5. EMISSIONS MODELING

Effective air quality modeling requires the development of accurate temporally, spatially, and chemically resolved emission estimates suitable for input to the photochemical model. Emissions are broadly categorized into major stationary (or point) sources, area and non-road sources (referred to herein collectively as area sources), on-road mobile sources, and biogenics. In addition, there are many subcategories that comprise the point and area sources. In the following sections, we describe the emission models that were used in this study. We also describe the source of emissions data and how they were used to develop base case emissions estimates for the Bay Area July/August 2000 and July 1999 modeling episodes.

EMISSION MODELS

EMS-95

In order to remain compatible with emissions preparation activities at the CARB for the Central California Ozone Study (CCOS), we used the 1995 Emissions Modeling System, or EMS-95 (Dickson and Oliver, 1991; Dickson et al., 1992; Bruckman and Oliver, 1993; Wilkinson et al., 1994; Janssen, 1998). Specifically, the CARB provided a copy of their version of EMS-95 for use in the current study. This ensured that the District's emissions estimates were compatible with those prepared for use in other CCOS-related studies as well as other on-going CARB-related studies. EMS-95 was used to prepare the spatially, temporally, and chemically resolved emissions estimates of total organic gases (TOG), oxides of nitrogen (NO_X), and carbon monoxide (CO) for the point and area sources. EMS-95 was used to prepare model-ready emissions estimates for CB-IV and SAPRC99 speciation for both the July 1999 and July/August 2000 episodes.

CARB (2004a) describes the methods used to prepare stationary and area source emissions estimates for use in CCOS, including the methods to prepare certain day-specific emissions estimates for the July/August 2000 episode. Note that day-specific point and area emission estimates were not included in the July 1999 episode due to the lack of data; however, as with the July/August 2000 episode, day-specific emissions were estimated for the biogenics and on-road mobile sources using methods described by Wilkinson (2004) and CARB (2004a, 2004d, 2004e).

Although EMS-95 is capable of preparing biogenics and on-road mobile source emissions estimates, the CARB used separate modeling systems to prepare these estimates. These are summarized below.

BEIGIS

For biogenics, the CARB used the Biogenic Emission Inventory Geographic Information System, or BEIGIS (CARB, 2001; CARB, 2004d) to estimate isoprene, methyl-butenol (MBO), and monoterpene emissions from the vegetation distribution over the CCOS modeling grid. Biogenic oxygenated and other volatile organic compounds (OVOCs) were estimated as thirty percent of the total isoprene, MBO, and monoterpenes (CARB, 2004d). Biogenic nitric oxide (BNO) was estimated using the Biogenic Model for Emissions (BIOME) (Wilkinson et al., 1994; Janssen, 1998), which is based on the Biogenic Emissions Inventory System version three (BEIS3) (Pierce, 2001) and the Biogenic Emissions Landuse Database version three (BELD3) (Pierce et al., 1998). CARB (2004b) describes the meteorology used to estimate the biogenic emissions. EMS-95 was used to chemically speciate the biogenic emissions estimates.

ITN, DTIM, and EMFAC

For on-road mobile sources, the CARB used the Integrated Transportation Network (ITN) (Wilkinson, 2004) coupled with the Direct Travel Impact Model (DTIM) (Fieber and Ireson, 2001) and the mobile source emissions factor model (EMFAC) (CARB, 2003) to estimate gridded, hourly emissions. Wilkinson (2004) describes how these systems and data were combined to estimate on-road mobile source emissions of CO, TOG, and NO_X (more information is provided below). Wilkinson (2004) also describes the meteorology that was used to estimate on-road mobile source emissions. Again, EMS-95 was used to chemically speciate the on-road mobile source emissions estimates.

EMISSIONS ESTIMATES FROM CARB FOR THE CCOS PERIOD

The CARB provided base emissions estimates for the entire CCOS domain (Figure 4-1) from the California Emissions Forecasting System (CEFS) (CARB, 2004f). The major stationary (point) source inventory for the study domain contained actual stack coordinates and included year 2000 and 1999 ozone season day estimates of TOG, NO_X, and CO for each process contained within the inventoried facilities. The inventory included the required elements in the format described in Appendix A (Section A-1) of the Bay Area Modeling Protocol (ENVIRON et al., 2002). The area source inventory included year 2000 and 1999, county-wide ozone season day estimates of TOG, NO_X, and CO for each area source category. The inventory included the required elements in the format described in Appendix A (Section A-2) of the Modeling Protocol. EMS-95 was used to process the major stationary source and area source inventories into gridded, speciated, hourly emissions estimates suitable for input to CAMx. The CEFS emissions database also contained day-specific emissions estimates for certain stationary and area sources during the July/August 2000 episode, as described in CARB (2004a). Although CEFS contains data for an ozone season day for each of the respective ozone season months, the episodes that were modeled span both weekend days and weekdays. Hence, EMS-95 was used to adjust the typical ozone season day emissions estimates to account for weekend day and weekday activity using data that are contained within EMS-95 and were prepared by CARB.

The CARB provided gridded, hourly biogenic emissions of isoprene, monoterpenes, MBO, and OVOCs for the CCOS domain for each day of the episodes. However, the project team prepared estimates of BNO for each day of the two episodes. The inventory included the required information as described in Appendix A (Section A-3) of the Modeling Protocol.

Finally, the CARB provided gridded, hourly on-road mobile source emissions of TOG, CO, and NO_X for the CCOS domain for each day of the two episodes. The inventory included the required information as described in Appendix A (Section A-4) of the Modeling Protocol.

More specific information on estimation techniques and ancillary emission estimates to improve the overall inventory are provided below.

On-Road Emissions

The base case CCOS on-road mobile source inventory was constructed using data from the ITN, DTIM, and EMFAC. The ITN is a combination of twenty-three individual networks from seven transportation planning agencies and CalTrans (Wilkinson, 2004). For counties that are not represented by a local transportation agency, the CalTrans statewide transportation network was used. However, unlike other transportation planning agencies, the CalTrans developed estimates of network travel only for personal travel and not commercial travel. Therefore, estimates of commercial travel for the CalTrans network were developed. Because the individual networks had VMT and trip end data from base years spanning 1995 through 2000, the VMT and trip ends were grown to a common base year – in this case, 2000. Researchers at the University of California at Davis allocated the link-based VMT, which was originally given for one or more time periods (i.e., AM peak, PM peak, midday peak, off peak, or daily), to twenty-four hourly bins (Lam et al., 2002). Intrazonal VMT and trip ends, in some cases by trip type, were allocated to twenty-four hourly bins (Wilkinson, 2004).

Emission factors from EMFAC v.2.20 were used by DTIM4 to estimate gridded, hourly on-road mobile source emissions estimates for the CCOS domain for the July 1999 and July/August 2000 episodes (Wilkinson, 2004) using meteorology developed by CARB (2004b). Wilkinson (2004) also describes how weekend emissions were estimated using weekday emissions as well as changes to account for NO_X emissions from heavy-duty diesel vehicles. Finally, county-wide emissions estimates prepared using EMFAC2002 v.2.20 were spatially and temporally distributed per the gridded, hourly emissions estimated using DTIM4 (Wilkinson, 2004). The reasons for this circuitous path to estimate on-road mobile source emissions are described in Wilkinson (2004), CARB (2004a), and CARB (2004c).

Marine Shipping Emissions

NO_X and VOC emissions estimates from oceangoing vessels are substantially underestimated in existing emissions inventories (Corbett et al., 1999; Corbett and Fischbeck, 1997). In order to correct this suspected deficiency, the project team estimated day-specific NO_X and VOC emissions for oceangoing and San Francisco Bay commercial marine traffic.

Shipping emissions originally in the CCOS inventory were prepared at the BAAQMD by Dinh (2002). Emission values were calculated as a function of month and year, based on 1999 ship traffic type data from the San Francisco Maritime Exchange (SFME) (Dinh, 2002).

Dinh (2002) used the following method to estimate ship emissions:

- It was assumed that 90% of SFBA ship traffic was motorship (a category that includes ships categorized by the SFME as "vehicle carriers" and "others"), while the other 10% was steamship. Motorships are propelled by internal combustion engines, while steamships are propelled by boiler-produced steam.
- Emissions during each the following ship "modes" of operation were estimated:
    - maneuvering within the SFBA,
    - berthing (or hotelling) when ships are stationary,
    - cruising (or in-transit) during inter-port movement within the SFBA and outside the Golden Gate, and
    - in-port berthing-change.
- Tugboat emissions were considered separately, while American and foreign vessels were also treated in different ways.
- Ship types were allocated to the different SFBA ports, with county fractional emission factors based on port activity, e.g., type of activities and number of ships.
- Ship emission projections to the year 2030 were estimated to increase at 2% per year.
- Month factors were based on activity patterns, but day to day variations were not estimated.
- Emission rates for six specific pollutants were based on usage of an assumed fuel type.

<u>Methods to Estimate Daily Shipping Emissions</u>

Whereas Dinh (2002) estimated monthly ship emission values, the current study has developed an estimate of the day to day variations in SFBA ship emissions during the July-August 2000 modeling period. This was accomplished by use of additional ship movement data from the SFME.

Two types of daily ship movement data for the period of July-August 2000 were obtained from the SFME: non-tug and tug. Data used in the subsequent non-tug calculations included vessel name, activity date, and port movements, while the tug calculations included the number of tugs used. The number of non-tug ships in the SFBA during the thirteen day period from 24 July to 5 August 2000 was tabulated, as was the number of days that each ship remained in the area. The number of tugs in the SFBA during 22 July to 4 August 2000 was also tabulated.

Results showed that the number of non-tug ships varied from 13 to 24, almost a factor of two. Deviations from the average of almost 19 non-tug ships per day thus ranged from +37% to -32%, for a total variation of 69% around the mean. Results also showed that the number of tugs varied from 21 to 53, more than a factor of two. Deviations from the average of almost 37 tugs per day thus ranged from +43% to -43%, for a total variation of 86% around the mean. These daily factors from the mean were applied to the monthly July-August 2000 CCOS shipping inventory to adjust for day-specific marine shipping emission estimates. The same method was applied to the July 1999 episode to obtain day-specific shipping emissions estimates. Further, the results from the July 1999 episode were similar to those of the July-August 2000 episode.

While the number of non-tug ships in the SFBA on a given day appears small, a random check of ship traffic listed in the SF Chronicle on a recent day shows only six ships arriving and 10 leaving. Even if the ship list provided by the SFME did not include all ship types (e.g., no small pleasure crafts), the daily patterns calculated herein are an accurate estimate of day to day variations in total SFBA ship emissions.

Wildfire Emissions

The July/August 2000 CCOS episode was characterized by a heavy contribution from forest fire smoke, particularly from fires in the southern Sierra Nevada. The smoke plumes from this and other large regional fires in Oregon and Nevada were detected aloft on several days by multiple aircraft and ozonesonde samples taken throughout central California. Therefore, day-specific wildfire emissions were estimated for the July-August 2000 episode by the CARB. Discussions on the wildfire emissions for this episode are contained in CARB (2004c). This issue has affected every major area in California conducting air quality modeling for this CCOS episode, and arguments have been made concerning the representativeness of fire-dominated episodes for use in 1-hour ozone SIPs in California.

The July 1999 episode was not nearly affected by forest fire smoke, as fire activity levels were more representative of a “typical” ozone day (i.e., no single fire impacted ozone air quality in any California ozone nonattainment areas). Therefore, the emission inventory for July 1999 contained standard season day fire estimates.

Refinery Emissions

Based on investigative work performed by the BAAQMD, refinery emissions were increased, specifically from flaring operations, by a factor of one hundred from recent BAAQMD and CARB emissions inventories (from 0.1 tons per day [tpd] NO_X to 13 tpd NO_X). There is evidence to suggest that other refinery-related emissions were also underestimated (e.g. upset events, pressure relief valves, etc.), which might affect TOG emissions as well. In an effort to better characterize emissions from refinery operations, the BAAQMD undertook an effort to develop day-specific emissions estimates for refinery operations within the District’s jurisdiction. These day-specific emissions estimates were used in lieu of the previous standard BAAQMD/CARB estimates for the July/August 2000 base case air quality modeling. No such effort was performed for the July 1999 episode.

Nevada Emissions

In order to be consistent with current CARB work, no effort was expended to estimate emissions for that portion of Nevada contained with the CCOS modeling domain.

Other Emissions Data

Other emissions-related data were required in order to prepare CAMx model-ready emissions estimates. These data included the following:

- Area source spatial surrogates;
- Cross references between area source categories and their spatial surrogates;
- Chemical mechanism-specific hydrocarbon speciation profiles; and
- Cross references between source categories and their hydrocarbon speciation profiles.

The area source spatial surrogates were used to spatially allocate the county-wide area source emissions estimates to individual grid cells. The CARB developed four kilometer grid cell area source spatial surrogates based on census and other data that are representative of conditions prior to 2000 (CARB, 2004a). Using EMS-95, the project team used the surrogates to spatially allocate the county-wide area source emissions estimates. The CARB supplied these data per the file format described in Appendix A (Section A-7) of the Modeling Protocol.

The area source spatial surrogates cross reference data maps each area source category to a specific spatial surrogate. The CARB supplied these data per the file format described in Appendix A (Section A-8) of the Modeling Protocol.

The chemical mechanism-specific hydrocarbon speciation profiles are used to split the TOG emissions estimates into the individual VOC components that are modeled within the chemistry processes of CAMx. The CARB provided hydrocarbon speciation profiles for both the CB-IV and SPARC99 chemical mechanisms per the file format described in Appendix A (Section A-10) of the Modeling Protocol.

The hydrocarbon speciation profile cross reference data maps an area source category or source classification code (SCC) to a chemical mechanism-specific VOC speciation profile. The CARB provided this cross reference per the file format described in Appendix A (Section A-11) of the Modeling Protocol.

In an effort to understand the impacts of alternative speciation profiles on the CARB-based emissions, the project sponsors requested that the study team use the EPA-based CB-IV speciation profiles to determine what changes would occur to the reactive component of the inventory. The project team obtained the EPA-based speciation profiles and manually assigned the EPA profiles to the CARB emissions source categories. The resulting CB-IV emissions estimates are compared herein.

FUTURE YEAR EMISSIONS ESTIMATES

Though efforts were begun to estimate future year emissions, these efforts have not yet been completed as of this version of the BAAQMD Photochemical Modeling report.

EMISSIONS SUMMARY

Table 5-1 shows the emissions estimates for the July-August 2000 and July 1999 episodes. The emissions estimates are for the Bay Area (Alameda, Contra Costa, Marin, Napa, San Francisco, San Mateo, Santa Clara, Solano, and Sonoma counties), the Sacramento area (El Dorado, Placer, Sacramento, Sutter, and Yolo counties), the San Joaquin Valley (Fresno, Kern, Kings, Madera, Merced, San Joaquin, Stanislaus, and Tulare counties), and the rest of the CCOS domain. The emissions estimates are split out for electric generating utilities (EGU), other stationary sources (Other), area sources (Area), commercial marine shipping (Ship), non-road mobile sources (Off-road), on-road mobile sources (On-road), and biogenics (Bio). As expected, emissions between the two episodes are relatively consistent though biogenic emissions are noticeably higher in July 1999. Investigation into the higher July 1999 biogenic emissions indicates that MBO and monoterpenes are roughly double those of the July/August 2000 episode. The larger biogenic emissions were due to higher temperatures in key areas of the domain where plant species emit large quantities of the MBO and monoterpenes (e.g., large pine forests in the Sierra Nevada and coastal ranges).

Work performed by Tesche et al. (2004), Vizuete et al., (2004), and Emery and Tai (2004b) indicated that a possible explanation for persistent photochemical model under-predictions of ozone at key monitoring stations throughout the course of this project was due to the lack of reactivity in the organic gas emissions. The project sponsors directed the project team to utilize the standard EPA CB-IV speciation profiles (EPA, 2002), modified to accommodate the carbon bond species ethanol and methanol, to speciate the CARB-based emissions estimates. In order to perform this task, the project team had to assign the CARB emissions source categories to an appropriate EPA speciation profiles. Once this assignment effort was complete, it was a simple matter of rerunning the EMS-95 speciation programs. Note that, at the direction of the project sponsors, the speciation profiles for the biogenic and on-road mobile source emissions were not altered (i.e., CARB speciation profiles continued to be used for the biogenic and on-road mobile source components of the inventory).

Table 5-2 shows the results of speciating TOG emissions estimates using the CARB CB-IV speciation profiles, and Table 5-3 shows the results of speciating TOG emissions estimates using the EPA CB-IV speciation profiles. UNR indicates the unreactive portion of the emissions estimates. PAR indicates the paraffinic portion of the emissions estimates. REACTIVE indicates the sum of the remaining CB-IV components of the emissions estimates (i.e., higher molecular weight aldehydes [ALD2], ethylene [ETH], formaldehyde [FORM], isoprene [ISOP], olefins [OLE], toluene [TOL], and xylenes [XYL]).

Table 5-4 shows the difference between the two model-ready inventories (EPA minus CARB). The large differences in the UNR component are due to the fact that EPA does not include methane and ethane in its split factors whereas CARB does. The differences in UNR are unimportant in this context since this species does not participate in the CAMx CB-IV chemistry algorithms. For July/August 2000, PAR and REACTIVE increase using the EPA speciation profiles in the Bay Area and Sacramento subdomains but decrease in the San Joaquin Valley subdomain. For July 1999, PAR increases in all subdomains, and REACTIVE generally increase or hold steady in all subdomains. Given that the underlying criteria pollutant emissions estimates are similar between the two episodes, it is unclear why this is occurring. That is, one would expect that if speciated emissions increased in one episode, the same would hold true in the other episode. However, due to limited resources for this experiment, an explanation as to why this has occurred was not determined.

Figures 5-1 through 5-14 show the gridded, daily emissions estimates by major emissions source categories for a representative weekend day and weekday for the July/August 2000 episode. Part ‘a’ of each figure shows the VOC emissions estimates, and part ‘b’ of each figure shows the NO_X emissions estimates. Figures 5-15 through 5-28 show the gridded, daily emissions estimates by major emissions source categories for a representative weekend day and weekday for the July 1999 episode. Again, part ‘a’ of each figure shows the VOC emissions estimates, and part ‘b’ of each figure shows the NO_X emissions estimates. Careful examination of all but the electric generating utilities and other stationary source categories reveals that there is indeed weekend day and weekday variation in the emissions estimates. Because the stationary sources are represented as single points in the figures, it is difficult to distinguish the relative changes in the emissions estimates from the weekend day to the weekday.

Further, careful comparison of the corresponding emissions source categories between the two episodes reveals that there exist distinct differences in the emissions estimates for each episode. For example, the biogenic emissions estimates are higher in the July 1999 episode, which is due to higher temperatures. Also, on-road mobile source emissions show a distinctly higher density throughout the domain for July/August 2000 than the density for July 1999 (though overall emissions estimates are roughly the same), which is most likely due to a greater spread in the VMT throughout the domain in the July/August 2000 episode.

Table 5-1. Comparison of July-August 2000 and July 1999 CB-IV emissions estimates (tons per day).

Bay Area	CO					NOX					SOX					TOG				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	11	26	38	9	9	20	26	28	15	16	1	1	1	1	1	17	18	20	14	14
Other	29	31	244	36	38	63	66	64	77	81	71	69	65	62	63	377	431	437	361	413
Area	22	22	22	22	22	25	25	25	23	23	-	-	-	-	-	370	376	376	387	393
Ship	2	3	3	4	3	10	13	14	17	14	5	7	7	8	7	1	1	1	1	1
Off-road	1,051	570	570	873	483	147	199	199	147	200	2	2	2	2	2	182	100	100	158	88
On-road	1,781	2,054	2,047	1,472	1,689	263	343	331	219	293	2	3	3	2	2	196	228	229	195	227
Bio	-	-	-	-	-	9	10	10	11	13	-	-	-	-	-	339	457	396	642	731
Total	2,896	2,706	2,924	2,416	2,244	537	682	671	509	640	81	82	78	75	75	1,482	1,611	1,559	1,758	1,867

Sacramento	CO					NOX					SOX					TOG				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	2	2	2	2	2	1	1	2	1	1	-	-	-	-	-	2	2	2		
Other	9	11	10	12	13	5	5	6	8	9	1	1	1	1	1	30	30	30	18	20
Area	24	24	24	24	24	18	18	18	20	20	-	-	-	-	-	149	155	155	102	112
Ship	-	-	-	-		-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Off-road	460	185	185	406	157	56	67	67	51	64	1	1	1	1	1	66	30	30	59	26
On-road	636	659	671	626	727	81	104	100	82	117	1	1	1	1	1	72	76	76	71	84
Bio	-	-	-	-	-	11	12	12	13	15	-	-	-	-	-	398	468	425	623	715
Total	1,131	881	892	1,070	923	172	207	205	175	226	3	3	3	3	3	717	761	718	873	957

SJV	CO					NOX					SOX					TOG				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	2	3	3	3	4	6	6	6	5	5	1	1	1	1	1	4	4	4	4	4
Other	27	28	28	34	35	60	63	63	73	76	19	17	18	18	18	103	85	86	88	91
Area	33	34	34	241	273	111	114	114	114	118	11	12	12	11	12	1,136	1,160	1,160	1,152	1,187
Ship	-	-	-	-	-	-	-	-	-	-	1	-	-	-	-	-	-	-	-	-
Off-road	663	399	399	589	363	140	206	206	138	207	4	4	4	3	2	108	67	67	103	67
On-road	1,294	1,430	1,464	1,245	1,442	161	218	206	168	236	2	2	2	1	2	131	144	152	140	165
Bio	-	-	-	-	-	62	62	70	71	80	-	-	-	-	-	816	786	925	930	1,068
Total	2,019	1,894	1,928	2,112	2,117	540	669	665	569	722	38	36	37	34	35	2,298	2,246	2,394	2,417	2,582

Remaining CCOS Domain	CO					NOX					SOX					TOG				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	80	98	95	30	32	25	32	32	10	19	2	2	2	2	2	11	12	12	9	10
Other	85	99	93	99	106	72	77	77	100	106	16	17	17	21	22	109	136	135	60	73
Area	387	388	388	415	425	51	52	52	46	48	1	2	2	1	1	780	826	826	578	637
Ship	3	3	3	3	3	17	17	17	17	18	10	10	10	10	10	1	1	1	1	1
Off-road	1,294	557	557	1,166	494	161	199	199	154	195	5	5	5	4	3	263	103	103	248	94
On-road	1,686	1,975	1,923	1,834	2,109	217	292	272	223	290	2	2	2	2	2	186	219	213	193	224
Bio	-	-	-	-	-	72	75	77	83	89	-	-	-	-	-	2,557	3,011	2,944	5,060	5,759
Total	3,535	3,120	3,059	3,547	3,169	615	744	726	633	765	36	38	38	40	40	3,907	4,308	4,234	6,149	6,798

For July-August 2000: *J-WE* is Sunday 30-July-2000, *J-WD* is Monday 31-July-2000, and A-WD is Tuesday 01-August-2000.
For July 1999: *J-WE* is Sunday 11-July-1999 and *J-WD* is Monday 12-July-1999.

Table 5-2. Results of speciating TOG using CARB CB-IV speciation profiles (tons per day).

Bay Area	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	15	15	16	12	12	2	2	3	1	1	-	1	1	-	-
Other	312	340	344	301	315	45	58	59	38	54	14	22	23	13	24
Area	225	225	225	217	217	72	75	75	89	91	41	43	43	46	49
Ship	-	-	-	-		-	-	-	-	-	-	1	1	1	1
Off-road	24	14	14	21	12	80	42	42	69	37	80	44	44	70	39
On-road	24	27	27	20	23	115	136	136	123	144	57	65	65	52	60
Bio	-	-	-	-	-	44	55	54	85	96	270	366	325	478	545
Total	600	621	626	571	579	358	368	369	405	423	462	542	502	660	718

Sacramento	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-
Other	15	16	16	15	15	9	9	9	2	3	4	4	4	-	1
Area	105	106	106	54	55	23	26	26	26	31	12	14	14	14	17
Ship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Off-road	9	4	4	8	3	29	13	13	26	12	29	13	13	26	11
On-road	8	8	8	8	9	44	48	48	44	53	20	20	20	19	22
Bio	-	-	-	-	-	81	95	91	133	152	281	330	303	403	462
Total	139	136	136	85	82	186	191	187	231	251	346	381	354	462	513

SJV	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	3	3	3	3	3	-	-	-	-	-	-	-	-	-	-
Other	50	49	49	68	68	35	24	24	14	16	13	9	9	4	4
Area	913	918	918	895	902	121	133	133	133	150	51	56	56	64	73
Ship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Off-road	15	9	9	14	10	45	25	25	41	24	50	32	32	49	33
On-road	16	17	18	17	19	78	86	91	82	98	37	41	42	47	47
Bio	-	-	-	-	-	165	163	190	205	238	593	568	675	618	711
Total	997	996	997	997	1,002	444	431	463	475	526	744	706	814	782	868

Remaining CCOS Domain	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	9	10	10	8	8	2	2	2	1	1	-	1	1	-	-
Other	37	39	39	34	36	47	61	61	18	24	17	25	25	4	7
Area	589	590	590	403	406	89	116	116	86	120	50	64	64	54	71
Ship	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1
Off-road	35	13	13	33	12	116	44	44	110	41	115	45	45	108	42
On-road	22	25	25	23	27	111	131	128	113	133	54	62	60	56	65
Bio	-	-	-	-	-	519	594	600	1,027	1,164	1,841	2,178	2,148	3,361	3,830
Total	692	677	677	501	489	884	948	951	1,355	1,483	2,078	2,376	2,344	3,584	4,016

Table 5-3. Results of speciating TOG using EPA CB-IV speciation profiles (tons per day).

Bay Area	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	3	3	4	2	2	6	6	7	5	5	4	4	5	4	4
Other	216	234	235	200	205	73	88	90	70	88	63	77	78	61	78
Area	111	111	111	155	155	104	106	106	126	128	44	46	46	53	55
Ship	-	-	-	-	-	-	-	-	-	-	-	1	1	1	-
Off-road	16	6	6	14	5	84	43	43	73	37	73	45	45	65	41
On-road	24	27	27	20	23	115	136	136	123	144	57	65	65	52	60
Bio	-	-	-	-	-	44	55	54	85	96	270	366	325	478	545
Total	370	381	383	391	390	426	434	436	482	498	511	604	565	714	783

Sacramento	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	1	2	2	-	-	-	-	-	-	-	-	-	1	-	-
Other	15	15	15	15	15	8	8	8	1	2	4	5	5	1	2
Area	24	24	24	39	39	48	50	50	35	40	26	28	28	13	17
Ship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Off-road	6	2	2	5	1	32	13	13	28	12	25	13	13	23	11
On-road	8	8	8	8	9	44	48	48	44	53	20	20	20	19	22
Bio	-	-	-	-	-	81	95	91	133	152	281	330	303	403	462
Total	54	51	51	67	64	213	214	210	241	259	356	396	370	459	514

SJV	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	3	3	3	3	3	-	-	-	-	-	-	-	-	1	1
Other	41	41	41	58	58	34	22	22	13	14	15	11	12	6	7
Area	233	235	235	725	728	85	95	95	179	194	38	46	46	73	85
Ship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Off-road	9	4	4	9	4	49	27	27	45	26	44	31	31	43	32
On-road	16	17	18	17	20	78	86	91	82	98	37	41	42	41	47
Bio	-	-	-	-	-	165	163	190	205	238	593	568	675	618	711
Total	302	300	301	812	813	411	393	425	524	570	727	697	806	782	883

Remaining CCOS Domain	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	4	5	5	3	3	3	3	3	3	3	2	3	3	2	2
Other	27	28	28	27	29	45	57	57	15	19	19	28	28	8	11
Area	332	332	332	344	345	121	145	145	131	161	48	62	62	55	74
Ship	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1
Off-road	26	7	7	24	6	129	48	48	122	43	99	43	43	94	40
On-road	22	25	25	24	27	111	131	128	113	133	54	62	60	56	65
Bio	-	-	-	-	-	519	594	600	1,027	1,164	1,841	2,178	2,148	3,361	3,830
Total	411	397	397	422	410	928	978	981	1,411	1,523	2,064	2,377	2,345	3,577	4,023

Table 5-4. Difference between CB-IV speciated emissions estimates (d = EPA – CARB), in tons per day.

Bay Area	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	(12)	(12)	(12)	(10)	(10)	4	4	4	4	4	4	3	4	4	4
Other	(96)	(106)	(109)	(101)	(110)	28	30	31	32	34	49	55	55	48	54
Area	(114)	(114)	(114)	(62)	(62)	32	31	31	37	37	3	3	3	7	6
Ship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	(1)
Off-road	(8)	(8)	(8)	(7)	(7)	4	1	1	4	-	(7)	1	1	(5)	2
On-road	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	(230)	(240)	(243)	(180)	(189)	68	66	67	77	75	49	62	63	54	65

Sacramento	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	(1)	-	-	-	-	-	-	-	-	-	-	-	1	-	-
Other	-	(1)	(1)	-	-	(1)	(1)	(1)	(1)	(1)	-	1	1	1	1
Area	(81)	(82)	(82)	(15)	(16)	25	24	24	9	9	14	14	14	(1)	-
Ship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Off-road	(3)	(2)	(2)	(3)	(2)	3	-	-	2	-	(4)	-	-	(3)	-
On-road	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	(85)	(85)	(85)	(18)	(18)	27	23	23	10	8	10	15	16	(3)	1

SJV	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1
Other	(9)	(8)	(8)	(10)	(10)	(1)	(2)	(2)	(1)	(2)	2	2	3	2	3
Area	(680)	(683)	(683)	(170)	(174)	(36)	(38)	(38)	46	44	(13)	(10)	(10)	9	12
Ship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Off-road	(6)	(5)	(5)	(5)	(6)	4	2	2	4	2	(6)	(1)	(1)	(6)	(1)
On-road	-	-	-	-	1	-	-	-	-	-	-	-	-	(6)	-
Bio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	(695)	(696)	(696)	(185)	(189)	(33)	(38)	(38)	49	44	(17)	(9)	(8)	-	15

Remaining CCOS Domain	UNR					PAR					REACTIVE				
	July-August 2000			Jul-99		July-August 2000			Jul-99		July-August 2000			Jul-99	
	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD	J-WE	J-WD	A-WD	J-WE	J-WD
EGU	(5)	(5)	(5)	(5)	(5)	1	1	1	2	2	2	2	2	2	2
Other	(10)	(11)	(11)	(7)	(7)	(2)	(4)	(4)	(3)	(5)	2	3	3	4	4
Area	(257)	(258)	(258)	(59)	(61)	32	29	29	45	41	(2)	(2)	(2)	1	3
Ship	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Off-road	(9)	(6)	(6)	(9)	(6)	13	4	4	12	2	(16)	(2)	(2)	(14)	(2)
On-road	-	-	-	1	-	-	-	-	-	-	-	-	-	-	-
Bio	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	(281)	(280)	(280)	(79)	(79)	44	30	30	56	40	(14)	1	1	(7)	7

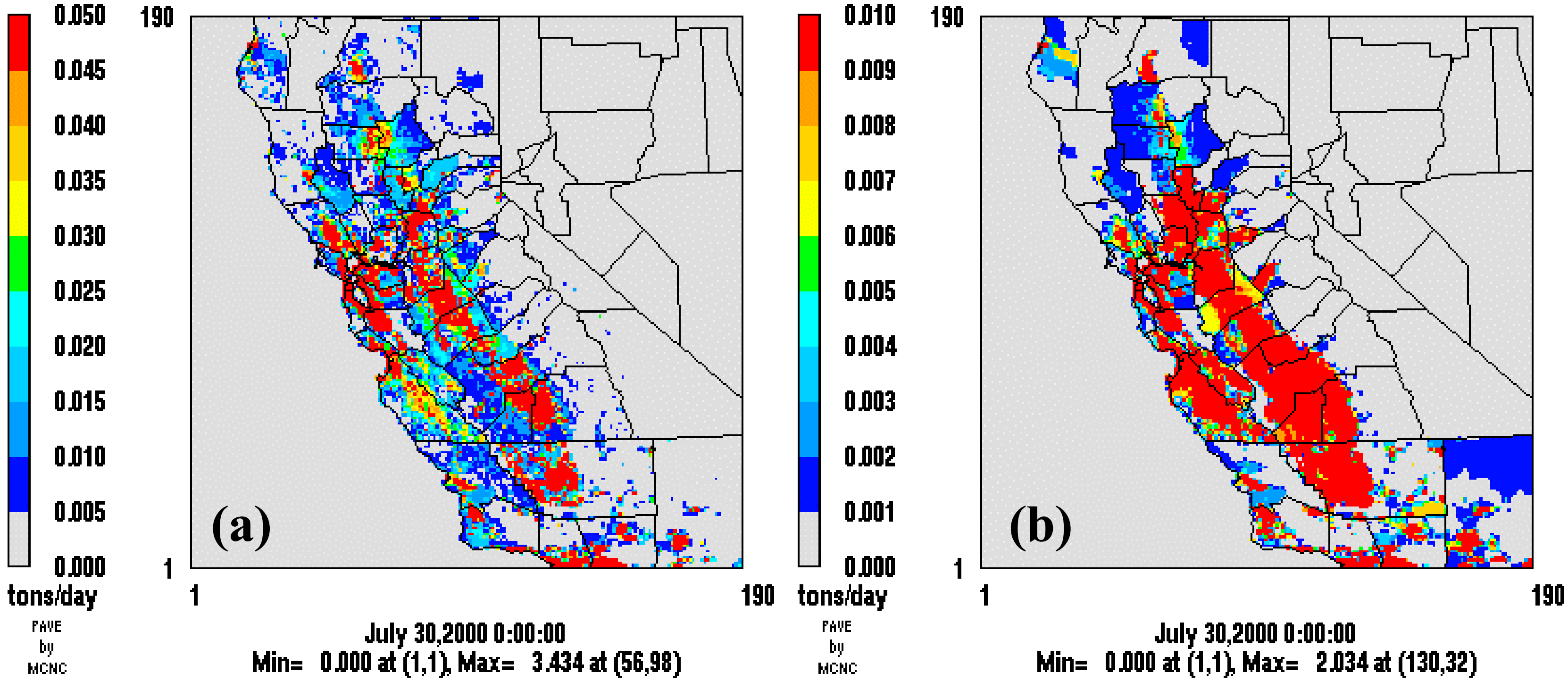

Figure 5-1. Daily area source emissions estimates for Sunday, 30-July-2000. (a) VOC. (b) NOX.

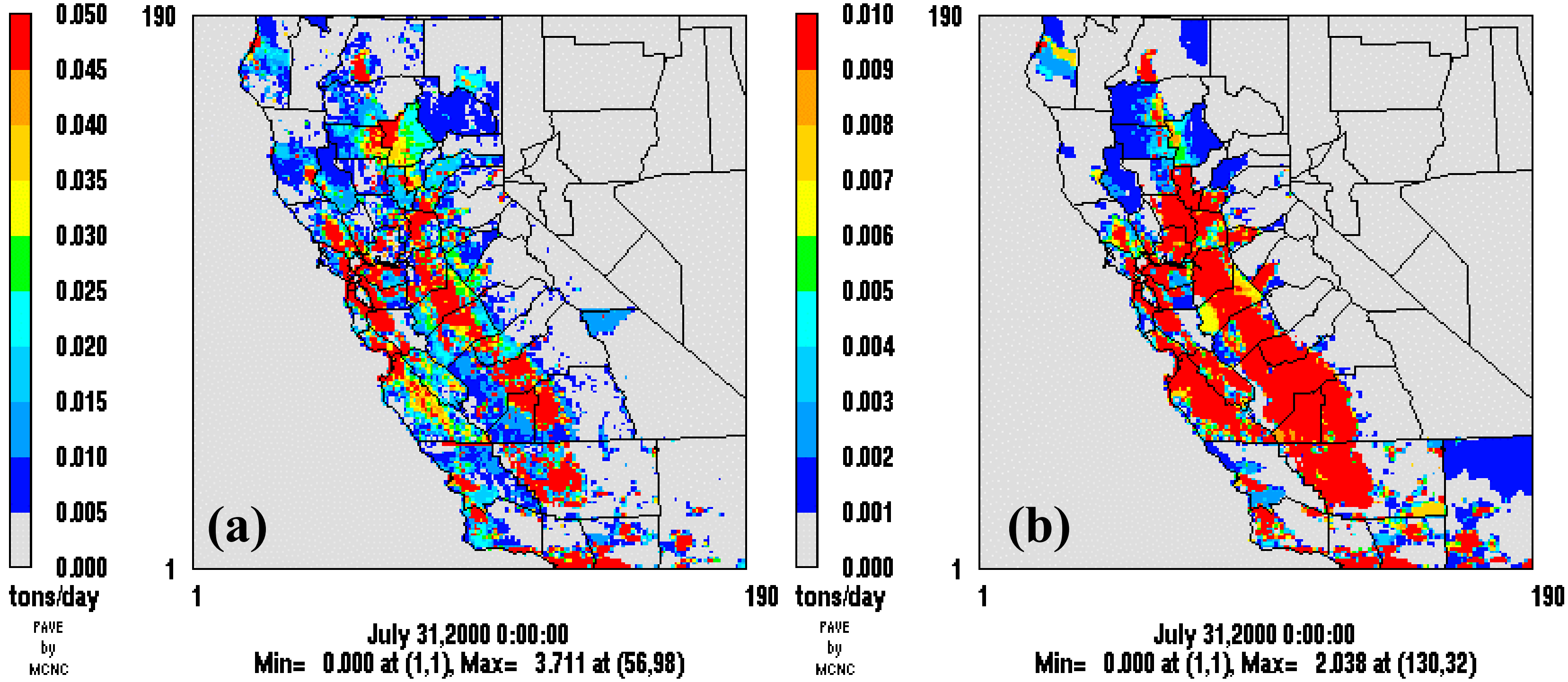

Figure 5-2. Daily area source emissions estimates for Monday, 31-July-2000. (a) VOC. (b) NOX.

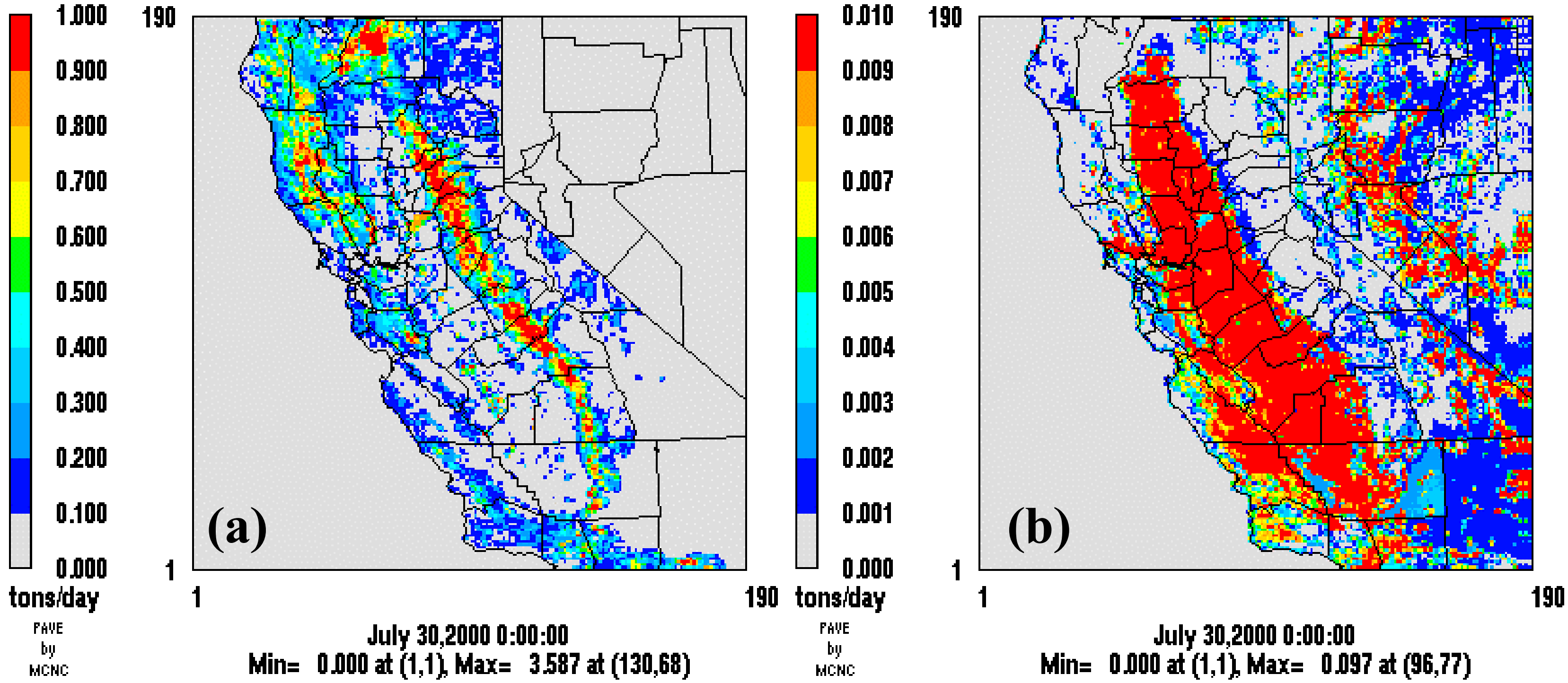

Figure 5-3. Daily biogenic emissions estimates for Sunday, 30-July-2000. (a) VOC. (b) NOX.

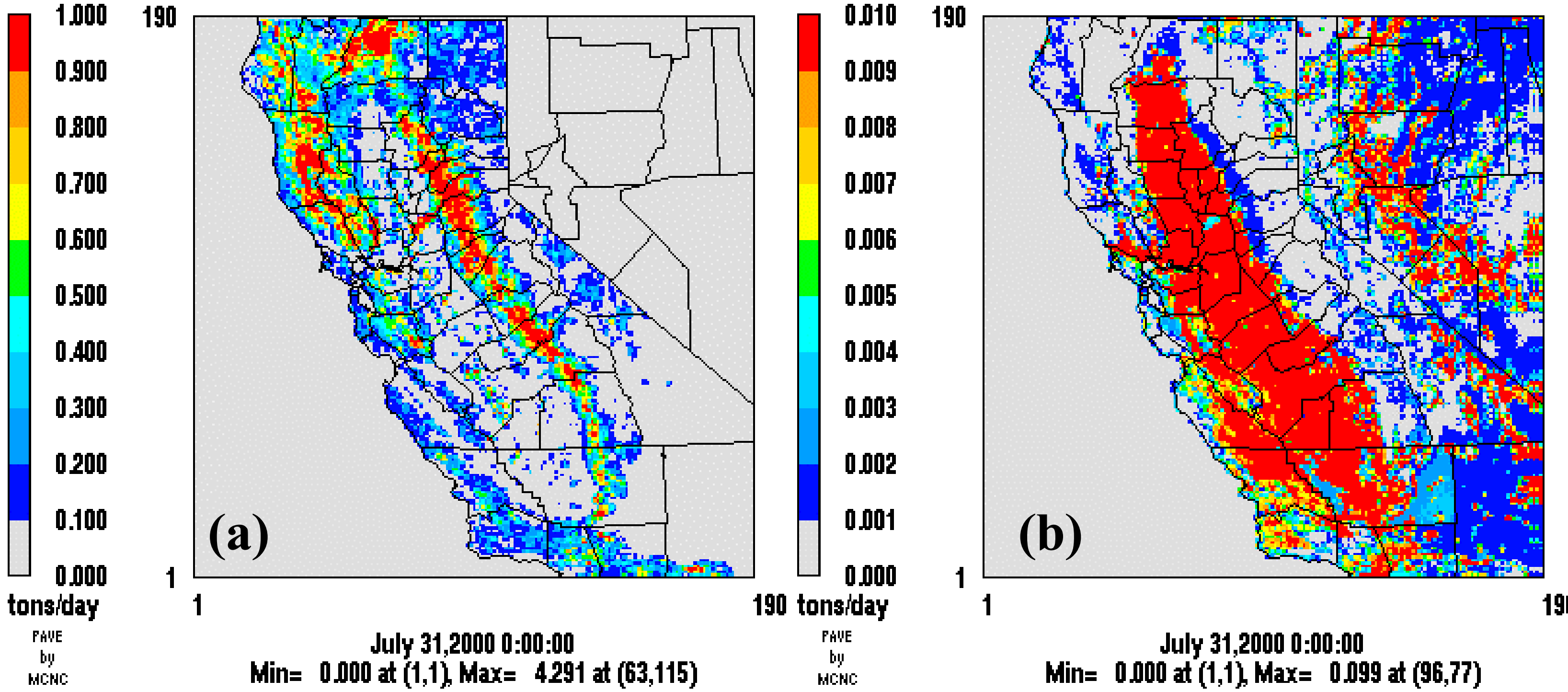

Figure 5-4. Daily biogenic emissions estimates for Monday, 31-July-2000. (a) VOC. (b) NOX.

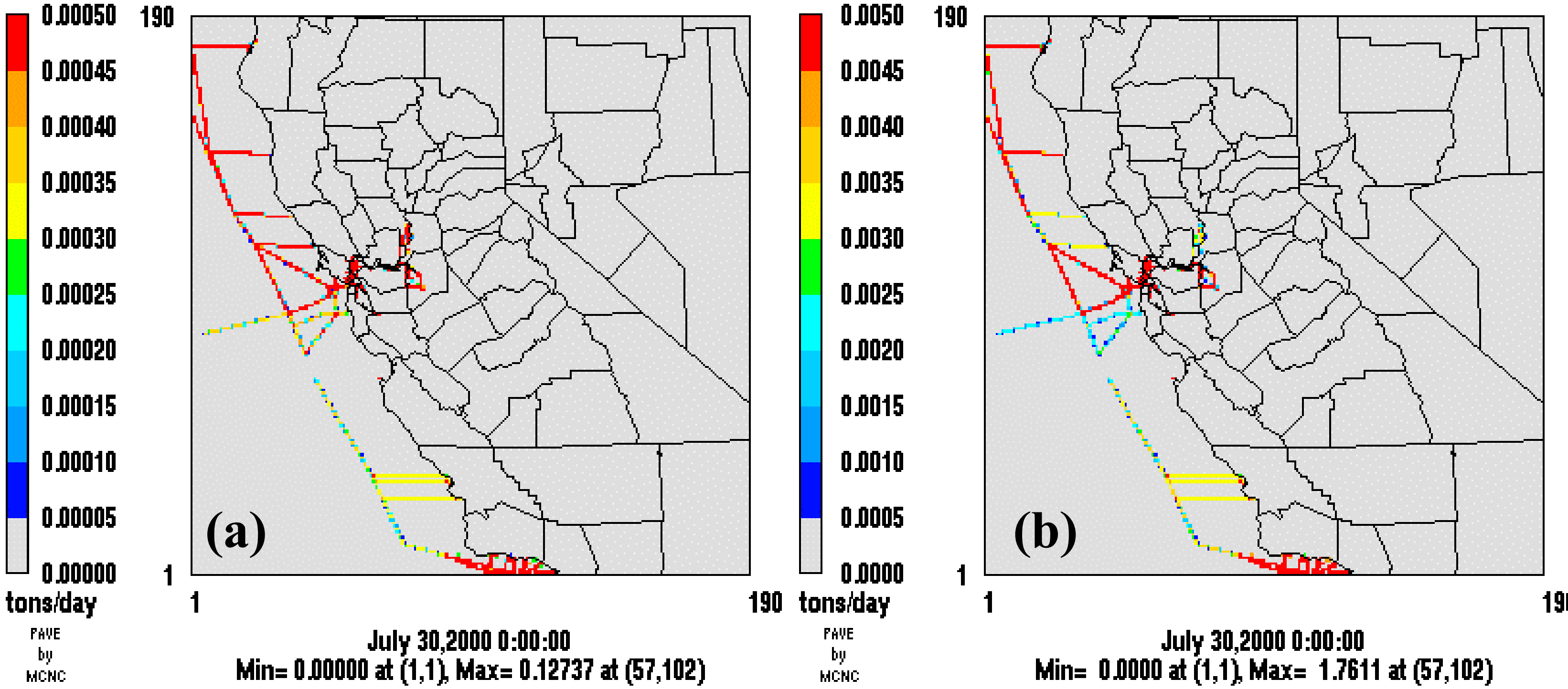

Figure 5-5. Daily commercial shipping emissions estimates for Sunday, 30-July-2000. (a) VOC. (b) NOX.

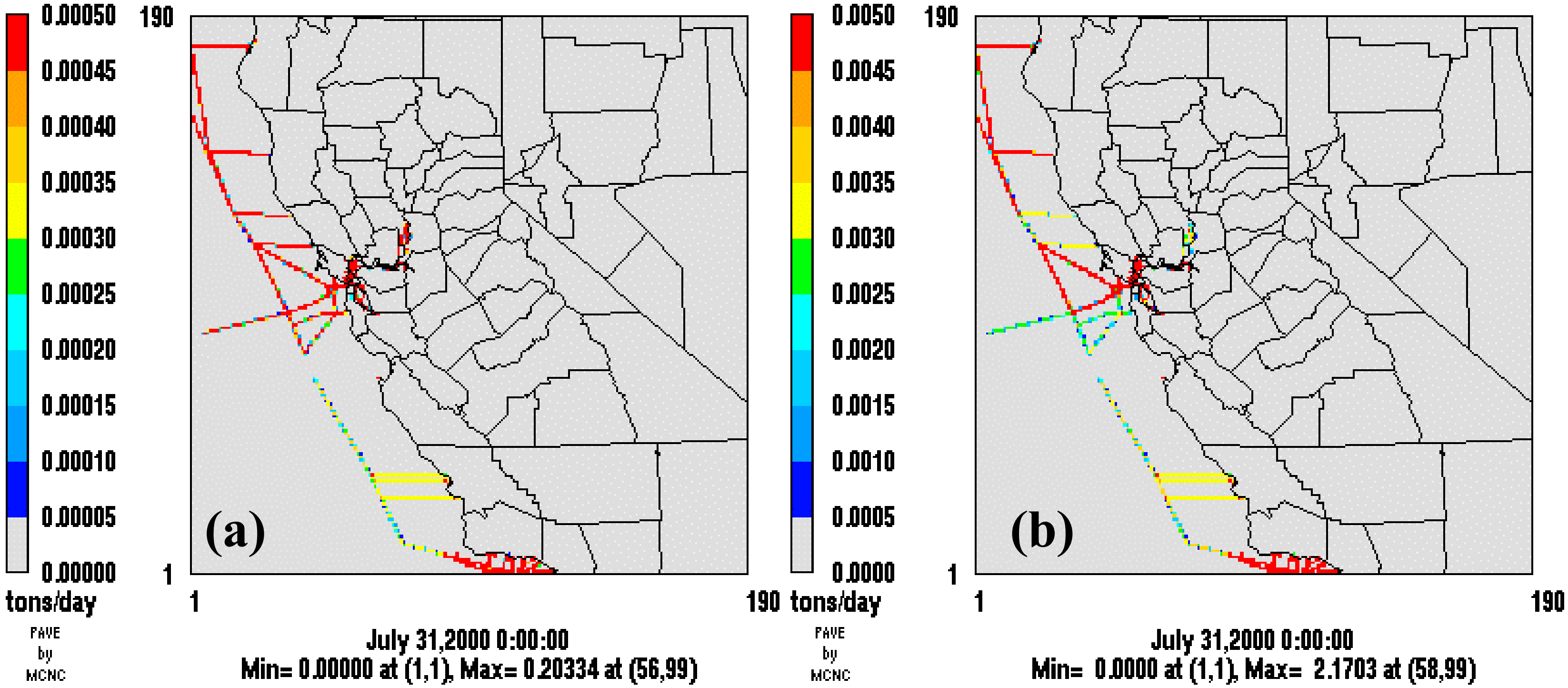

Figure 5-6. Daily commercial shipping emissions estimates for Monday, 31-July-2000. (a) VOC. (b) NOX.

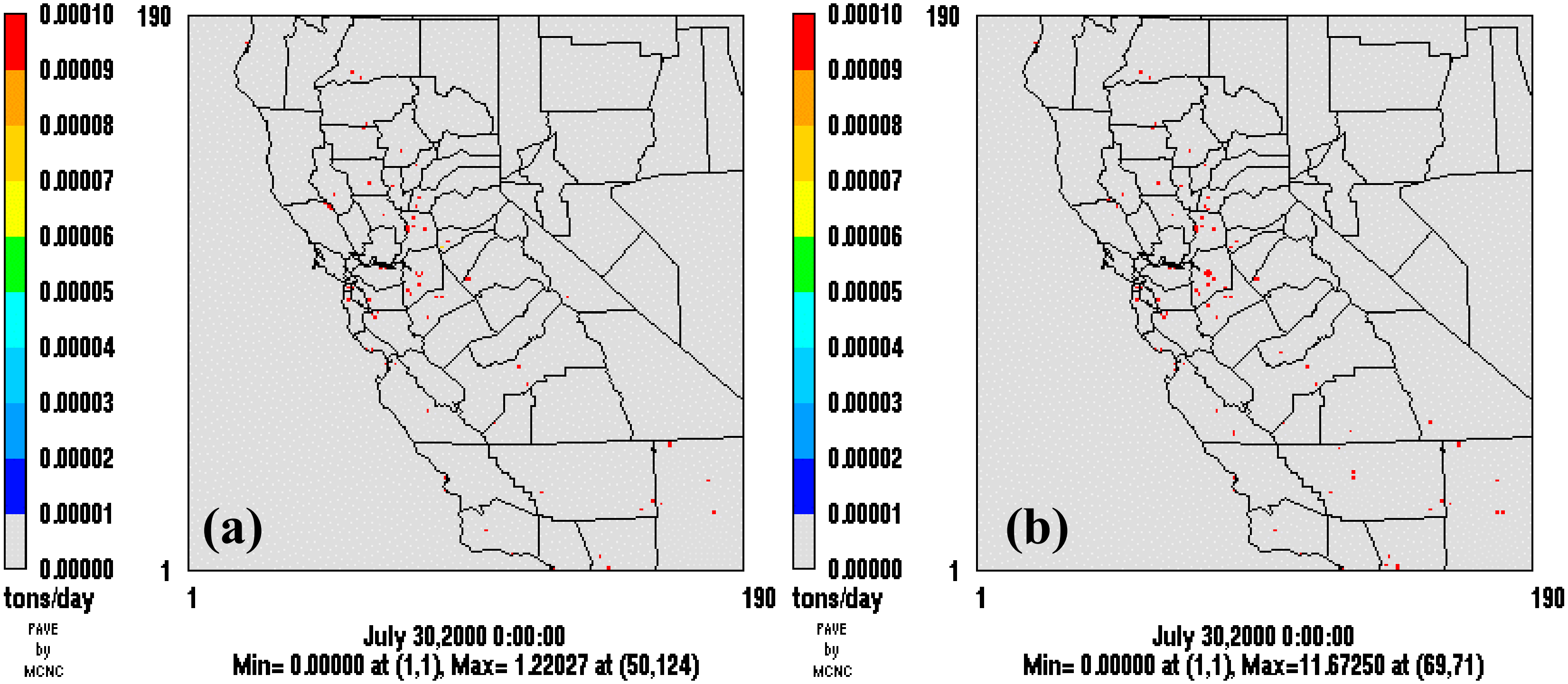

Figure 5-7. Daily electric generating utility emissions estimates for Sunday, 30-July-2000. (a) VOC. (b) NOX.

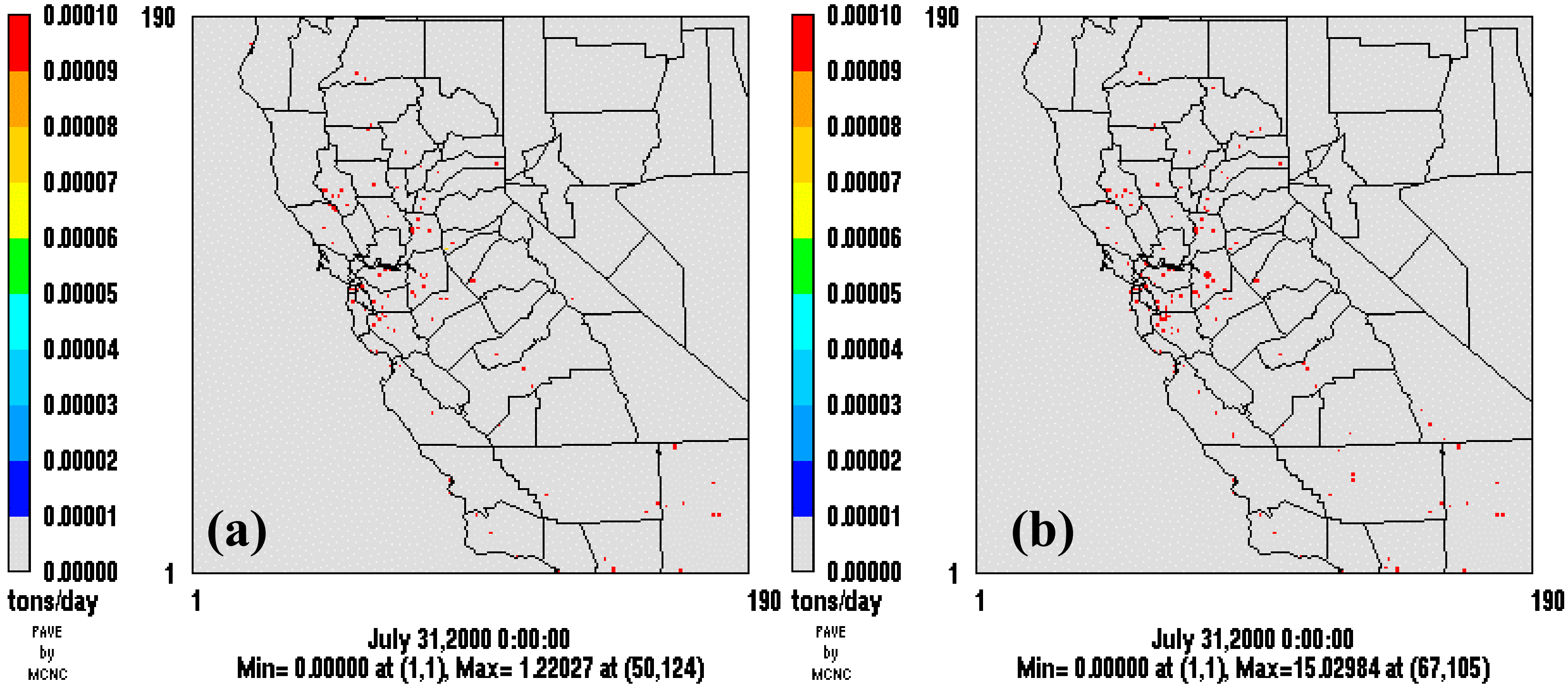

Figure 5-8. Daily electric generating utility emissions estimates for Monday, 31-July-2000. (a) VOC. (b) NOX.

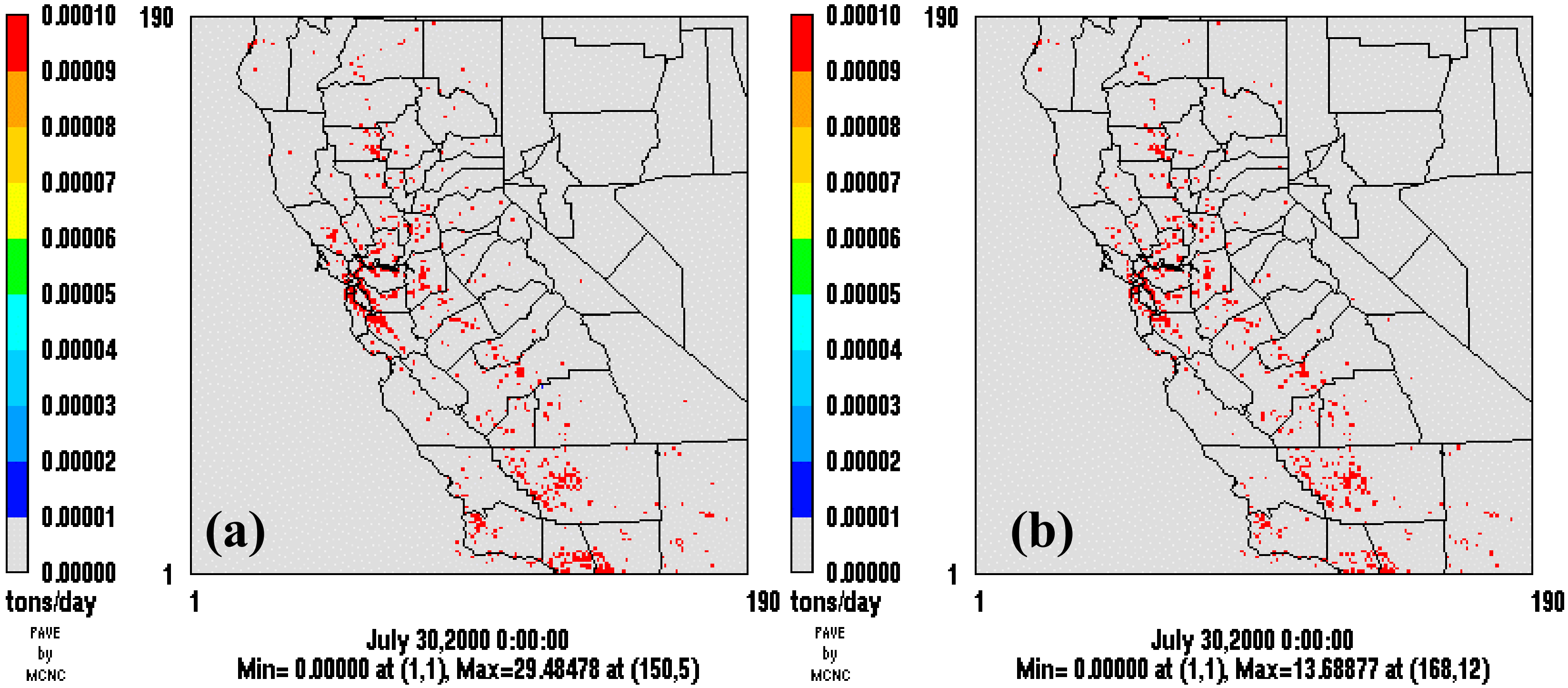

Figure 5-9. Daily other stationary source emissions estimates for Sunday, 30-July-2000. (a) VOC. (b) NOX.

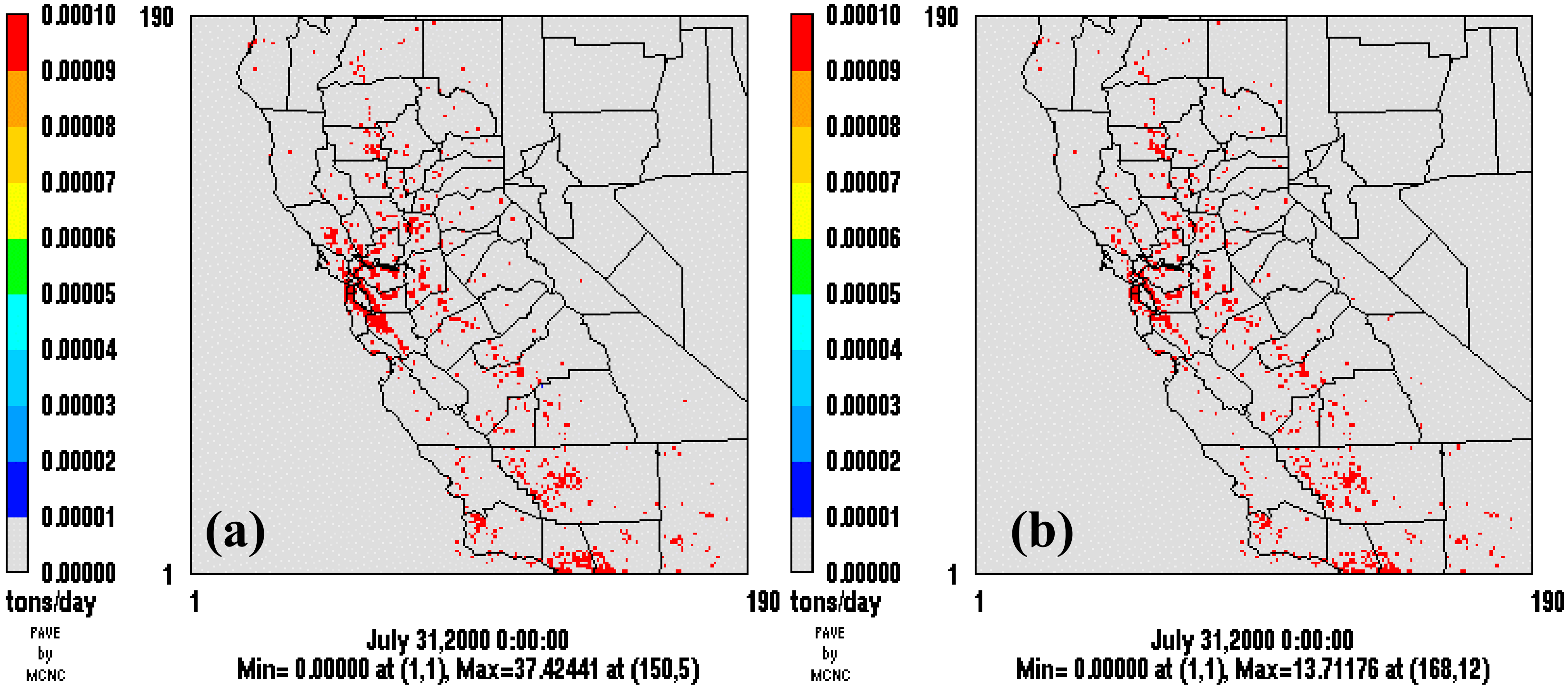

Figure 5-10. Daily other stationary source emissions estimates for Monday, 31-July-2000. (a) VOC. (b) NOX.

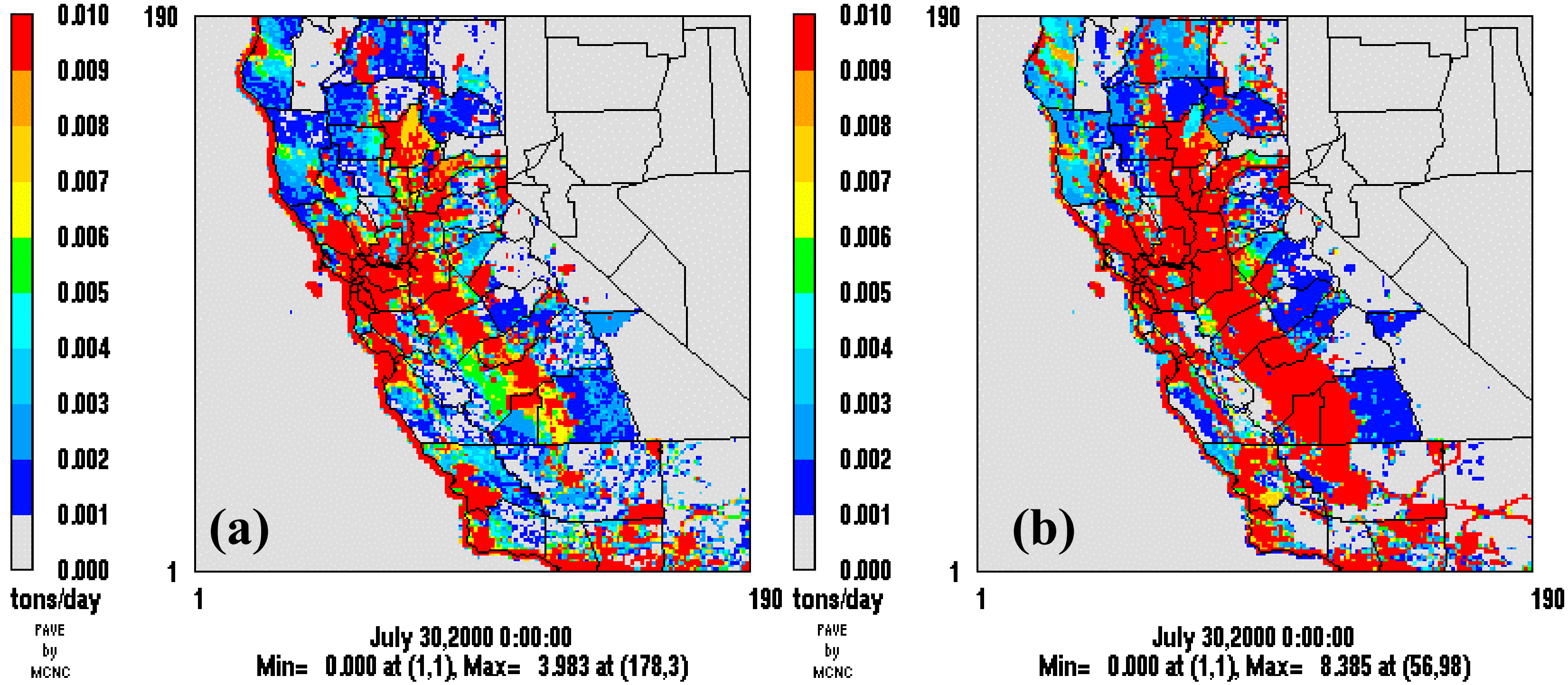

Figure 5-11. Daily off-road mobile source emissions estimates for Sunday, 30-July-2000. (a) VOC. (b) NOX.

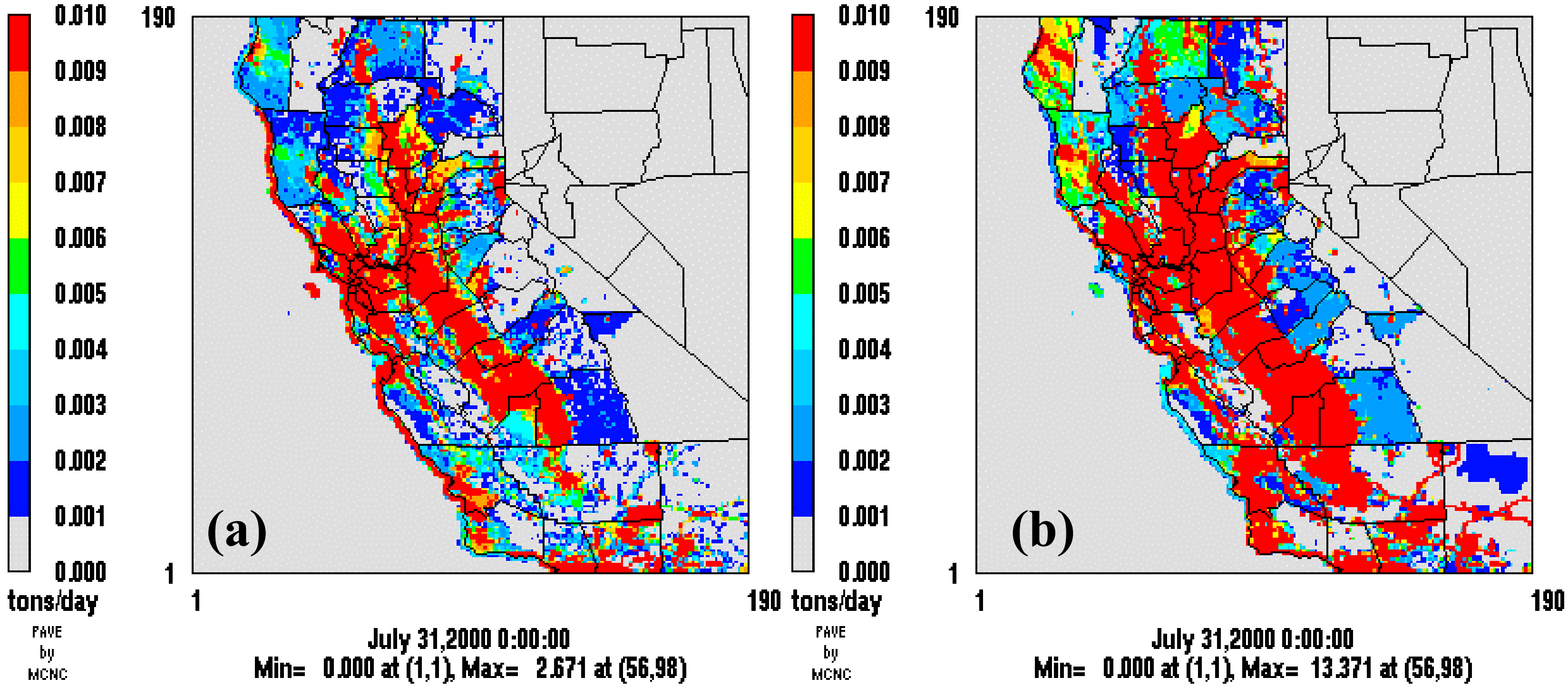

Figure 5-12. Daily off-road mobile source emissions estimates for Monday, 31-July-2000. (a) VOC. (b) NOX.

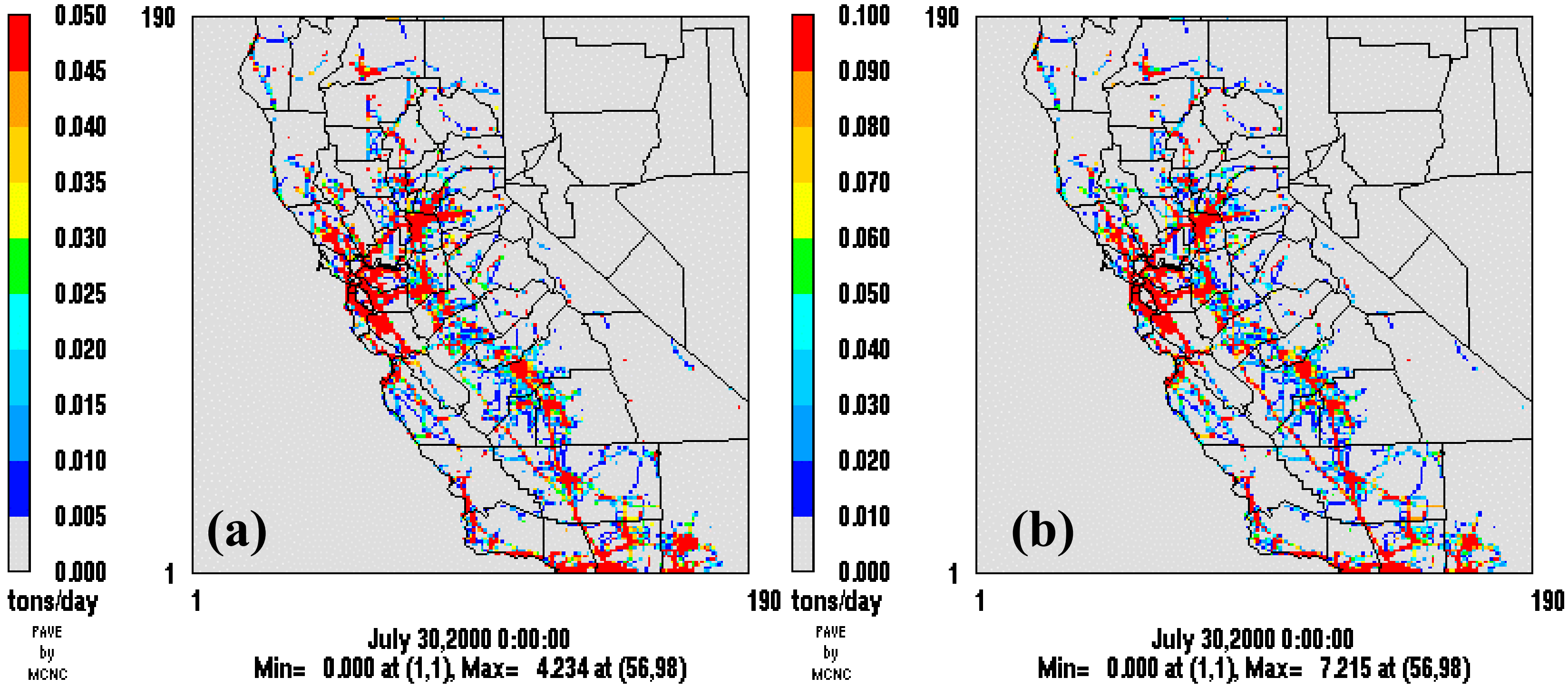

Figure 5-13. Daily on-road mobile source emissions estimates for Sunday, 30-July-2000. (a) VOC. (b) NOX.

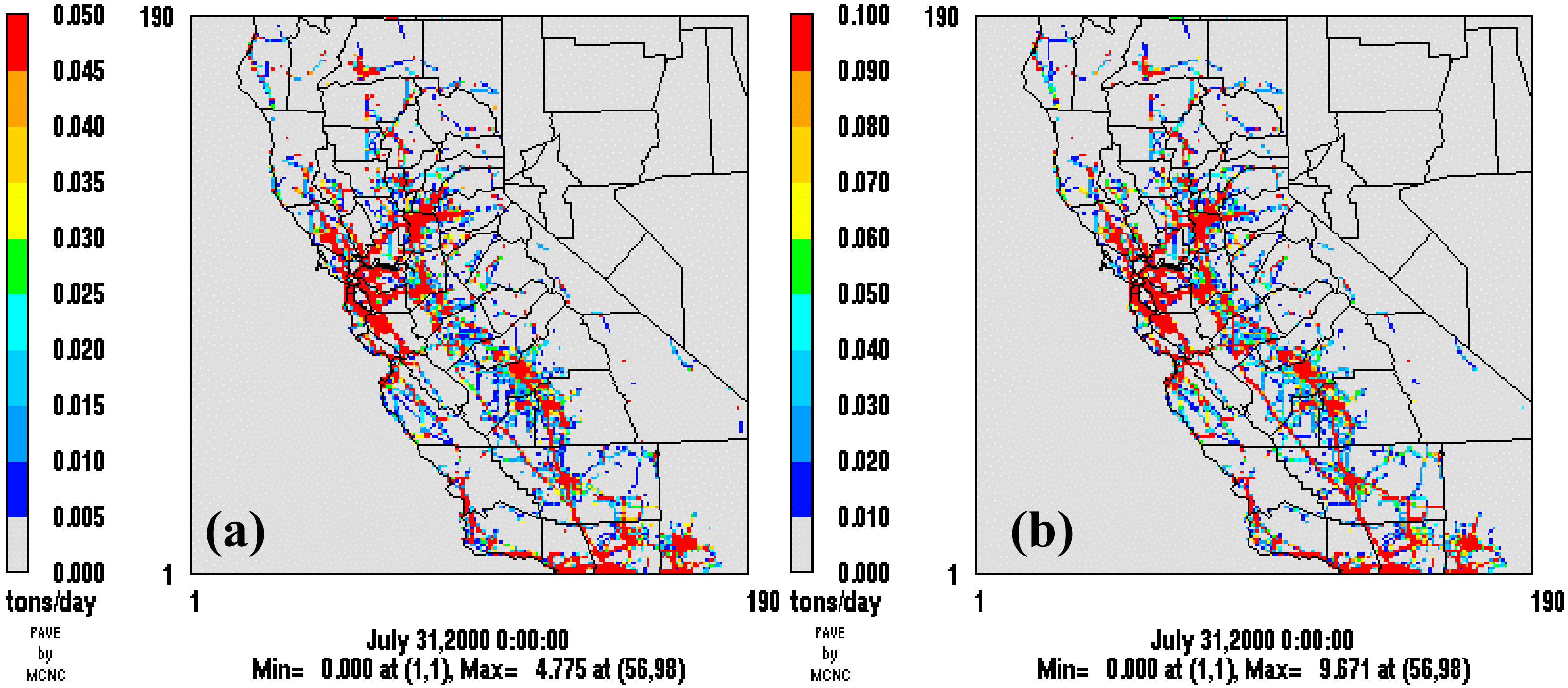

Figure 5-14. Daily on-road mobile source emissions estimates for Monday, 31-July-2000. (a) VOC. (b) NOX.

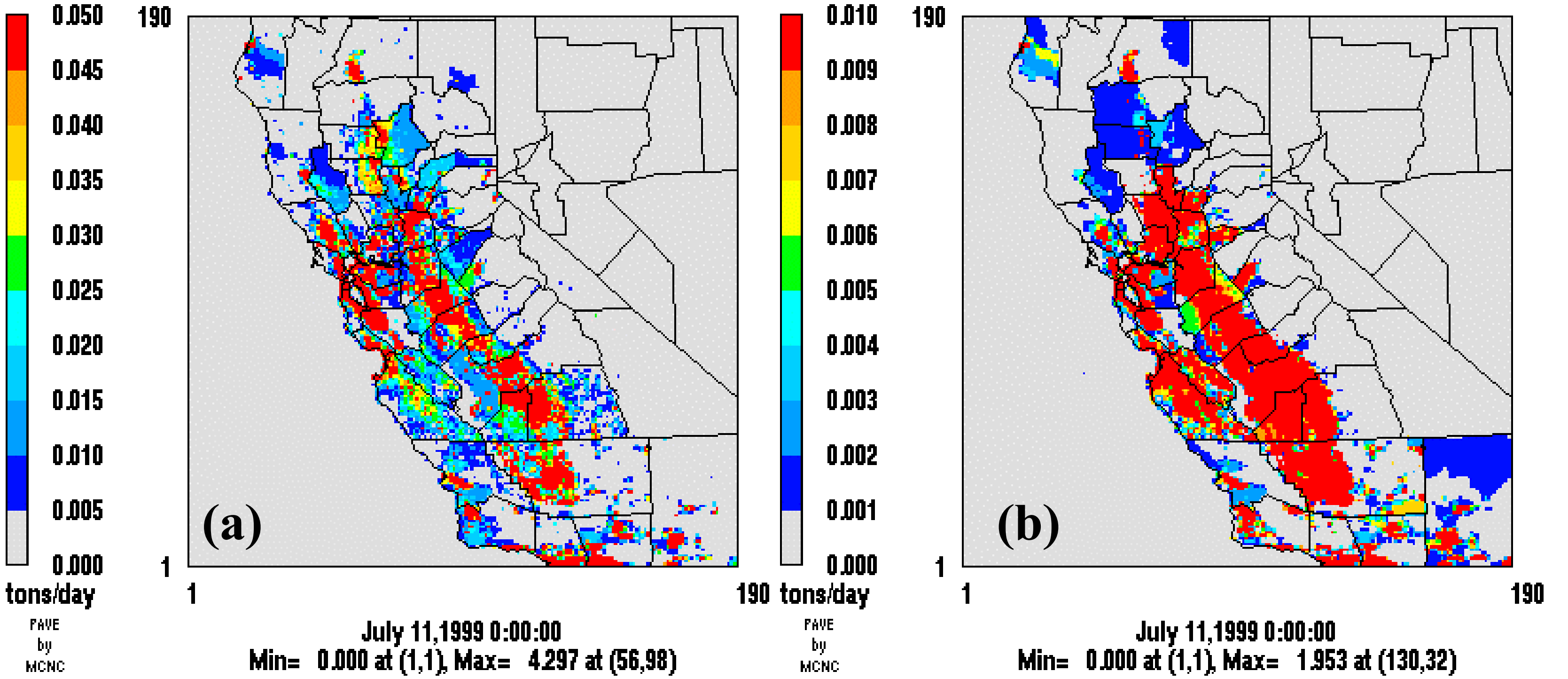

Figure 5-15. Daily area source emissions estimates for sunday, 11-July-1999. (a) VOC. (b) NOX.

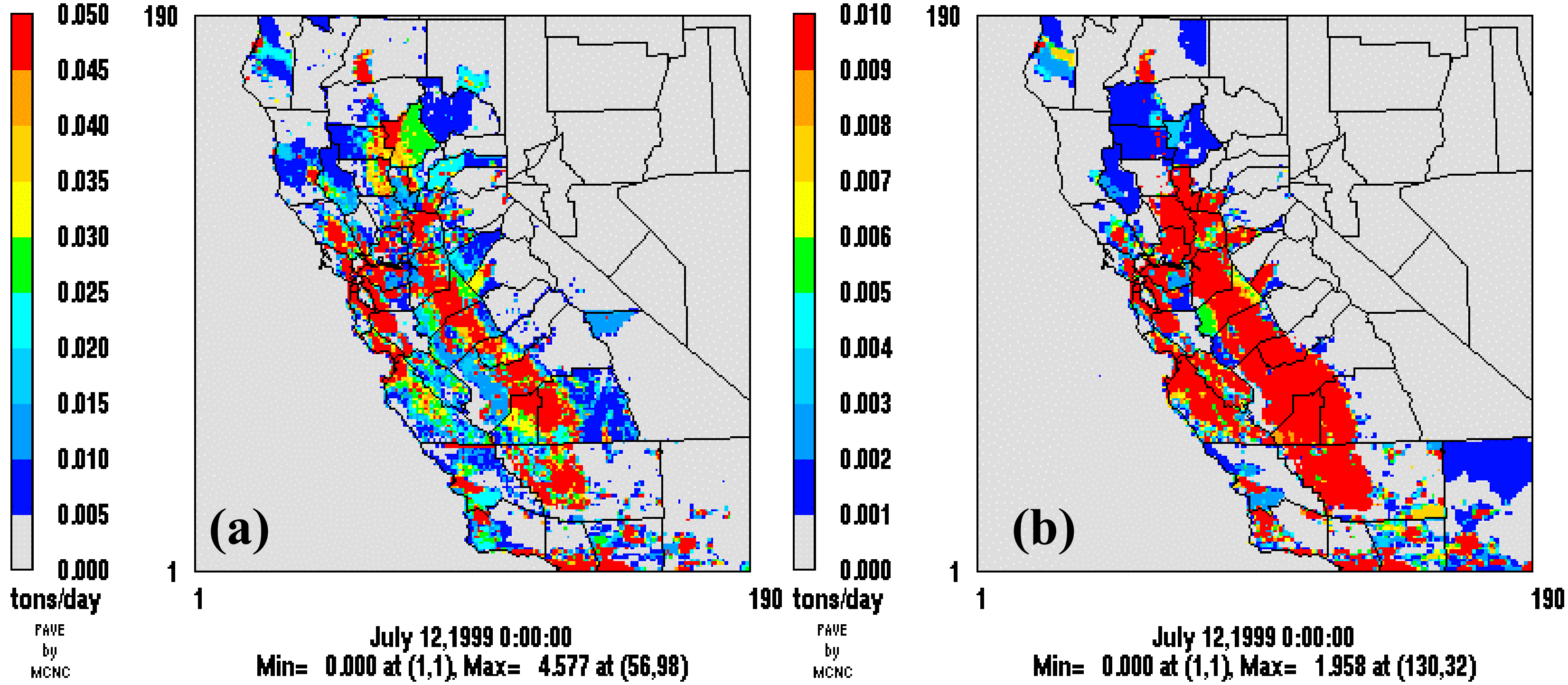

Figure 5-16. Daily area source emissions estimates for Monday, 12-July-1999. (a) VOC. (b) NOX.

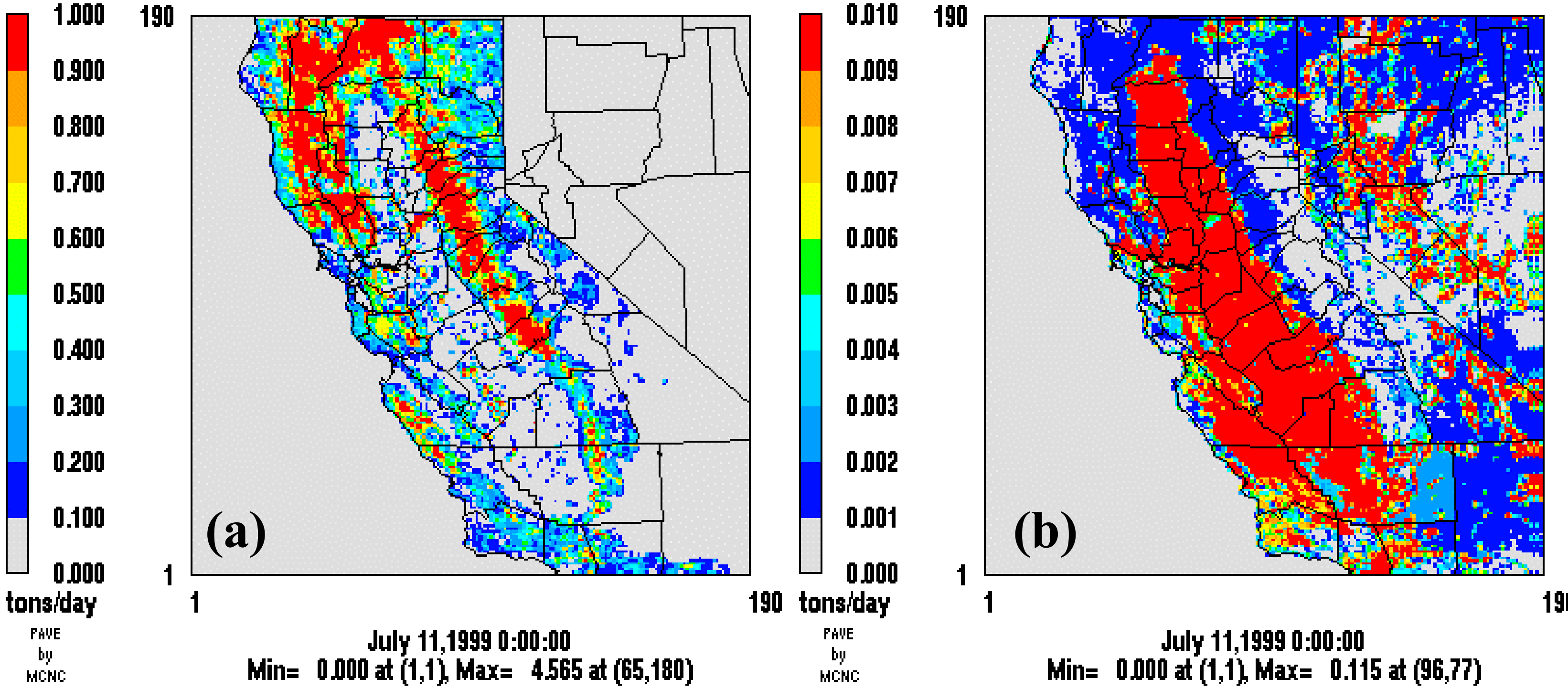

Figure 5-17. Daily biogenic emissions estimates for Sunday, 11-July-1999. (a) VOC. (b) NOX.

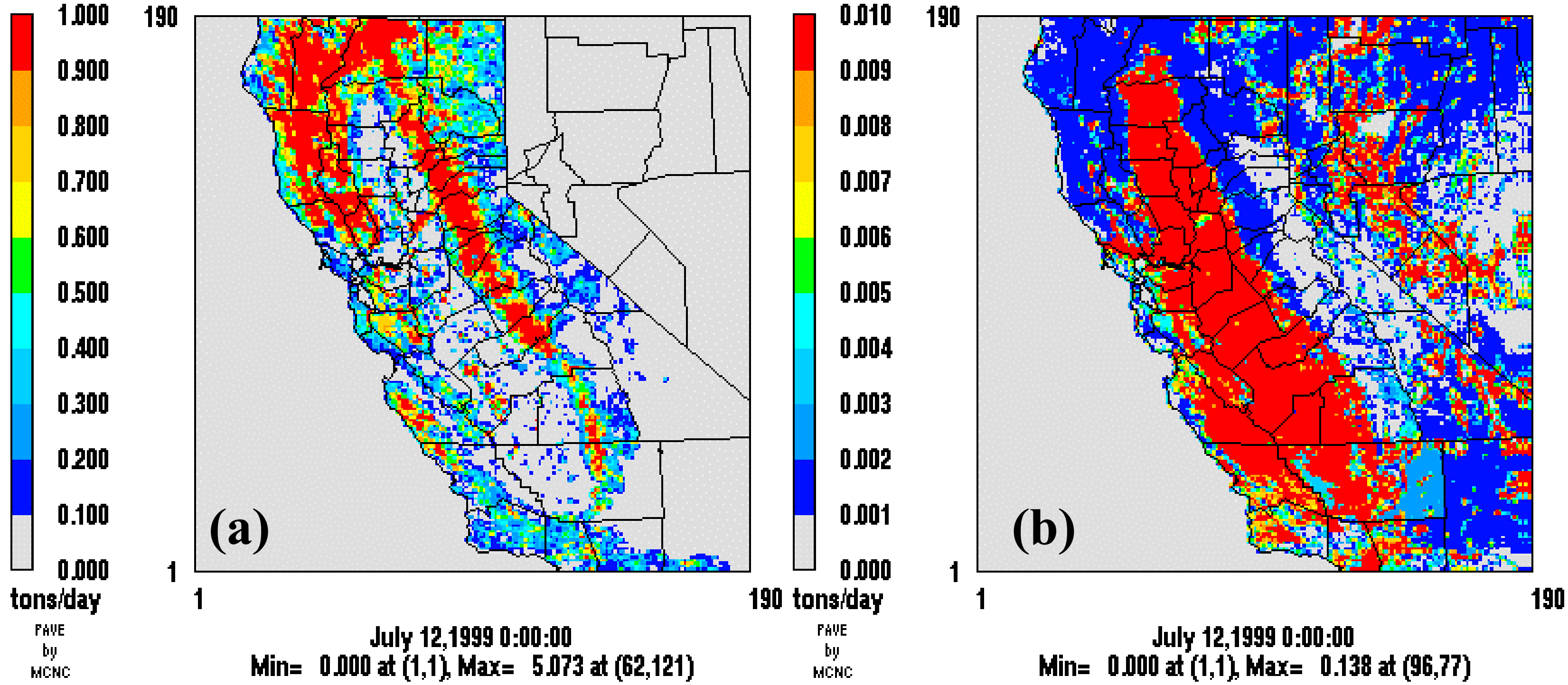

Figure 5-18. Daily biogenic emissions estimates for Monday, 12-July-1999. (a) VOC. (b) NOX.

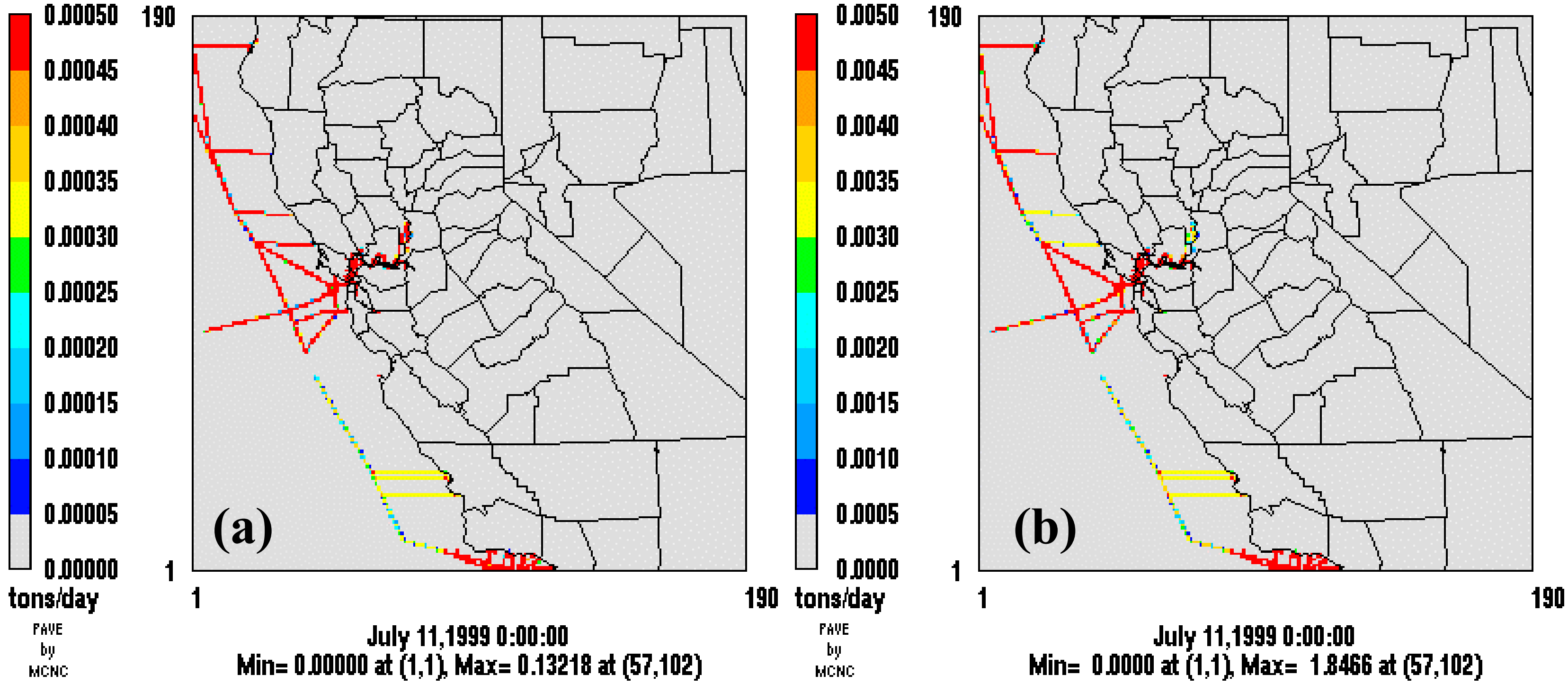

Figure 5-19. Daily commercial shipping emissions estimates for Sunday, 11-July-1999. (a) VOC. (b) NOX.

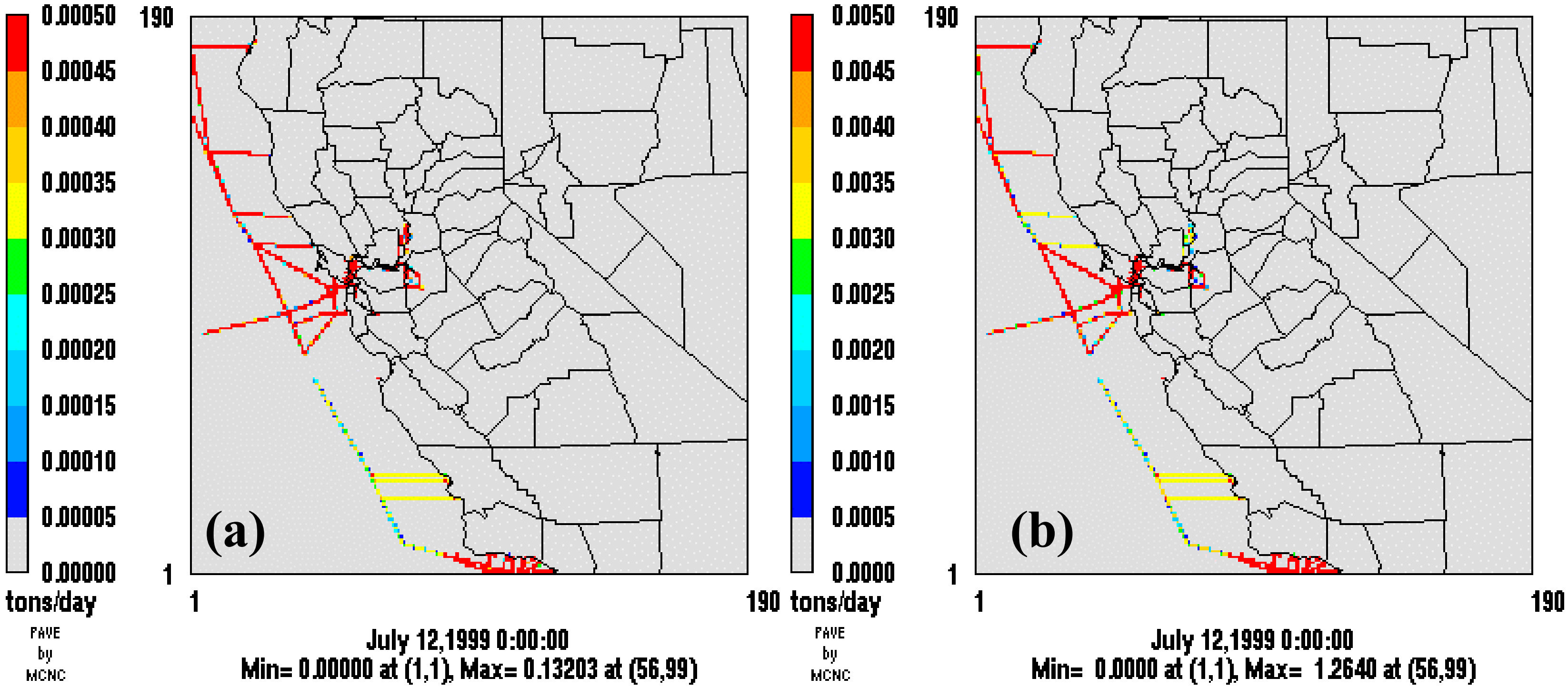

Figure 5-20. Daily commercial shipping emissions estimates for Monday, 12-July-1999. (a) VOC. (b) NOX.

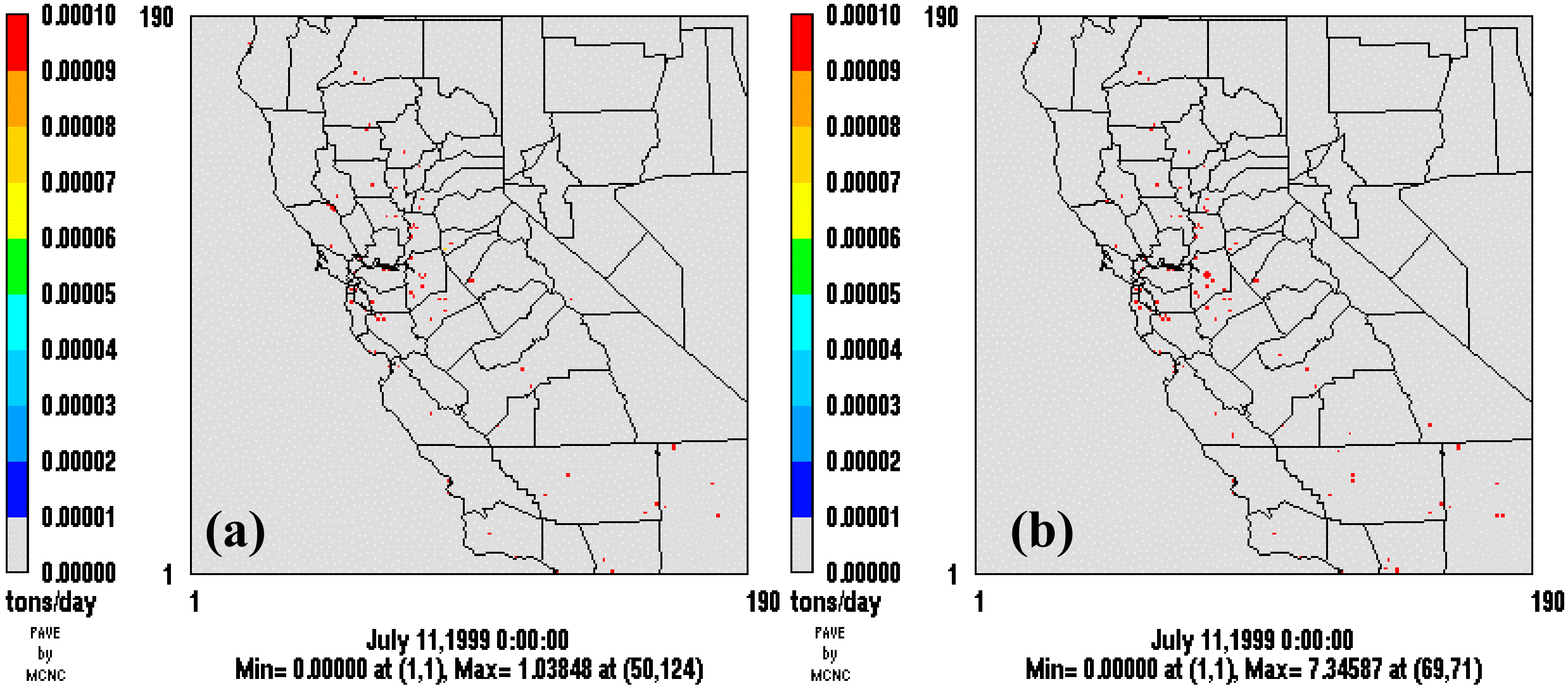

Figure 5-21. Daily electric generating utility emissions estimates for Sunday, 11-July-1999. (a) VOC. (b) NOX.

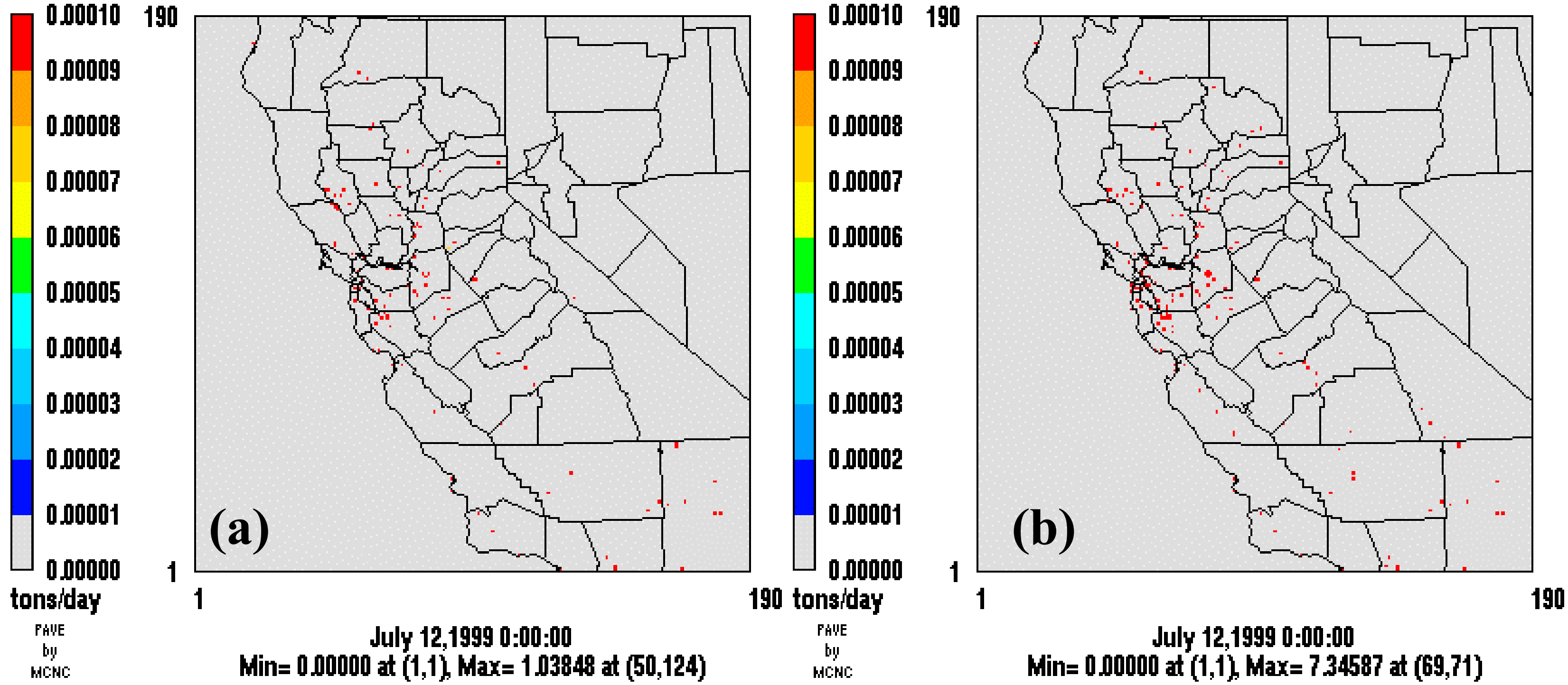

Figure 5-22. Daily electric generating utility emissions estimates for Monday, 12-July-1999. (a) VOC. (b) NOX.

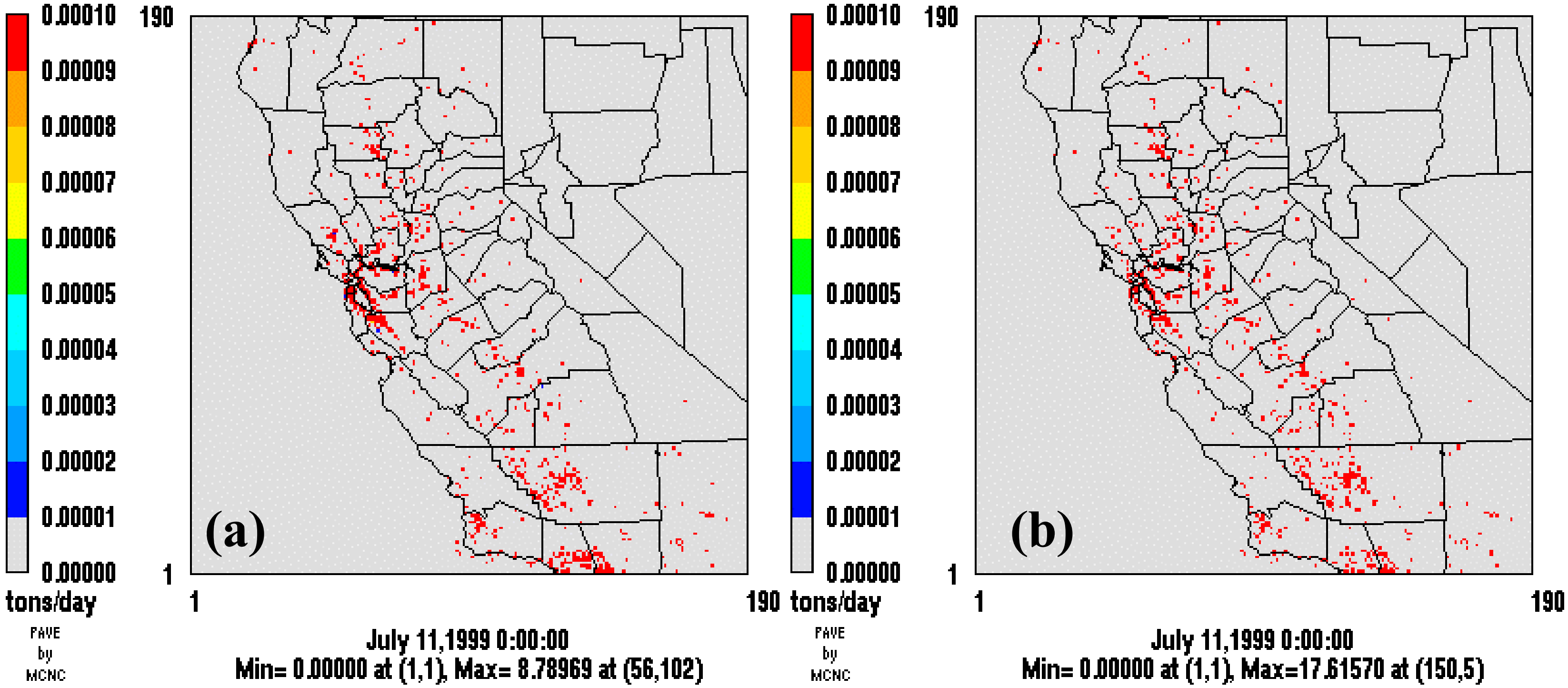

Figure 5-23. Daily other stationary source emissions estimates for Sunday, 11-July-1999. (a) VOC. (b) NOX.

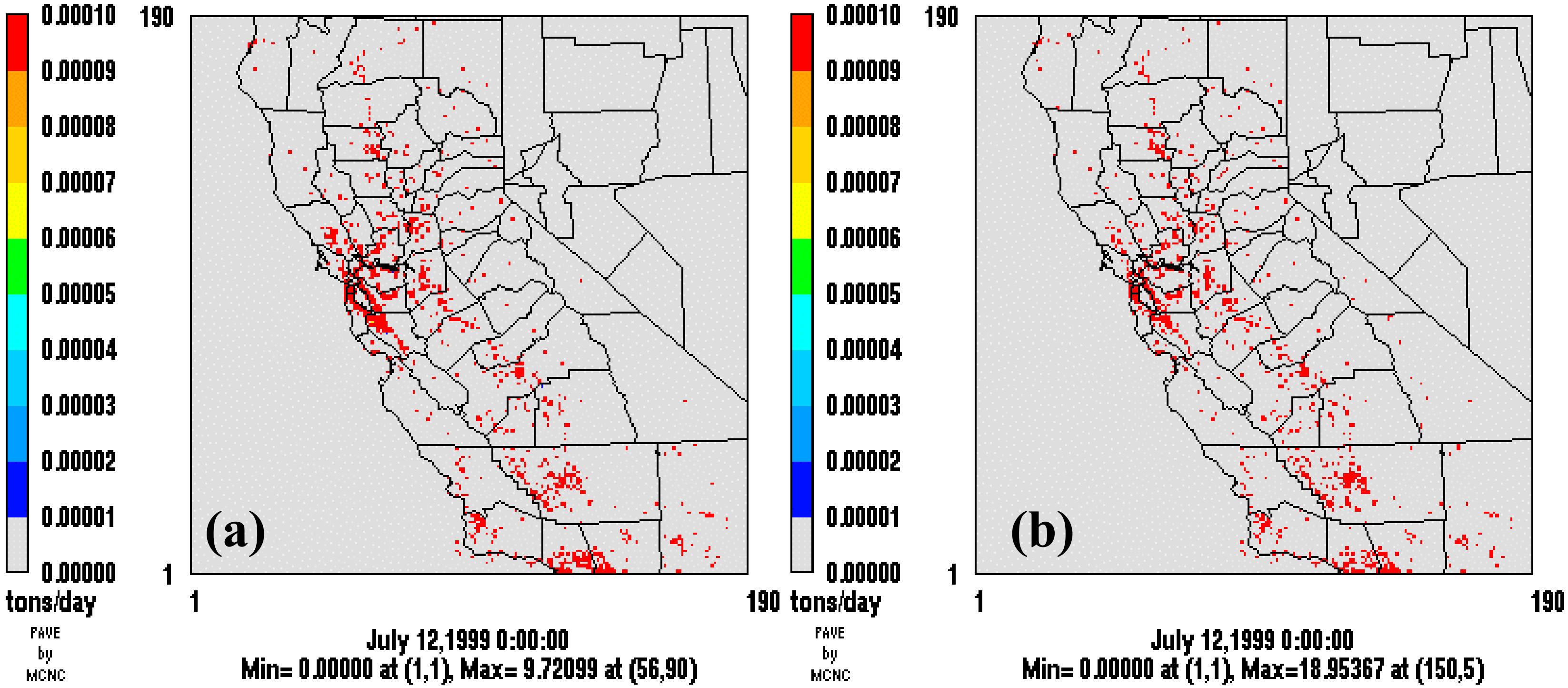

Figure 5-24. Daily other stationary source emissions estimates for Monday, 12-July-1999. (a) VOC. (b) NOX.

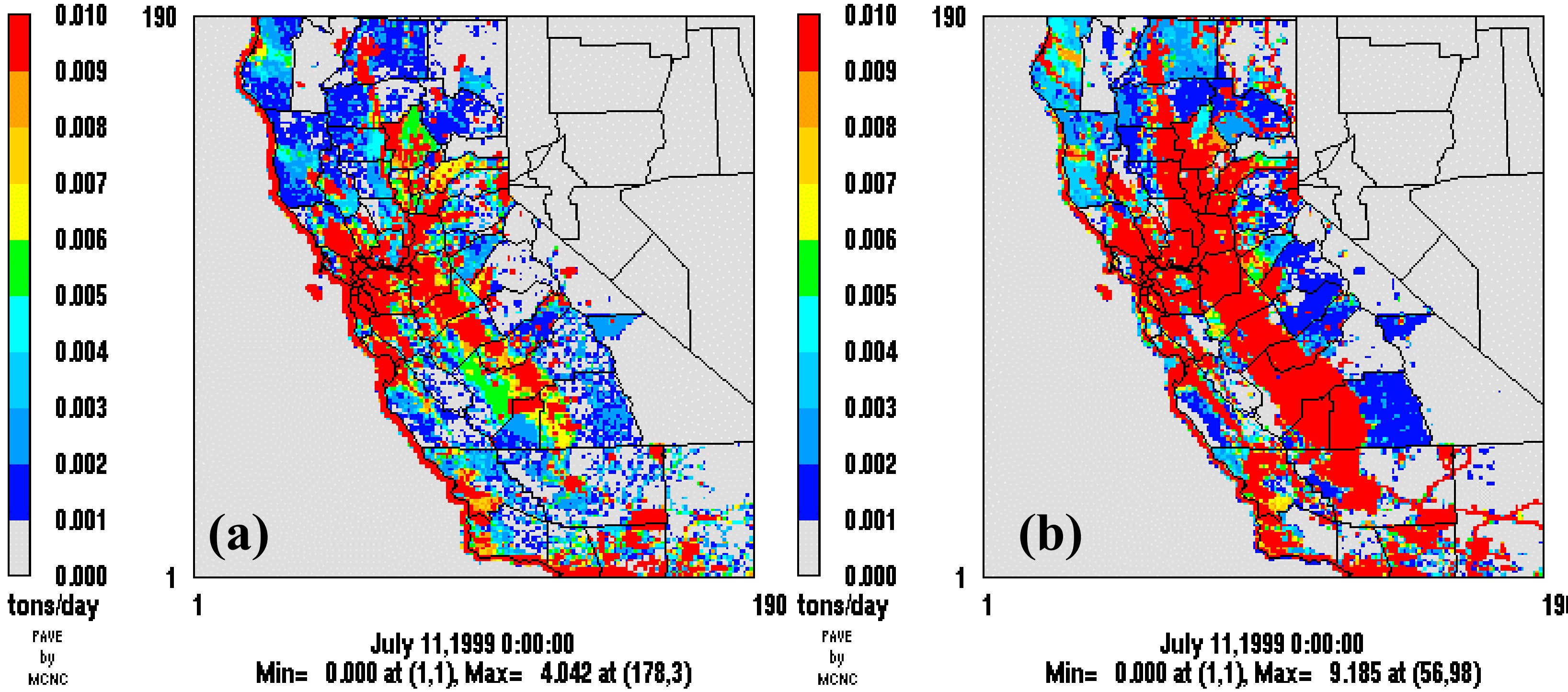

Figure 5-25. Daily off-road mobile source emissions estimates for Sunday, 11-July-1999. (a) VOC. (b) NOX.

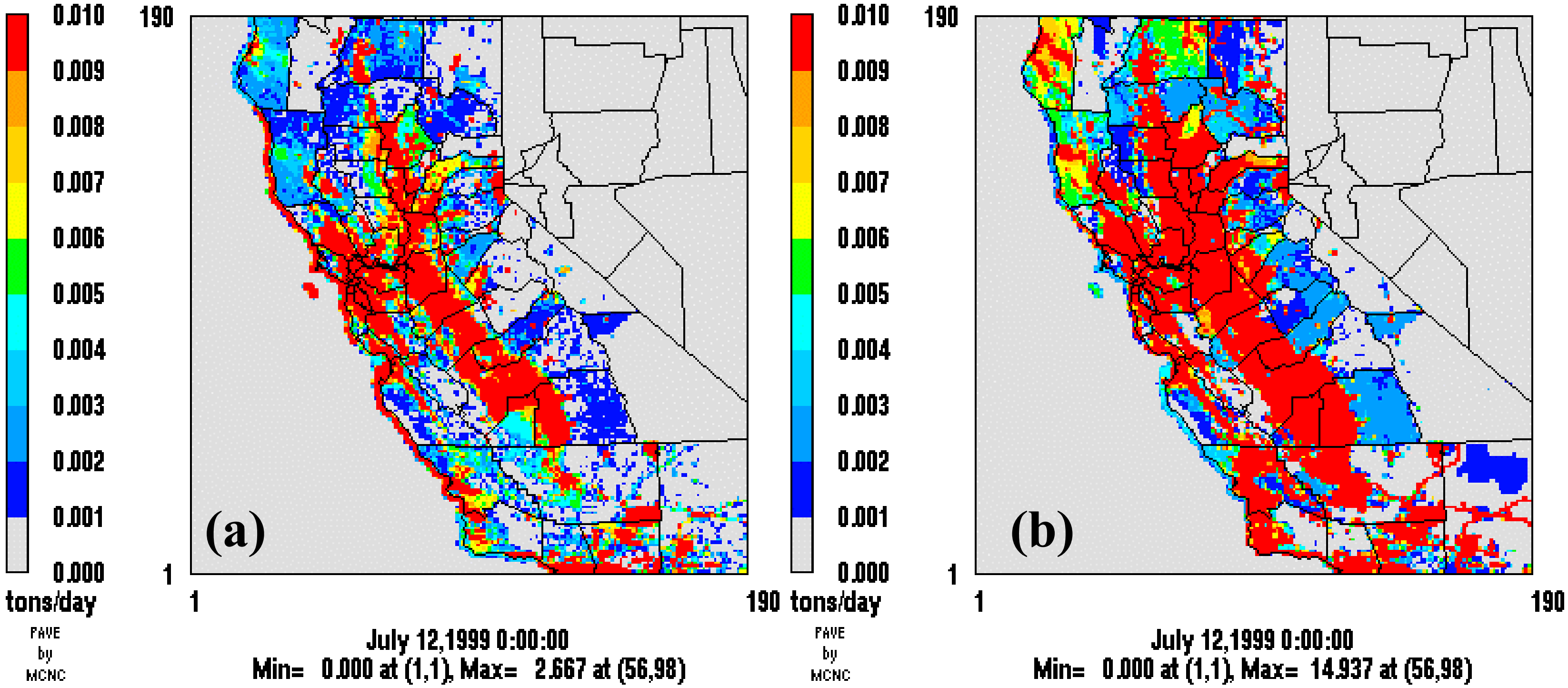

Figure 5-26. Daily off-road mobile source emissions estimates for Monday, 12-July-1999. (a) VOC. (b) NOX.

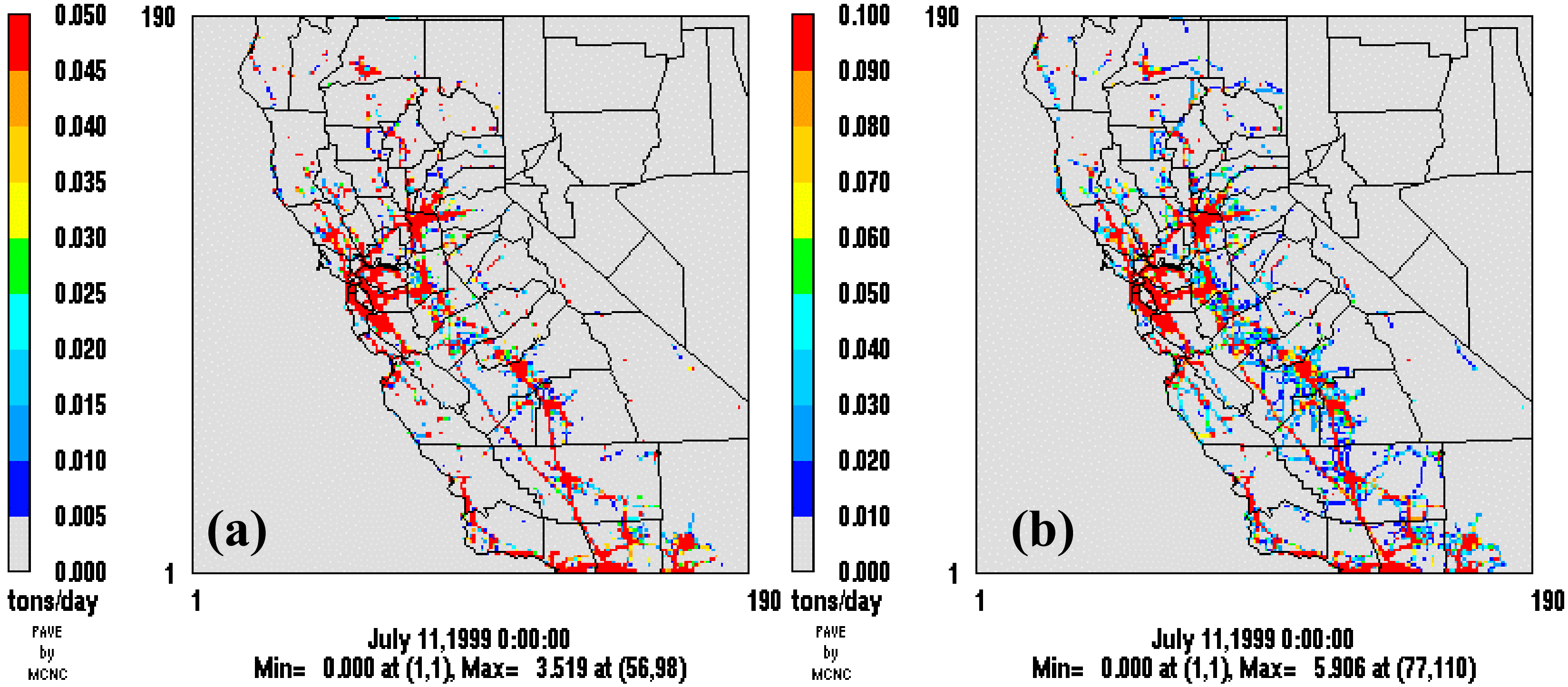

Figure 5-27. Daily on-road mobile source emissions estimates for Sunday, 11-July-1999. (a) VOC. (b) NOX.

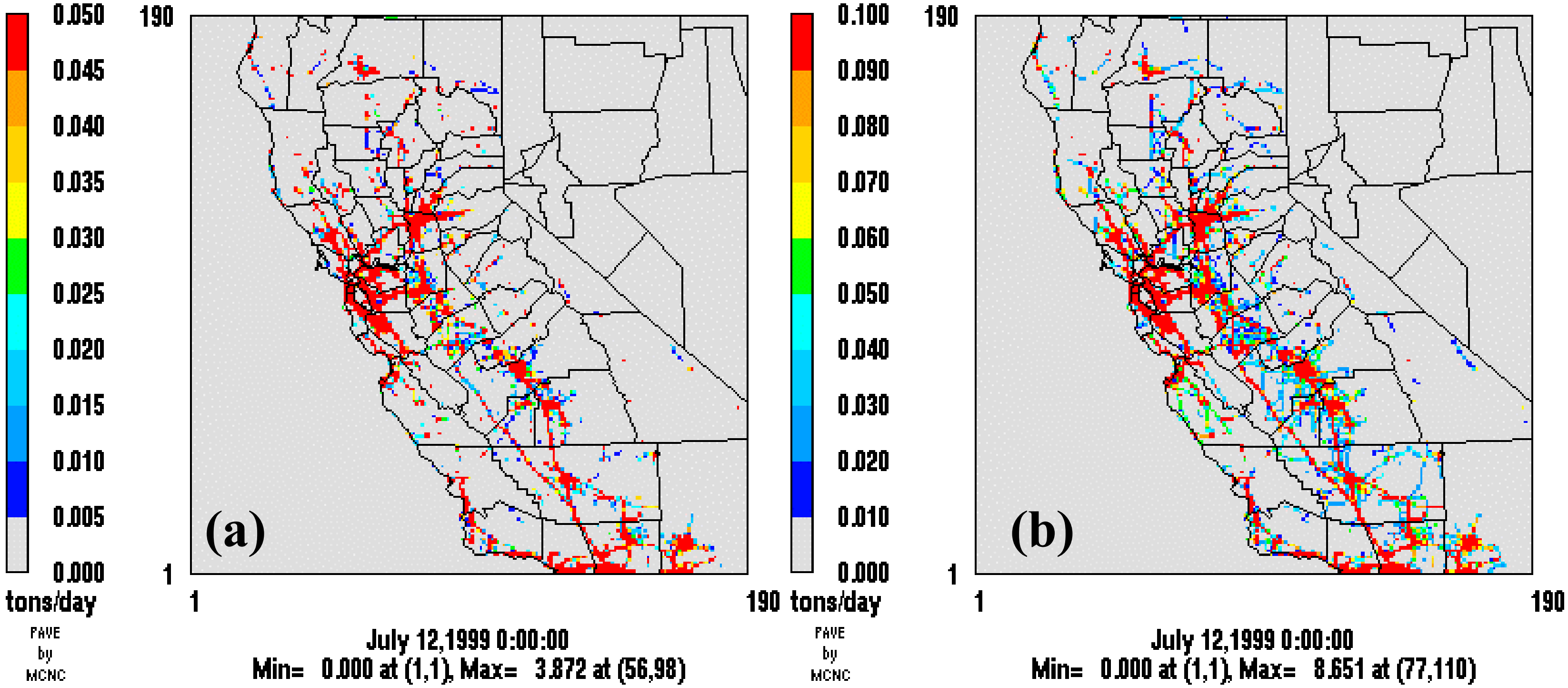

Figure 5-28. Daily on-road mobile source emissions estimates for Monday, 12-July-1999. (a) VOC. (b) NOX.