

Weather Normalization: What is Normal Weather?

Presented by:
Dave Hanna
Itron, Inc.

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Agenda

- What is Weather Normalization
- Components of Load
- Common Normal Weather Datasets
- An Alternative Method of Developing Normal Weather
- Comparison of Alternative to TMY2

What is Weather Normalization?

- Forecasting Perspective
- DSM Perspective
- Rate Making & Billing Perspective

What is in a Load?

- Weather Sensitivity
- Calendar Events
- Sunrise and Sunset
- Economic Factors
- Spurious Events

Normal Weather

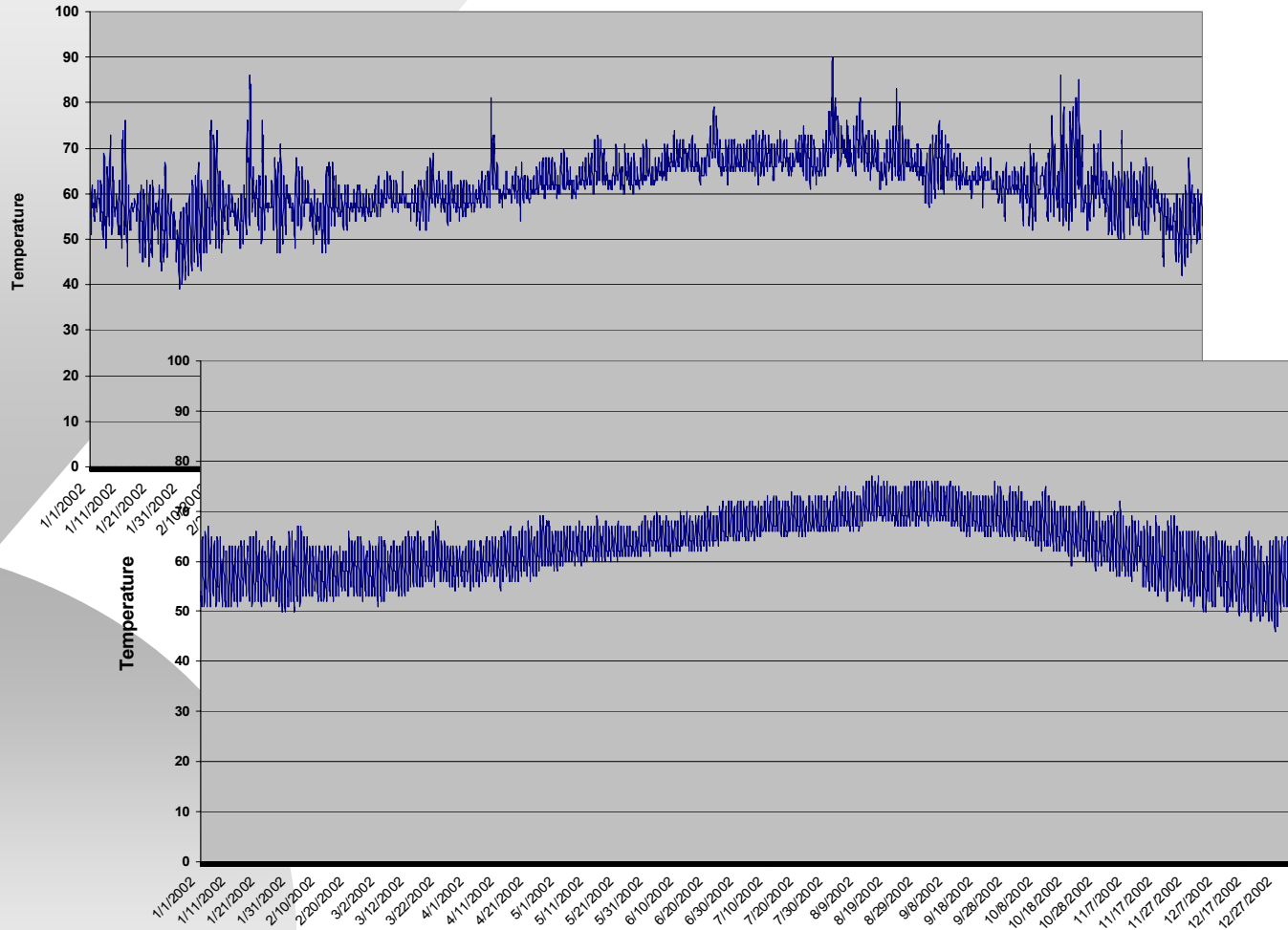
- Commonly Used Normal Weather Datasets
 - Historical Averages
 - Average by either date or day of the week
 - TMY (Typical Meteorological Year)
 - Hourly values of solar and meteorological values
 - Actual monthly data selected as “typical”
 - Data from 1952 – 1975
 - 239 locations across the US
 - **TMY2**
 - Actual monthly data selected as “typical”
 - Data from 1961 – 1990
 - More recent and accurate than TMY
 - Different format, elements and units than TMY
 - Others:
 - WYEC2 (Weather Year Energy Calculations)
 - CTMY2 (Canadian TMY2)
 - CTZ2 (California Thermal Zones)

Historical Averages

- Advantage
 - Very easy to produce
- Disadvantage
 - Averages out the extremes

Actual Temperatures

San Diego – 2002 Actual vs Historical Average



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Choice of Typical Months

- Cumulative Distribution Functions (CDF) for several solar and meteorological variables used to compare candidate months
 - Long term CDFs are from 1961 – 1990
 - Individual months compared to long term CDF

- CDFs used to develop indexes

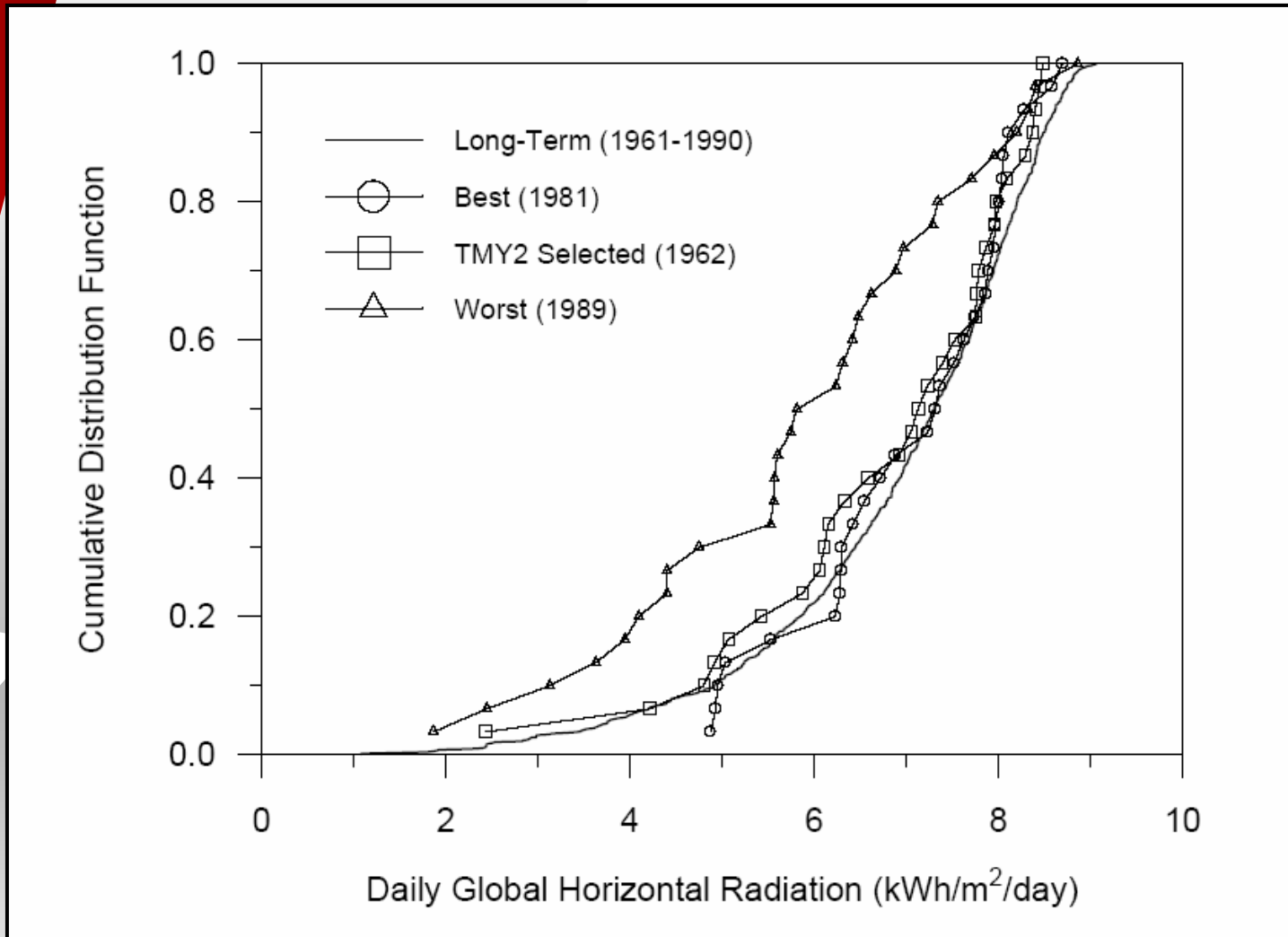
$$Index = (1 / n) \sum_{i=1}^n \delta_i$$

- Where

- » Delta equals the absolute difference between the long-term CDF and the candidate month CDF at x_i .
- » n equals the number of daily readings in a month.

- Indexes are weighted and summed
 - Index weights are arbitrary

TMY2 Methodology (cont.)



Source: User's Manual for TMY2s, NREL, June, 1995.

TMY2 Methodology (cont.)

Weightings for Solar & Meteorological Indexes

Index	Sandia Method	NSRDB TMY2s
Max Dry Bulb Temp	1/24	1/20
Min Dry Bulb Temp	1/24	1/20
Mean Dry Bulb Temp	2/24	2/20
Max Dew Point Temp	1/24	1/20
Min Dew Point Temp	1/24	1/20
Mean Dew Point Temp	2/24	2/20
Max Wind Velocity	2/24	1/20
Mean Wind Velocity	2/24	1/20
Global Radiation	12/24	5/20
Direct Radiation	Not Used	5/20

Source: User's Manual for TMY2s, NREL, June, 1995.

Alternative Approach to Normal Weather

- Rank and Average Approach
 - Can be developed using any quantify of historical data
 - Can be used with numerous meteorological variables
 - Captures average extremes
 - Can be assigned to any calendar year
 - Adjacent weather stations have coincident conditions

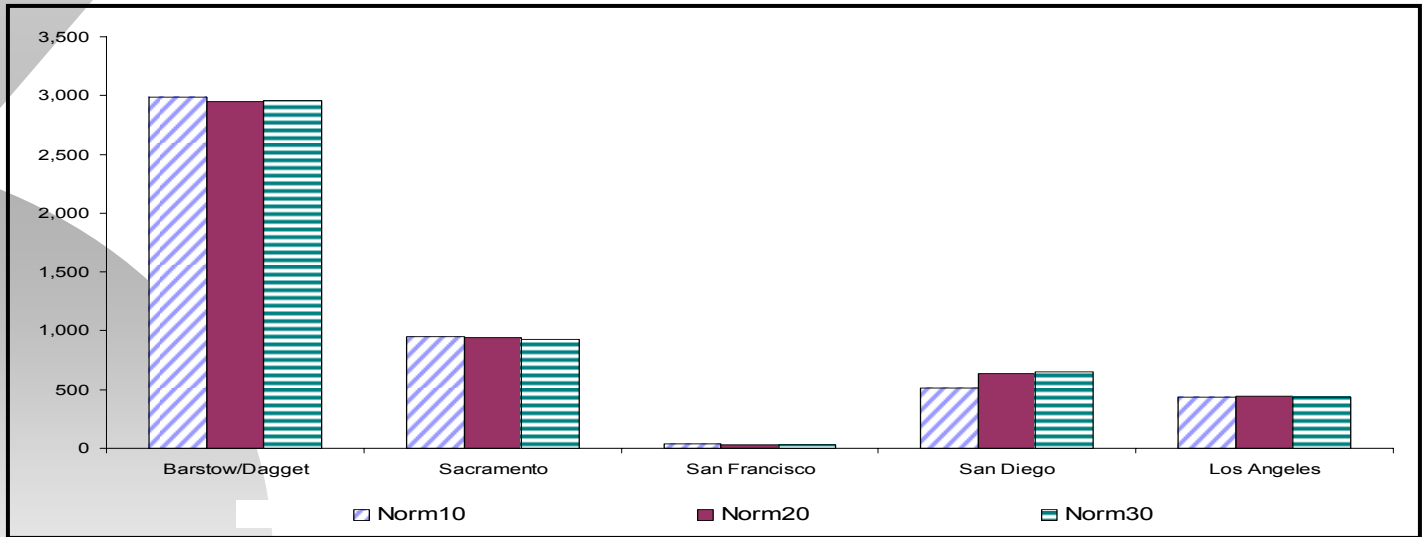
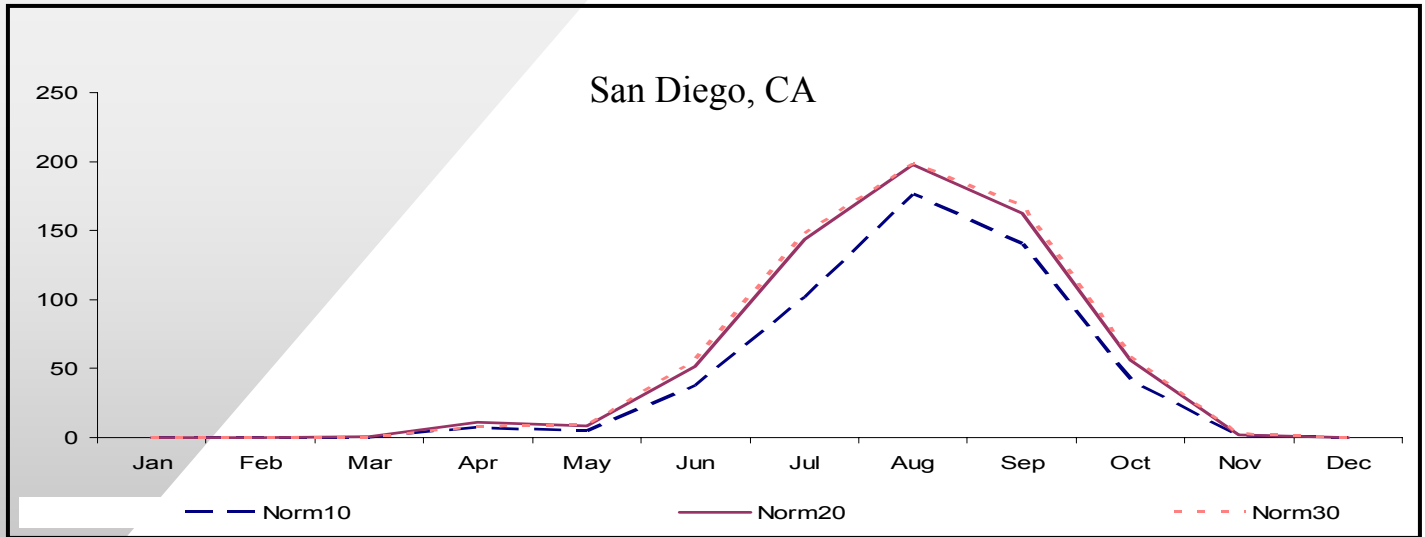
Rank and Average Methodology

- First Step
 - Historical period of daily weather data (peak temperature) for a given month.
- Second Step
 - Values are sorted from hottest to coldest
 - For days with equal peak temperature, sort by the average temperature during the daytime hours (from 1 p.m. until 5 p.m.)
- Third Step
 - The hourly values are averaged by rank across all years.
 - The result is a typical hottest day for the month, a typical second hottest day, and so on through to the typical coldest day.

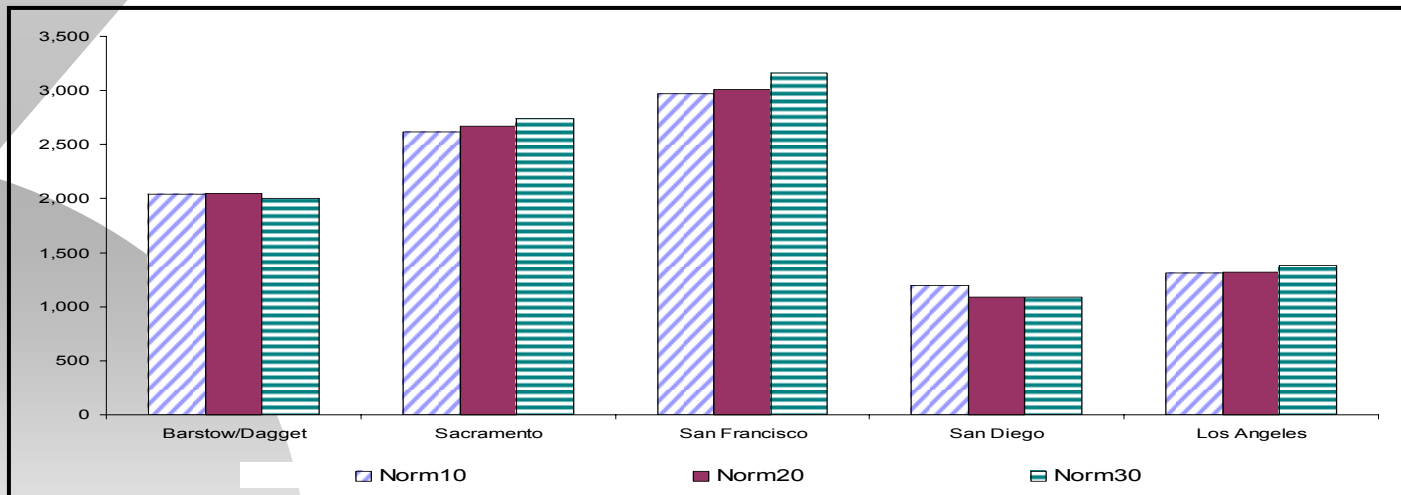
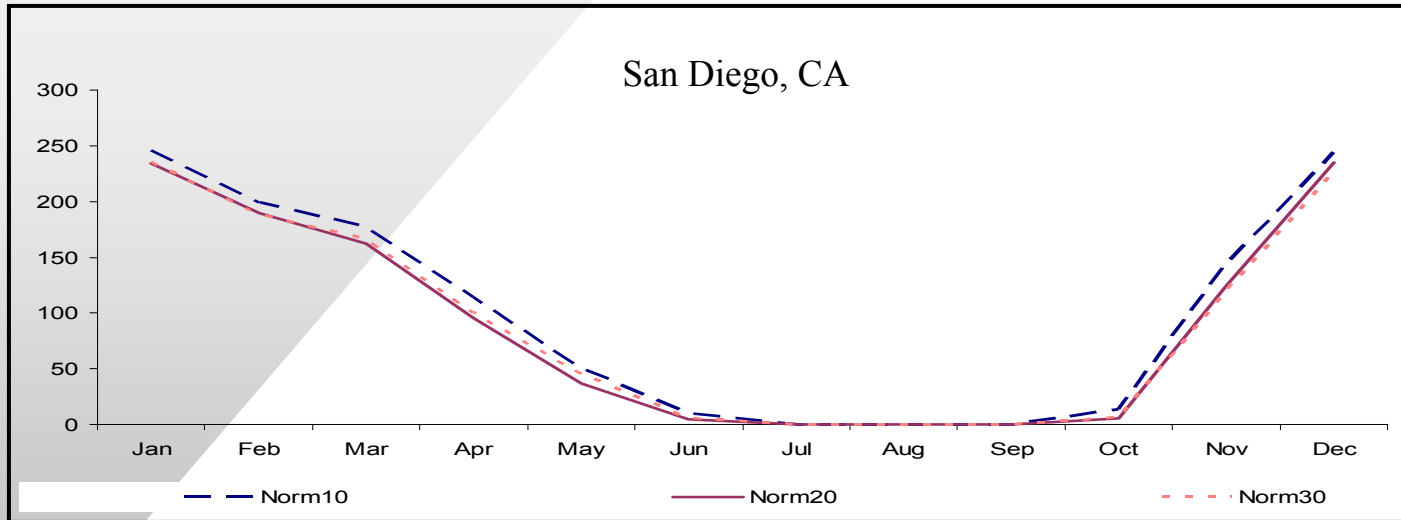
Rank and Average Methodology (cont.)

- Fourth Step
 - The same rank and average process is then repeated for each month (January through December)
 - The result is a database of 365 days of hourly temperature values ranked from hottest to coldest day by month.
- Final Step
 - Days are assigned to a reference year based on the same temperature ranking of the days in the reference year.
 - For example, the average hottest day hourly temperature profile is assigned to the date in the reference month that has the highest temperature value. The second average hottest day is then assigned to the date in the reference month with the next highest temperature, and so on.

Cooling Degree Days



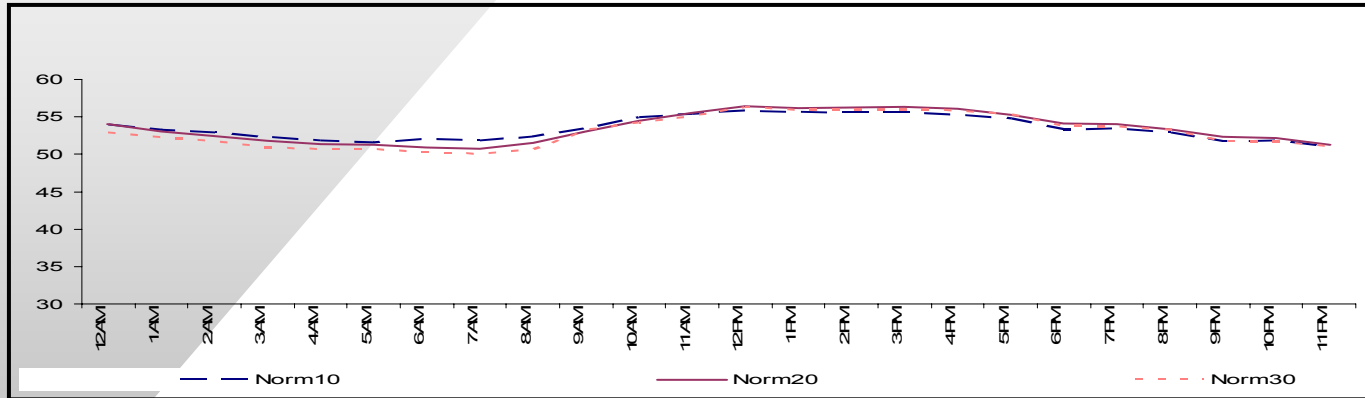
Heating Degree Days



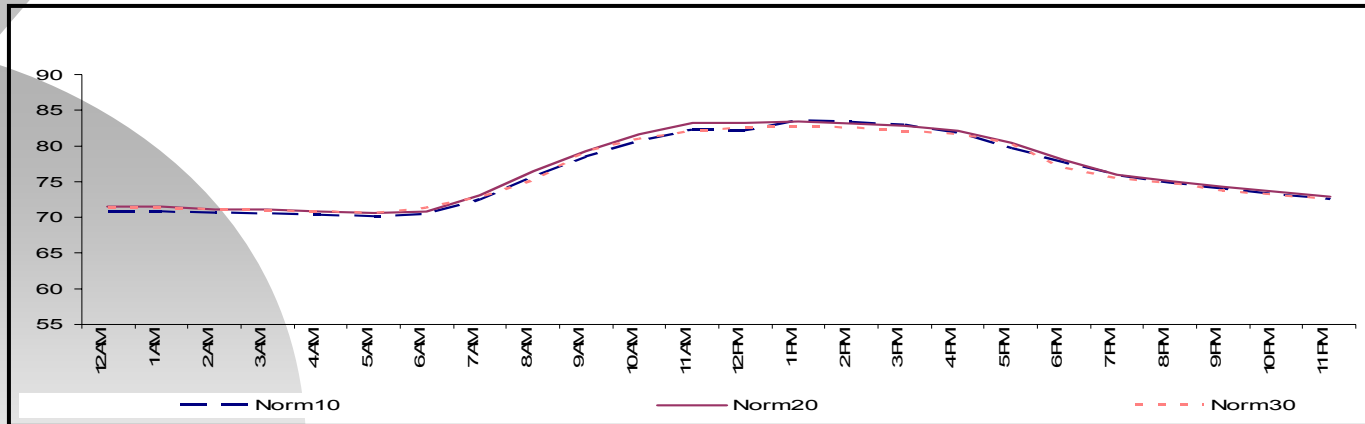
Extreme Temperature Days

San Diego, CA

Coldest January Day



Hottest August Day



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California Historical Weather Availability

Climate Zone	Weather Station / NWSID	2002	2001	2000	1999	1998	1997	1996	1995	1994	1993	1992
1	Arcata/Eureka Arpt.	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV	ACV
2	Santa Rosa	STS	STS	STS	STS	STS	STS	STS	STS	na	na	na
3A	San Francisco Intl.	SFO	SFO	SFO	SFO	SFO	SFO	SFO	SFO	SFO	SFO	SFO
3B	Oakland	OAK	OAK	OAK	OAK	OAK	OAK	OAK	OAK	OAK	OAK	NGZ
3C	Monterey	MRY	MRY	MRY	MRY	MRY	MRY	MRY	MRY	na	na	na
4	San Jose Intl.	SJC	SJC	SJC	SJC	SJC	SJC	SJC	SJC	na	na	NUQ
5	Santa Maria	SMX	SMX	SMX	SMX	SMX	SMX	SMX	SMX	SMX	SMX	SMX
6	Los Angeles Intl.	LAX	LAX	LAX	LAX	LAX	LAX	LAX	LAX	LAX	LAX	LAX
7	San Diego/Lindberg Field	SAN	SAN	SAN	SAN	SAN	SAN	SAN	SAN	SAN	SAN	SAN
8	Long Beach	LGB	LGB	LGB	LGB	LGB	LGB	LGB	LGB	LGB	LGB	LGB
9	Burbank	BUR	BUR	BUR	BUR	BUR	BUR	BUR	BUR	na	na	LAX
10A	San Diego/Miramar	NKX	NKX	NKX	NKX	NKX	NKX	NKX	NKX	NKX	NKX	NKX
10B	Riverside	RIV	RIV	RIV	RIV	RIV	RIV	RIV	RIV	na	na	NZJ
11	Red Bluff	RBL	RBL	RBL	RBL	RBL	RBL	RBL	RBL	RBL	RBL	RDD
12	Sacramento	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC	SAC
13	Fresno	FAT	FAT	FAT	FAT	FAT	FAT	FAT	FAT	FAT	FAT	FAT
14	Barstow/Dagget	DAG	DAG	DAG	DAG	DAG	DAG	DAG	DAG	DAG	DAG	DAG
15	Blythe	BLH	BLH	BLH	BLH	BLH	BLH	BLH	BLH	na	na	na
16A	Blue Canyon	BLU	BLU	BLU	BLU	BLU	BLU	BLU	BLU	na	na	BLU
16B	Bishop	BIH	BIH	BIH	BIH	BIH	BIH	BIH	BIH	BIH	BIH	BIH



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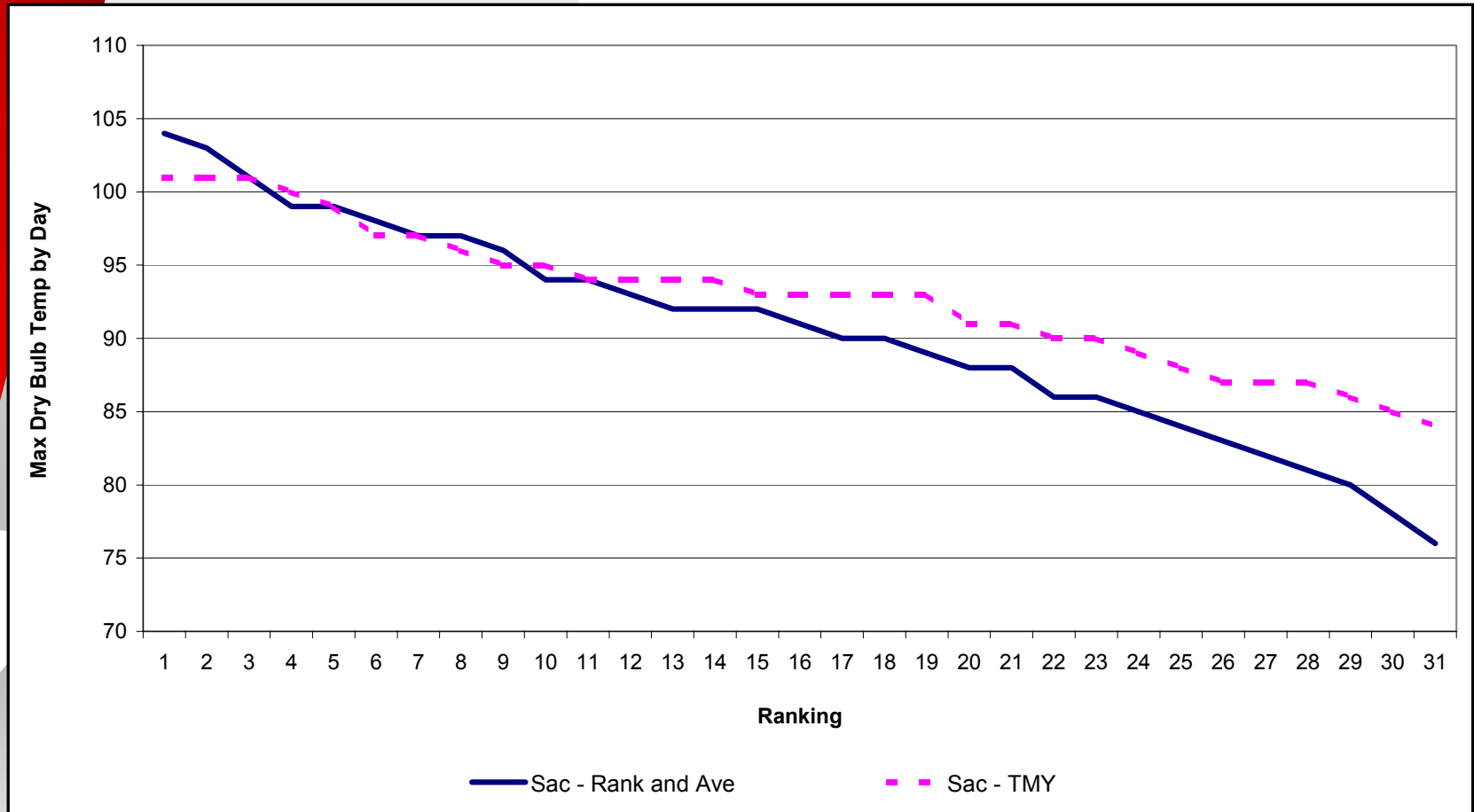
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Comparison of R&A to TMY2

- Peak Temperature
- Hottest Day
- Second Hottest Day

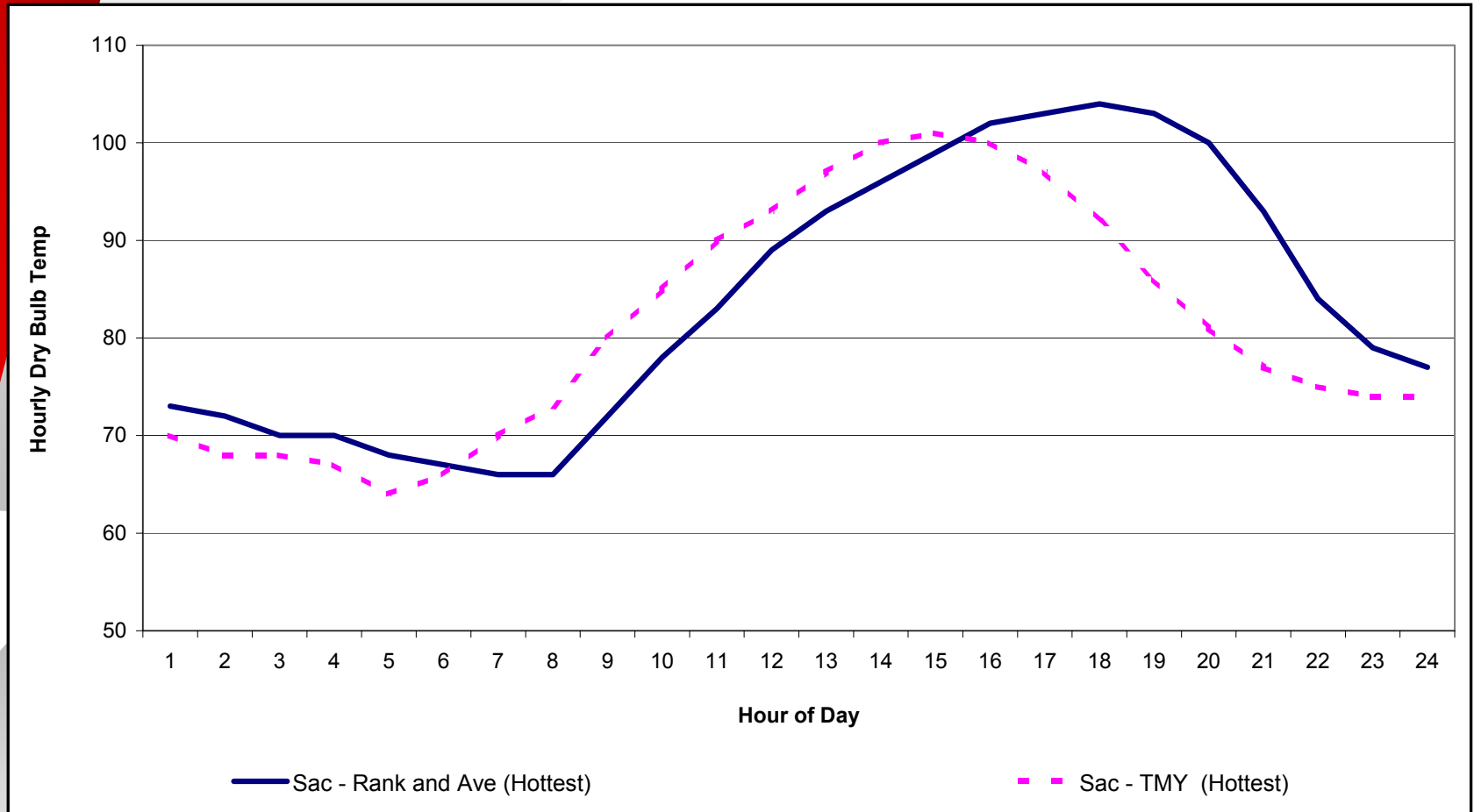
Comparison of R&A to TMY2

Peak Temperature - Sacramento, CA



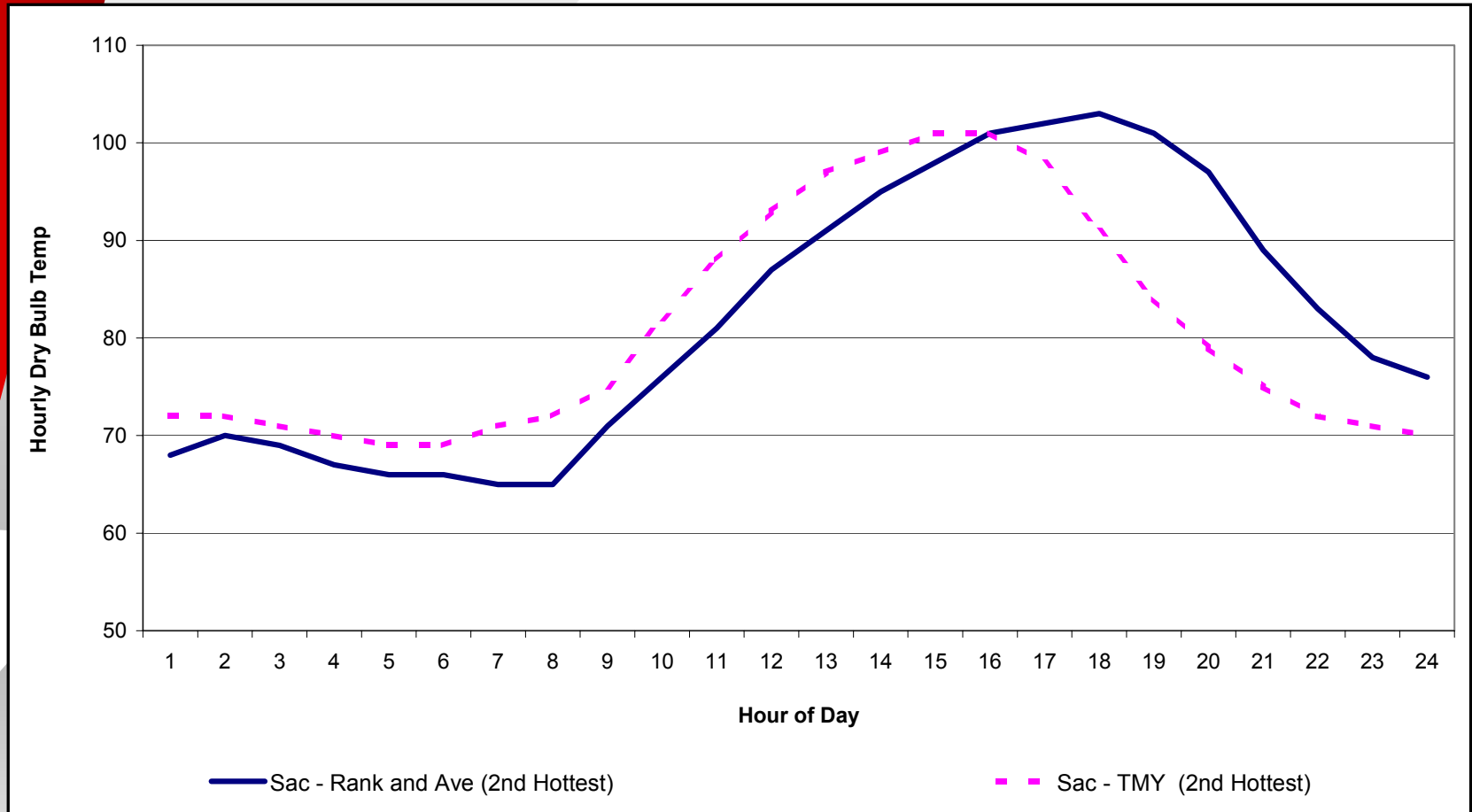
Comparison of R&A to TMY2

Hottest Day – Sacramento, CA



Comparison of R&A to TMY2

Second Hottest Day - Sacramento, CA

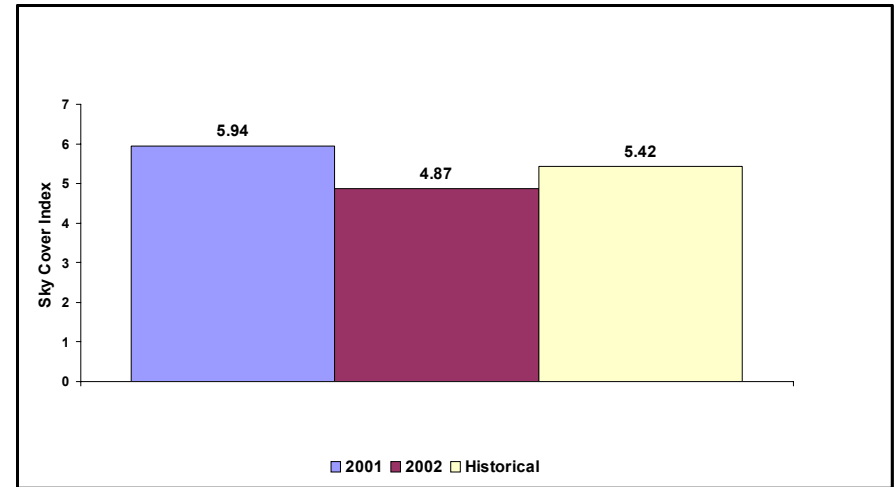


Selecting a Reference Year

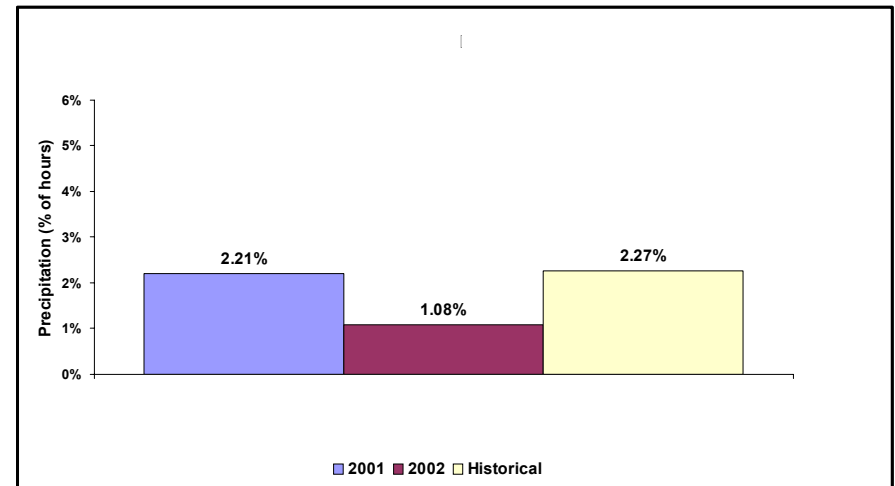
- Depends on what you are trying to accomplish.
- The choice of a reference year can have an effect on weather variables that are index variables and do not lend themselves to being averaged.
- If no index variables are used, this is not a significant issue.
- If index variables are used, the issue arises as to how representative of normal is the reference year.

Selecting a Reference Year (cont.)

- Annual Sky Cover



- Annual Occurrence of Rain



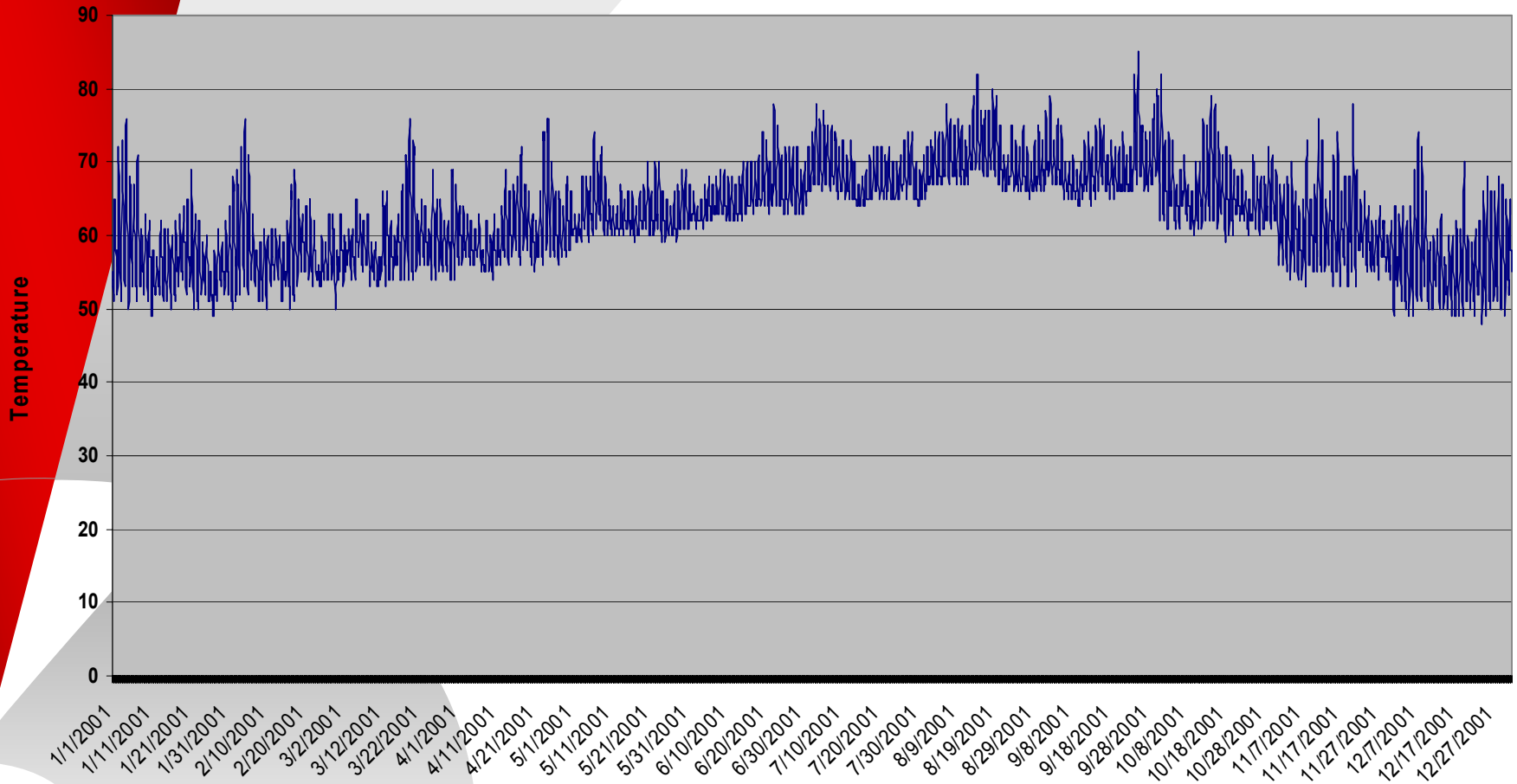
Conclusions

Rank & Average Normal Weather

- Relatively easy to develop,
- Captures average extremes better than TMY2,
 - More focused on temperature than TMY2
- Can use as much historical data as needed or available,
 - More recent than TMY2,
- Can be assigned to any reference year.
 - Coincident with adjacent weather stations.

Rank and Average Normal Weather

Questions?



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