EMFAC Modeling Change Technical Memo

SUBJECT: REVISED PLANNING RELATIVE HUMIDITY PROFILES

LEAD: DILIP PATEL

SUMMARY

The EMFAC model contains daily ambient relative humidity profiles for use in evaluating air conditioner usage by automobile drivers and NOx conversion in automobile exhaust. The model has annual average daily relative humidity profiles for each county or geographical area in the State. The model also has month-by-month average daily relative humidities, and two planning profiles: one marked “summer” and one marked “winter”. These two profiles are used as worst-case scenarios in planning exercises. The “summer” profile is actually the profile for a day in which high ambient ozone concentrations are noted. This is normally during hot weather or the summer season.

Hour-by-hour temperature, relative humidity and ozone concentration data from 700 stations in the AIRS, NCDC, and RAWS data bases for the years 1996-2004 were gathered. For each station throughout California, the temperature profiles for 18 days with ozone concentration around the Federal 8-hour ozone design value were selected. The temperature profiles were extended by interpolation onto a 4-km grid of California. For each geographical area the countywide results were determined by weighting these temperatures with the VMT on each grid.

The absolute humidity (relative humidity multiplied by saturation humidity at recorded temperature) at each grid point was likewise interpolated and weighted. The resulting absolute humidity field was then divided by the saturation humidity at the local weighted grid temperatures to determine the temporal and spatial relative humidity profiles.

In general the high-ozone-day relative humidities proposed are lower than the previous values by 5 to 15 percentage points.

A summary of the results for various areas in the State is shown in Tables 1 and 2 below for the years 2002 and 2015. Employment of the revised relative humidity profiles is estimated to increase the planning-day emissions from on-road motor vehicles by 112 tons per day (tpd) or 6.4% statewide for NOx, and decrease the statewide CO_2 inventory by 3506 tpd (or 0.7%) in calendar year 2002.

Table 1
Summary of Emissions Changes due to Revised Planning Relative Humidity Profiles
Planning day, Calendar Year 2002

Air Basin	Emission Changes by Pollutant, tons per day				
	ROG	CO	NOx	CO_2	PM
Statewide	-1.3	-65.4	111.5	-3506	0.00
South Coast	-0.3	-13.9	26.6	-799	0.00
San Joaquin Valley	-0.3	-15.3	27.0	-702	0.00
Sacramento Valley	-0.2	-9.2	10.9	-430	0.00
San Diego	-0.1	-4.4	8.3	-266	0.00
San Francisco Bay Area	-0.4	-18.2	22.0	-916	0.00

Table 2
Summary of Emissions Changes due to Revised Planning Relative Humidity Profiles
Episode day, Calendar Year 2015

Air Basin	Emission Changes by Pollutant, tons per day				
	ROG	CO	NOx	CO_2	PM
Statewide	-0.4	-28.6	48.4	-4917	0.00
South Coast	-0.1	-5.3	10.6	-962	0.00
San Joaquin Valley	-0.1	-6.8	12.1	-1130	0.00
Sacramento Valley	-0.1	-4.3	4.7	-691	0.00
San Diego	0.0	-1.9	3.5	-344	0.00
San Francisco Bay Area	-0.1	-7.0	8.1	-1212	0.00

NEED FOR REVISION

The planning relative humidity profiles presently in the EMFAC model were created by taking hourly relative humidity observations on high ozone days at various recording stations throughout California. These observations were spatially distributed by ZIP code and weighted by population.

The resulting weighted profiles for temperature seemed rather cool, because evidently most of the travel occurred in cooler temperate areas.

A project was initiated to produce more representative or reasonable weighted temperature profiles. The corresponding relative humidities for the ambient days were reanalyzed at the same time.

AFFECTED SOURCE CODE/VERSION

RHAssign.for (3/22/2001). Module RHUM_DATA.
The affected lines of Subroutine RHUM_INIT are shown in Attachment A.

METHODOLOGY FOR REVISION

Hour-by-hour temperature, relative humidity and ozone concentration data from 700 stations in the U.S. EPA Aerometric Information Retrieval System (AIRS), National Climatic Data Center (NCDC), and Desert Research Institute's Remote Automated Weather Stations (RAWS) databases for the years 1996-2004 were gathered.

For each station throughout California, the temperature profiles for 18 days with ozone concentration around the Federal 8-hour ozone design value were selected. Only days with multiple local stations reporting high ozone were chosen. This favors local ozone generation days over transport days.

The temperature profiles were extended by interpolation onto a 4-km grid of California.

For each geographical area the countywide results were determined by weighting these temperatures with the VMT on each grid.

The absolute humidity (relative humidity multiplied by saturation humidity at recorded temperature) at each grid point was likewise interpolated and weighted. The resulting absolute humidity field was then divided by the saturation humidity at the local weighted grid temperatures to determine the temporal and spatial relative humidity profiles.

In Table 3 is shown the increase of relative humidity of the new ozone planning temperature and relative humidity profiles for each of the geographical areas used in the EMFAC model. The increase shown is for the mid-day value, when the relative humidity is at its lowest point. The extrema of the new profiles are also shown.

Table 3
Changes in Relative Humidity Profiles

GAI	Air Basin	County	Mid day Increase % pts	High %	Low %
1	GBV	Alpine	5	77	32
2	GBV	Inyo	-3	48	22
3	GBV	Mono	7	79	32
4	LC	Lake	-9	42	20
5	LT	El Dorado	2	77	30
6	LT	Placer	3	77	29
7	MC	Amador	-5	42	20
8	MC	Calaveras	-6	44	21
9	MC	El Dorado	-6	41	21
10	MC	Mariposa	-2	50	30
11	MC	Nevada	-5	44	23
12	MC	Placer	-5	47	24
13	MC	Plumas	-8	61	21
14	MC	Sierra	-5	54	24
15	MC	Tuolumne	-1	49	25
16	NCC	Monterey	-15	53	27
17	NCC	San Benito	-22	54	24
18	NCC	Santa Cruz	-11	61	27
19	NC	Del Norte	7	49	27
20	NC	Humboldt	-24	49	26
21	NC	Mendocino	-12	46	19
22	NC	Sonoma	-10	40	20
23	NC	Trinity	-28	47	20
24	NEP	Lassen	-13	64	21
25	NEP	Modoc	-8	73	23
26	NEP	Siskiyou	-16	64	25
27	SV	Butte	-11	45	21
28	SV	Colusa	-10	46	19
29	SV	Glenn	-9	47	21
30	SV	Placer	-8	49	19
31	SV	Sacramento	-6	50	20
32	SV	Shasta	-30	42	19
33	SV	Solano	-2	53	22
34	SV	Sutter	-9	48	20
35	SV	Tehama	-7	51	23
36	SV	Yolo	-5	52	20
37	SV	Yuba	-8	47	21
38	SD	San Diego	-9	48	27
39	SF	Alameda	-18	41	22
40	SF	Contra Costa	-2	39	20
41	SF	Marin	-6	42	22
42	SF	Napa	-9	45	18

Table 3 Continued
Changes in Relative Humidity Profiles

GAI	Air Basin	County	Mid day Increase % pts	High %	Low %
43	SF	San Francisco	-18	43	24
44	SF	San Mateo	-6	49	25
45	SF	Santa Clara	-8	46	22
46	SF	Solano	-5	42	18
47	SF	Sonoma	-9	49	20
48	SJV	Fresno	-13	42	20
49	SJV	Kern	-6	39	20
50	SJV	Kings	-6	41	19
51	SJV	Madera	-10	43	20
52	SJV	Merced	-11	45	21
53	SJV	San Joaquin	-4	45	21
54	SJV	Stanislaus	-15	44	20
55	SJV	Tulare	-6	39	18
56	SCC	San Luis Obispo	-1	55	24
57	SCC	Santa Barbara	6	54	33
58	SCC	Ventura	1	53	32
59	SC	Los Angeles	-1	58	34
60	SC	Orange	-6	55	35
61	SC	Riverside	-12	54	24
62	SC	San Bernardino	-8	55	23
63	SS	Imperial	-23	32	14
64	SS	Riverside	-17	37	17
65	MD	Kern	-7	38	19
66	MD	Riverside	-19	31	16
67	MD	Riverside	-21	28	14
68	MD	Los Angeles	-17	40	18
69	MD	San Bernardino	-12	38	19

INVENTORY EFFECTS

The emission changes for the ozone episode day as a result of the revised ambient relative humidity profiles are shown below in Tables 5 through 9. Scenario years of 2002, 2005, 2010, 2015, and 2020 are shown. The areas shown are Statewide overall, Sacramento Valley Air Basin, San Diego County, San Francisco Bay Air Basin, San Joaquin Valley Air Basin, and South Coast Air Basin.

Table 5
Summary of Emissions Changes due to Revised Planning Relative Humidity Profiles
Planning day, Calendar Year 2002

Air Basin	Emission Changes by Pollutant, tons per day				
	ROG	CO	NOx	CO_2	PM
Statewide	-1.3	-65.4	111.5	-3506	0.00
South Coast	-0.3	-13.9	26.6	-799	0.00
San Joaquin Valley	-0.3	-15.3	27.0	-702	0.00
Sacramento Valley	-0.2	-9.2	10.9	-430	0.00
San Diego	-0.1	-4.4	8.3	-266	0.00
San Francisco Bay Area	-0.4	-18.2	22.0	-916	0.00

Table 6
Summary of Emissions Changes due to Revised Planning Relative Humidity Profiles
Planning day, Calendar Year 2005

Air Basin	Emission Changes by Pollutant, tons per day				
	ROG	CO	NOx	CO_2	PM
Statewide	-1.0	-52.9	97.4	-3776	0.00
South Coast	-0.2	-10.1	21.1	-798	0.00
San Joaquin Valley	-0.2	-12.8	25.3	-789	0.00
Sacramento Valley	-0.1	-8.0	9.9	-496	0.00
San Diego	-0.1	-3.6	7.0	-290	0.00
San Francisco Bay Area	-0.3	-14.2	17.7	-981	0.00

Table 7
Summary of Emissions Changes due to Revised Planning Relative Humidity Profiles
Planning day, Calendar Year 2010

Air Basin	Emission Changes by Pollutant, tons per day				
	ROG	CO	NOx	CO_2	PM
Statewide	-0.6	-39.4	72.4	-4362	0.00
South Coast	-0.1	-7.3	15.8	-901	0.00
San Joaquin Valley	-0.1	-9.7	18.7	-969	0.00
Sacramento Valley	-0.1	-6.0	7.1	-583	0.00
San Diego	0.0	-2.6	5.0	-311	0.00
San Francisco Bay Area	-0.2	-9.9	12.3	-1098	0.00

Table 8
Summary of Emissions Changes due to Revised Planning Relative Humidity Profiles
Episode day, Calendar Year 2015

Air Basin	Emission Changes by Pollutant, tons per day				
	ROG	CO	NOx	CO_2	PM
Statewide	-0.4	-28.6	48.4	-4917	0.00
South Coast	-0.1	-5.3	10.6	-962	0.00
San Joaquin Valley	-0.1	-6.8	12.1	-1130	0.00
Sacramento Valley	-0.1	-4.3	4.7	-691	0.00
San Diego	0.0	-1.9	3.5	-344	0.00
San Francisco Bay Area	-0.1	-7.0	8.1	-1212	0.00

Table 9
Summary of Emissions Changes due to Revised Planning Relative Humidity Profiles
Planning day, Calendar Year 2020

Air Basin	Emission Changes by Pollutant, tons per day				
	ROG	CO	NOx	CO_2	PM
Statewide	-0.3	-21.6	32.8	-5436	0.00
South Coast	0.0	-4.0	7.1	-1029	0.00
San Joaquin Valley	-0.1	-5.0	7.8	-1271	0.00
Sacramento Valley	0.0	-3.2	3.1	-775	0.00
San Diego	0.0	-1.4	2.6	-371	0.00
San Francisco Bay Area	-0.1	-5.1	5.5	-1313	0.00

The change to drier ambient relative humidity profiles for the ozone planning scenario resulted in an increase in NOx emissions. This is due to decreased reaction of NO_2 and water vapor, which scavenges NOx in the air. The decrease is about 6.4% in 2002, falling to 5.5% in 2020. This trend with time is largely the effect of the total emissions dropping due to the prevalence of low-emissions technology. The San Joaquin Valley Air Basin shows a bigger effect than the South Coast Air Basin because the proposed relative humidity profile decrease is more pronounced for the San Joaquin Valley.

Due to the drier planning relative humidity profiles, the CO_2 estimates for the planning day are lower. This is probably due to decreased air conditioner usage. The magnitude of the decrease is 0.7% in 2002 to 0.8% in 2020.