
Za, W, & W convergence weaker in CCSM upstream, only ridge similar to NNRA1

7. Hot Spells Conclusions
1. NNRA1: LSMP evolution consistent with WAF convergence building: mid-Pacific trough & W coast ridge (KE increase) and W coast ridge (temperature increase)
2. NNRA1: Some trajectories from subtropics while many are zonal & pass through diabatic heating region ahead of trough. Then high potential temperature air aloft sinks over western US coastal region enhancing surface hot spell; adiabatic warming lowered & intensified subsidence inversion, blocked sea breeze. Do 2 paths mean two ways to generate hot spell conditions?
3. CCSM has weaker: LSMP and WAF. Za & WAF convergence patterns similar only where hot spell located
4. CCSM4 trajectories from subtropics, not from west, before arriving at location where max sinking occurs. Model paths cross weak diabatic heating ahead of trough, sink over western US inland. CCSM LSMP extends much further north
5. So: WAF weaker & origin of hot air more meridional in CCSM than in NNRA1 data. CCSM LSMP extends further north, but missing diabatic enhancement

8. Acknowledgment & References
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