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Photochemical Modeling Analysis of Emission Control Strategies in the New York Metropolitan Area

PHOTOCHEMICAL MODELING ANALYSIS OF EMISSION CONTROL STRATEGIES IN THE NEW YORK METROPOLITAN AREA

by

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ABSTRACT

Despite a downward trend in the emissions of ozone precursors, like many urban areas in the United States, the New York metropolitan area continues to experience high levels of ozone concentrations. Because different types of Volatile Organic Compounds (VOCs) have different levels of reactivity, determining which control strategies would be most effective in reducing the ambient ozone concentration levels is a complex problem. The primary objective of this study is to evaluate in the New York metropolitan area some of the specific emission control options, envisioned under the EPA's post-1987 ozone policy and various bills before Congress.

The emission control strategies analyzed in this study were evaluated using the Urban Airshed Model (UAM) with the aerometric data for one of the high ozone days in 1980. Although the strategies considered here can achieve a reduction in VOCs and nitrogen oxides (NO_x) emissions over the modeling domain by about 53% and 47%, respectively, from the base year, the predicted peak ozone concentration in the New York metropolitan area is still well above the level of the ozone National Ambient Air Quality Standard (NAAQS). A modeling simulation with an across-the-board reduction in the VOC emissions over the modeling domain of 80% as well as upwind boundary concentration reduction of 80% from the 1980 level while keeping the NO_x concentrations at their 1980 levels, indicates that even this level of VOC emissions reduction is not sufficient to reduce the peak ozone concentration in the New York metropolitan area below the level of the ozone NAAQS. However, the model predicts that the peak ozone concentration over the New York metropolitan area can be reduced to the level of the ozone NAAQS for the day modeled with the VOC concentration reduction from the upwind boundary at the 80% level when coupled with an acrossthe-board reduction in the VOC emissions within the modeling domain by 95% from their 1980 levels.

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CHAPTER 1

INTRODUCTION

Ozone concentrations in the northeastern part of the United States continue to exceed the level of the National Ambient Air Quality Standard (NAAQS) for ozone despite a downward trend in the emissions of ozone precursors in this region. These exceedances mainly occur during the months of May through October, the so-called "ozone season," and are found to be region-wide indicating that ozone is a pervasive air contaminant. Currently, the level of the ozone air quality standard is exceeded in over 60 urban areas across the country. As a result, a large portion of the population continues to be exposed to frequently healthful levels of ozone. Both Congress and the U.S. Environmental Protection Agency are under increasing pressure to develop and implement effective emission control programs for protecting the public health and welfare[1]. This study attempts to analyze the effectiveness of a series of control strategies in mitigating the ozone problem in the urban areas.

The relationship of ozone to its precursors, in fact, the ozone-forming process in its entirety, must be elucidated before rational and effective precursor control strategies can be developed. Because the oxidation of non-methane organic compounds (NMOCs) leads to the formation of ozone, a reduction in NMOC is expected to reduce ozone production. The efficiency of ozone reduction, however, depends upon the amount of oxides of nitrogen (NO_x). Since different types of volatile organic compounds (VOCs) have different levels of reactivity, determining which control strategies will be most effective in reducing the ambient ozone levels is a complex problem. A one ton reduction of VOCs from mobile sources will not have the same impact on ozone formation as will a one ton reduction of VOCs from architectural coatings. The "VOC reactivity" issue has been attracting increased attention because cost-effective reductions might be achieved by excluding unreactive VOCs both from inventory and control.

Ozone is not usually emitted directly into the atmosphere, but is instead a secondary pollutant that is formed over a period of time from a variety of atmospheric reactants. The magnitude of the ozone concentration in an urban

area depends upon the transport of ozone and its precursors into the region, precursors emitted within the region, the rate at which the chemical reactions take place, and the transport and diffusion of pollutants out of the region. In order to assess whether a region will be in compliance with the ozone NAAQS at some future date, one needs to utilize mathematical models which predict the complex relationship between the precursor emissions and ozone air quality. The current generation of photochemical air quality models can with reasonable accuracy predict the peak ozone concentration downwind of an urban area resulting from prescribed changes in source emissions. The Urban Airshed Model (UAM) is one of the grid-based photochemical air quality models which treats the atmospheric physical and chemical processes in a sophisticated manner. With this model, it is possible to determine the most effective means for reducing the ozone concentrations in a large metropolitan area through the application of control strategies to specific source categories.

The objectives of this study (referred to as the SCOPE Project) are to: (a) evaluate the impacts of specific control options on ambient ozone concentrations in the New York metropolitan area, and (b) assess the relative merit of various control plans in mitigating the ozone problem in other major urban areas. As part of this investigation, new emission inventories for a future year have been developed for the New York metropolitan area to analyze the impact of reductions from such source categories as evaporative emissions from the use of high RVP gasoline, gasoline refueling emissions, enhanced inspection/maintenance programs, autobody refinishing and architectural coatings, alternative fueled vehicles, etc. The UAM has been applied with each emission inventory for a selected meteorological scenario. In this study, controls have been applied on an incremental basis, i.e., an additional control for each model simulation so the effects of each set of control strategies could be analyzed separately. Such information can then be used by the regulatory agencies in their efforts to identify cost-effective ozone control strategies.

Although the control strategies considered in this study can achieve a reduction in VOC and NO_x emissions over the New York metropolitan area by about 53% and 47%, respectively, from their corresponding 1980 emission levels, the predicted peak ozone concentration in the modeling domain is still well above the level of the ozone NAAQS. A modeling simulation with an across-the-board

reduction in the VOC emissions over the New York metropolitan area of 80% as well as upwind boundary concentration reduction of 80% from the 1980 level, while keeping the NO_x concentrations at their 1980 levels, indicates that even this level of reduction in the VOC emissions is not sufficient to reduce the peak ozone concentration over the modeling domain below the level of the ozone NAAQS. However, a simulation retaining the VOC concentration reduction from the upwind boundary at the 80% level when coupled with an across-the-board reduction in the VOC emissions in the New York metropolitan area by 95% from their 1980 levels, reveals that for the day modeled the peak ozone concentration over the New York metropolitan area can be reduced to the level of the ozone NAAQS.

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CHAPTER 2

MODEL APPLICATION

In examining the various emission control strategies for achieving the ozone NAAQS in the New York metropolitan area, the modeling domain (see Figure 2.1) encompassing portions of the States of New Jersey, New York and Connecticut, has been utilized. Thus, the results from this study can be compared with those of the previous study on the Urban Airshed Model application to this region (OMNYMAP)[2]. The following is a brief description of the model set-up and its application. Further details on the model design can be found elsewhere.[2]

2.1 MODELING DOMAIN

The modeling domain (see Figure 2.1) extends 248 km east-west and 200 km north-south with its southwest corner set approximately at Trenton, NJ and northeast corner at East Thompson, CT. near the Massachusetts and Rhode Island border. The grid size was set at 8 km resulting in 31 cells in the east-west and 25 cells in the north-south directions, respectively. The layer between the ground and the top of the simulation region was divided into four levels whose thicknesses were varied during the day as a function of the height of the mixed-layer.

2.2 MODELING DAY - AUGUST 8, 1980 (JD80221)

Based upon the application of the UAM to the New York metropolitan area for five high ozone days in the 1980 oxidant season,[2] August 8, 1980 was selected as the candidate day in this study. UAM simulation for this day indicated that the peak modeled concentration agreed well with the peak measured ozone concentration. Also, the correlation coefficient between the measured and predicted concentrations is 0.74, the highest correlation achieved over the five high ozone day simulations performed under the OMNYMAP study. Further, since a variety of sensitivity and strategy simulations have been reported with the July 21, 1980 case in the OMNYMAP study, examination of a different day could provide additional confidence in the modeling results. Hence, in this study,

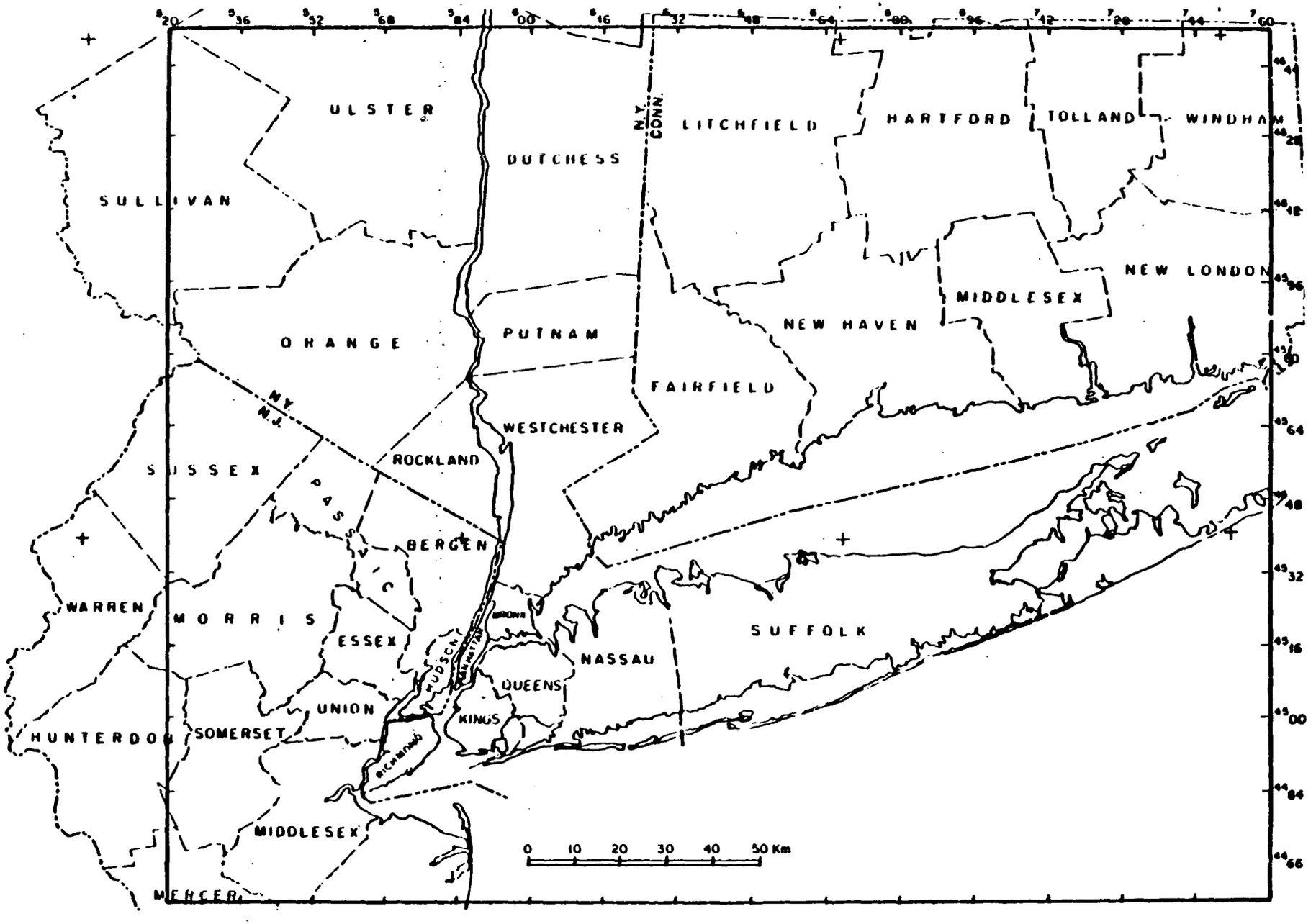


Figure 2.1 Model Domain Covering Portions of the States of New Jersey, New York, and Connecticut

all the analyses were conducted with the August 8, 1980 case. The synoptic weather pattern, shown in Figure 2.2, consists of a "Bermuda High" with an extension over the Appalachians and a high near James Bay with a stationary front that extends to a low over the Lake Superior. The surface winds during the day were from a south-southwesterly direction with speeds in the range of 3.5 to 5 m/s with maximum surface temperature in the 90-95^{o}F range. The hourly highest and second highest measured ozone concentrations are given in Table 2.1. The measured ozone peak value for the day is 246 ppb at Stratford Light House, CT, with several other monitoring stations in the region reporting concentrations in excess of the ozone NAAQS.

The meteorological conditions for the UAM simulation are provided in Tables 2.2 through 2.4, respectively. The air quality data, initial and boundary concentration fields required for the model were estimated from the 1980 ambient data and are shown in Figures 2.3 and 2.4. The initial and boundary fields which were representative of the 1980 conditions need to be "modified" to reflect the future-year conditions under the various emission control strategy scenarios. This was accomplished, as in the OMYNMAP study, by scaling the initial and boundary concentrations of the precursor pollutants to reflect the changes in the precursor emissions from their 1980 levels. In the case of ozone, the future-year initial and boundary fields due to changes in the precursor emissions cannot be estimated easily. The region-top concentrations of ozone range from 60 to 85 ppb for the 5 days of 1980 modeled in the OMNYMAP study. With the projected decreases in the precursor emissions, these levels should probably be in the range of 40 to 60 ppb, or a 20 to 30% reduction from the 1980 concentration level consistent with the the suggested estimates[3,4] of the background concentrations. In this study, as a first approximation, the assumed reduction in ozone was set at 20% from the 1980 level for all future strategy simulations. Table 2.5 provides the pollutant concentrations at the top of the modeling region for the 1980 simulation as well as for the future-year scenarios.

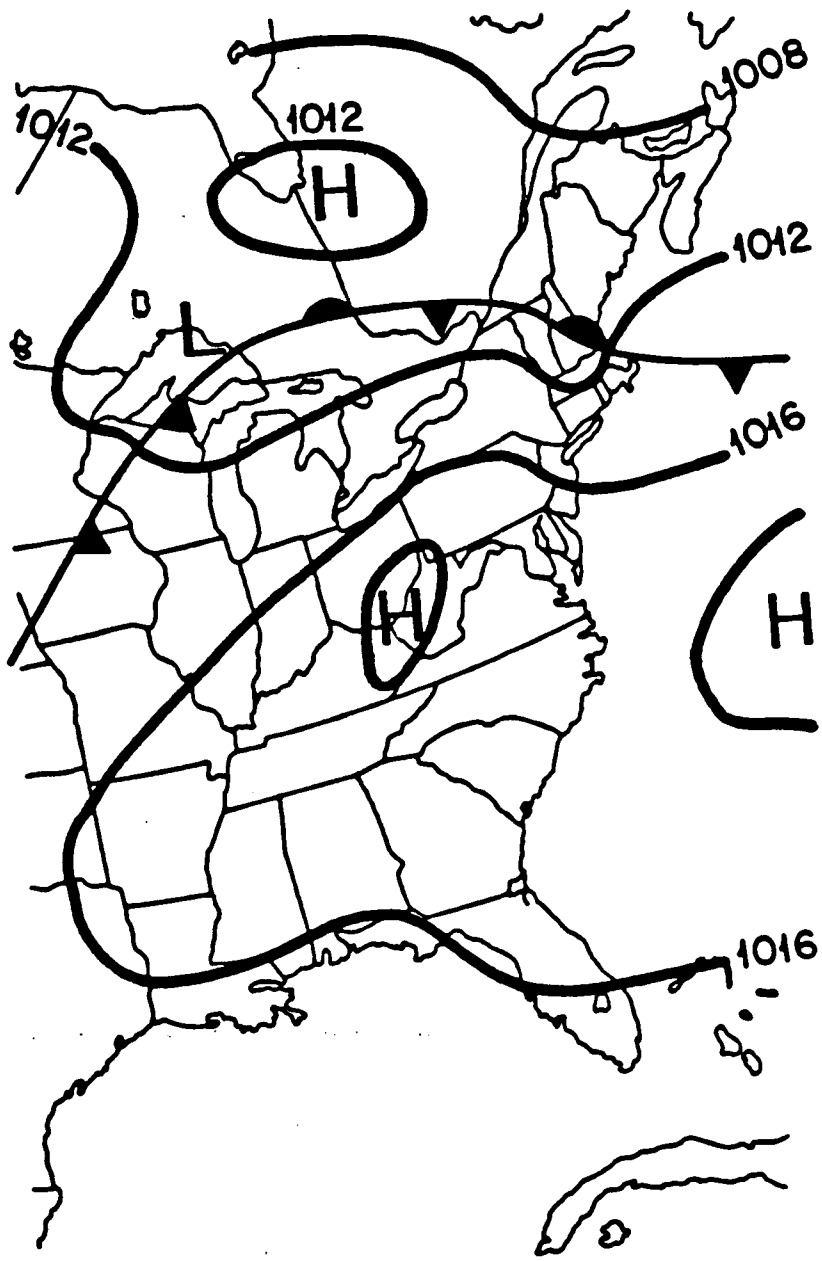


Figure 2.2 Synoptic Weather Pattern for August 8, 1980 (JD80221)

TABLE 2.1

Hourly Highest and Second Highest Ozone Concentrations
Measured on August 8, 1980 (JD80221)

HOUR OF THE DAY	HIGHEST CONCENTRATION (ppb)	MONITORING STATION	2nd HIGHEST CONCENTRATION (ppb)	MONITORING STATION
1200 - 1300	213	Stratford	180	Greenwich
1300 - 1400	246*	Stratford	170	Bridgeport
1400 - 1500	237**	Stratford	167	Bridgeport
1500 - 1600	236	Stratford	145	Stony Brook
1600 - 1700	197	Stratford	141	Derby
1700 - 1800	160	Stratford	132	Derby
1800 - 1900	143	Stratford	143	Middletown

* Highest for the day
** Second highest for the day

TABLE 2.2

Hourly Diffusion Break (Mixing Height), Region and Vertical Cell Top Heights for August 8, 1980 (JD80221)

HOUR OF THE DAY	DIFFUSION BREAK (m)	REGION TOP (m)	TOP OF CELL (m) 3	2	1
0400 - 0500	345	1000	345	230	115
0500 - 0600	345	1000	345	230	115
0600 - 0700	345	1000	345	230	115
0700 - 0800	375	1000	375	250	125
0800 - 0900	405	1000	405	270	135
0900 - 1000	450	1040	450	300	150
1000 - 1100	540	1100	540	360	180
1100 - 1200	700	1160	660	440	220
1200 - 1300	1020	1280	780	520	260
1300 - 1400	1400	1400	900	600	300
1400 - 1500	1400	1400	900	600	300
1500 - 1600	1400	1400	900	600	300
1600 - 1700	1400	1400	900	600	300
1700 - 1800	1170	1400	795	530	265
1800 - 1900	940	1400	705	470	235
1900 - 2000	710	1400	630	420	210

TABLE 2.3

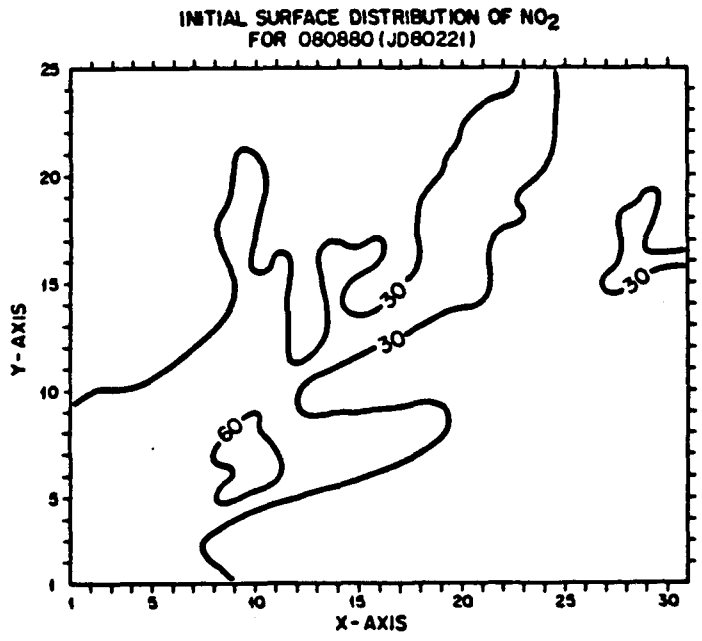
Vector-Averaged Hourly Winds for August 8, 1980 (JD80221)

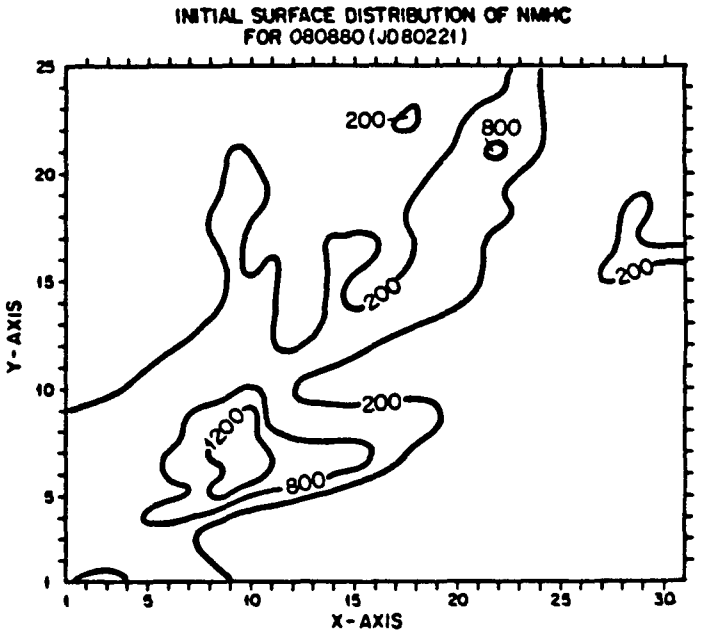
HOUR OF THE DAY	WIND SPEED (m/s)	WIND DIRECTION (°)
0600 - 0500	3.53	227
0500 - 0600	3.48	234
0600 - 0700	3.77	241
0700 - 0800	3.24	244
0800 - 0900	3.67	231
0900 - 1000	3.82	232
1000 - 1100	3.99	237
1100 - 1200	4.57	238
1200 - 1300	5.26	233
1300 - 1400	4.80	235
1400 - 1500	5.09	236
1500 - 1600	5.63	236
1600 - 1700	4.49	234
1700 - 1800	5.11	245
1800 - 1900	4.48	239
1900 - 2000	4.84	224

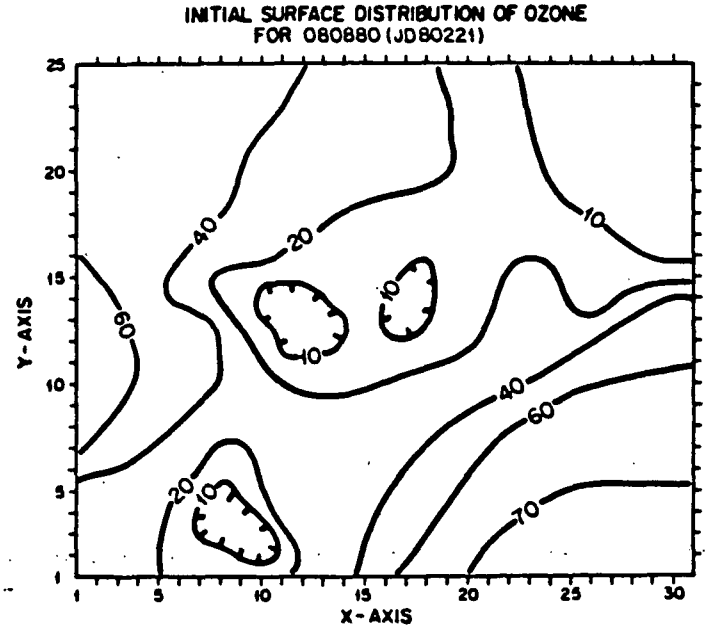
TABLE 2.4

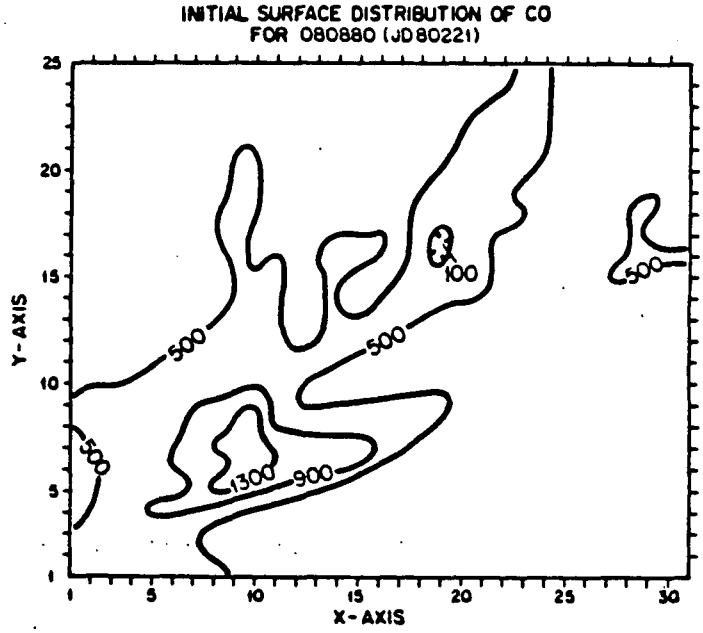
Metscalar Parameters for August 8, 1980 (JD80221)

HOUR OF THE DAY	TEMPERATURE GRADIENT (^{O}K/m) BELOW	ABOVE	EXPOSURE INDEX	PHOTOLYSIS RATE	CONCENTRATION OF WATER VAPOR (PPM)	ATMOSPHERIC PRESSURE (ATM)
0400-0500	.0049	-.0069	0	.0010	16065.0	0.9813
0500-0600	.0049	-.0069	0	.0010	16065.0	0.9811
0600-0700	.0008	-.0075	1	.0848	16065.0	0.9810
0700-0800	.0008	-.0075	1	.2355	16065.0	0.9810
0800-0900	-.0039	-.0063	1	.3509	16065.0	0.9811
0900-1000	-.0084	-.0051	2	.4247	16072.0	0.9807
1000-1100	-.0099	-.0061	2	.4718	16072.0	0.9807
1100-1200	-.0112	-.0070	2	.5020	16083.0	0.9801
1200-1300	-.0106	-.0064	2	.5234	16093.0	0.9796
1300-1400	-.0101	-.0058	1	.5319	16603.0	0.9791
1400-1500	-.0098	-.0063	1	.5120	16614.0	0.9787
1500-1600	-.0096	-.0068	1	.4733	16126.0	0.9775
1600-1700	-.0093	-.0073	1	.4059	16136.0	0.9771
1700-1800	-.0090	-.0078	0	.2861	16143.0	0.9768
1800-1900	-.0088	-.0083	0	.1125	16659.0	0.9763
1900-2000	-.0088	-.0083	-1	.0010	16659.0	0.9761









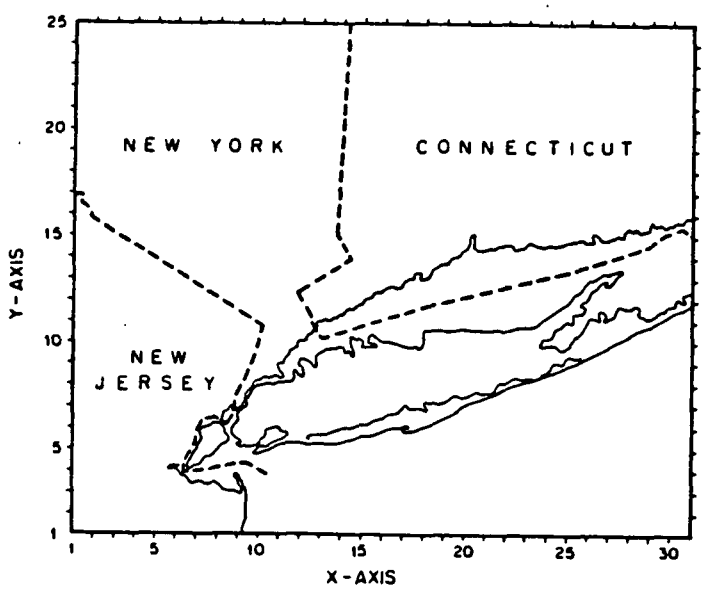


Figure 2.3 Initial Pollutant Distribution for August 8, 1980 (JD80221)

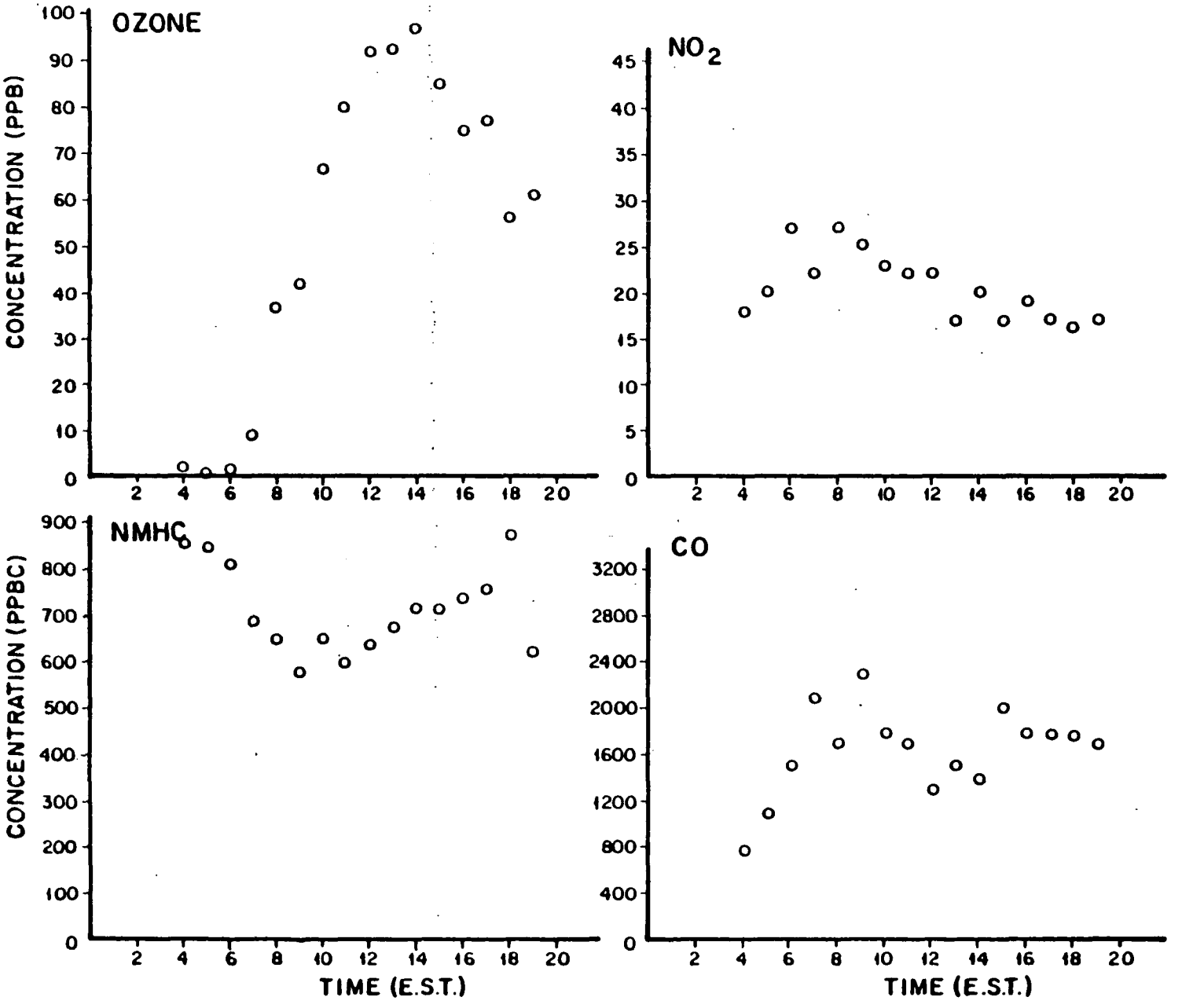


Figure 2.4 Diurnal Variation of Pollutant Concentrations at the Southwest Corner Cell for August 8, 1980 (JD80221)

TABLE 2.5

Pollutant Concentrations at the Top of the Modeling Region for August 8, 1980 (JD80221) for Base Case (1980) and Strategies

Pollutant	Concentration at the Top of the Modeling Region (ppb)	
	Base Case	Strategies
O_3	70	56
NO_2	6	6
NMHC*	30	30
CO	20	20

*ppbc

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CHAPTER 3

EMISSION INVENTORIES - BASE CASE AND CONTROL STRATEGIES

The UAM version used in this study employs the Carbon Bond II (CBII) Chemical Mechanism to speciate the hydrocarbon emissions. The 1980 emissions data base for the New York metropolitan area for each of the three states is presented in Table 3.1 by source category on a tons per year basis. The speciated emissions summary for a typical model day is provided in Table 3.2. The details on the development of this database can be found elsewhere.[1]

3.1 SCOPE BASE EMISSIONS

To reflect reality more accurately, changes were made to the OMNYMAP emissions inventory. The 1988 base inventory, referred to hereafter as the SCOPE BASE Scenario, was adjusted in the following way: The Stage II gasoline marketing controls assumed in OMNYMAP to be in place over the New Jersey portion of the domain were removed, since Stage II is not currently implemented. The Reid Vapor Pressure (RVP) for gasoline was adjusted from 10.0 psi (assumed in the OMNYMAP study) to 11.7 psi for all gasoline related emissions over the domain, as this is the vapor pressure of gasoline sold in the New York metropolitan area. Since no data were available for Publicly Owned Treatment Works (POTWs) when the OMNYMAP study was conducted, they were not included in the 1988 OMNYMAP emission inventory. However, for this study, information on the emissions and locations of POTW sources was obtained from USEPA Region II[5] for the New Jersey, New York portions of the domain. No such data were available for Connecticut. Assuming that these sources have a stack height less than 65 m, they were treated as minor point sources with speciation characteristics similar to those in the consumer/commercial solvent category. In this manner, these data were incorporated into the 1988 SCOPE BASE inventory.

The annual emissions (tpy) by state and source category and in terms of model day summary for the SCOPE BASE are listed in Tables 3.3 and 3.4, respectively. Even though the inventory shows an increase in the precursor pollutants emissions from 1980 to 1988 for the major point and area source categories, the remaining categories, minor and mobile sources, show a greater

TABLE 3.1

Summary of 1980 Emissions (OMNYMAP Base) over the Modeling Domain (Tons/Year)

	NEW YORK		NEW JERSEY		CONNECTICUT		MODELING DOMAIN	
CATEGORY	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES*	—	61,488	957	62,349	297	26,089	1,254	149,926
MINOR POINT SOURCES	27,651	2,175	114,978	131,039	9,029	8,586	151,658	141,800
AREA SOURCES	132,883	129,390	149,288	67,716	79,002	22,551	361,173	219,657
MOBILE SOURCES	219,482	158,297	117,035	84,124	115,317	101,167	451,834	343,588
TOTAL	380,016	351,350	382,258	345,228	203,645	158,393	965,919	854,971

*Sources with emissions greater than 100 tpy and a stack height exceeding 65m.

TABLE 3.2

Summary of Typical Day (0400 to 2000 hrs) Speciated Emissions (G-Moles) for OMNYMAP Base

CATEGORY	NO	NO_2	NO_x	PAR	OLE	CARB	ARO	ETH	VOC
MAJOR POINT SOURCES	5,175,182	393,014	5,568,196	68,853	1,136	42,280	368	0	112,637
MINOR POINT SOURCES	2,663,471	91,041	2,754,512	9,850,952	566,199	861,614	612,787	624,259	12,515,811
AREA SOURCES	9,078,919	754,870	9,833,789	44,929,998	445,118	2,773,712	681,070	571,640	49,401,538
MOBILE SOURCES	15,684,255	1,742,748	17,427,003	38,577,935	1,818,341	4,253,342	1,818,341	3,020,000	49,487,959
TOTAL	32,601,827	2,981,673	35,583,500	93,427,738	2,830,794	7,930,948	3,112,566	4,215,566	111,517,945

TABLE 3.3

Summary of Emissions for SCOPE BASE Over the Modeling Domain (Tons/Year)

	NEW YORK		NEW JERSEY		CONNECTICUT		MODELING DOMAIN	
CATEGORY	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES	--	61,488	957	62,349	850	29,141	1,807	152,978
% Change from 1980					186.2	11.7	44.1	2.0
MINOR POINT SOURCES	13,167	2,175	69,444	128,446	7,223	5,104	89,864	135,725
% Change from 1980	-52.4		-39.6	-2.0	-20.0	-40.6	-40.8	-4.3
AREA SOURCES	134,031	132,722	160,266	69,945	79,248	23,246	373,545	225,913
% Change from 1980	0.9	2.6	7.4	3.3	0.3	3.1	3.4	2.8
MOBILE SOURCES	105,438	95,764	66,610	63,599	57,073	64,878	229,121	224,241
% Change from 1980	-52.0	-39.5	-43.1	-24.4	-50.5	-35.9	-49.3	-34.7
TOTAL	252,636	292,149	297,277	324,339	144,394	122,369	694,307	738,857
% Change from 1980	-33.5	-16.8	-22.2	-6.1	29.1	-22.7	-28.1	-13.6

TABLE 3.4

Summary of Typical Day (0400 to 2000 hrs) Speciated Emissions (G-Moles) for SCOPE BASE

CATEGORY	NO	NO_2	NO_x	PAR	OLE	CARB	ARO	ETH	VOC
MAJOR POINT SOURCES	5,398,898	419,890	5,818,788	87,393	4,624	38,756	656	0	131,429
MINOR POINT SOURCES	3,122,126	88,163	3,210,289	5,779,210	346,394	566,566	324,334	391,897	7,408,401
AREA SOURCES	8,949,727	733,730	9,683,457	43,552,626	457,694	2,748,050	672,181	592,912	48,023,463
MOBILE SOURCES	10,253,727	1,139,370	11,393,097	17,453,368	969,852	2,098,413	999,702	1,768,691	23,289,954
TOTAL	27,724,478	2,381,153	30,105,631	66,872,597	1,778,564	5,451,785	1,996,873	2,753,428	78,853,247

amount of reduction, resulting in a net decrease in the total emissions over the New York metropolitan area. The reductions for the SCOPE BASE Case are in the amount of about 28% and 14% over the domain for VOCs and NO_x, respectively, from their 1980 levels.

3.2 SCOPE STRATEGY 1

This strategy looked at the impact of a series of motor vehicle controls. To analyze the full effect of those controls, the modeling region was assumed to have a fully implemented federal motor vehicle control program (FMVCP) and a fully implemented on-board gasoline vapor recovery system with 93% control efficiency. RVP was set at 9.0 psi. The average emission rate (g/mile) for a future year, 2005, was estimated using the MOBILE3 model and New York's 1988 mobile source inventory. These future-year emission rates were assumed to be reflective of a FMVCP and a fully implemented on-board gasoline vapor recovery system and were applied to the mobile source inventory of SCOPE BASE. The net effect of STRATEGY 1 was a reduction of about 44% in the VOCs and 23% in the NO_x from their corresponding 1980 levels. The annual emissions (tpy) for the SCOPE STRATEGY 1 are listed in Tables 3.5 and 3.6 by state and source category, and in terms of model day summary, respectively.

3.3 SCOPE STRATEGY 2

The second control strategy analyzed the effect of reduction in emissions from certain categories of organic solvents in conjunction with the measures imposed in SCOPE STRATEGY 1 on the mobile source category. Again, modeling from controls incrementally to Strategy 1 allows assessment of both the relative effect of Strategy 2 controls and the combined effectiveness of Strategies 1 and 2.

The SCOPE STRATEGY 1 emissions inventory was adjusted to reflect a specified level of reduction from each of the following sources: a 50% reduction in (a) consumer/commercial solvents, (b) auto refinishing and (c) POTWs; and a 65% reduction in the categories of (i) architectural surface coatings (oil-based) and (ii) traffic marking coatings. Several other source types that were considered for inclusion under this strategy were hazardous

TABLE 3.5

Summary of Emissions for SCOPE STRATEGY 1 over the Modeling Domain (Tons/Year)

	NEW YORK		NEW JERSEY		CONNECTICUT		MODELING DOMAIN	
CATEGORY	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES	—	61,488	957	62,349	850	29,141	1,807	152,978
% Change from 1980					186.2	11.7	44.1	2.0
MINOR POINT SOURCES	13,167	2,175	69,444	128,446	7,223	5,104	89,864	135,725
% Change from 1980	-52.4	0.0	-39.6	-2.0	-20.0	-40.6	-40.8	-4.3
AREA SOURCES	116,948	132,722	143,727	69,945	73,227	23,246	333,902	225,913
% Change from 1980	-12.0	2.6	-3.7	3.3	-7.3	3.1	7.6	2.8
MOBILE SOURCES	53,765	60,063	33,966	39,864	29,102	40,691	116,833	140,618
% Change from 1980	-75.5	-62.1	-71.0	-52.6	-74.8	-59.8	-74.1	-59.1
TOTAL	183,880	256,448	248,094	300,604	110,402	98,182	542,376	655,234
% Change from 1980	-51.6	-27.0	-35.1	-12.9	-45.8	-38.0	-43.8	-23.4

TABLE 3.6

Summary of Typical Day (0400 to 2000 hrs) Speciated Emissions (G-Moles) for SCOPE STRATEGY 1

CATEGORY	NO	NO_2	NO_x	PAR	OLE	CARB	ARO	ETH	VOC
MAJOR POINT SOURCES	5,398,898	419,890	5,818,788	87,393	4,624	38,756	656	0	131,429
MINOR POINT SOURCES	3,122,126	88,163	3,210,289	5,779,210	346,394	566,566	324,334	391,897	7,408,401
AREA SOURCES	8,949,727	733,730	9,683,457	37,721,815	402,426	2,601,997	663,132	592,912	41,982,282
MOBILE SOURCES	6,426,606	707,114	7,136,720	8,746,644	507,561	1,114,206	499,787	948,584	11,816,782
TOTAL	23,897,357	1,951,897	25,849,254	52,335,062	1,261,005	4,321,525	1,487,909	1,933,393	61,338,894

waste treatment, storage and disposal facilities (TSDF's), coke ovens, wood furniture refinishing, and web offset lithography. However, either the emissions data were not available or the source categories were not identified in the modeling domain and, thus, were not included in this analysis. The above adjustments were applied to the SCOPE STRATEGY 1 inventory, and the resulting inventory, SCOPE STRATEGY 2 is shown on an annual basis (tpy) and in terms of speciated summary of a typical model day emissions in Tables 3.7 and 3.8, respectively. **Under this strategy, the overall emission reductions in VOCs is about 50% from their 1980 levels with substantial emissions reductions coming from the New York portion of the modeling domain.**

3.4 SCOPE STRATEGY 3

Under this emission control strategy in addition to the controls in Strategies 1 and 2, 30% of the light-duty gasoline powered vehicle population was assumed to be fueled with methanol. Based upon consultations with the EPA Office of Mobile Sources,[6] Ann Arbor, MI, the estimated reduction in emissions was 36% and 92% from exhaust and evaporative hydrocarbons, respectively, for 100% methanol-fueled versus gasoline-fueled vehicles. It should be noted here that the current version of the UAM utilizes the CBII mechanism which does not explicitly treat formaldehyde (HCHO) emissions, unlike the Carbon Bond IV (CBIV) or other chemical mechanisms. Thus, under this scenario no changes were made to the NO_x or CO emissions inventories and to the speciation characteristics of the VOC's resulting from the penetration of methanol-fueled vehicles into the fleet. Performing appropriate adjustments to the mobile source emissions in SCOPE STRATEGY 2, the inventory was prepared and summarized on an annual basis (tpy) and on a model day basis in Tables 3.9 at 3.10, respectively.

3.5 SCOPE STRATEGY 4

This strategy assumed a stationary source NO_x "RACT" rule was in place and all <u>non-mobile</u> NO_x emissions were reduced by 40% from the SCOPE STRATEGY 3 emissions inventory, resulting in an overall reduction of 47% from the 1980 NO_x emissions (See Tables 3.11 and 3.12). This is due to the fact that 59% of the reductions in NO_x were achieved from the mobile source category itself under SCOPE STRATEGY 1.

TABLE 3.7

Summary of Emissions for SCOPE STRATEGY 2 over the Modeling Domain (Tons/Year)

	NEW YORK		NEW JERSEY		CONNECTICUT		MODELING DOMAIN	
CATEGORY	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES	--	61,488	957	62,349	850	29,141	1,807	152,978
% Change from 1980					186.2	11.7	44.1	2.0
MINOR POINT SOURCES	13,167	2,175	69,444	128,446	7,223	5,104	89,864	135,725
% Change from 1980	-52.4	0.0	-39.6	-2.0	-20.0	-40.6	-40.8	-4.3
AREA SOURCES	85,550	132,722	124,388	69,945	63,200	23,246	273,138	225,913
% Change from 1980	-35.6	2.6	-16.7	3.3	-20.0	3.1	24.4	2.8
MOBILE SOURCES	53,765	60,063	33,966	39,864	29,102	40,691	116,833	140,618
% Change from 1980	-75.5	-62.1	-71.0	-52.6	-74.8	-59.8	-74.1	-59.1
TOTAL	152,482	256,448	228,755	300,604	100,375	98,182	481,612	655,234
% Change from 1980	-59.9	-27.0	-40.2	-12.9	-50.7	-38.0	-50.1	-23.4

TABLE 3.8

Summary of Typical Day (0400 to 2000 hrs) Speciated Emissions (G-Moles) for SCOPE STRATEGY 2

CATEGORY	NO	NO_2	NO_x	PAR	OLE	CARB	ARO	ETH	VOC
MAJOR POINT SOURCES	5,398,898	419,890	5,818,788	87,393	4,624	38,756	656	0	131,429
MINOR POINT SOURCES	3,122,126	88,163	3,210,289	5,779,210	346,394	566,566	324,334	391,897	7,408,401
AREA SOURCES	8,949,727	733,730	9,683,457	29,660,285	402,426	1,956,857	550,077	592,912	33,162,557
MOBILE SOURCES	6,426,606	710,114	7,136,720	8,746,644	507,561	1,114,206	499,787	948,584	11,816,782
TOTAL	23,897,357	1,951,897	25,849,254	44,273,532	1,261,005	3,676,385	1,374,854	1,933,393	52,519,169

TABLE 3.9

Summary of Emissions for SCOPE STRATEGY 3 over the Modeling Domain (Tons/Year)

	NEW YORK		NEW JERSEY		CONNECTICUT		MODELING DOMAIN	
CATEGORY	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES	--	61,488	957	62,349	850	29,141	1,807	152,978
% Change from 1980					186.2	11.7	44.1	2.0
MINOR POINT SOURCES	13,167	2,175	69,444	128,446	7,223	5,104	89,864	135,725
% Change from 1980	-52.4		-39.6	-2.0	-20.0	-40.6	-40.8	-4.3
AREA SOURCES	85,550	132,722	124,388	69,945	63,200	23,246	273,138	225,913
% Change from 1980	-35.6	2.6	-16.7	3.3	-20.0	3.1	24.4	2.8
MOBILE SOURCES	42,811	60,063	27,046	39,864	23,173	40,691	93,029	140,618
% Change from 1980	-80.5	-62.1	-76.9	-52.6	-79.9	-59.8	-79.4	-59.1
TOTAL	141,528	256,448	221,835	300,604	94,446	98,182	457,808	655,234
% Change from 1980	-62.8	-27.0	-42.0	-12.9	-53.6	-38.0	-52.6	-23.4

TABLE 3.10

Summary of Typical Day (0400 to 2000 hrs) Speciated Emissions (G-Moles) for SCOPE STRATEGY 3

CATEGORY	NO	NO_2	NO_x	PAR	OLE	CARB	ARO	ETH	VOC
MAJOR POINT SOURCES	5,398,898	419,890	5,818,788	87,393	4,624	38,756	656	0	131,429
MINOR POINT SOURCES	3,122,126	88,163	3,210,289	5,779,210	346,394	566,566	324,334	391,897	7,408,401
AREA SOURCES	8,949,727	733,730	9,683,457	29,660,285	402,426	1,956,857	550,077	592,912	33,162,557
MOBILE SOURCES	6,426,606	710,114	7,136,720	6,946,396	339,689	883,891	392,652	752,121	9,374,749
TOTAL	23,897,357	1,951,897	25,849,254	42,473,284	1,153,133	3,446,070	1,267,719	1,736,930	50,077,136

TABLE 3.11

Summary of Emissions for SCOPE STRATEGY 4 over the Modeling Domain (Tons/Year)

	NEW YORK		NEW JERSEY		CONNECTICUT		MODELING DOMAIN	
CATEGORY	VOC	NO_x	VOC	NO_x	VOC	NO_x	VOC	NO_x
MAJOR POINT SOURCES	--	36,893	957	37,409	850	17,485	1,807	91,787
% Change from 1980		-40.0		-40.0	186.2	33.0	44.1	-38.8
MINOR POINT SOURCES	13,167	1,305	69,444	77,068	7,223	3,062	89,834	81,435
% Change from 1980	-52.4	-40.0	-39.6	-41.2	-20.0	-64.3	-40.8	-42.6
AREA SOURCES	85,550	79,633	124,388	41,967	63,200	13,948	273,138	135,548
% Change from 1980	-35.6	-38.5	-16.7	-38.0	-20.0	-38.2	-24.4	-38.3
MOBILE SOURCES	42,811	60,063	27,046	39,864	23,173	40,691	93,029	140,618
% Change from 1980	-80.5	-62.1	-76.9	-52.6	-79.9	-59.8	-79.4	-59.1
TOTAL	141,528	177,894	221,835	196,308	94,446	75,186	457,808	449,388
% Change from 1980	-62.8	-49.4	-42.0	-43.1	-53.6	-52.5	-52.6	-47.4

TABLE 3.12

Summary of Typical Day (0400 to 2000 hrs) Speciated Emissions (G-Moles) for SCOPE STRATEGY 4

CATEGORY	NO	NO_2	NO_x	PAR	OLE	CARB	ARO	ETH	VOC
MAJOR POINT SOURCES	3,239.339	251,934	3,491,273	87,393	4,624	38,756	656	0	131,429
MINOR POINT SOURCES	1,873,276	52,898	1,926,173	5,779,210	346,394	566,566	324,334	391,897	7,408,401
AREA SOURCES	5,369,836	440,238	5,810,074	29,660,285	402,426	1,956,857	550,077	592,912	33,162,557
MOBILE SOURCES	6,426,606	710,114	7,136,720	6,946,396	339,689	883,891	392,652	752,121	9,374,749
TOTAL	16,909,057	1,455,184	18,364,240	42,473,284	1,153,133	3,446,070	1,267,719	1,736,930	50,077,136

3.6 SCOPE STRATEGY 5

Strategy 5 was aimed at determining the level of emissions reductions required to meet the ozone NAAQS in the region. This calls for an "educated guess" of the reduction levels needed in the precursor emissions. Based upon several sensitivity analyses performed with UAM, the required level of reduction in VOCs was estimated to be 95% from the 1980 level within the domain with no change in the NO_x level from the base year. It should be noted that these are across-the-board reductions and are not source category selective as in the previous control strategies. In the case of initial and boundary concentration fields, no changes were made to the levels of CO, NO and NO_2 from these 1980 levels, while those of NMOC and ozone were reduced by 80% and 40%, respectively.

3.7 SYNOPSIS OF THE SCOPE STRATEGIES

The proposed emission control strategy scenarios, listed in Table 3.13, were assembled to examine their effects on the levels of ozone in the New York metropolitan area. The first three strategies were incremental in nature and were designed to assess improvement in the ozone air quality in relation to a specific variety of controls imposed upon the VOC emissions. Figure 3.1 shows a summary view of these changes on a state-by-state basis and over the domain. The fourth strategy was aimed at examining NO_x controls; a summary of these reductions is shown in Figure 3.2. Finally, a strategy with an across-the-board reduction in the VOC emissions was evaluated to bring the peak ozone concentrations in the New York metropolitan area to the level of the ozone NAAQS.

TABLE 3.13

Summary of the Emission Control Strategies
Considered for the New York Metropolitan Area

Strategy	Type of Controls	Percent Change from 1980 Emissions VOC	Percent Change from 1980 Emissions NO_x
SCOPE BASE 1988 Base Case	RVP set at 11.7 psi No Stage II emissions from POTWs included	28	14
SCOPE STRATEGY 1 Mobile Control Measures	RVP set at 9.0 psi Fully implemented on-board gasoline vapor recovery and FMVCP	44	23
SCOPE STRATEGY 2 Control Technology Measures	50% reduction in commercial/consumer solvents and auto-refinishing emission 60% reduction in architechtural, surface coating and traffic marking coating emissions	50	23
SCOPE STRATEGY 3 Methanol Option	30% penetration of methanol fueled vehicles in the light duty gasoline vehicle fleet	52	23
SCOPE STRATEGY 4 NO_x RACT	Non-mobile NO_x emission reduced by 40%	52	47
SCOPE STRATEGY 5 What if?	Across-the-board reductions	95	-

VOC EMISSIONS

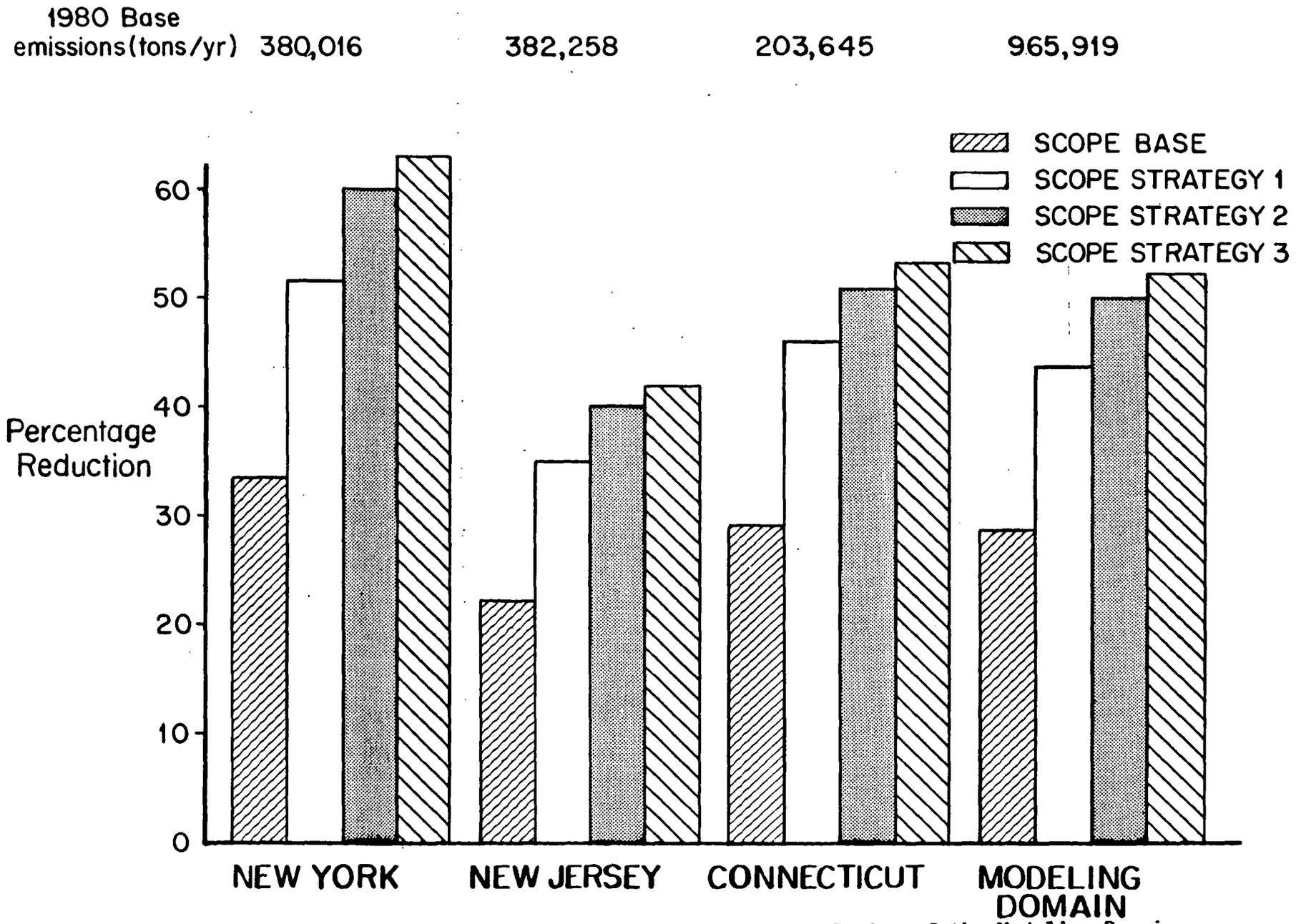

Figure 3.1 Summary of Percentage of VOC Reduction in the Tri-State Region of the Modeling Domain

NO_x EMISSIONS

	NEW YORK	NEW JERSEY	CONNECT.	MODELING DOMAIN
1980 Base Emissions (tons/yr)	351,350	345,228	158,393	854,971

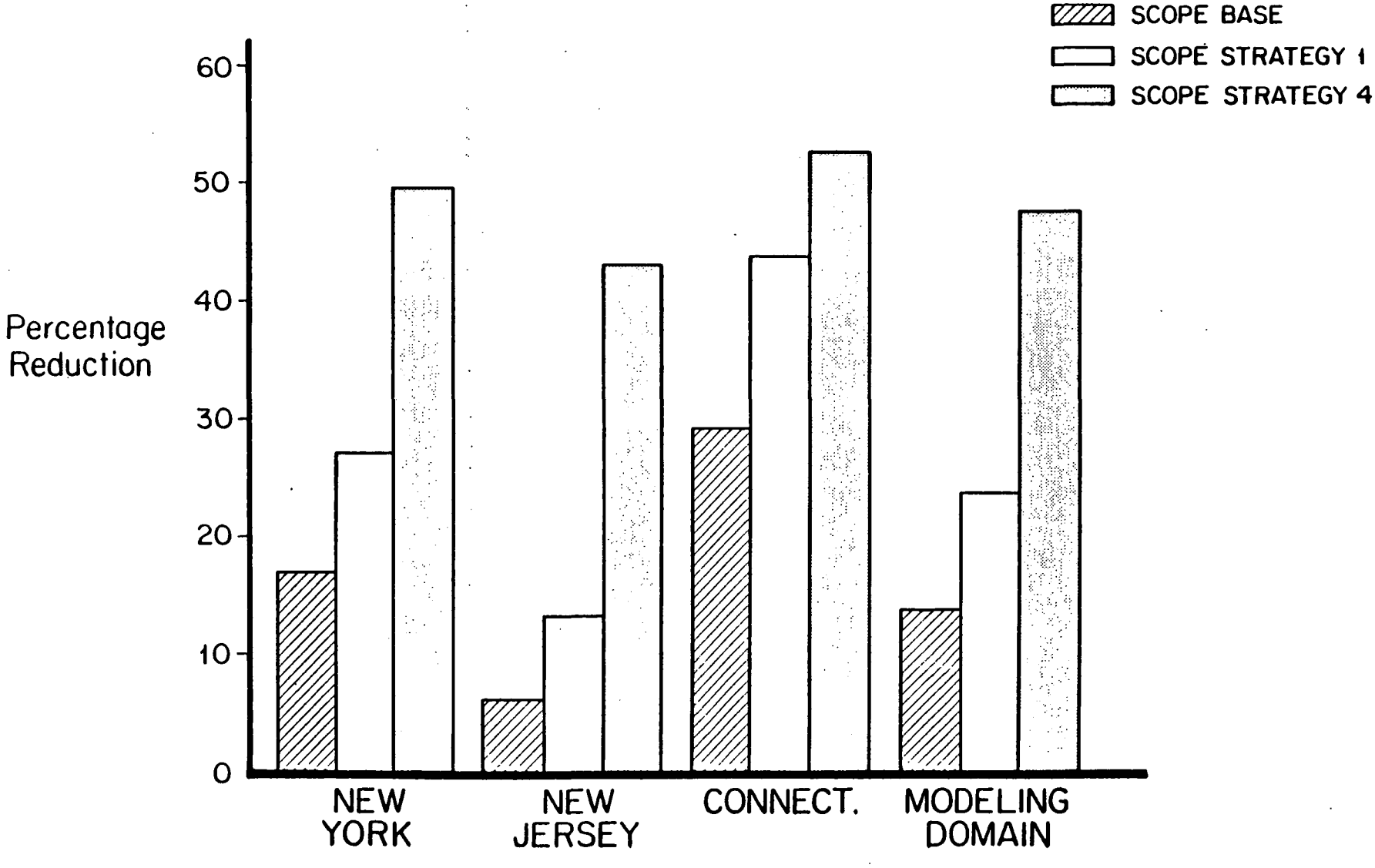

Figure 3.2 Summary of Percentage of NO_x Reduction in the Tri-State Region of the Modeling Domain

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CHAPTER 4

MODELING RESULTS

The UAM simulations of ambient ozone air quality were performed for the emissions inventories assembled with the August 8, 1980 meteorological conditions and appropriately adjusted initial and boundary concentration fields. The results of the UAM simulations are presented and discussed in this section.

4.1 BASE CASE AND STRATEGY SIMULATIONS

As noted earlier, the boundary concentrations of the precursors with the exception of SCOPE STRATEGY 5 were obtained by scaling the 1980 boundary concentration values with a factor consistent with the emission reduction from the 1980 level. For example, in the case of SCOPE BASE simulation, the VOC and NO_x concentrations were reduced by about 28% and 14%, respectively, from their 1980 levels while the the O_3 concentration was reduced by 20% from its 1980 level. The diurnal variation of the pollutant concentrations at the southwest corner cell are shown in Figure 4.1 for all the strategies with the exception of SCOPE STRATEGY 5. The results of the UAM simulations for the 1980 and 1988 base cases and for each of the strategies are presented in Figures 4.2 through 4.8.

The 1980 OMNYMAP base case[1] simulation, shown in Figure 4.2, has a double peak oriented in a southwest-northeast direction with high ozone concentrations extending from the northeastern New Jersey-New York area to central Connecticut. The distinct double peak structure present in the early afternoon hours merges into a single peak over the northeastern New Jersey-New York area as the day progresses. While the measured maximum of 246 ppb for this day over the domain was at Stratford, CT at 1300 hrs, the predicted maximum of 246 ppb occurred at 1600 hrs in the vicinity of New Haven, CT.

The 1980 SCOPE BASE simulation, shown in Figure 4.3, reveals essentially the same features as those found for the 1980 OMNYMAP case except for a peak value of 205 ppb over Connecticut. This reduction of about 17% in the predicted peak ozone concentration from the base case corresponds to a decrease of 28% and 14% in VOCs and NO_x emissions, respectively, from their 1980 levels. Also,

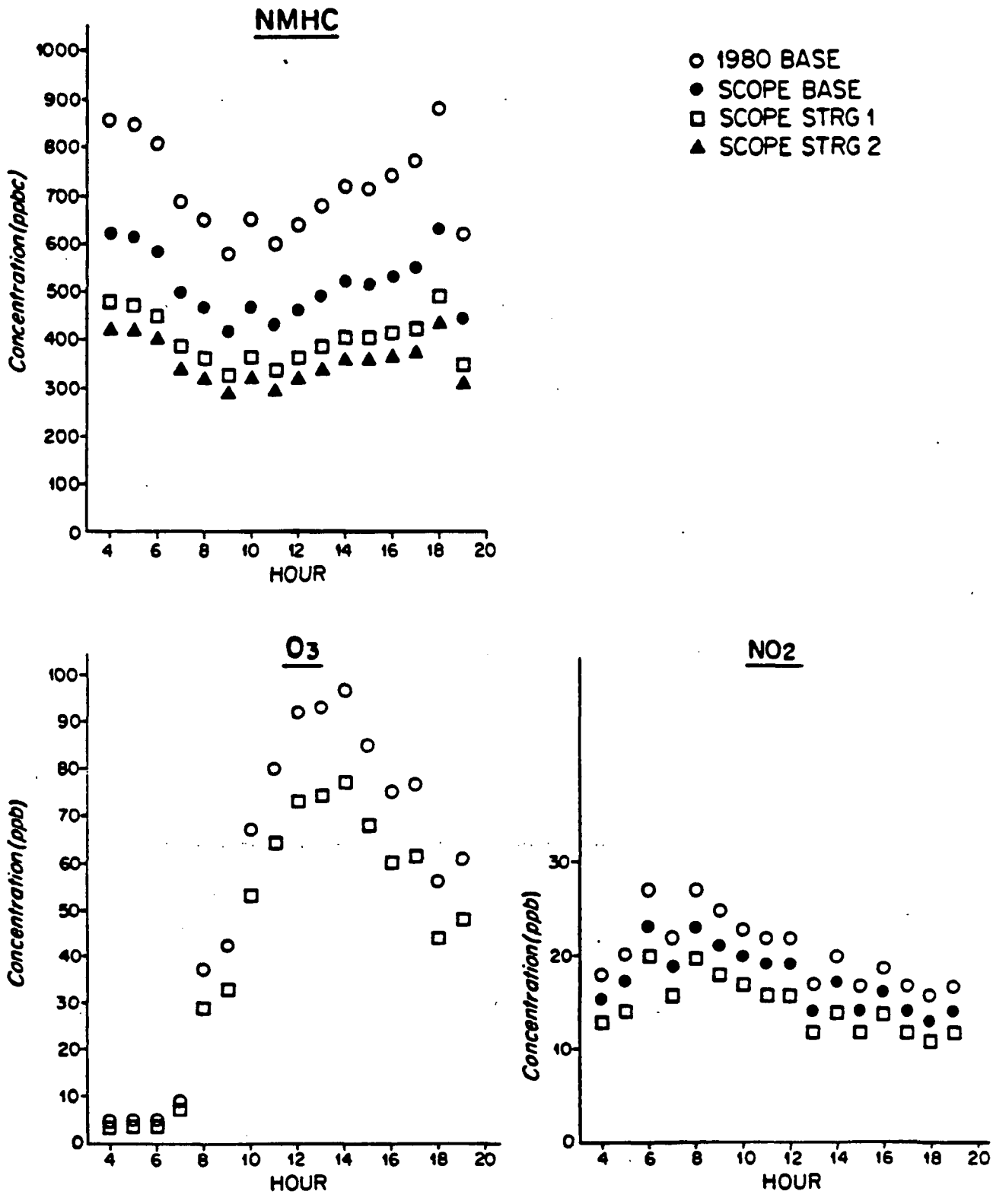

Figure 4.1 Diurnal Plot of Pollutant Concentrations at the Southwest Corner Grid Cell of the Modeling Domain

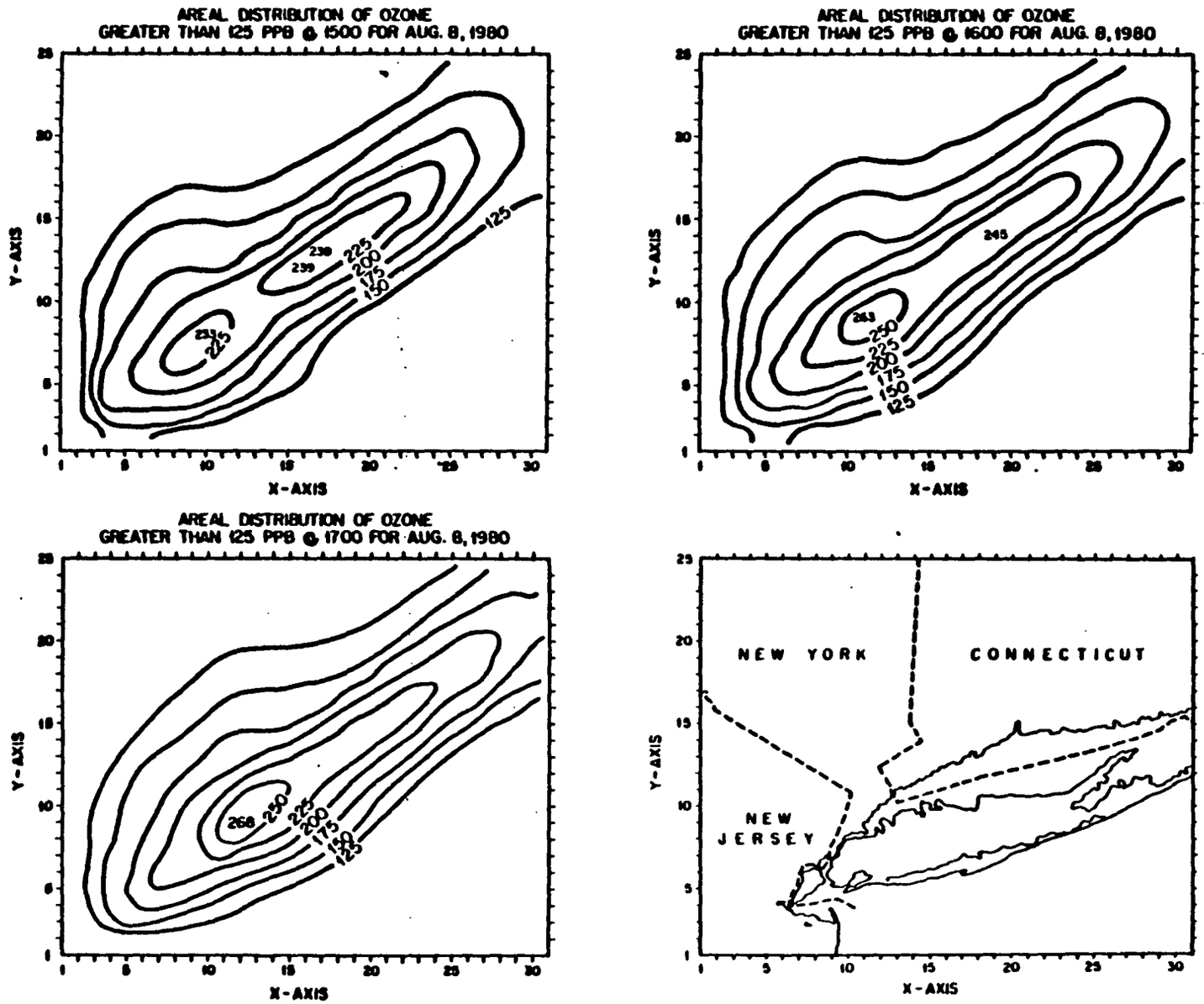

Figure 4.2 Areal Distribution of Ozone for OMNYMAP BASE 1980 Simulation

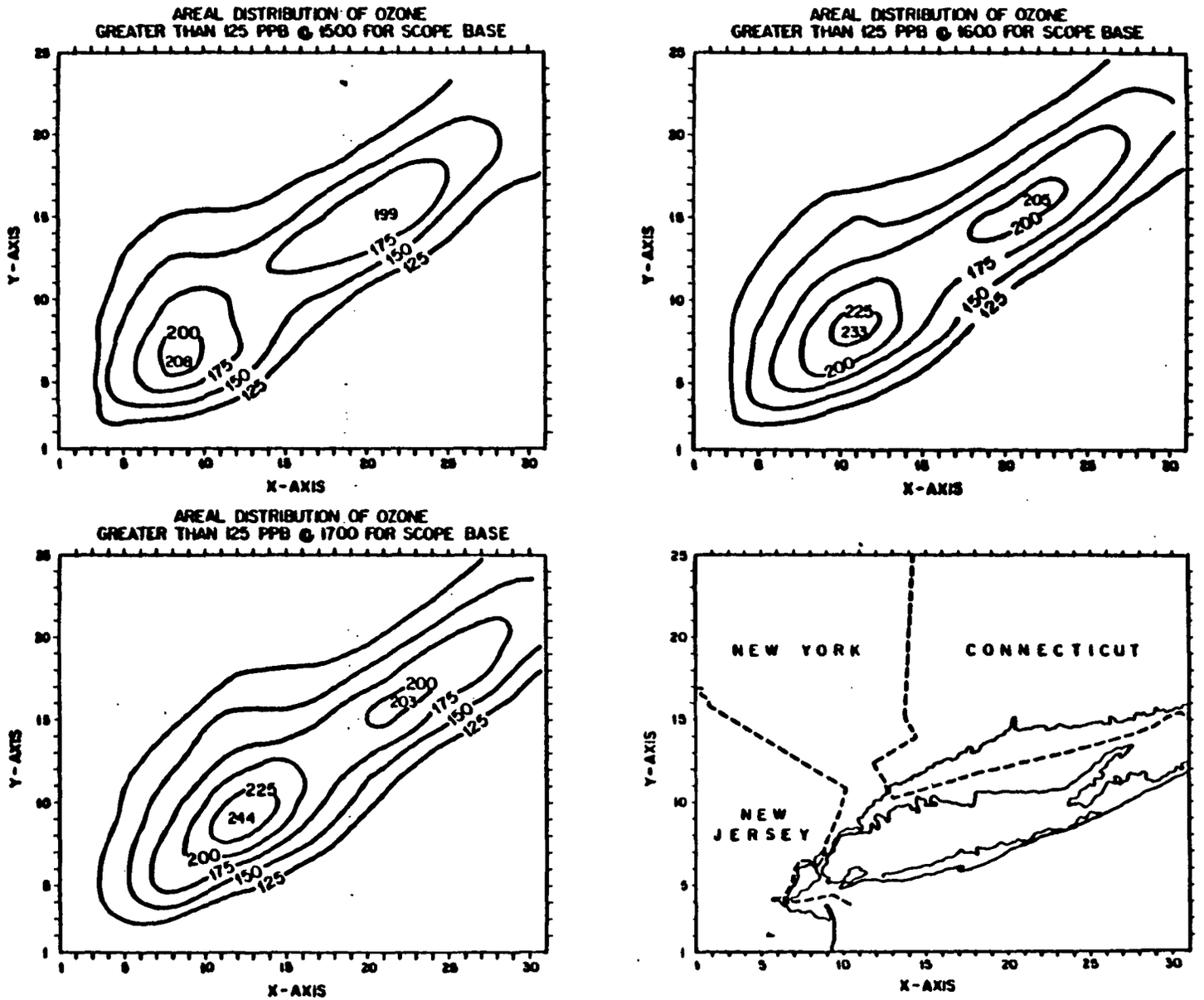

Figure 4.3 Areal Distribution of Ozone for SCOPE BASE 1988 Simulation

there is a general decrease in the areal extent of the concentrations exceeding the NAAQS level of 0.12 ppm, from the 1980 base level.

The ozone distribution resulting from SCOPE STRATEGY 1, which consists mainly of lower gasoline RVP along with fully implemented federal motor vehicle control programs, is shown in Figure 4.4. Under these controls, the total VOC reduction was 44% from the 1980 level with no change in the NO_x emissions from the SCOPE BASE level. The ozone peak over Connecticut has decreased to 171 ppb or about a 22% reduction from the 1980 level. The peak over New Jersey-New York is also found to be reduced by about 18% from its 1980 level.

Figure 4.5 shows the ozone distribution resulting from the imposition of Control Technology Guidance (CTG) measures in addition to those of SCOPE STRATEGY 1. The incremental change from SCOPE STRATEGY 1 in the predicted peak ozone concentration over Connecticut is about 6% corresponding to a VOC reduction of approximately the same percentage. The incremental decrease in the peak occurring over New Jersey-New York is about 11%. There is an overall decrease in the areal extent exceeding the NAAQS level for ozone from the previous strategy.

In SCOPE STRATEGY 3, in addition to the above VOC and NO_x changes, the VOC emissions were adjusted for a 30% methanol-fueled auto fleet. This resulted in an incremental reduction of the total VOCs by about 2%, or a reduction of 52.6% from their 1980 level with NO_x emissions remaining at the SCOPE STRATEGY 2, level. The incremental effect of these emission reductions on the peak ozone level, shown in Figure 4.6, over Connecticut when compared with SCOPE STRATEGY 2, is a reduction of only 3 ppb. However, in relation to the 1980 level, the reduction in the peak ozone level is about 28% as compared with 27% for SCOPE STRATEGY 2.

Recent modeling studies[7,8,9] utilizing chemical mechanisms which explicitly treat emissions of formaldehyde from methanol-fueled vehicles (MFV) suggest that there is a decrease in the levels of ozone when compared with conventionally fueled vehicles (CFV). In these studies, there were reductions in the NO_x ad CO emissions along with the VOC reductions due to penetration of MFV into the auto fleet. However, the predicted decreases in the ambient ozone concentrations are

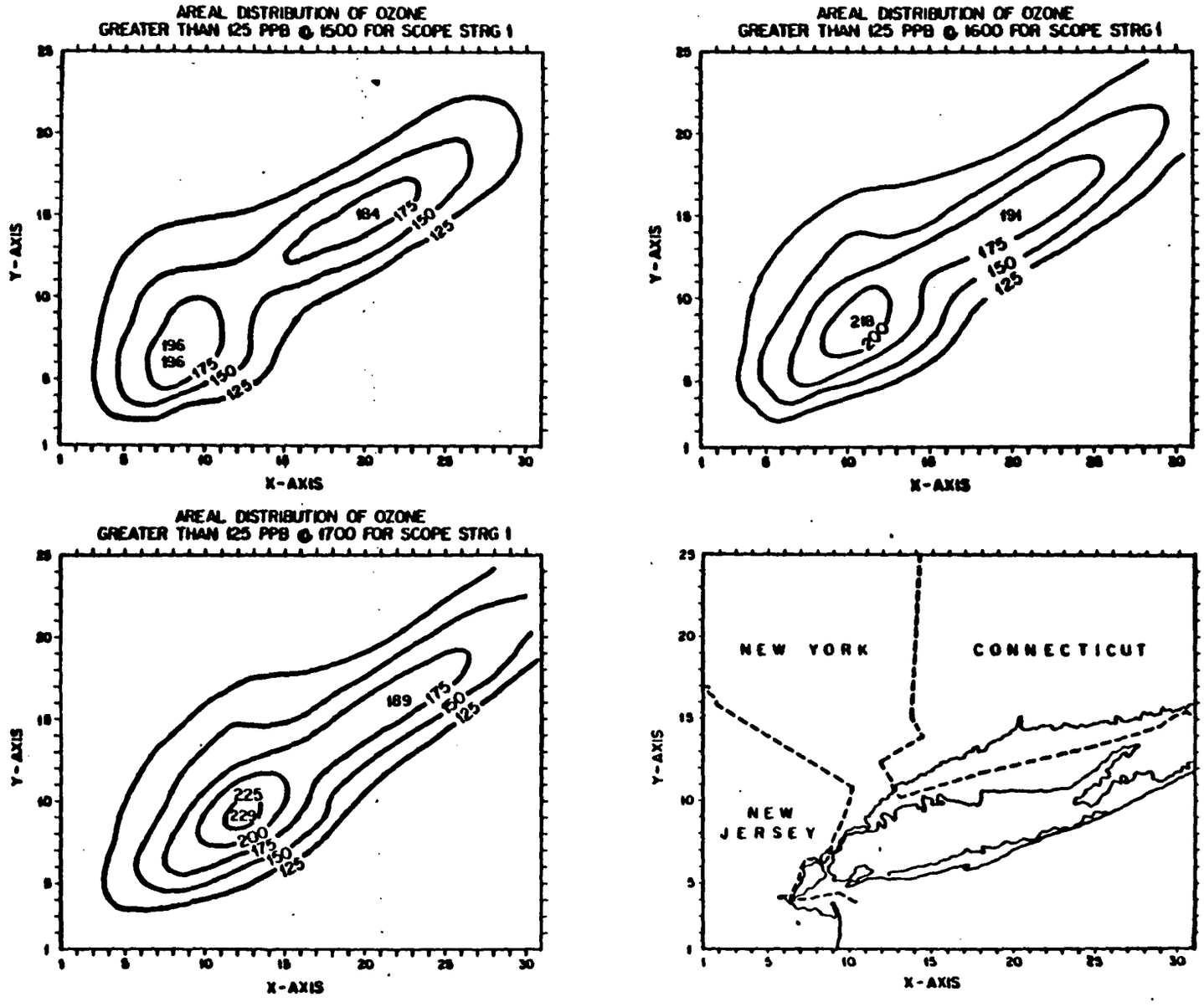

Figure 4.4 Areal Distribution of Ozone for SCOPE STRATEGY 1 Simulation

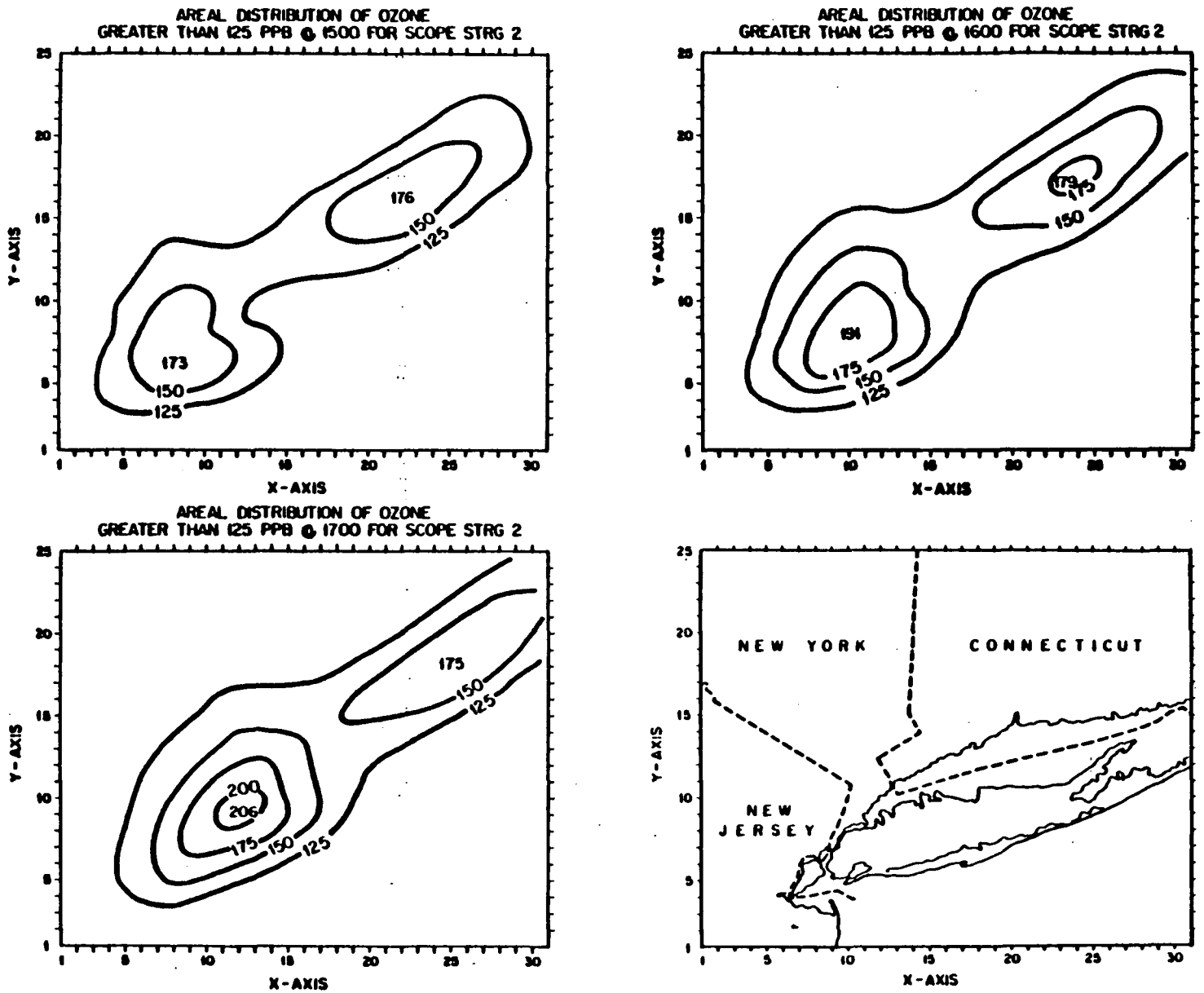

Figure 4.5 Areal Distribution of Ozone for SCOPE STRATEGY 2 Simulation

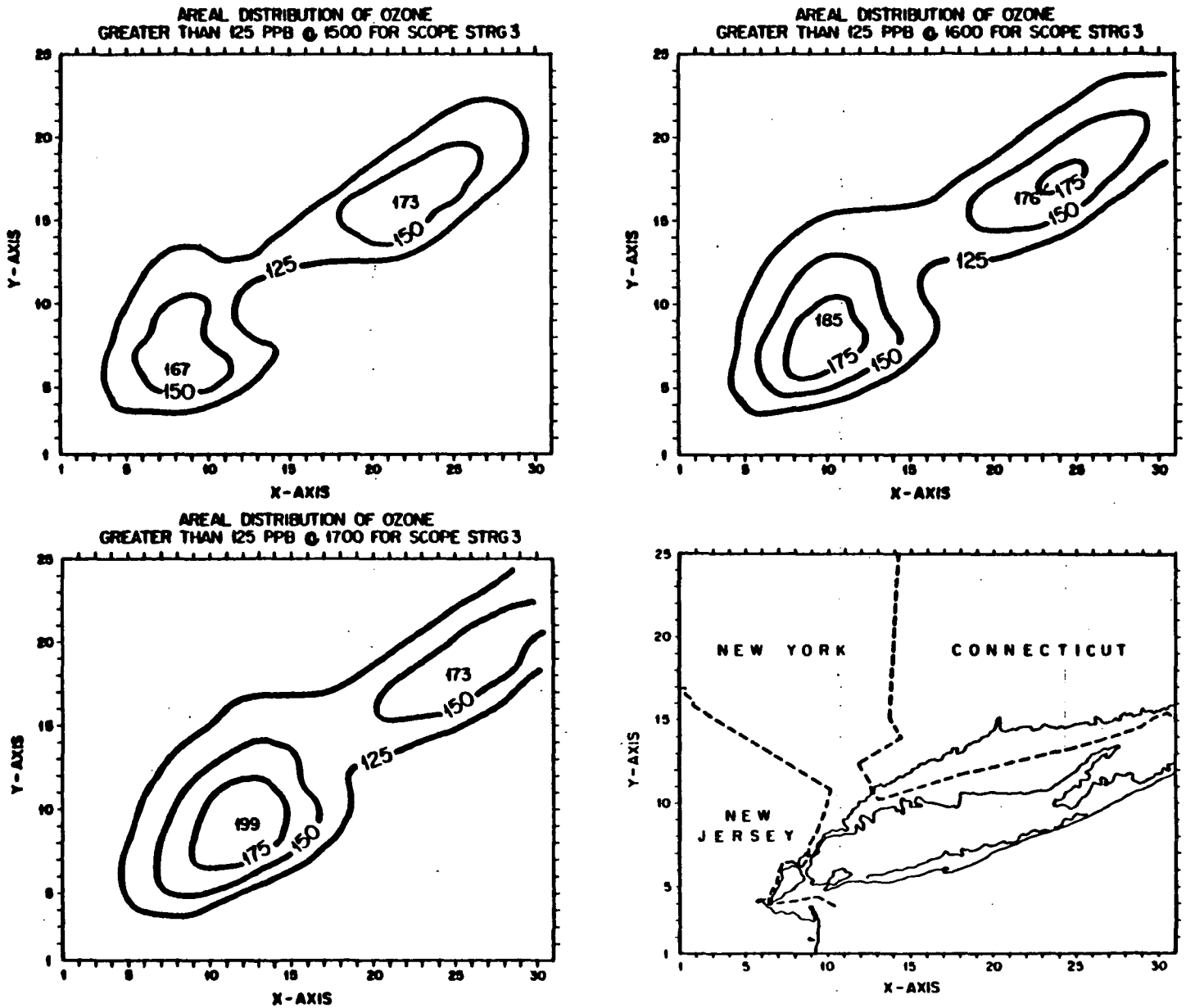

Figure 4.6 Areal Distribution of Ozone for SCOPE STRATEGY 3 Simulation

quite sensitive to the assumed initial and boundary conditions and to the amount of formaldehyde emitted by the MFV. For example, with no emission of formaldehyde from MFV the reduction in the ozone levels ranged from 1% to 36%, while with a MFV exhaust consisting of 10% formaldehyde, the reduction in ozone was predicted to be in the range of only 0% to 13%.

To assess the changes expected from reductions in NO_x emissions on the ozone levels, all NO_x sources with the exception of the Mobile Source Category were reduced by 40% in SCOPE STRATEGY 4. The results of this simulation are shown in Figure 4.7. Even though the peak values over Connecticut and New Jersey-New York area show reductions of about 7 to 8 ppb from SCOPE STRATEGY 3, there is an increase in the concentration levels in the New YorkConnecticut corridor of White Plains, Greenwich, and Bridgeport by as much as 15 to 20 ppb.

4.2 STRATEGY TO REDUCE OZONE LEVELS TO THE NAAQS - SCOPE STRATEGY 5

In the above simulations, the various emission control strategies considered were aimed toward reducing the peak ozone concentration to the level of the ozone NAAQS over the domain. The UAM results reveal that even with a projected reduction of 53% and 47% in the precursor emissions of VOCs and NO_x from the 1980 levels, the peak ozone level over Connecticut can be reduced by only 32% from its 1980 level; the peak predicted concentration over the modeling domain is still well above the level of the ozone NAAQS. Hence, model sensitivity simulations were needed to assess the level(s) of emission reduction required to reduce the peak ozone concentration over the region to the level of the NAAQS for ozone.

These sensitivity simulations included (a) no emissions, (b) clean influx, and (c) clean initial conditions. For these simulations, the SCOPE STRATEGY 3 data base was utilized along with the pollutant concentrations listed in Table 4.1 to represent "CLEAN" conditions. The ozone distribution resulting from the simulations are shown in Figure 4.8.

The simulation with "no emissions" in the domain indicates that there are two localized areas, one exceeding the NAAQS over New Jersey-New York area, and the other approaching the NAAQS level in the northeastern part of Connecticut --

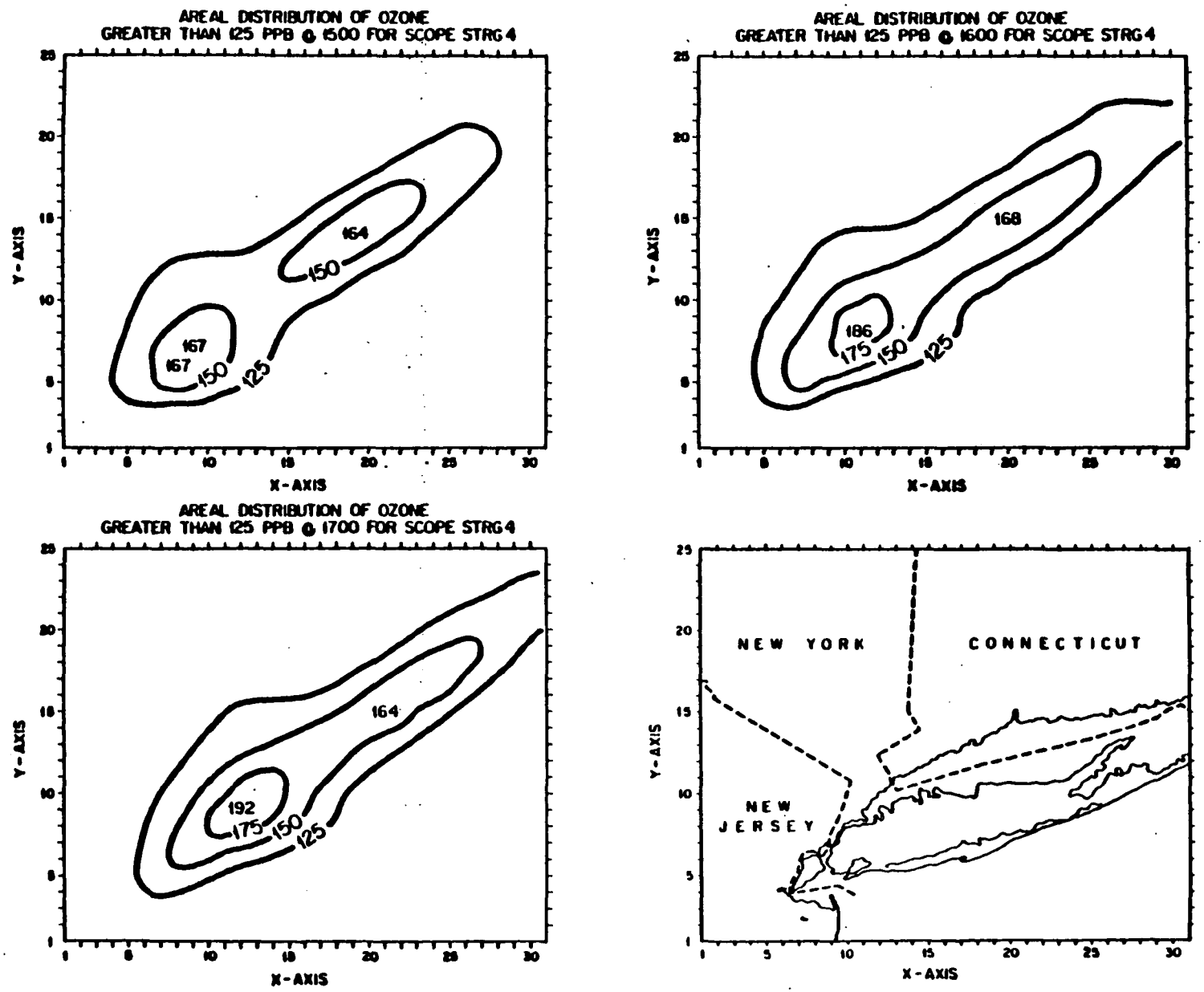

Figure 4.7 Areal Distribution of Ozone for SCOPE STRATEGY 4 Simulation

TABLE 4.1

Pollutant Concentrations for "Clean" Conditions

POLLUTANT	CONCENTRATION (ppb)
O_3	0.1
NO_2	2.0
NO	1.0
NMHC*	5.0
CO	20.0

*ppbc

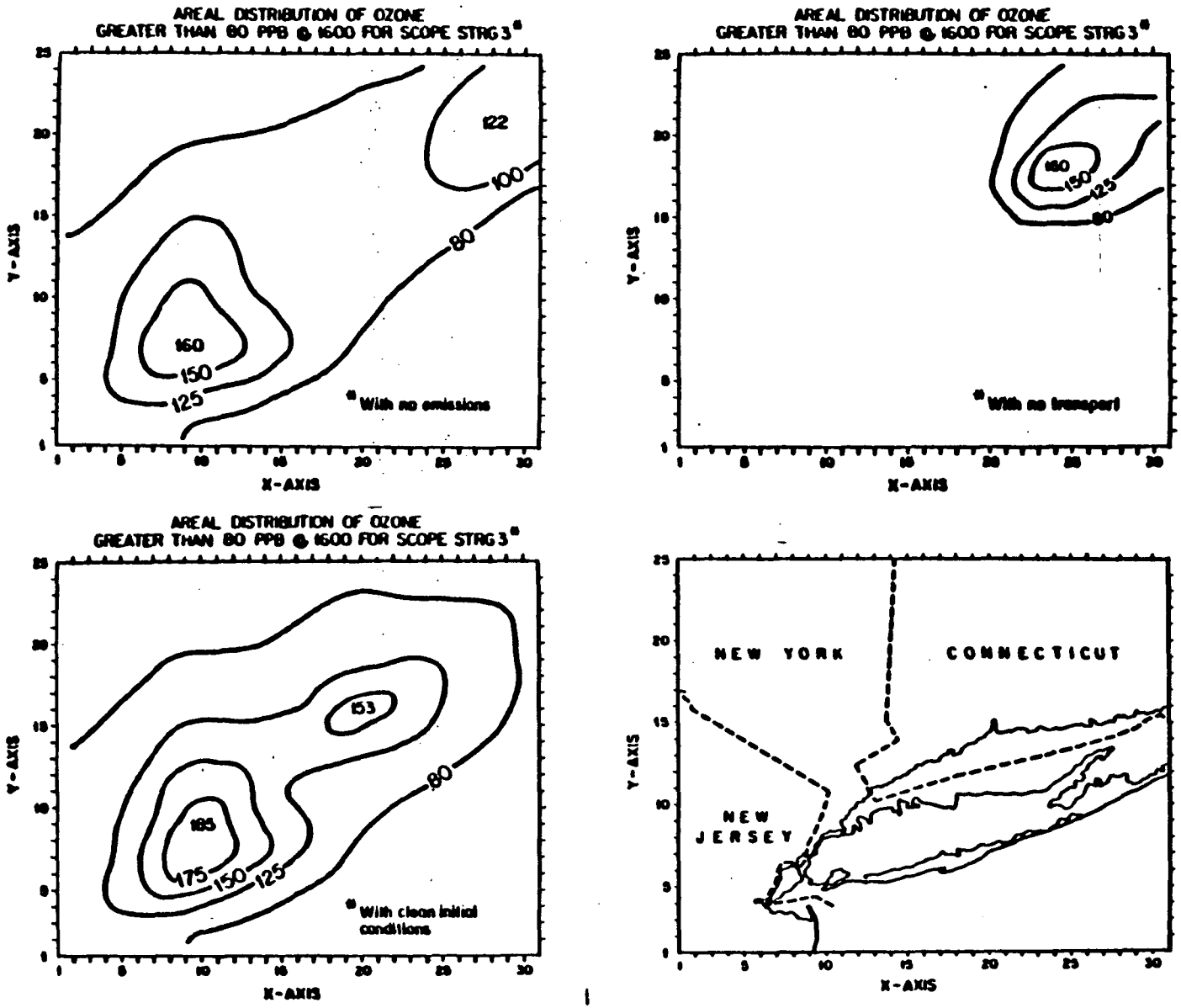

Figure 4.8 Areal Distribution of Ozone Under Different Sensitivity Conditions for SCOPE STRATEGY 3

indicating the effect of the transport of ozone and its precursors into the domain as well as the influence of the initial concentrations at the start of the simulation. The simulation with no transport ("clean influx") shows ozone exceedances over the northeastern portion of Connecticut with the remaining area of the modeling domain well below the NAAQS, while the simulation with "clean initial conditions" shows a pattern very similar to the SCOPE STRATEGY 3 (see Figure 4.6) but with a reduced level of peak concentration over Connecticut. From these simulations, it is evident that either the emissions in the domain by themselves with no influx of pollutants or no emissions in the domain but with influx of pollutants could lead to exceedance of the ozone NAAQS in the region. Therefore, both precursor emissions within the domain as well as influx of ozone and its precursors into the region need to be reduced in order to attain the ozone NAAQS over the New York metropolitan area.

Based upon this premise, the next simulation, SCOPE STRATEGY 5A, was set with the conditions listed in Table 4.2; the resulting UAM prediction is shown in Figure 4.9a. With the exception of the northeastern portion of Connecticut, the remaining portions of the domain are well below the NAAQS level. Thus, it appears from this simulation that a fine tuning of the emissions may bring the entire domain to within the NAAQS level for ozone.

Thus, in SCOPE STRATEGY 5b, the VOCs were reduced further by another 15% or a total of 95% from the 1980 level with other conditions set similar to those of SCOPE STRATEGY 5a. The modeling conditions for this case are listed in Table 4.3. The ozone distribution resulting from this simulation, shown in Figure 4.9b, indicates that the entire modeling domain is below the NAAQS level, with a peak value of 122 ppb occurring in the northeast corner of the State of Connecticut.

4.3 DISCUSSION

In this study, four emission control strategies were investigated to assess their role in the reduction of the ozone levels over the New York metropolitan area. The strategies that were considered were designed incrementally in order to provide information regarding the effects of each of the control strategies on the ozone levels on a relative basis. Figure 4.10 shows a diurnal plot of the number of cells exceeding 125 ppb of ozone for the four SCOPE STRATEGIES as

TABLE 4.2

Conditions for SCOPE STRATEGY 5A

EMISSIONS: 1980 VOCs REDUCED BY 80% ACROSS-THE-BOARD
1980 NO_x UNCHANGED

INITIAL CONDITIONS: CO, NO, NO_2 - NO CHANGE FROM 1980
NMHC REDUCED BY 80% FROM 1980 LEVEL
OZONE REDUCED BY 40% FROM 1980 LEVEL

BOUNDARY CONDITIONS AT THE SURFACE LAYER:

POLLUTANT INFLUX NOT TO EXCEED: OZONE = 58 ppb, NO_2 = 27 ppb
NMHC = 176 ppbc, NO = 13 ppb,
CO = 2300 ppb

CONCENTRATIONS AT THE REGION TOP:

OZONE = 40 ppb NO_2 = 6 ppb
NMHC = 30 PPBC NO = 3 ppb, CO= 20 ppb

TABLE 4.3

Conditions for SCOPE STRATEGY 5B

EMISSIONS: 1980 VOCs REDUCED BY 95% ACROSS-THE-BOARD
1980 NO_x UNCHANGED

INITIAL CONDITIONS: NMHC REDUCED BY 95% FROM 1980 LEVEL
OZONE, CO, NO, NO_2 SAME AS SCOPE STRATEGY-5A

BOUNDARY CONDITIONS: SAME AS SCOPE STRATEGY-5A

CONCENTRATIONS AT THE REGION TOP:

SAME AS SCOPE STRATEGY-5A

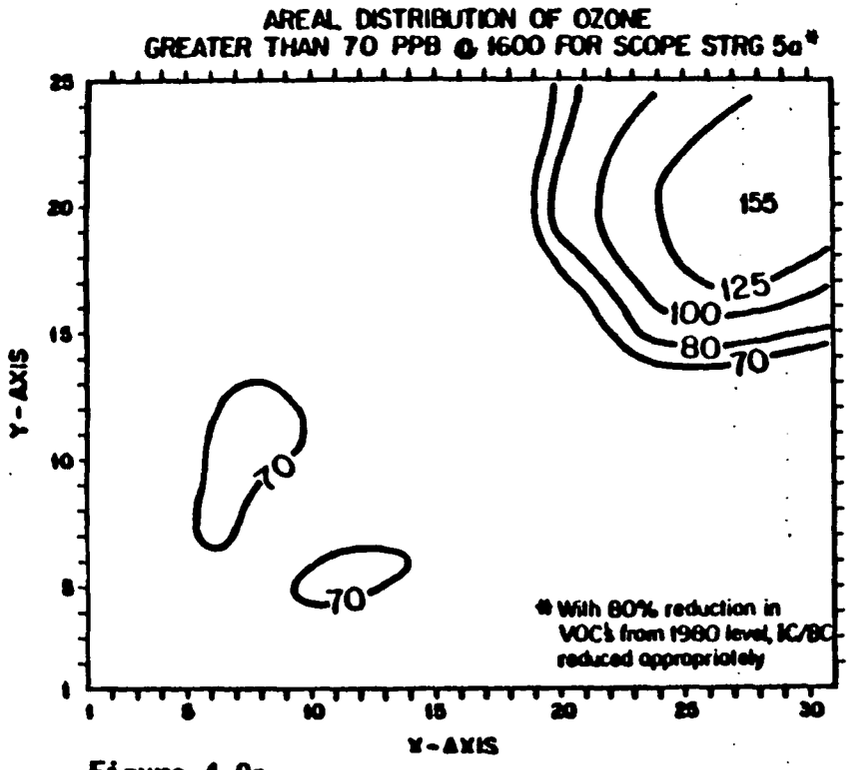

Figure 4.9a

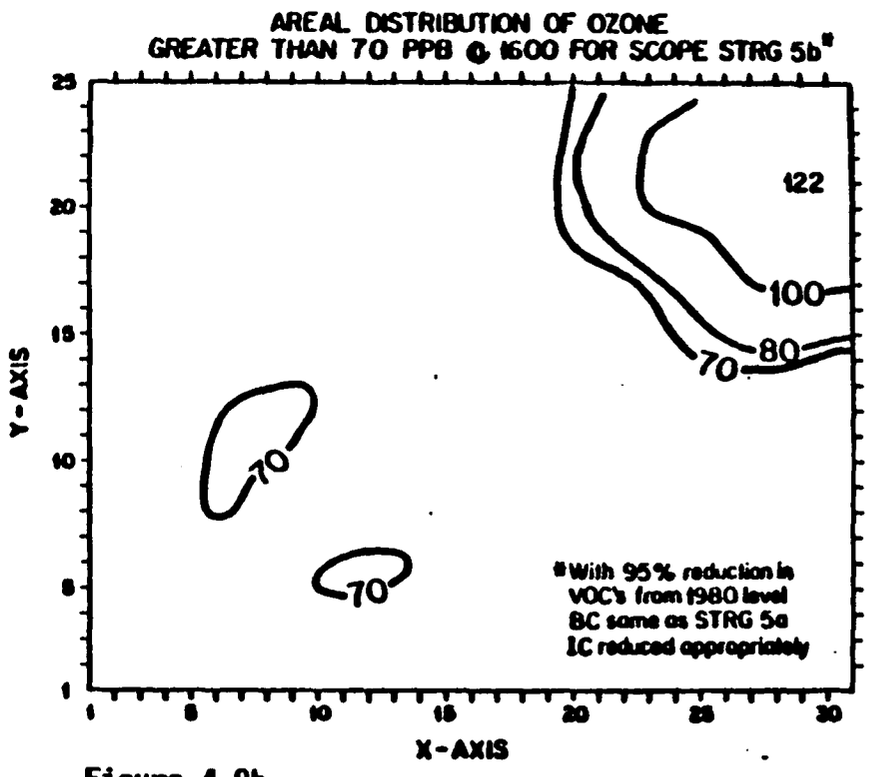

Figure 4.9b

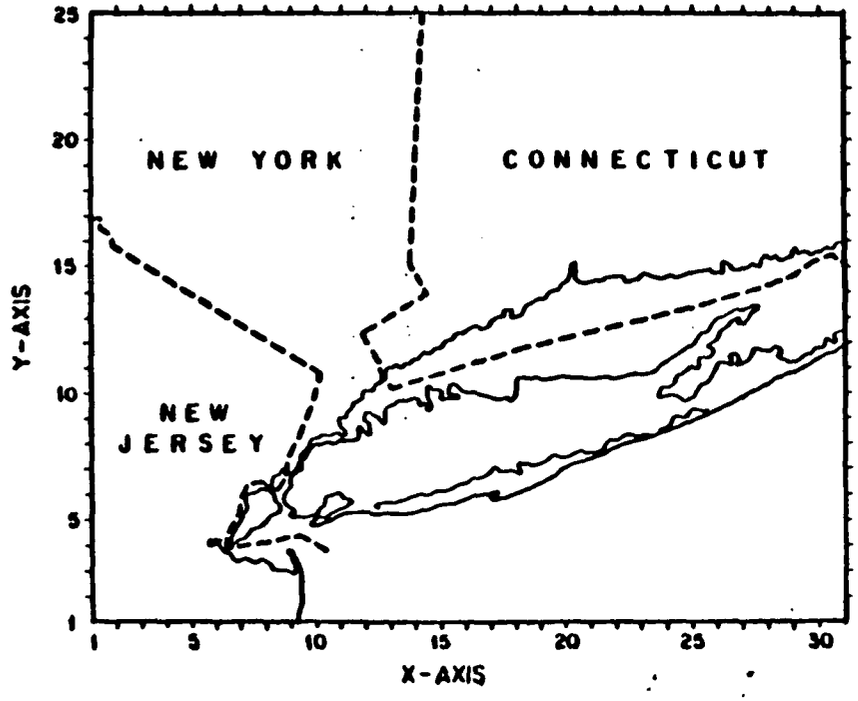

Figure 4.9a Areal Distribution of Ozone for SCOPE STRATEGY 5a Simulation

Figure 4.9b Areal Distribution of Ozone for SCOPE STRATEGY 5b Simulation

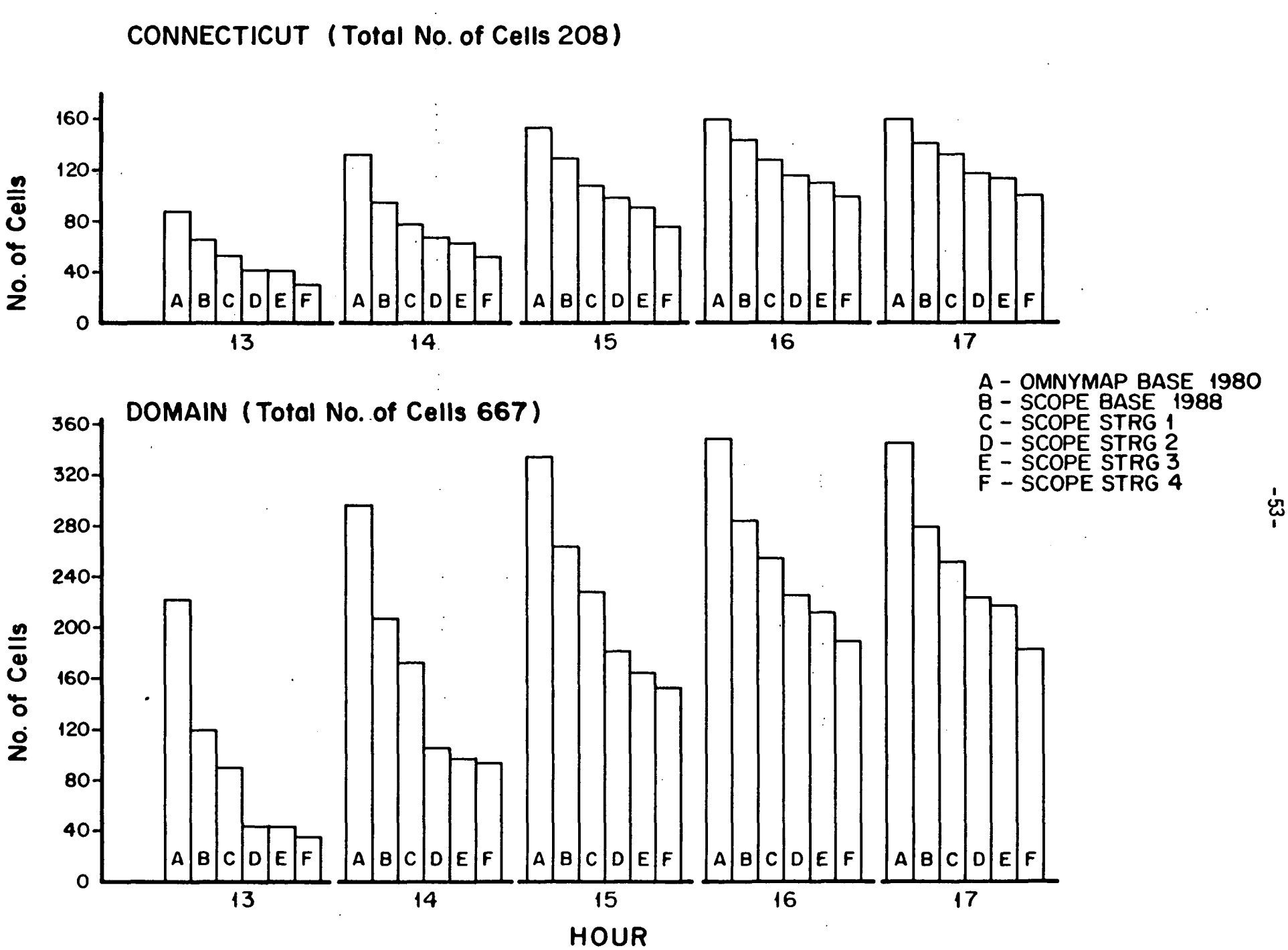

Figure 4.10 Number of Cells Exceeding the Ozone NAAQS Level Under Each UAM Simulation

well as the 1980 and 1988 Base cases. The range of improvement in terms of the decrease in the number of grid cells exceeding 125 ppb over Connecticut varies from 37% to 60% depending upon the hour in consideration. Given the same meteorological conditions for all the simulations, the results indicate that the maximum areal extent exceeding 125 ppb was during 1700-1800 hrs, while the peak ozone concentration over the domain was found to occur at 1600-1700 hrs. The effects of these strategies on the ozone peak over Connecticut are summarized in Table 4.4.

In Figure 4.11, the percent change in the predicted ozone level as a function of reduction in the VOCs resulting from the strategies evaluated in this study is shown for a monitoring location (Bridgeport/Stratford) as well as for the peak concentration over the Connecticut region. With increasing reduction in VOCs, the predicted improvement in the ozone concentration level at a given location, for example, Bridgeport/Stratford, is significantly greater than what would result if the predicted peak value over Connecticut is considered. At 80% VOCs reduction, the concentration at Bridgeport/Stratford was reduced from 236 ppb to 31 ppb or a decrease of 88% while the peak predicted ozone concentration over Connecticut decreased from 246 ppb to 155 ppb, or a reduction of only 37%. These results suggest that the relative merit of the emission control plans in reducing the ambient ozone concentrations must be evaluated in terms of peak ozone concentration over the domain as opposed to concentration changes at a given receptor location. These simulations demonstrate that the UAM is a very useful tool for evaluating the spatial and temporal characteristics of the ozone concentrations as a function of the precursor emissions levels.

TABLE 4.4

Peak Ozone Level Over Connecticut Under Various Strategies for a Selected Meteorological Scenario

Strategy	Ozone Concentration (ppb)	Percent Change from 1980 Base
1980 Base Case	245	-
1988 Scope Base	205	16
Scope Strategy 1	191	22
Scope Strategy 2	179	27
Scope Strategy 3	176	28
Scope Strategy 4	168	31
Scope Strategy 5	122	50

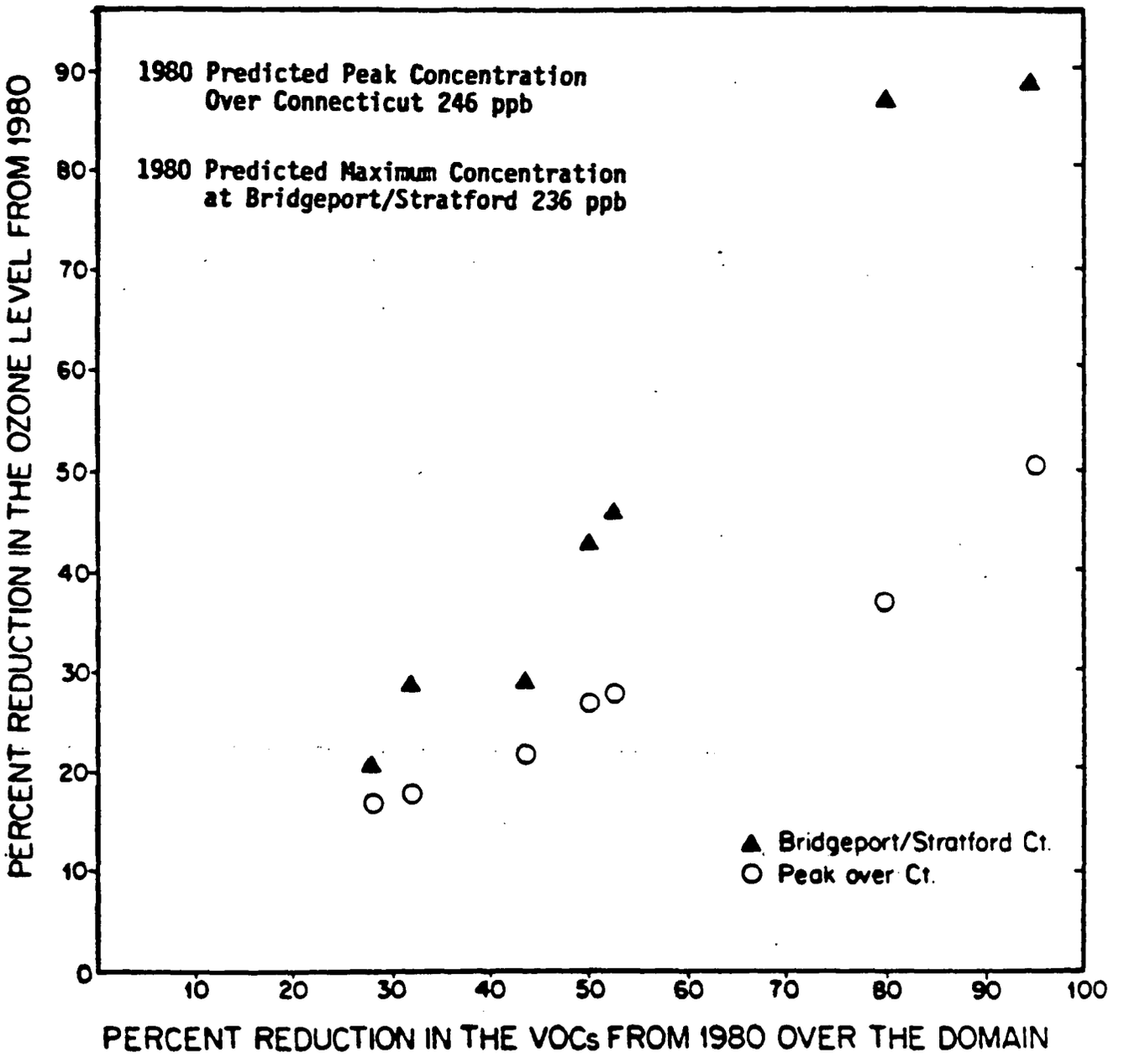

Figure 4.11 Percentage Reduction in the Predicted Ozone Concentrations Associated with the VOC and NO_x Emission Control Strategies Evaluated in this Study.

CHAPTER 5

SUMMARY AND RECOMMENDATIONS

In this study, four emission control strategy simulations were performed with UAM utilizing the aerometric data for one of the high ozone days in 1980 to examine their effectiveness in meeting the ozone NAAQS over the New York metropolitan area. These control strategies, which were incremental in design, were aimed at reducing VOC emissions from specific source categories. Given the VOC emission reductions in the range of 28 to 53% from their 1980 level for these strategies, the UAM simulations show a decrease in the peak ozone level over Connecticut of 18 to 28% from its 1980 level. In addition, UAM predicted an overall improvement in the areal extent of the modeling region exceeding the ozone NAAQS level of 0.12 ppm. However, it was found from a one-day simulation of these strategies that the peak ozone concentration in the New York metropolitan area is still well above the level of the ozone NAAQS.

Given the aerometric conditions prevailing on August 8, 1980, Strategy 5 was aimed at assessing the level of reduction in precursor emissions required for the region to be at or below the ozone NAAQS level. Strategy 5 simulation results indicate that a reduction of 95% in the VOCs from their 1980 levels over the domain together with 80% reduction in the concentrations of ozone precursors at the upwind boundary can bring the modeling domain to the level of the ozone NAAQS. It should be noted that these VOC reductions are across-the-board and do not reflect technology-based or source-specific type controls. Thus, additional modeling analyses of innovative VOC emission controls both within and outside the domain are clearly needed to demonstrate the attainment of the ozone NAAQS over the New York metropolitan area.

In this study, the usefulness of a grid model such as UAM in simulating spatial distribution of the ozone concentrations is demonstrated by consideration of the predicted peak over the region of interest versus concentrations at a fixed monitoring location. The results show that given 80% reduction in the VOCs from the 1980 level there is a decrease in the predicted concentration by 80% at a receptor location whereas there is a decrease of only 37% in the peak ozone concentration from the 1980 ozone level over the modeling domain.

It should be noted that in this study several assumptions regarding the chemical mechanism, speciation characteristics, upwind emissions, and future levels of concentrations of both the precursors and ozone were invoked. Also, it should be recognized that although the emissions inventory assembled for this study is based upon best available information, there is an uncertainty associated with the accuracy of the projected emissions. Further, the version of the UAM used in this study employs the CBII chemical mechanism, and the emissions from the point source were assumed to be uniformly distributed in the cell at plume height. An improved version of the UAM which includes the CBIV chemical mechanism and treats the point source emissions and the advection process in a more realistic manner must be considered for enhancing the scientific credibility of the analysis of the relative merit of the various emission control options in reducing the ambient ozone concentrations. Also, model-nesting, for example - interfacing the urban-scale model with the regional-scale model - needs to be explored for developing the detailed input data bases required for the UAM simulation of the emission control strategies. In addition, model simulations for the other high ozone days in 1980 must be performed to determine whether the above control strategies can reduce the peak ozone concentration in the New York metropolitan area to the level of the NAAQS and to identify the strategies for achieving compliance with the ozone NAAQS.

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