

Updating Energy Commission standard weather data for use in California building energy efficiency standards

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**Workshop on the 2013 California
Building Energy Efficiency Standards
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Scope of project

- **Not an attempt to evaluate or revise current CTZ boundaries**
- **Focus is on developing a more current set of reference weather files, taking advantage of the increased availability of weather and solar data within the past five years**
- **A two step procedure has been used to first develop and archive as many historical weather files as possible for California locations, which are then used to produce “typical year” weather files for each available location**
- **From the resulting 88 “typical year” weather files, a subset of 16 have been selected as the certified weather files for use in updating the Title-24 building energy standards**
- **Work yet to be done include the development of localized weather files for microclimate variations within each CTZ, and of future year weather files taking into account the projected effects of global climate change.**



Existing CTZ weather files

- done by meteorologist Loren Crow in 1979-1983
- defined 16 California Thermal Zones (CTZ)
- reference weather files for each CTZ based on raw weather data from 1950 to 1980
- CTZ boundaries have been refined in the 1980's and 1990's, but overall definition of 16 CTZs have proven workable
- CTZ weather files were modified in 1990 to better match the mean weather of locations within each CTZ

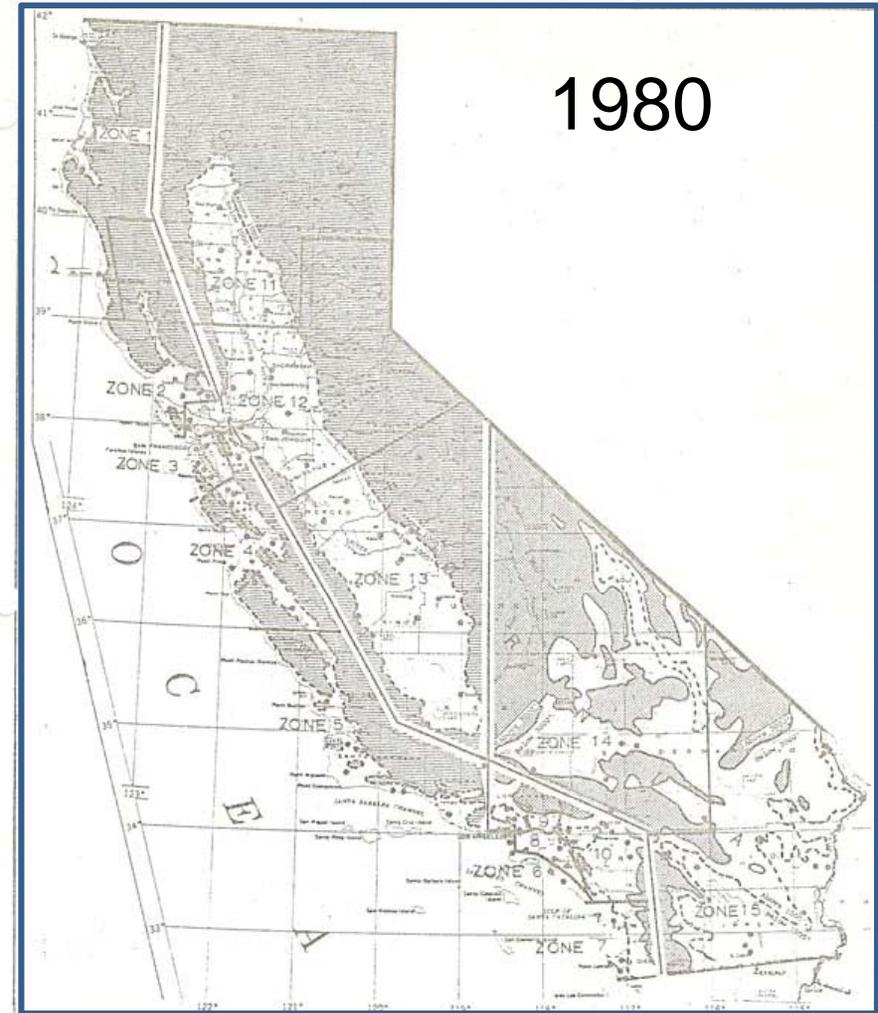
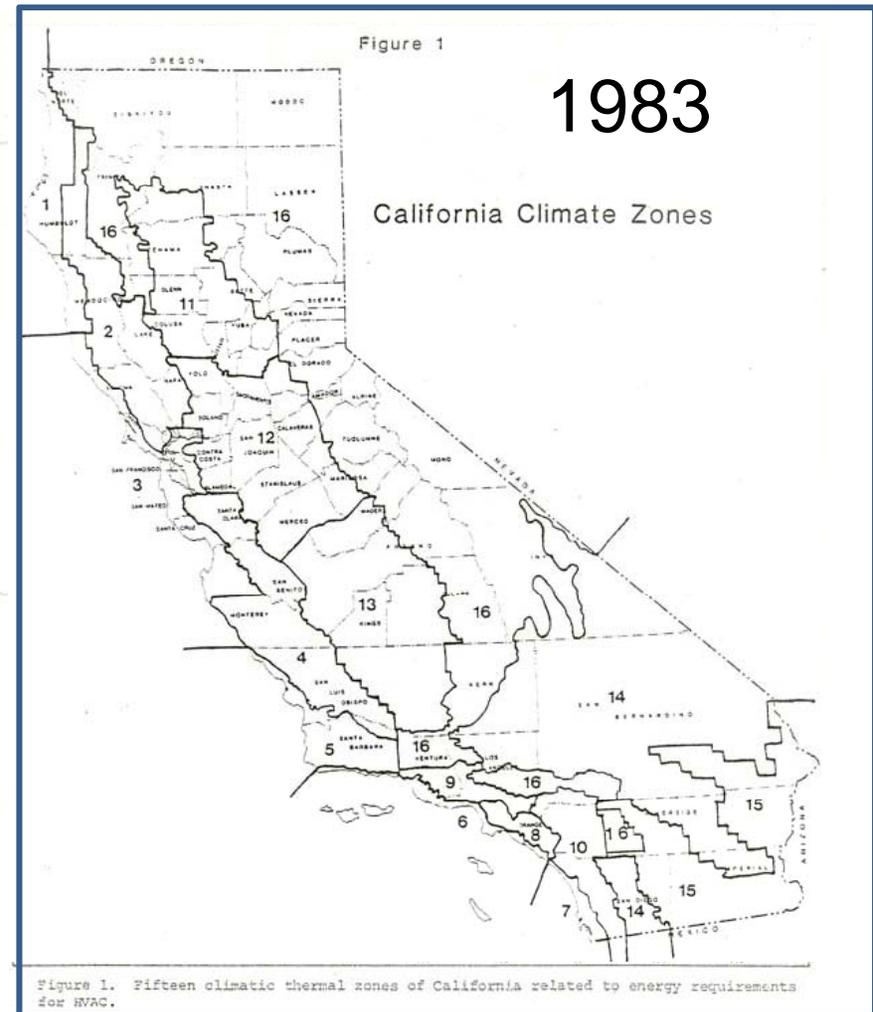


Figure 1. Fifteen climatic thermal zones of California related to energy requirements for HVAC.



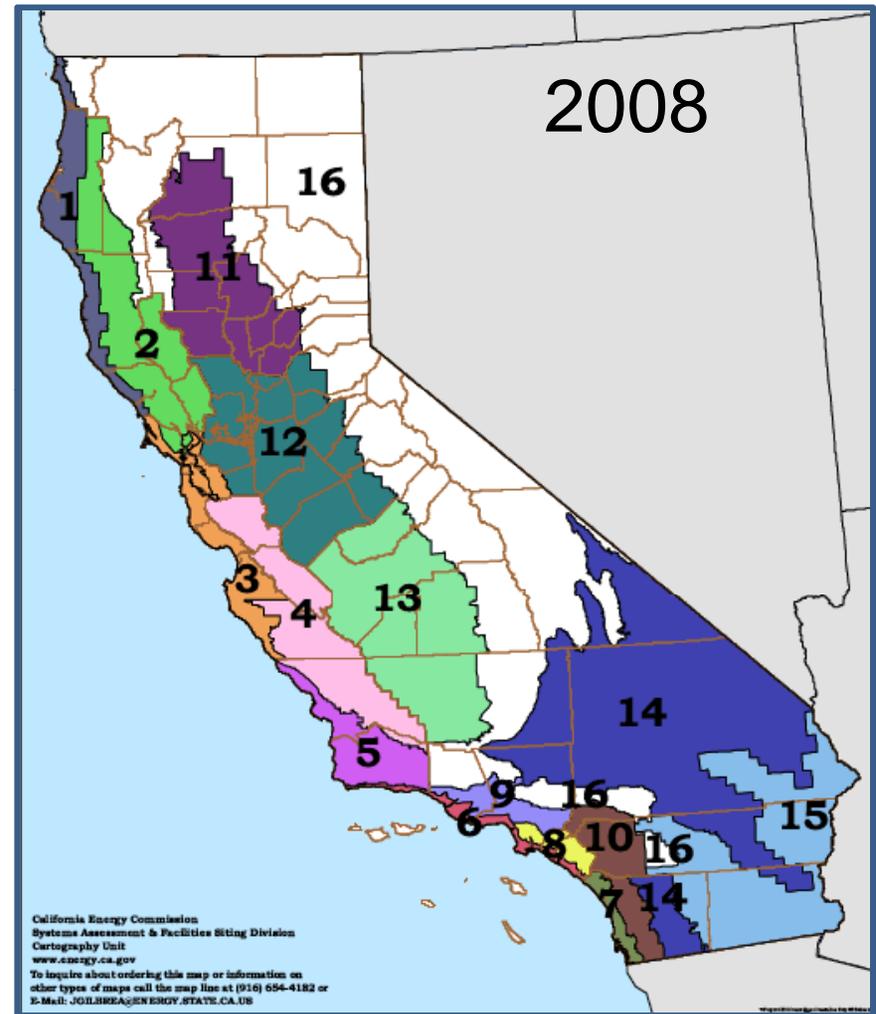
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Limitations of existing CTZ files

- **Average age of weather data is 45 years** (climate may have changed due to regional or global trends, as well as human effects such as urbanization)
- **Selection of reference locations for the 16 CTZs highly limited by data availability** (many CTZs had only one available station from which to chose)
- **Solar data on some of the CTZ files are questionable** (some stations have solar data that differ significantly from average values from other sources such as the NSRDB)
- **Weather files are not synchronized** (each file uses a different historical month based on local statistics, which creates problems when the TDVs are applied)



Project status as of Nov 2010

Completed Tasks

- Created historical weather files for the last 12 years (1997 – 2008) for 88 California locations in NCDC's ISH (Integrated Surface Hourly) data base that had sufficient data for producing hourly weather files
- Incorporated satellite-derived solar data developed by Richard Perez/SUNY and obtained from NREL on a 10-km grid (~ 6 mile) for the entire state for eight years 1998-2005
- Selected state-wide “typical months” using standard TMY methodology, but combining the statistics for all 88 locations weighted by county populations, from 1998-2005
- Created “typical year” weather files for all 88 locations using selected state-wide “typical months”
- Select reference locations for the 16 California CTZs from the pool of 88 “typical year” weather files



Project status as of Nov. 2010

Remaining tasks (scheduled for completion late Spring 2011)

- Incorporate satellite-derived solar data 2006-2008 to expand pool of historical weather files from 8 to 11
- Merge METAR data on temperature and wind speed on a 10-km grid (~ 6 mile) to produce microclimate weather files at the same resolution for any location in the state
- Develop future year weather files incorporating predicted climate changes from global climate change models



Sources of weather data

The Integrated Surface Hourly (ISH) data base

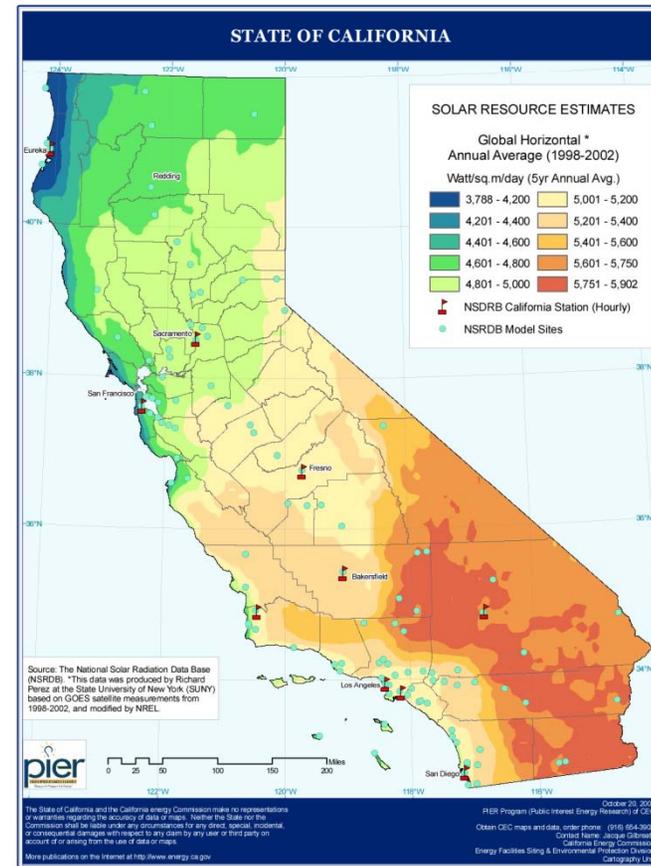
- The surface observations are taken from the ISH, which is a large data base maintained by the National Climatic Data Center (NCDC) containing up to 28 years of weather data for over 12,000 weather stations around the world, of which up to 7,000 (1,400 in the US, 100 in California) have data of sufficient resolution for developing hourly weather files
- The ISH is periodically updated, so that the latest weather records are delayed a month or so from real time
- In 2006, NCDC made the ISH available on the Web, with access free of charge for US government and educational institutions, and at cost for commercial applications



Sources of weather data

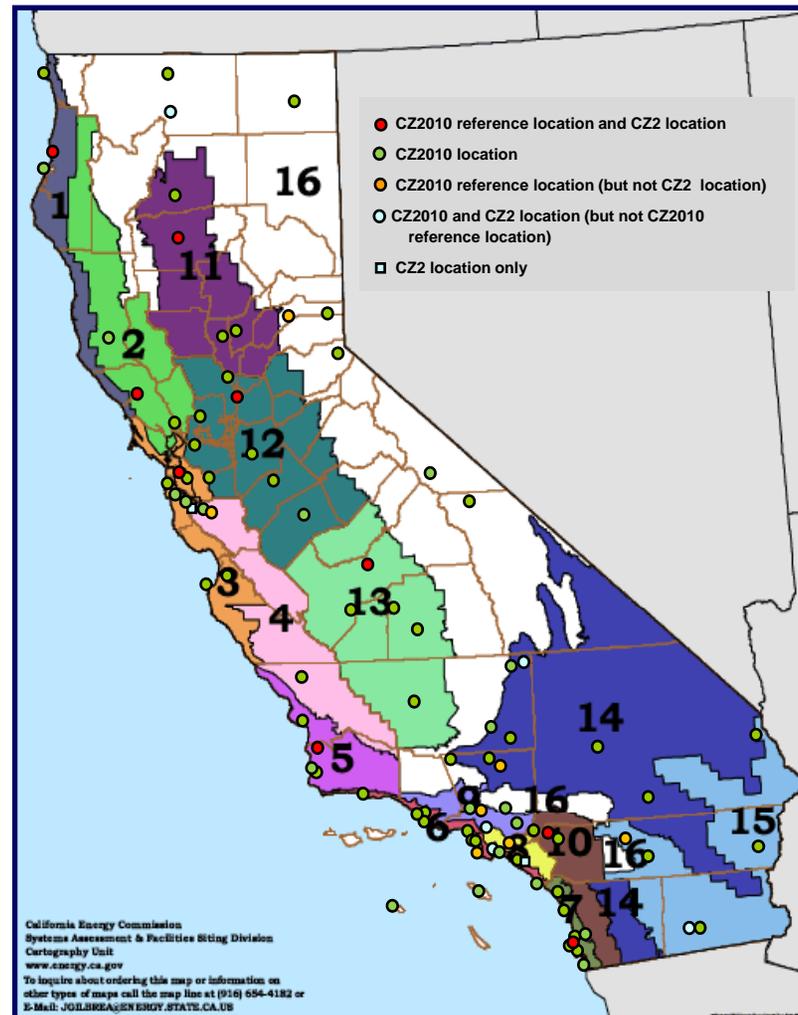
Satellite-derived solar radiation

- In 2008, eight years (1998-2005) of solar radiation derived using a satellite radiation model by Richard Perez at SUNY has been made available on the Web by NREL on a 10-km grid for the entire US. Commission staff obtained this data for California locations, and provided it to the project to incorporate into the weather files.
- The project later also obtained 3 more years of this data (2006-2008) directly from Richard Perez and Clean Power Research



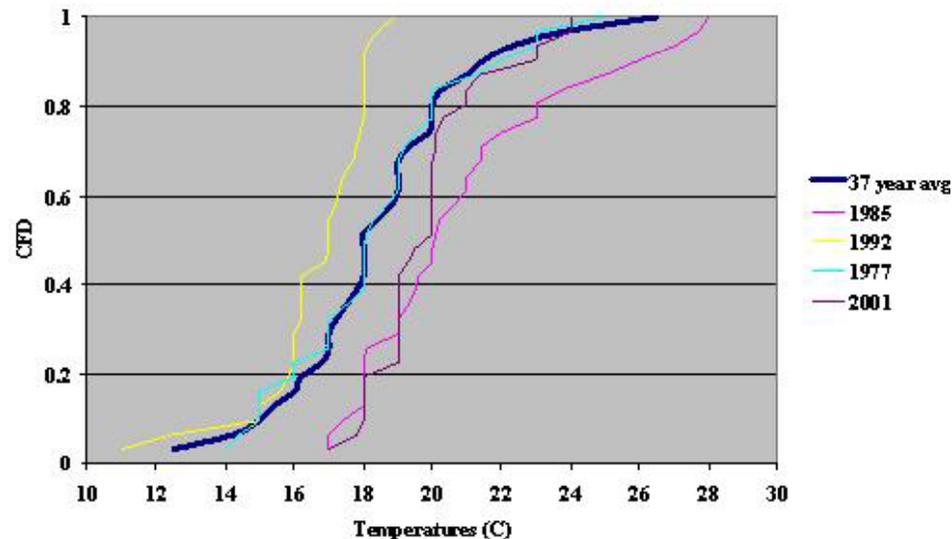
CZ2010 Weather file locations

- The last 12 years was selected as the window of time for creating the CZ2010 weather files
- 88 California locations were found to have ISH data of sufficient completeness and record length for producing CZ2010 weather files
- For each CTZ, there were a minimum of 3 stations and a maximum of 8 stations



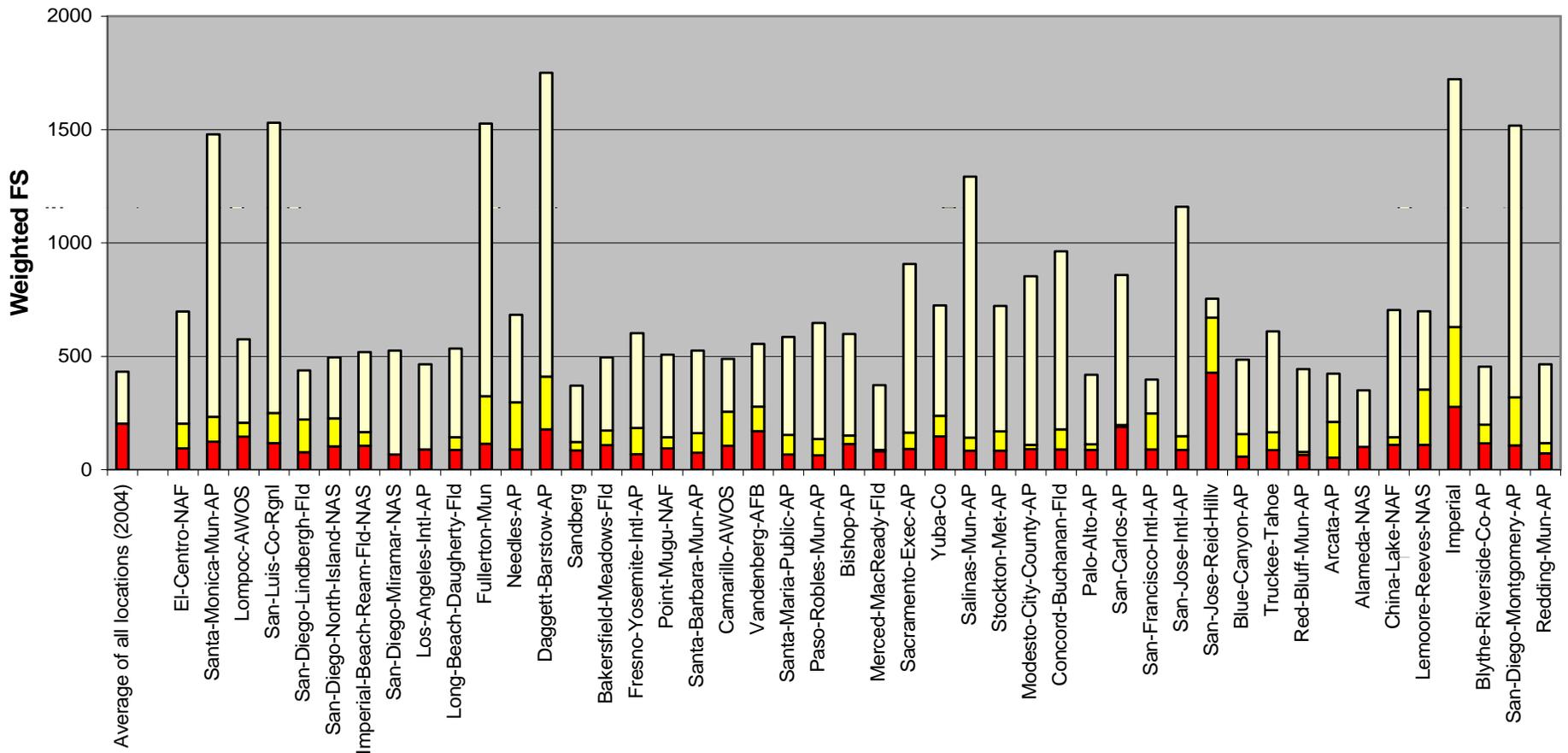
Methodology for selecting “typical months”

- 12 calendar months from the historical period of record are selected as the representative months based on various criteria and weighting.
- The Typical Meteorological Year (TMY) method developed by NREL compares the Finkelstein-Shafer Statistic (FS), or difference in the cumulative distribution of each climate variable compared to its long-term cumulative distribution, and picks the month with the smallest FS.



Impact of using the same “typical month” for 45 California locations

Weighted FS for January (average for all locations 2004)



Weighting the FS statistic for each station by its share of the county population

03_statewide (excerpt)

City	Population	FS by year							
	Weight	1998	1999	2000	2001	2002	2003	2004	2005
Alturas	0.043	1.564	1.257	1.128	1.066	1.607	1.176	1.674	0.868*
Arcata AP	0.063	1.356	1.150	1.449	0.867*	1.763	1.230	1.574	1.232
Bakersfield Meadows Fld	0.132	1.522	2.027	0.966*	1.170	1.778	0.999	2.773	1.295
Bishop AP	0.018	1.255	1.646	0.712*	1.149	1.651	0.742	1.968	1.108
Blue Canyon AP	0.324	1.649	1.529	1.066*	1.471	1.343	1.303	2.166	1.269
Blythe Riverside Co AP	0.105	1.062	1.057	0.970	1.532	1.609	0.710*	1.402	0.912
Burbank/Glendale AP	1.012	1.117	1.713	0.823*	1.021	1.331	1.146	1.897	1.071
Camarillo (AWOS)	0.251	1.106	1.421	0.874*	1.487	2.212	1.155	1.579	1.387
Camp Pendleton MCAS	0.352	0.896*	1.526	0.904	1.473	1.674	1.720	1.552	0.959
Carlsbad/Palomar	0.352	1.213	1.357	0.989	1.334	1.351	1.296	1.924	0.944*
China Lake NAF	0.132	0.941	1.352	0.738	1.043	1.498	0.682*	1.445	1.082
Chino AP	1.120	1.867	1.840	0.700*	1.324	1.926	1.471	2.084	0.961
Concord Buchanan Fld	0.949	1.225	1.960	0.868*	0.872	1.102	1.170	1.996	1.315
Crescent City FAA AP	0.028	0.967*	2.003	1.697	1.412	1.636	1.624	1.882	1.381
Daggett Barstow AP	0.293	1.021	0.930	0.758	0.978	1.648	0.605*	2.018	1.174
Edwards AFB	0.132	0.905	1.394	0.810*	1.133	1.535	1.266	1.501	1.318
El Centro NAF	0.071	1.000	1.569	1.040	1.408	1.218	0.893*	1.860	0.944
Eureka	0.063	1.219	1.709	1.378	0.956*	1.683	1.214	1.472	1.186
.....
Cumulative weight and FS	35.060	1.310	1.607	1.019*	1.160	1.413	1.162	1.862	1.318
Selected year = 2000 (Cumulative FS = 1.019)									



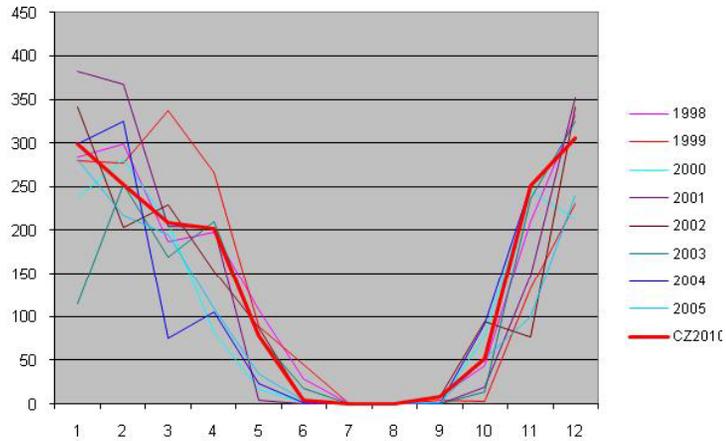
Selected statewide “typical months” for CZ2010 weather files (pool years 1998-2005)

January	2004
February	2003
March	2000
April	2001
May	2003
June	2002
July	2002
August	2004
September	2002
October	2005
November	2004
December	2004

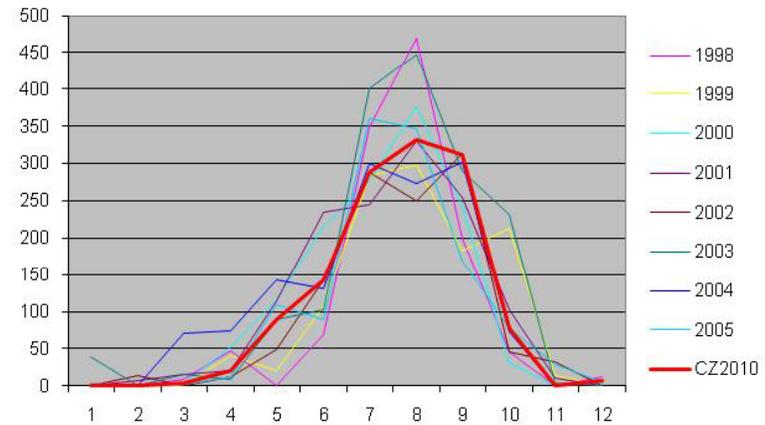


Comparison of CZ2010 to historical weather files for Burbank

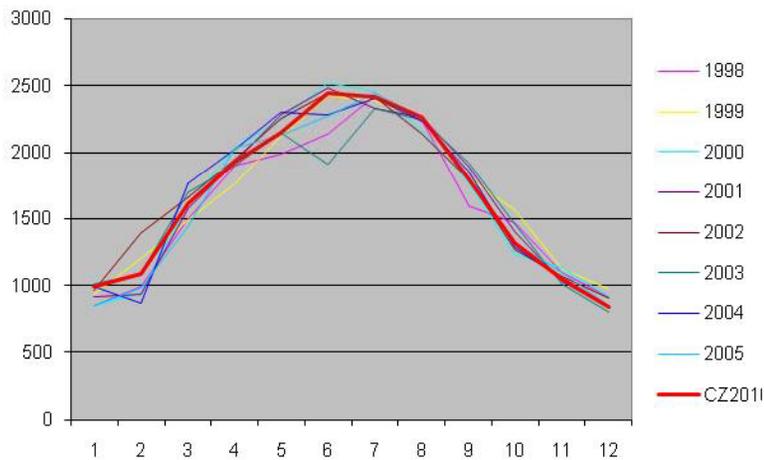
Burbank Heating Degree Days



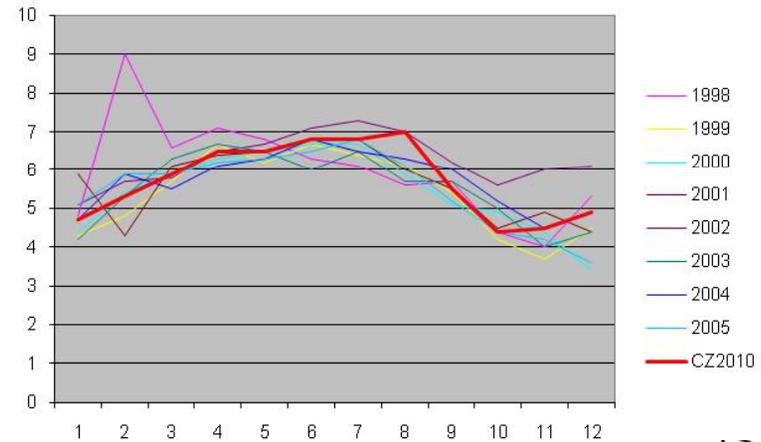
Burbank Cooling Degree Days



Burbank Average Daily Solar

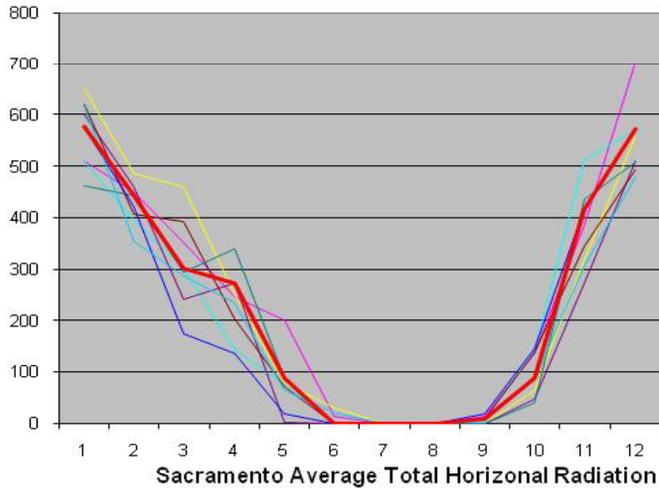


Burbank Average Wind Speed

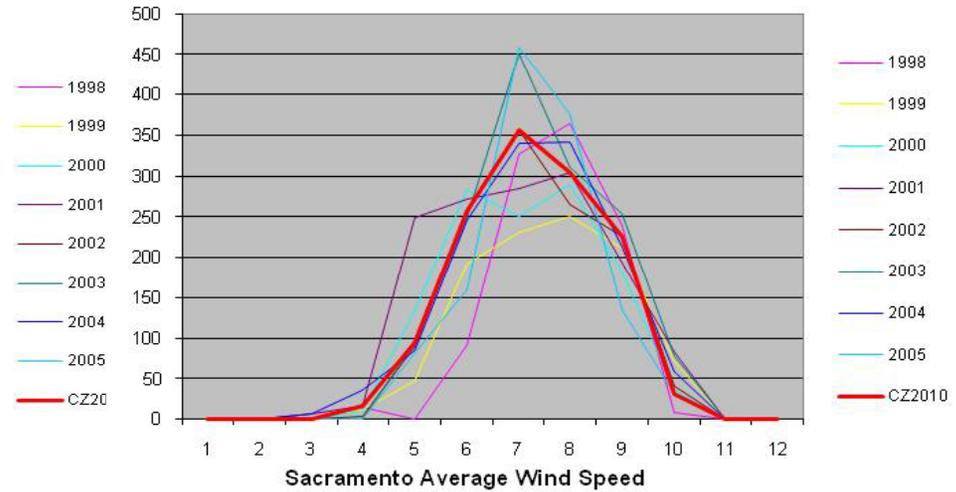


Comparison of CZ2010 to historical weather files for Sacramento

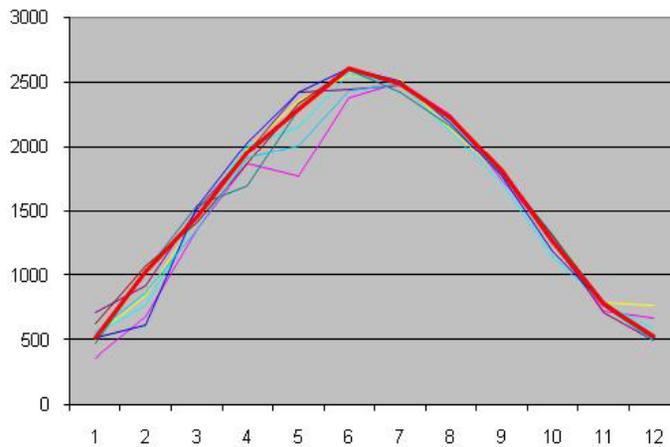
Sacramento Heating Degree Days



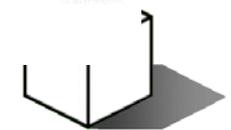
Sacramento Cooling Degree Days



Sacramento Average Total Horizontal Radiation

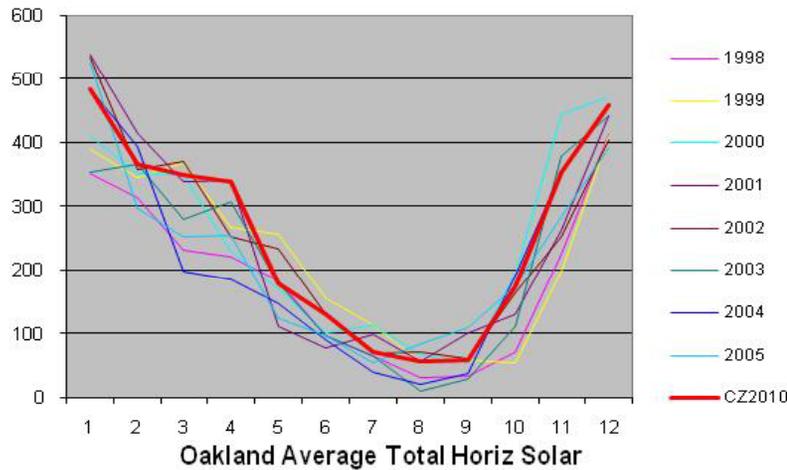


Sacramento Average Wind Speed

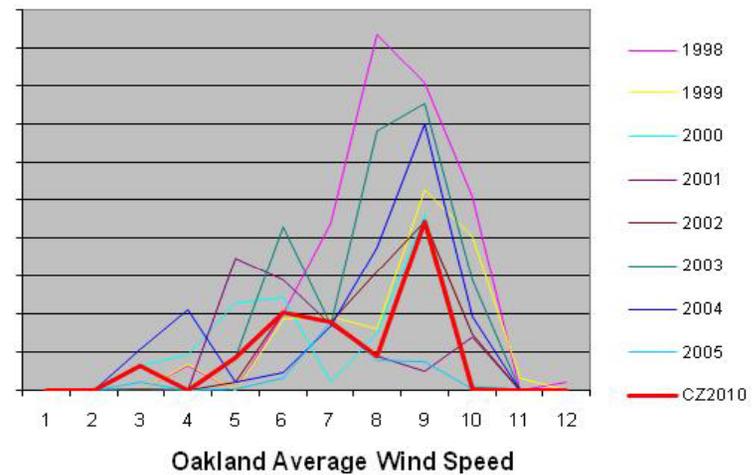


Comparison of CZ2010 to historical weather files for Oakland

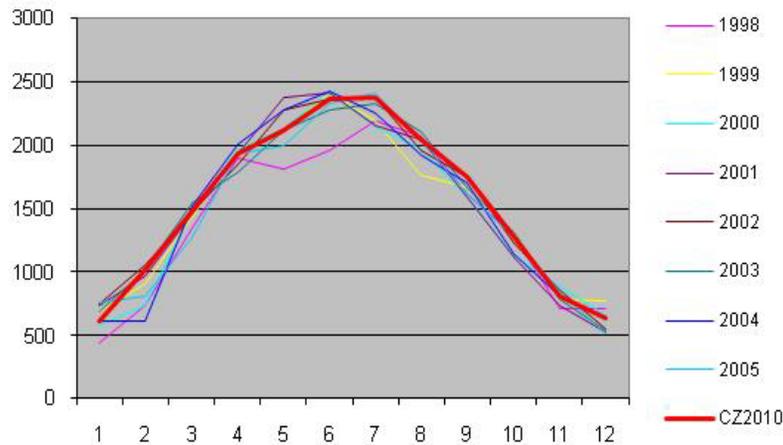
Oakland Heating Degree Days



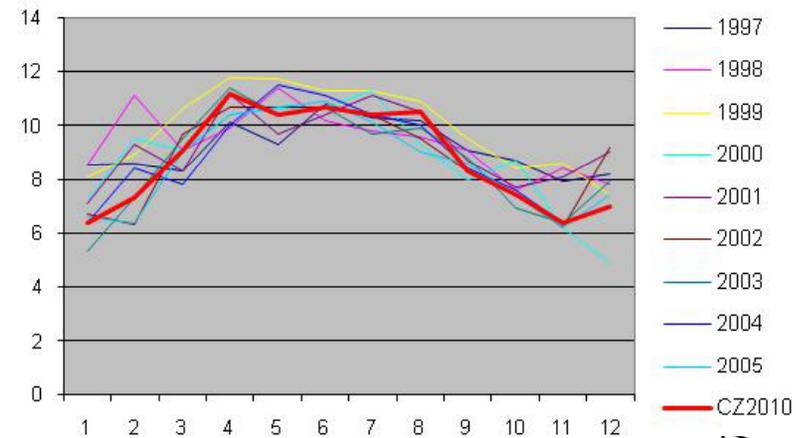
Oakland Cooling Degree Days



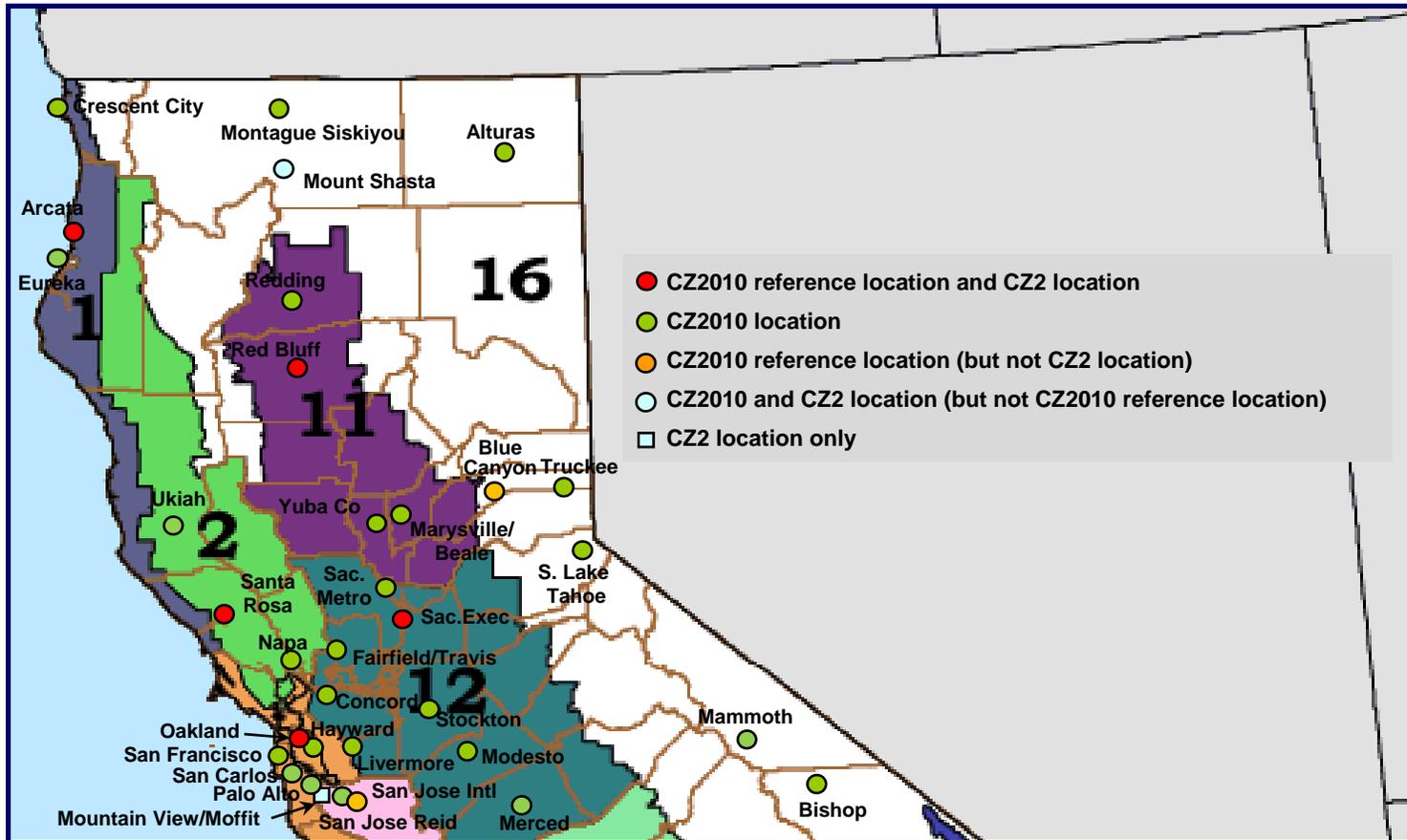
Oakland Average Total Horiz Solar



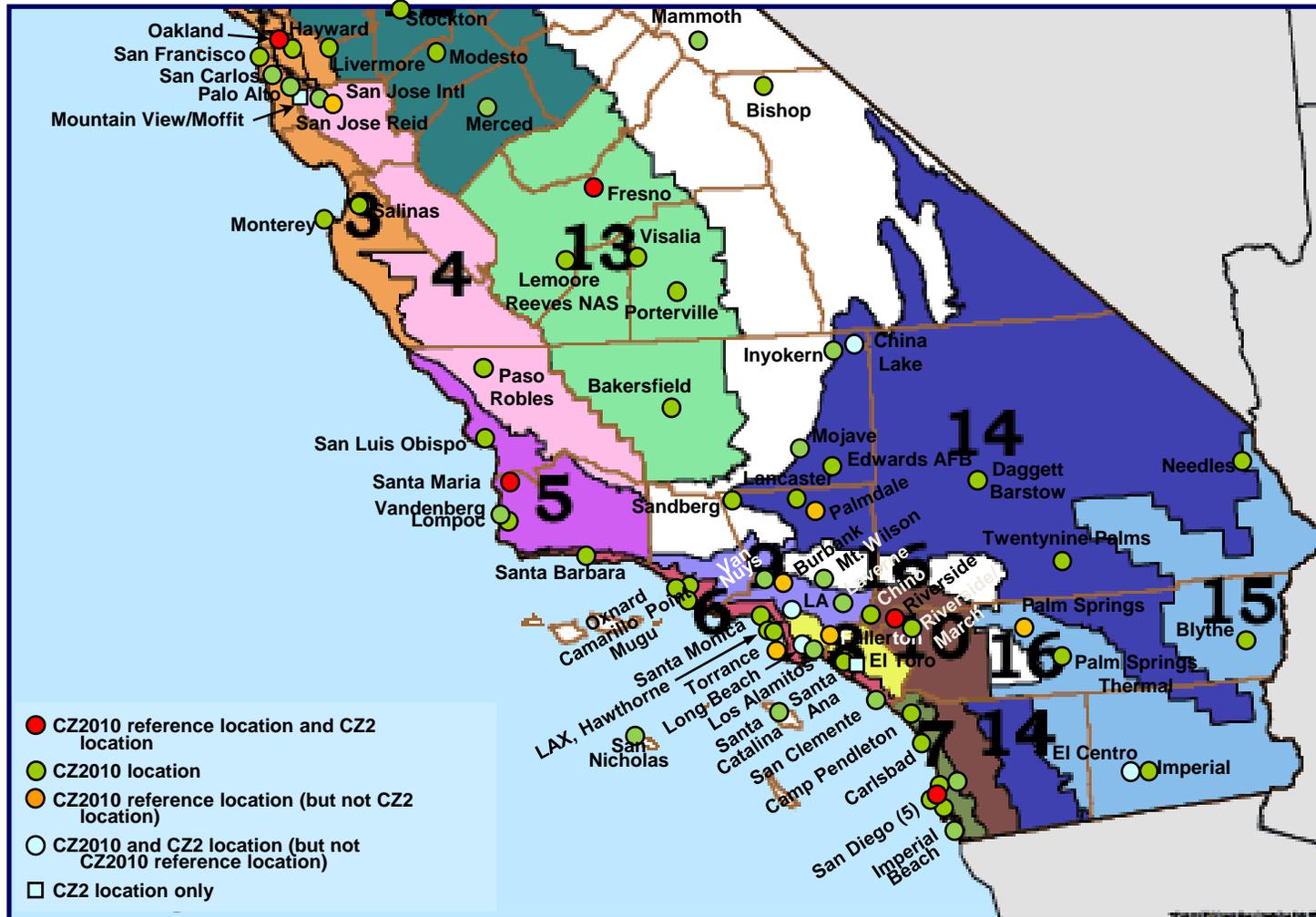
Oakland Average Wind Speed



Northern California CZ2010 weather files



Southern California CZ2010 weather files

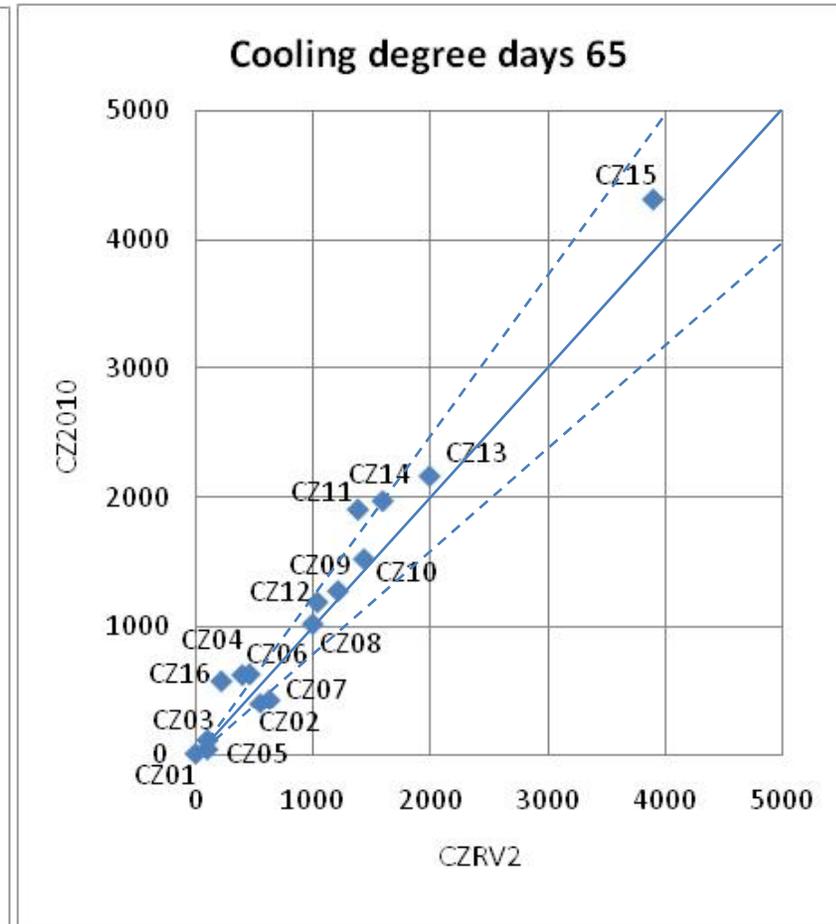
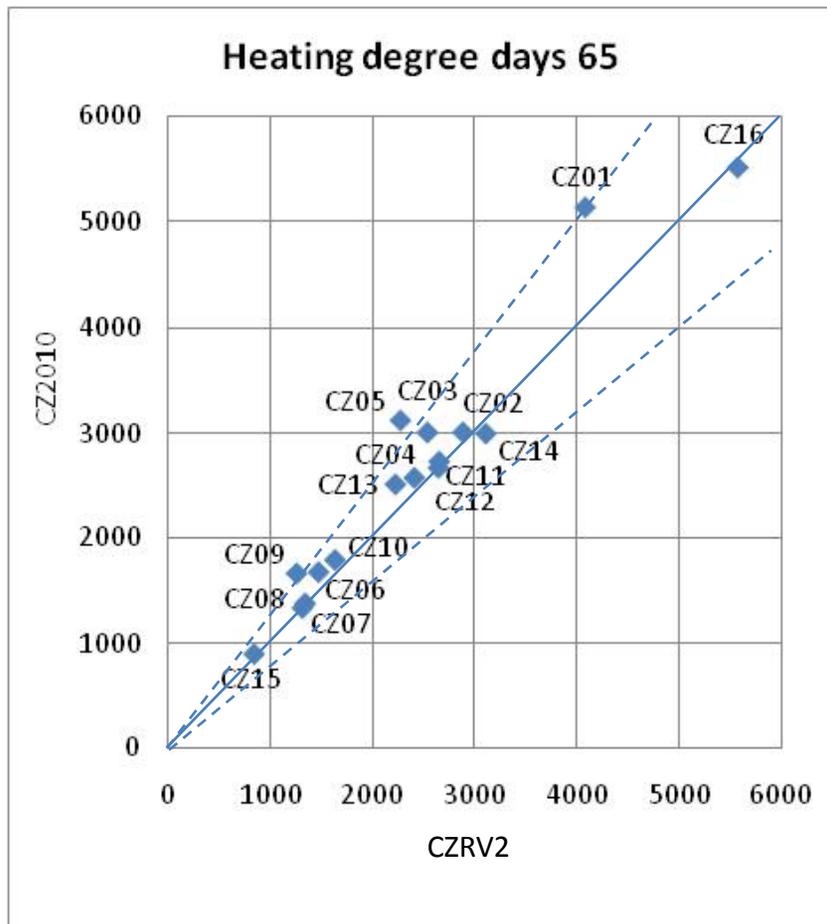


CZ2010 reference locations by CTZ

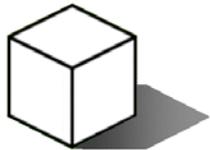
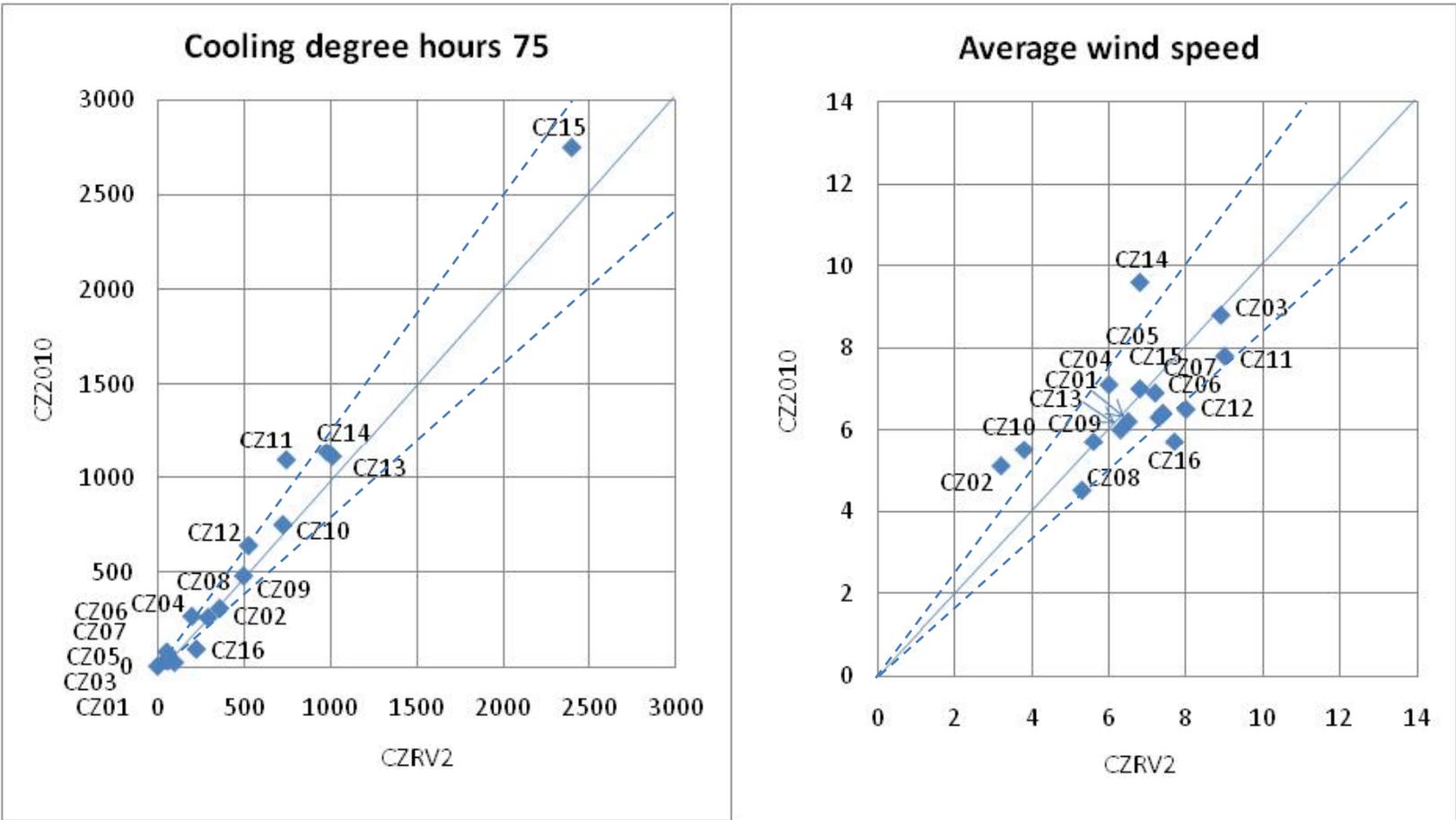
- CTZ01 Arcata Arcata
- CTZ02 Santa Rosa Santa Rosa
- CTZ03 Oakland Oakland
- CTZ04 **San Jose-Reid** Mountain View/Moffit Field
- CTZ05 Santa Maria Santa Maria
- CTZ06 **Torrance** Long Beach
- CTZ07 San Diego-Lindbergh San Diego-Lindbergh
- CTZ08 **Fullerton** El Toro
- CTZ09 **Burbank-Glendale** Pasadena
- CTZ10 Riverside Riverside
- CTZ11 Red Bluff Red Bluff
- CTZ12 Sacramento-Executive Sacramento-Executive
- CTZ13 Fresno Fresno
- CTZ14 **Palmdale** China Lake
- CTZ15 **Palm Springs-Intl** El Centro
- CTZ16 **Blue Canyon** Mt. Shasta



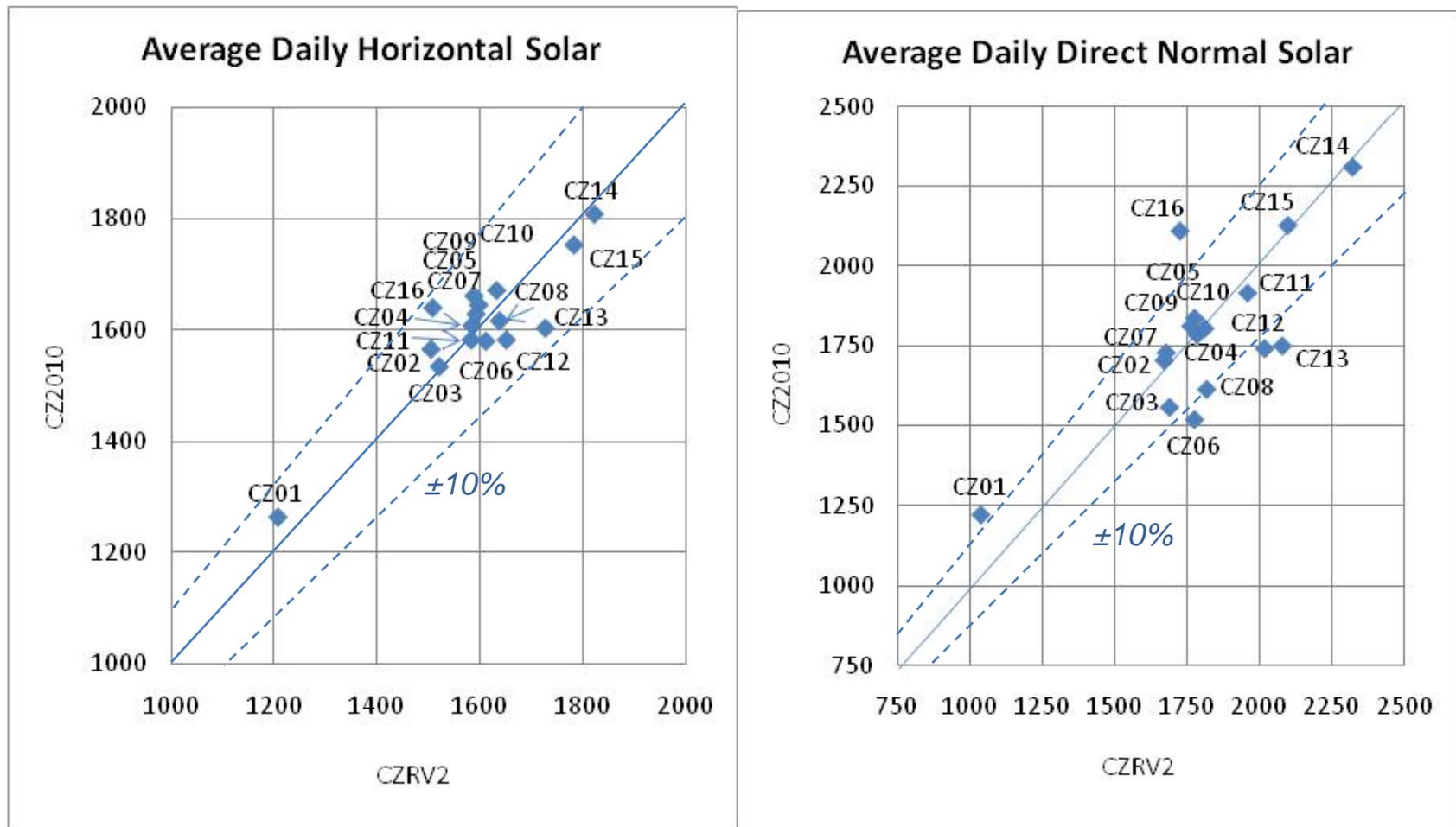
Comparison of climate statistics between CZRV2 and CZ2010 weather files



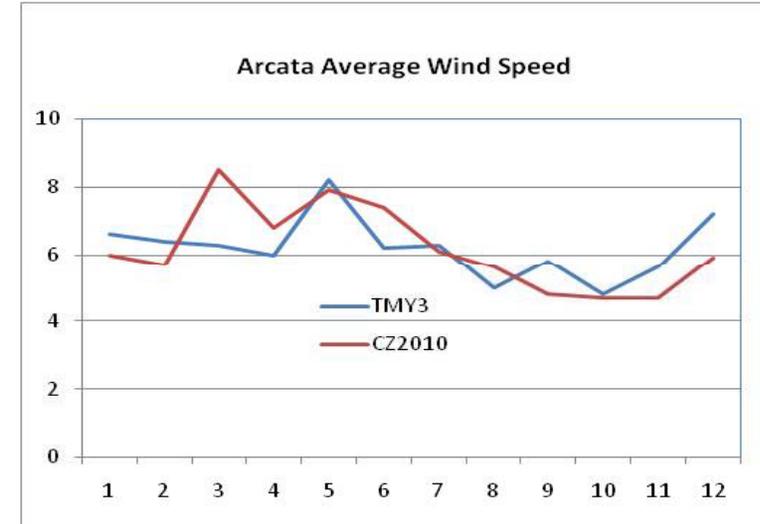
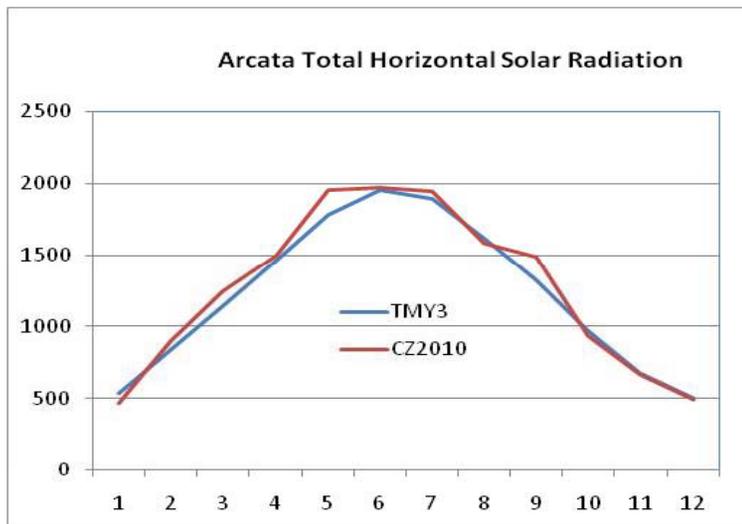
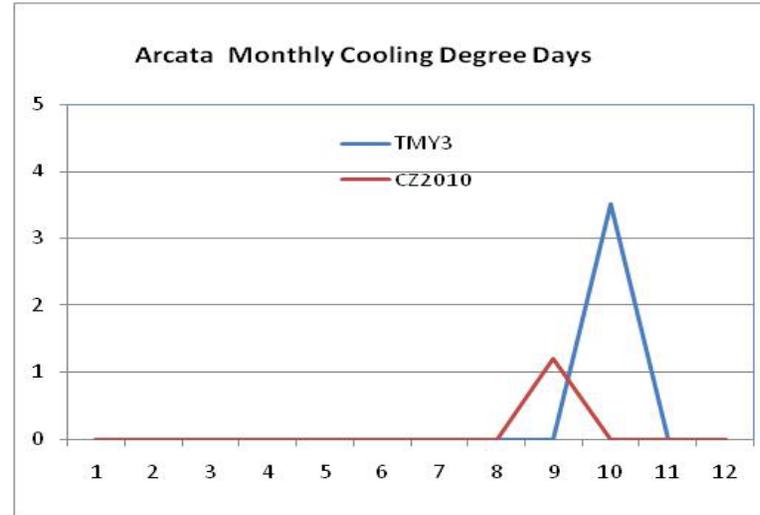
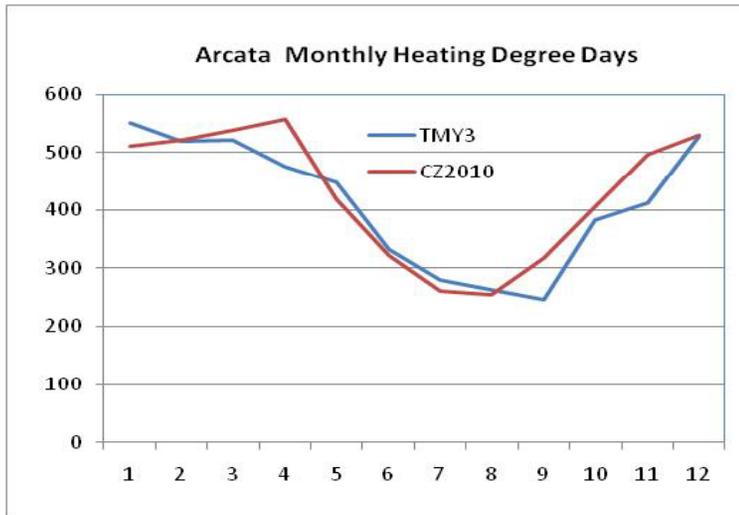
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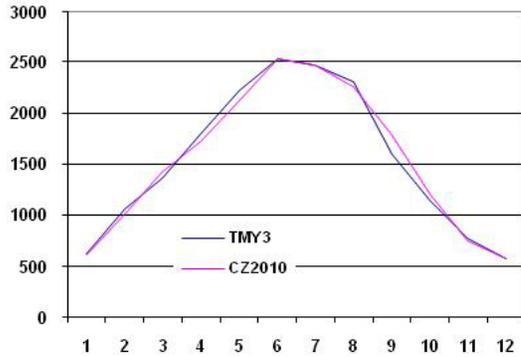


Comparison of CZ2010 to TMY3 weather file for Arcata

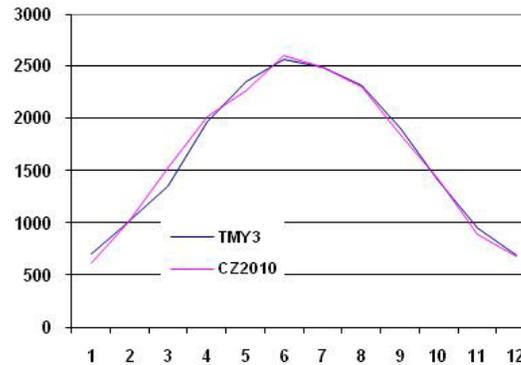


Comparison of monthly solar radiation between CZ2010 to TMY3 weather files

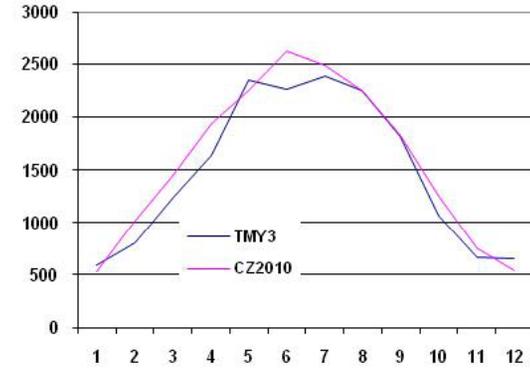
Alturas Total Horizontal Solar



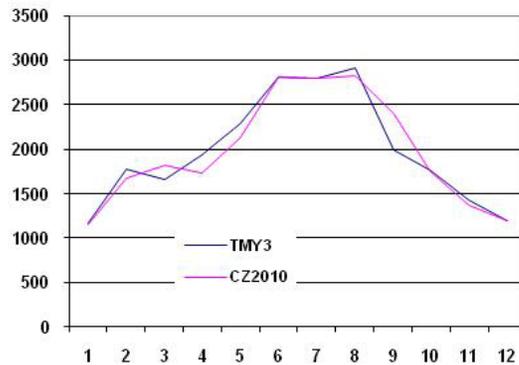
Bakersfield Total Horizontal Solar



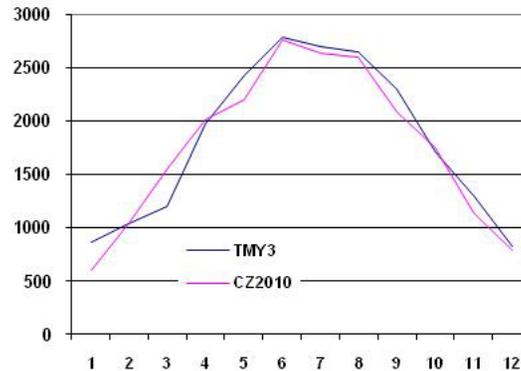
Marysville Total Horizontal Solar



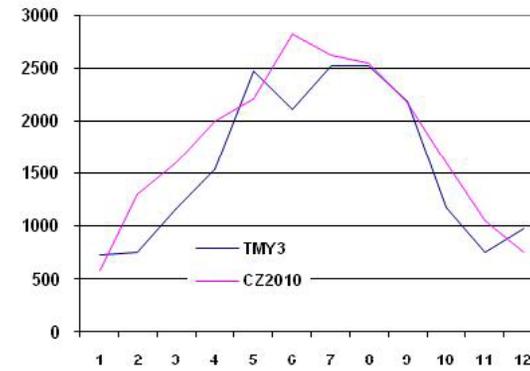
Alturas Direct Normal Solar



Bakersfield Direct Normal Solar



Marysville Direct Normal Solar



Current status of CZ2010 weather files

- **Set of CZ2010 weather files for 88 locations created using 8 years of data (1998-2005) was completed in June 2010, and provided to Commission staff and consultants for testing and evaluation**
- **Weather files are available in several formats: TMY2, FIN4 (working format developed by contractor), TMY3 CSV, DOE-2 BIN, and EnergyPlus EPW**
- **Subset of CZ2010 weather files for 16 representative CTZ locations selected in September**



Ongoing work

- **Addition satellite-derived solar obtained in October for 2006-2008. This increases the pool of available historical weather data from 8 to 11 years. This solar data will be spliced into the weather files for the 88 locations and a modified set of CZ2010 files produced**
- **The satellite-derived solar data also came with hourly METAR data on temperatures and wind speeds at the same 10-km grid for all 11 years (1998-2008). Project staff is now investigating whether this data can be merged with the 88 historical weather files to produce full weather files for any location in the grid**
- **Produce future year weather files for all 88 locations by merging the historical data with the regional and global climate changes projected by Global Circulation Models**



**Thank you for your attention
I'm happy to answer any questions
pertaining to this project**

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