Department of Pesticide Regulation

Brian R. Leahy
Director

Edmund G. Brown Jr.
Governor

M E M O R A N D U M

TO: Randy Segawa
Environmental Program Manager I
Environmental Monitoring Branch

FROM: Bruce Johnson, Ph.D. *Original signed by*
Research Scientist III
Environmental Monitoring Branch
916-324-4106

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SUBJECT: PRELIMINARY LOOK AT THE RELATIONSHIP BETWEEN MAXIMUM AIR TEMPERATURE AND MAXIMUM 15CM SOIL TEMPERATURE BASED ON THE CALIFORNIA IRRIGATION MANAGEMENT INFORMATION SYSTEMS STATION DATA

I downloaded 5 years of data from 11 stations all from 2005 to 2009. The data consisted of maximum daily soil temperature (MDST), maximum daily air temperature (MDAT), net radiation, solar radiation, precipitation. For this preliminary analysis, I only used temperatures. The soil temperature is listed at 15 cm depth. The stations are generally described as being located on irrigated grass or alfalfa.

I examined the data for missing values in MDST or MDAT. For groups of about eight or less missing values, I interpolated. However, some missing runs were longer and I deleted these days. I regressed the MDST on MDAT. I used the resulting regression equation to calculate the air temperature value corresponding to 90F soil temperature (air[90]). I counted the number of days where the MDST >=90 and MDAT >= air(90).

Results

The lowest r2 value was in Oxnard at 0.18, and the next lowest was Salinas South in Monterey at 0.33. The remaining r2 values were above 0.5 (Table 1). Slopes ranged from 0.55 to 0.76 and intercepts from 104 to 126. Seven of the 11 stations had no days with soil temperature above 90F or air temperatures above air(90). In the five years of data, Arvin-Edison had 124 days where soil temperatures exceeded 90F and 27 days where maximum air temperature exceeded air(90). In the four cases where there were soil temperatures above 90, the air(90) value under predicted the number of days of soil temperatures above 90, by a factor of 2-4 (except Oxnard).

The r2 value in the three coast sites (156, 89, 113) were the three lowest values. This suggests that coastal sites have a poorer relationship between MDST and MDAT, then the inland sites. There were no days above 90F soil temperature in the three coastal sites. There were 4 of 8 inland stations with soil temperatures exceeding 90.

Discussion

The conditions in these California Irrigation Management Information Systems (CIMIS) Stations contrast to likely conditions preceding a soil fumigation. An obvious difference will be the lack of vegetation preceding the fumigation. All of the CIMIS stations I used appeared to be vegetated, which is a criterion for establishing a CIMIS station. Figure 1 and 2 are snapshots at two illustrative stations, showing the grassy ground cover. Another likely difference is soil moisture. Soil conditions in the irrigated pastures are probably moister than pre-fumigated fields. The pre-fumigated field soil has probably been extensively cultivated and fluffed up with perhaps a lower bulk density than the irrigated pastures of CIMIS stations.

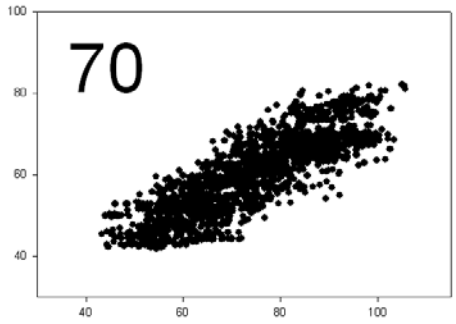
My intuition is that the presence of the grass and the greater moisture depress the maximum surface temperatures. Overall, I would expect less variability in the soil temperatures in the CIMIS plots than soil temperatures in pre-fumigated fields. It would be desirable to extrapolate these results to bare soil situations.

Conclusion

Maximum daily air temperature and maximum daily soil temperature at 15cm are related. That relationship was weakest, as measured by r2, in the three coastal sites and strongest in the other 8 sites located in the southern San Joaquin Valley. Half of the 8 inland sites had soil temperatures maxima that exceeded 90F for some days during the five year period, and half had no days where the 90F threshold was breached. In all cases where daily soil temperatures had exceeded 90F, the predicted number of exceedance days based on air(90) underpredicted the measured number of exceedance days by a factor of 2 to 4.

Figure 1. Looking East toward station #86, Lindcove in Tulare County. “Irrigated grass” according to station details.

Figure 2. Looking West toward station #125, Arvi-Edison in Kern County. “Irrigated grass” according to station details.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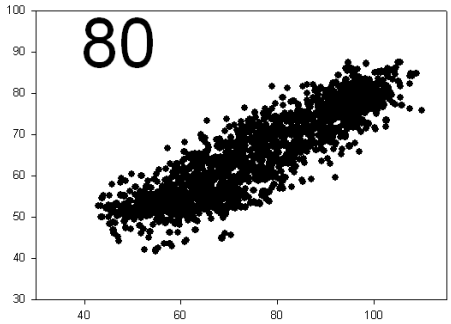
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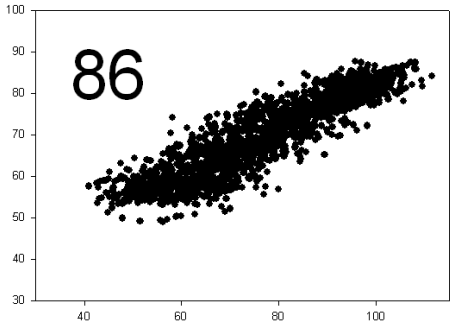
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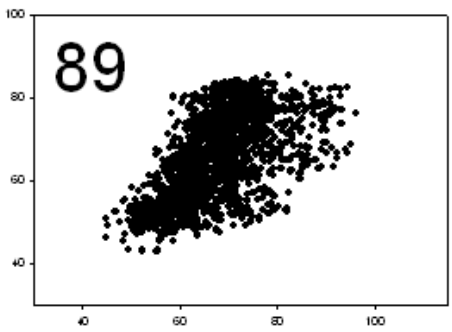
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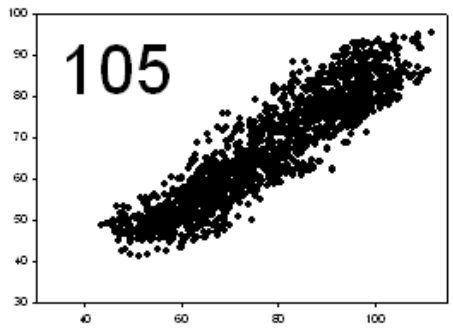
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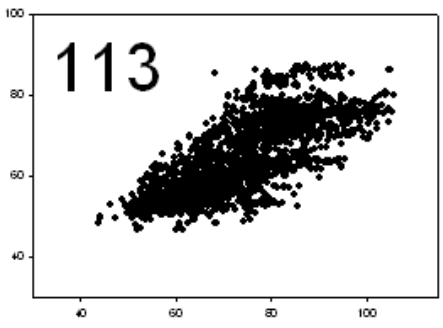
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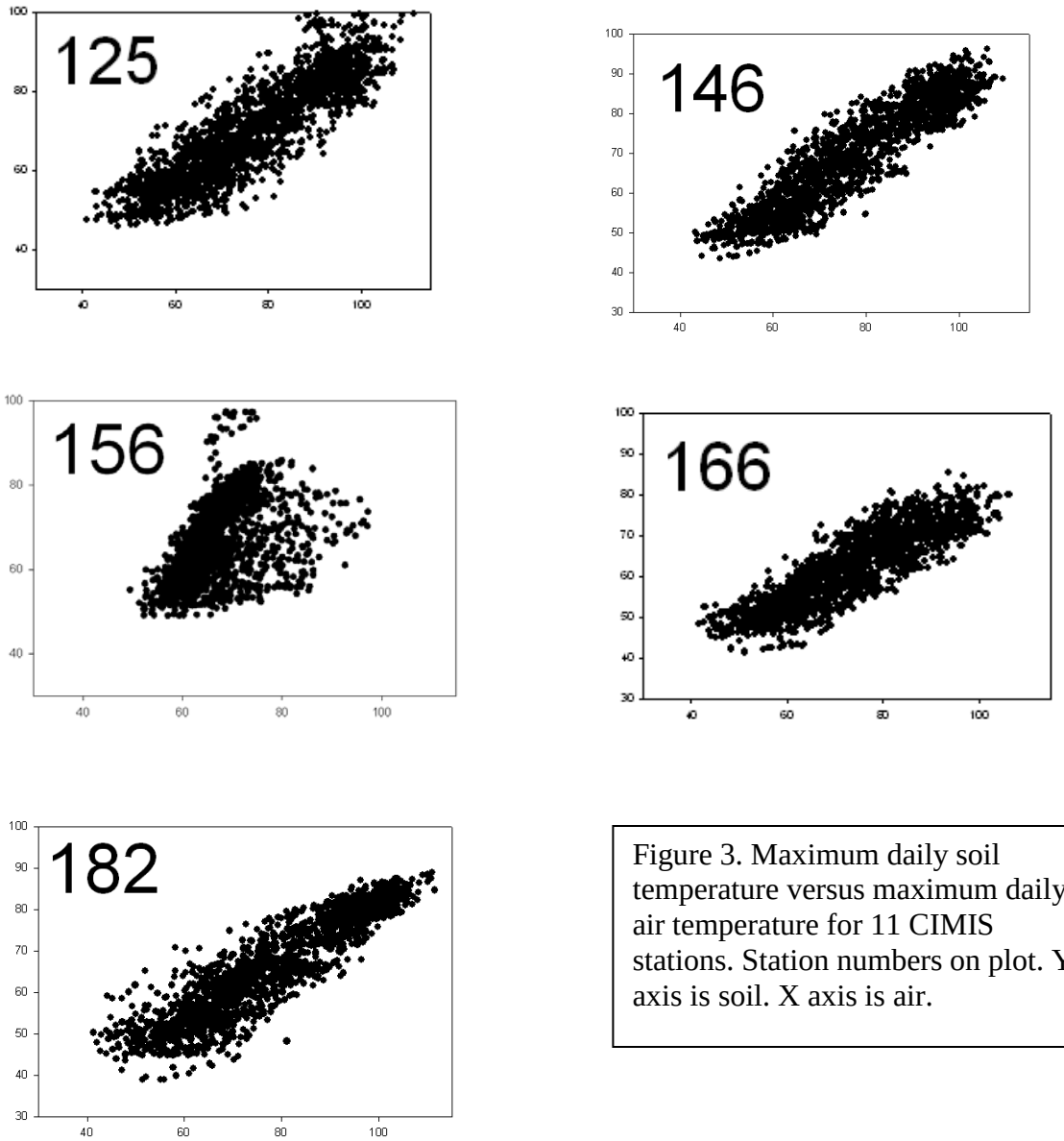

Figure 3. Maximum daily soil temperature versus maximum daily air temperature for 11 CIMIS stations. Station numbers on plot. Y axis is soil. X axis is air.

Table 1. Analysis of eleven CIMIS stations with focus on relationship between maximum daily soil temperature at15cm depth and maximum daily air temperature.

						Regression Statistics						
Station	**Station Number**	**County**	**#days**	**soil temperature (F)**	**air temperature (F)**	**slope**	**intercept (F)**	**r2**	**air(90) (F)**	**#days soil > 90**	**#days air > air(90)**	**Station Surface Description**
Manteca	70	San Joaquin	1826	82.0	105.6	0.5756	17.5	0.72	126.0	0	0	"flood irrigated pasture"
Lodi West	166	San Joaquin	1803	85.4	106.3	0.6028	17.8	0.77	119.8	0	0	"permanent pasture"
Oxnard	156	Ventura	1826	97.3	97.3	0.5815	28.4	0.18	105.9	28	0	NA
Lindcove	86	Tulare	1787	87.8	111.4	0.5477	27.7	0.83	113.8	0	0	"small plot of grass"
Delano	182	Tulare	1767	88.9	111.4	0.6874	12.6	0.83	112.6	0	0	(picture shows grass, bare beneath instrument stand)
Salinas South	89	Monterey	1826	85.5	96.2	0.6793	20.1	0.33	102.9	0	0	(picture shows dense grass)
King City	113	Monterey	1825	87.4	105.7	0.5905	21.3	0.56	116.4	0	0	(picture shows grass)
Belridge	146	Kern	1825	96.3	109.3	0.7644	10.3	0.85	104.2	49	26	(picture shows grass)
Arvin-Edison	125	Kern	1825	100.9	111.5	0.7383	13.5	0.77	103.7	124	27	"sprinkler irrigated seasonal grasses"
Westlands	105	Fresno	1825	95.5	111.9	0.7546	8.3	0.85	108.3	50	12	"grassed area", "irrigated"
Fresno State	80	Fresno	1825	87.6	109.9	0.5962	20.0	0.80	117.3	0	0	"flood irrigated pasture"