



 OCTOBER 8 & 9  DOWNEY, CA

ET Summit Fall 2018

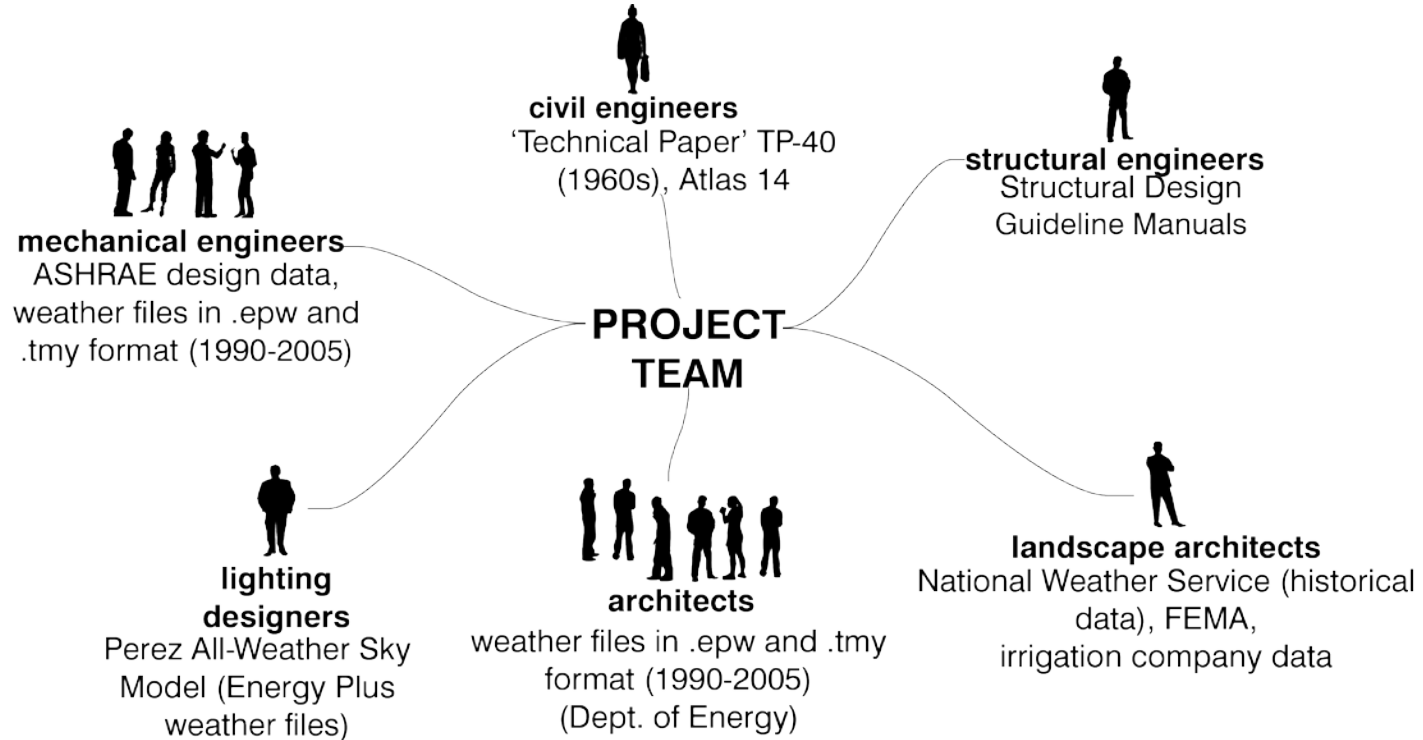
COMMERCIAL + RESIDENTIAL BUILDINGS

Emerging Technology: Weather Data for Building Design: Predicting the Future

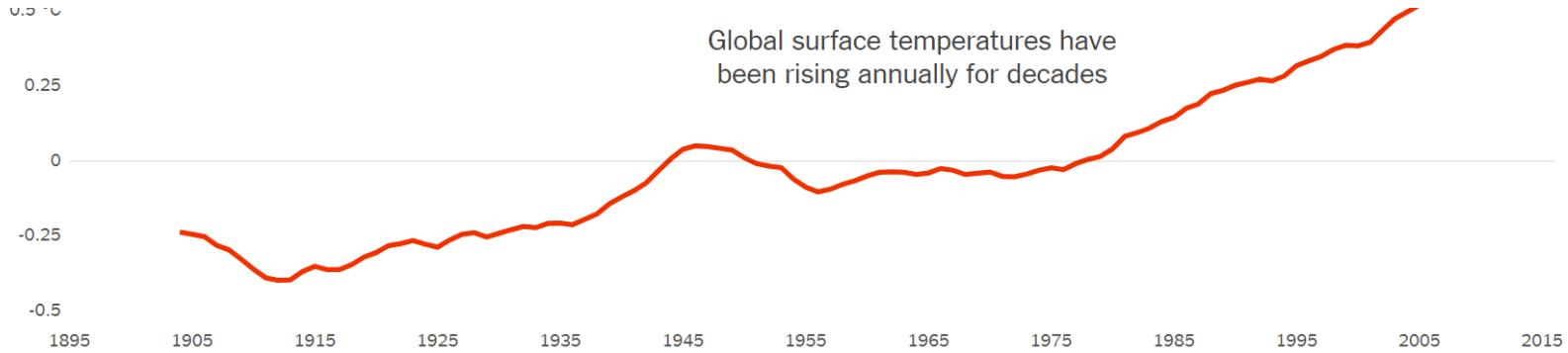


Jim Bradburn, PE
Associate Vice President
HGA Architects and Engineers

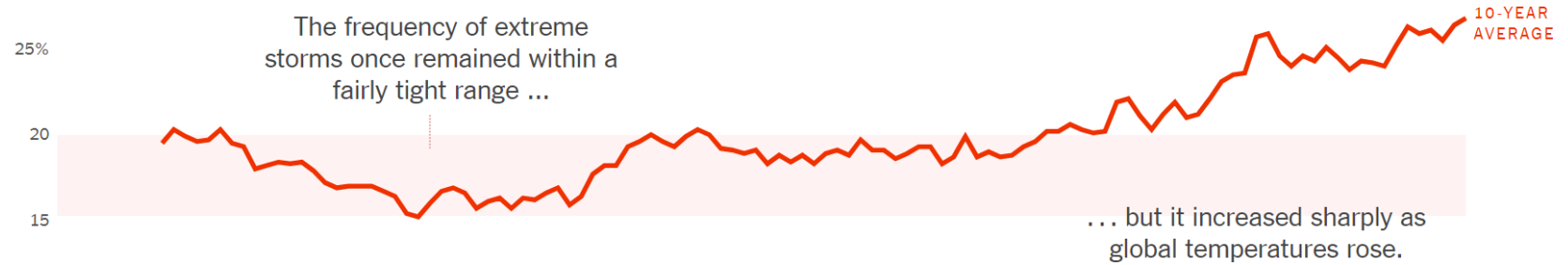




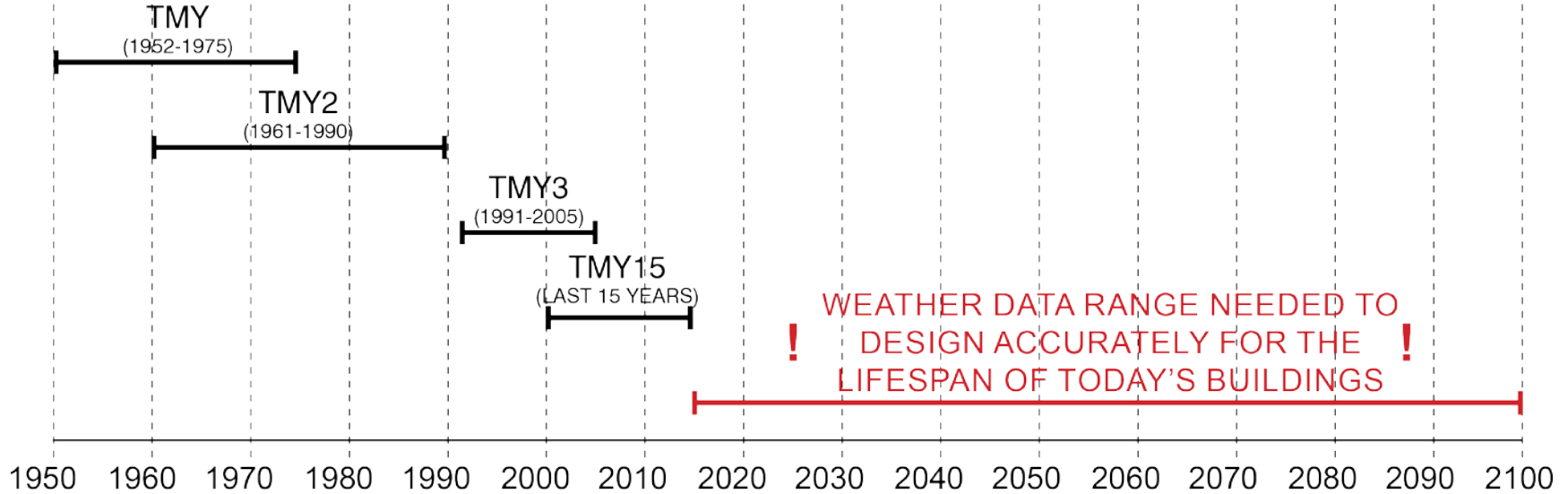
Source: HGA



U.S. WEATHER STATIONS EXPERIENCING AN EXTREME RAINSTORM

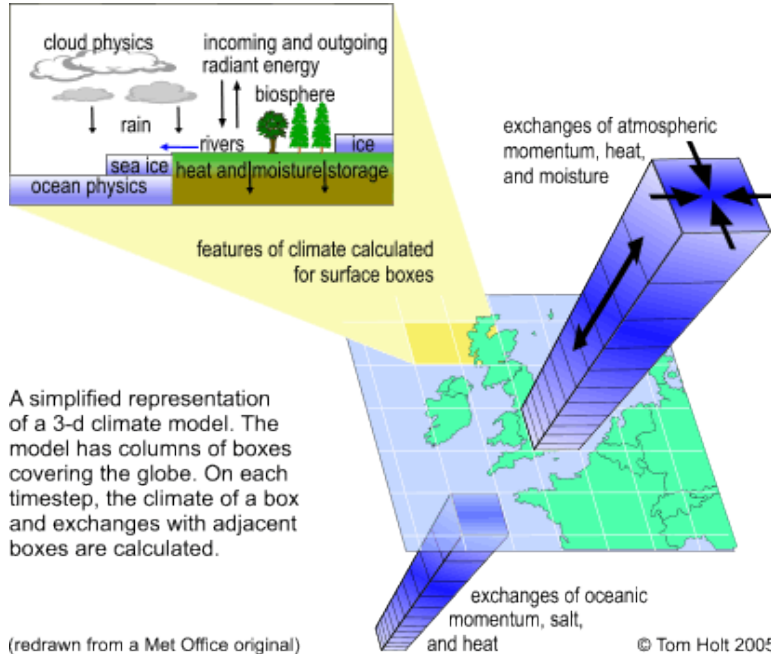


Typical Meteorological Year

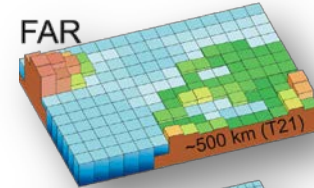


Source: HGA

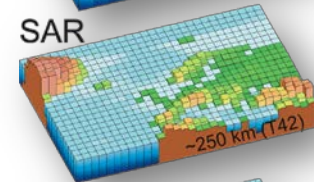
General Circulation Model



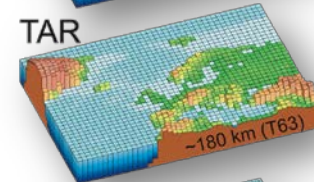
1990



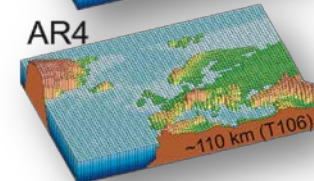
1995



2001



2007



Statistical Downscaling

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[LOCATION,Climate Zone 3,CA,USA,CTD02,24000,17.0, 322.20, 8.6,2.0
DESIGN CONDITIONS,1,Climate Design Data 2000 annual handbook,weather,1,2,9,4,2,-6,2,3,10,7,-2,5,3,1,10,7,11,4,11
TYPICAL /EXTREME PERIODS,6,Summer - Month Meanest Max Temperature For Period,Extreme,9/23,9/23,Summer - Month Meanest
GROUND TEMPERATURES,,1,,10,34,10,63,11,18,12,46,14,33,16,09,17,28,17,64,17,82,15,66,13,33,12,14,2,,12,10,11
INCLUDING OVERLIGHT SAVINGS,No,0,0
COMMENTS 1,California Climate Zone 03 Version 2;
COMMENTS 2, -- Ground temps produced with a standard soil diffusivity of 2.3225760E-03 (m^2/day)
DATA PERIODS,1,1,Data,Sunday, 1/ 1,12/31
1970,1,1,1,00,A,A,-5* 9 9 9 9 * * * 8.5,3.09,101310,0,9999,273,0,0,0,999900,999900,999900
1970,1,1,2,00,A,A,-11* 9 9 9 9 * * * 5.4,3.95,101270,0,9999,273,0,0,0,999900,999900,999900
1970,1,1,3,00,A,A,-5* 9 9 9 9 * * * 4.4,3.6,95,101110,0,9999,273,0,0,0,999900,999900,999900
1970,1,1,4,00,A,A,-5* 9 9 9 9 * * * 10.1,10.0,0,9999,273,0,0,0,999900,999900,999900
1970,1,1,5,00,A,A,-5* 9 9 9 9 * * * 10.1,10.0,0,9999,280,0,0,0,999900,999900,999900
1970,1,1,6,00,A,A,-5* 9 9 9 9 * * * 150,0,9999,291,0,0,0,999900,999900,999900
1970,1,1,7,00,A,A,-5* 9 9 9 9 * * * 100,0,9999,294,0,0,0,999900,999900,999900
1970,1,1,8,00,A,A,-5* 9 9 9 9 * * * 2.9,10,18280,33,9999,295,9,45,4,999900,999900,9999
1970,1,1,9,00,A,A,-5* 9 9 9 9 * * * 7.0,10,1860,238,9999,292,118,480,49,999900,999900,9999
1970,1,1,10,00,A,A,-5* 9 9 9 9 * * * 11.6,6,10,18440,436,9999,286,266,700,51,999900,9999
1970,1,1,11,00,A,A,-5* 9 9 9 9 * * * 11.1,2,2,54,102440,581,9999,294,381,733,80,999900,9999
1970,1,1,12,00,A,A,-5* 9 9 9 9 * * * 15,1,1,7,46,102440,646,9999,301,590,811,49,999900,9999
1970,1,1,13,00,A,A,-5* 9 9 9 9 * * * 15,0,1,19,101440,678,9999,309,663,830,70,999900,9999
1970,1,1,14,00,A,A,-5* 9 9 9 9 * * * 14,3,0,3,10,101470,623,9999,305,420,802,64,999900,9999
1970,1,1,15,00,A,A,-5* 9 9 9 9 * * * 12,6,0,5,10,101310,562,9999,301,120,720,60,999900,9999
1970,1,1,16,00,A,A,-5* 9 9 9 9 * * * 12,9,-1,5,36,101540,124,9999,297,185,309,100,999900,9999
1970,1,1,17,00,A,A,-5* 9 9 9 9 * * * 11,7,-2,0,35,101500,102,9999,291,26,81,21,999900,9999
1970,1,1,18,00,A,A,-5* 9 9 9 9 * * * 10,4,-4,3,14,101630,0,9999,286,0,0,0,999900,999900,9999
1970,1,1,19,00,A,A,-5* 9 9 9 9 * * * 9,2,5,8,12,101880,0,9999,278,0,0,0,999900,999900,9999
1970,1,1,20,00,A,A,-5* 9 9 9 9 * * * 8,5,-6,2,11,101770,0,9999,275,0,0,0,999900,999900,9999
1970,1,1,21,00,A,A,-5* 9 9 9 9 * * * 8,0,-6,5,11,101860,0,9999,272,0,0,0,999900,999900,9999

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TMY



GCM



FMY



RCP
Year
Percentile

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[LOCATION,Climate Zone 3,CA,USA,CTD02,24000,17.0, 322.20, 8.6,2.0
DESIGN CONDITIONS,1,Climate Design Data 2000 annual handbook,weather,1,2,9,4,2,-6,2,3,10,7,-2,5,3,1,10,7,11,4,11
TYPICAL /EXTREME PERIODS,6,Summer - Month Meanest Max Temperature For Period,Extreme,9/23,9/23,Summer - Month Meanest
GROUND TEMPERATURES,,1,,10,34,10,63,11,18,12,46,14,33,16,09,17,28,17,64,17,82,15,66,13,33,12,14,2,,12,10,11
INCLUDING OVERLIGHT SAVINGS,No,0,0
COMMENTS 1,California Climate Zone 03 Version 2;
COMMENTS 2, -- Ground temps produced with a standard soil diffusivity of 2.3225760E-03 (m^2/day)
DATA PERIODS,1,1,Data,Sunday, 1/ 1,12/31
1970,1,1,1,00,A,A,-5* 9 9 9 9 * * * 8.5,3.09,101310,0,9999,273,0,0,0,999900,999900,999900
1970,1,1,2,00,A,A,-11* 9 9 9 9 * * * 5.4,3.95,101270,0,9999,273,0,0,0,999900,999900,999900
1970,1,1,3,00,A,A,-5* 9 9 9 9 * * * 4.4,3.6,95,101110,0,9999,273,0,0,0,999900,999900,999900
1970,1,1,4,00,A,A,-5* 9 9 9 9 * * * 10.1,10.0,0,9999,273,0,0,0,999900,999900,999900
1970,1,1,5,00,A,A,-5* 9 9 9 9 * * * 10.1,10.0,0,9999,280,0,0,0,999900,999900,999900
1970,1,1,6,00,A,A,-5* 9 9 9 9 * * * 150,0,9999,291,0,0,0,999900,999900,999900
1970,1,1,7,00,A,A,-5* 9 9 9 9 * * * 100,0,9999,294,0,0,0,999900,999900,999900
1970,1,1,8,00,A,A,-5* 9 9 9 9 * * * 2.9,10,18280,33,9999,295,9,45,4,999900,999900,9999
1970,1,1,9,00,A,A,-5* 9 9 9 9 * * * 7.0,10,1860,238,9999,292,118,480,49,999900,999900,9999
1970,1,1,10,00,A,A,-5* 9 9 9 9 * * * 11.6,6,10,18440,436,9999,286,266,700,51,999900,9999
1970,1,1,11,00,A,A,-5* 9 9 9 9 * * * 11.1,2,2,54,102440,581,9999,294,381,733,80,999900,9999
1970,1,1,12,00,A,A,-5* 9 9 9 9 * * * 15,1,1,7,46,102440,646,9999,301,590,811,49,999900,9999
1970,1,1,13,00,A,A,-5* 9 9 9 9 * * * 15,0,1,19,101440,678,9999,309,663,830,70,999900,9999
1970,1,1,14,00,A,A,-5* 9 9 9 9 * * * 14,3,0,3,10,101470,623,9999,305,420,802,64,999900,9999
1970,1,1,15,00,A,A,-5* 9 9 9 9 * * * 12,6,0,5,10,101310,562,9999,301,120,720,60,999900,9999
1970,1,1,16,00,A,A,-5* 9 9 9 9 * * * 12,9,-1,5,36,101540,124,9999,297,185,309,100,999900,9999
1970,1,1,17,00,A,A,-5* 9 9 9 9 * * * 11,7,-2,0,35,101500,102,9999,291,26,81,21,999900,9999
1970,1,1,18,00,A,A,-5* 9 9 9 9 * * * 10,4,-4,3,14,101630,0,9999,286,0,0,0,999900,999900,9999
1970,1,1,19,00,A,A,-5* 9 9 9 9 * * * 9,2,5,8,12,101880,0,9999,278,0,0,0,999900,999900,9999
1970,1,1,20,00,A,A,-5* 9 9 9 9 * * * 8,5,-6,2,11,101770,0,9999,275,0,0,0,999900,999900,9999
1970,1,1,21,00,A,A,-5* 9 9 9 9 * * * 8,0,-6,5,11,101860,0,9999,272,0,0,0,999900,999900,9999

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Dynamic Downscaling

GCM



RCM



FMY



RCP Year Percentile

```

[EXTRACT]Climate Zone 3,CA,USA,CTRW2,24908,17.70, 322.20, 8.6,2.0
DESIGN CONDITIONS,1,Climate Design Data 2000 annual handbook,heating,1,2.9,4.2,-6.2,3.0,7,-2.5,3.1,10.7,11.4,11
TYPICAL /EXTREME PERIODS,6,Summer - Mean Hottest Max Temperature For Period,Extreme,5/23,5/23,Summer - Mean Hottest
GROUND TEMPERATURES,3,,5,,10,34,16.0,11.18,12.06,14.33,16.09,17.28,17.64,17.82,15.66,-13.33,12.34,2,,12,18,11
INCLUDING OUNTLIGHT SAVINGS,No,0,0
COMMENTS 1,California Climate Zone 03 Version 2;
COMMENTS 2, - Ground temp produced with a standard soil diffusivity of 2.3225760E-03 (m^2/2day)
DATA PERIODS,1,1,Data,Sunday, 1/ 1,12/31
1974.1.1.1.60.A.A.* * * * * 8.6.0.3.19,101318,0.9999,278,0.0,0.999900,999900,999900
1974.1.1.2.60.A.A.* * * * * 5.4.3.35,101270,0.9999,272,0.0,0.999900,999900,999900,999900
1974.1.1.3.60.A.A.* * * * * 4.4.3.6.35,101110,0.9999,273,0.0,0.999900,999900,999900,999900
1974.1.1.4.60.A.A.* * * * * 3.9.9.3,101050,0.9999,275,0.0,0.999900,999900,999900,999900
1974.1.1.5.60.A.A.* * * * * 3.6.9.3,100990,0.9999,280,0.0,0.999900,999900,999900,999900
1974.1.1.6.60.A.A.* * * * * 3.5.9.3,100930,0.9999,291,0.0,0.999900,999900,999900,999900
1974.1.1.7.60.A.A.* * * * * 3.4.9.3,100870,0.9999,294,0.0,0.999900,999900,999900,999900
1974.1.1.8.60.A.A.* * * * * 2.9.9.3,100810,31.9999,285,9.45,4.999900,999900,999900
1974.1.1.9.60.A.A.* * * * * 2.8.9.3,100750,278.9999,292,115.248,0.999900,999900
1974.1.1.10.60.A.A.* * * * * 2.7.9.3,100690,436.9999,286,266.780,31.999900,999900
1974.1.1.11.60.A.A.* * * * * 11.1.2.2.54,102440,581.9999,294,381.733,48.999900,999900
1974.1.1.12.60.A.A.* * * * * 15.1.1.7.66,102440,616.9999,286,356.780,51.999900,999900
1974.1.1.13.60.A.A.* * * * * 15.0.1.1.19,101448,678.9999,309,653.830,76.999900,999900
1974.1.1.14.60.A.A.* * * * * 14.0.0.3.10,101470,623.9999,305,618.882,64.999900,999900
1974.1.1.15.60.A.A.* * * * * 12.0.9.5,101310,562.9999,301,528.730,60.999900,999900
1974.1.1.16.60.A.A.* * * * * 12.9.1.5.36,101540,524.9999,297,485,309,100,999900,999900,999900,999900,999900,999900
1974.1.1.17.60.A.A.* * * * * 11.7.1.2.15,101580,482.9999,291,26,61,21,999900,999900
1974.1.1.18.60.A.A.* * * * * 10.4.4.2.14,101630,0.9999,286,0.0,0.999900,999900,999900,999900,999900,999900
1974.1.1.19.60.A.A.* * * * * 9.2.5.8.12,101680,0.9999,278,0.0,0.999900,999900,999900,999900,999900,999900
1974.1.1.20.60.A.A.* * * * * 8.5.6.2.11,101730,0.9999,275,0.0,0.999900,999900,999900,999900,999900,999900
1974.1.1.21.60.A.A.* * * * * 8.0.6.5.11,101860,0.9999,272.0.0.0.999900,999900,999900,999900

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TMY

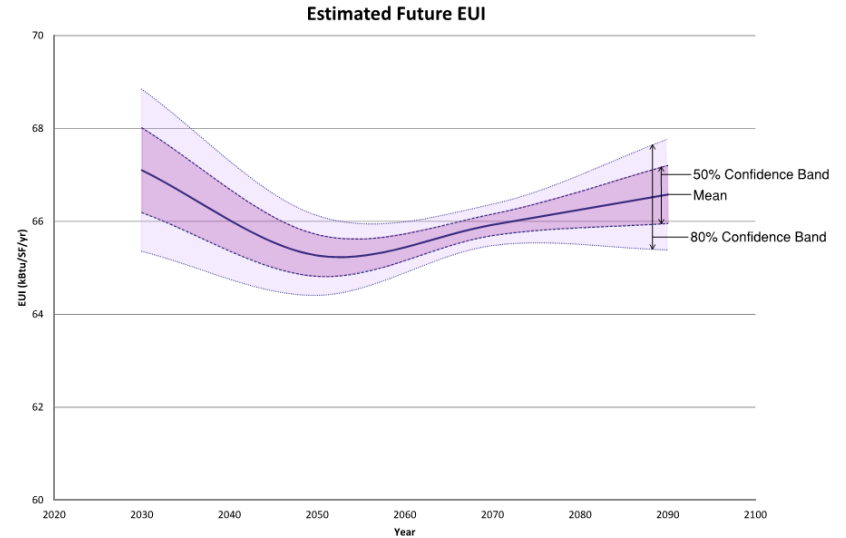
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GROUND TEMPERATURES,3,,5,,10,34,16.0,11.18,12.06,14.33,16.09,17.28,17.64,17.82,15.66,-13.33,12.34,2,,12,18,11
INCLUDING OUNTLIGHT SAVINGS,No,0,0
COMMENTS 1,California Climate Zone 03 Version 2;
COMMENTS 2, - Ground temp produced with a standard soil diffusivity of 2.3225760E-03 (m^2/2day)
DATA PERIODS,1,1,Data,Sunday, 1/ 1,12/31
1974.1.1.1.60.A.A.* * * * * 8.6.0.3.19,101318,0.9999,278,0.0,0.999900,999900,999900,999900
1974.1.1.2.60.A.A.* * * * * 5.4.3.35,101270,0.9999,272,0.0,0.999900,999900,999900,999900
1974.1.1.3.60.A.A.* * * * * 4.4.3.6.35,101110,0.9999,273,0.0,0.999900,999900,999900,999900
1974.1.1.4.60.A.A.* * * * * 3.9.9.3,101050,0.9999,275,0.0,0.999900,999900,999900,999900
1974.1.1.5.60.A.A.* * * * * 3.6.9.3,100990,0.9999,280,0.0,0.999900,999900,999900,999900
1974.1.1.6.60.A.A.* * * * * 3.5.9.3,100930,0.9999,291,0.0,0.999900,999900,999900,999900
1974.1.1.7.60.A.A.* * * * * 3.4.9.3,100870,0.9999,294,0.0,0.999900,999900,999900,999900
1974.1.1.8.60.A.A.* * * * * 2.9.9.3,100810,31.9999,285,9.45,4.999900,999900,999900,999900
1974.1.1.9.60.A.A.* * * * * 2.8.9.3,100750,278.9999,292,115.248,0.999900,999900
1974.1.1.10.60.A.A.* * * * * 2.7.9.3,100690,436.9999,286,266.780,51.999900,999900
1974.1.1.11.60.A.A.* * * * * 11.1.2.2.54,102440,581.9999,294,381.733,48.999900,999900
1974.1.1.12.60.A.A.* * * * * 15.1.1.7.66,102440,616.9999,286,356.780,51.999900,999900
1974.1.1.13.60.A.A.* * * * * 15.0.1.1.19,101448,678.9999,309,653.830,76.999900,999900
1974.1.1.14.60.A.A.* * * * * 14.0.0.3.10,101470,623.9999,305,618.882,64.999900,999900
1974.1.1.15.60.A.A.* * * * * 12.0.9.5,101310,562.9999,301,528.730,60.999900,999900
1974.1.1.16.60.A.A.* * * * * 12.9.1.5.36,101540,524.9999,297,485,309,100,999900,999900,999900,999900,999900,999900
1974.1.1.17.60.A.A.* * * * * 11.7.1.2.15,101580,482.9999,291,26,61,21,999900,999900
1974.1.1.18.60.A.A.* * * * * 10.4.4.2.14,101630,0.9999,286,0.0,0.999900,999900,999900,999900,999900,999900
1974.1.1.19.60.A.A.* * * * * 9.2.5.8.12,101680,0.9999,278,0.0,0.999900,999900,999900,999900,999900,999900
1974.1.1.20.60.A.A.* * * * * 8.5.6.2.11,101730,0.9999,275,0.0,0.999900,999900,999900,999900,999900,999900
1974.1.1.21.60.A.A.* * * * * 8.0.6.5.11,101860,0.9999,272.0.0.0.999900,999900,999900,999900

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HGA

- Resiliency Planning
- Future weather visualization
- Improved methodology



“Essentially, all models are wrong, but some are useful.”

– George Box, 1987, *Empirical Model-Building and Response Surfaces*

Jim Bradburn, PE

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HGA Architects and Engineers
Jbradburn@hga.com
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