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Project Summary

The National Air Pollution Background Network Final Project Report

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The U.S. Environmental Protection Agency, in cooperation with the U.S. Forest Service, operated a network of ozone monitoring stations from 1976 through 1983 in selected National Forests within the continental U.S. The primary objective of this project was to determine the level of ozone concentrations occurring in remote areas, especially in relation to the National Ambient Air Quality Standard for ozone. Secondary objectives included the evaluation of regional differences, the characterization of seasonal and diurnal patterns, and the assessment of long-term trends for ozone concentrations in remote areas. Annual mean ozone concentrations were found to vary from site-to-site and year-to-year within a range of 25 to 50 parts per billion (ppb). Hourly ozone concentrations in excess of 120 ppb, the current level of the National Ambient Air Quality Standard, were occasionally observed. Such events, however, were rare and generally confined to the spring and summer months at sites in the eastern half of the U.S. and during the first half of the study period. No such events were observed after 1980. Seasonal mean ozone concentrations were greatest during the spring months (April through June), and diurnal maximums occurred most frequently during the early afternoon (1-3 p.m.). While no statistically significant trends were observed in mean ozone concentrations, the frequency of exceedances of the National Ambient Air Quality Standard decreased over the course of the study.

This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

In 1971, the National Ambient Air Quality Standard (NAAQS) for ozone was established at an hourly average concentration not to exceed 80 parts per billion (ppb) more than once per year. At that time, very few ozone measurements were available from rural and remote areas, and ozone concentrations in such areas were assumed to be generally low and inconsequential relative to the standard. Furthermore, ozone from background areas was thought to be largely removed by chemical scavengers upon entry into an urban environment.

In the mid-1970's, the U.S. Environmental Protection Agency (EPA) sponsored several field studies monitoring ozone concentrations in rural areas. This monitoring was conducted during summer months in small cities and agricultural areas in the eastern half of the U.S. The results suggested that rural areas experienced a greater range in ozone concentration than had been previously supposed and that ozone transported from rural to urban areas should not always be disregarded.

In 1976, in response to these and other findings, EPA began to establish a nationwide network of ozone monitoring stations located in remote areas. This project, originally called the National Forest Ozone Study, was a joint

undertaking of EPA's Environmental Monitoring Systems Laboratory (EMSL), and Office of Air Quality Planning and Standards (OAQPS), both located in Research Triangle Park (RTP), North Carolina. The Forest Service of the U.S. Department of Agriculture, working under an interagency agreement, participated in the project by providing monitoring site locations within National Forest (NF) areas and by performing routine operations at the monitoring stations.

Eventually, the National Air Pollution Background Network (NAPBN) consisted of eight remote monitoring stations, each collecting continuous measurements of ozone by the chemiluminescence technique. Each site was located as far as was practical from any heavily used roadway and at least 100 miles from any major urban area. The sites were located in open and relatively elevated areas for good exposure to ensure representative sampling. An effort was made to distribute the sites across the continental U.S. to cover as many regions of the country as possible. Site locations are shown in Figure 1, and station descriptions are provided in Table 1.

The NAPBN was established to provide a reasonably long-term and continuous record of ozone concentrations and patterns in areas well removed from anthropogenic sources of air pollution and to make these data available to EPA and other interested researchers. The network was discontinued at the end of 1983. All valid data are on file and may be accessed through the National Aerometric Data Bank (NADB), U.S. EPA, Mail Drop 14, Research Triangle Park, North Carolina 27711.

Procedure

The National Air Pollution Background Network (NAPBN) became fully operational in late 1979 with the establishment of the eighth and final air monitoring station which was located within the Ochoco National Forest in Oregon. At each site, U.S. Forest Service personnel visited the monitoring station once per week to perform routine operation and maintenance procedures and to cut and label strip charts. These charts were mailed to EMSL/RTP where they were reduced to hourly average values which were keypunched and entered into EPA's mainframe computer. After validation, including statistical procedures to test for outliers, the data were entered into EPA's SAROAD data storage system. Site visits were made quarterly by either EPA or contractor personnel to audit and calibrate each ozone analyzer. Calibration was performed using a certified UV photometer.

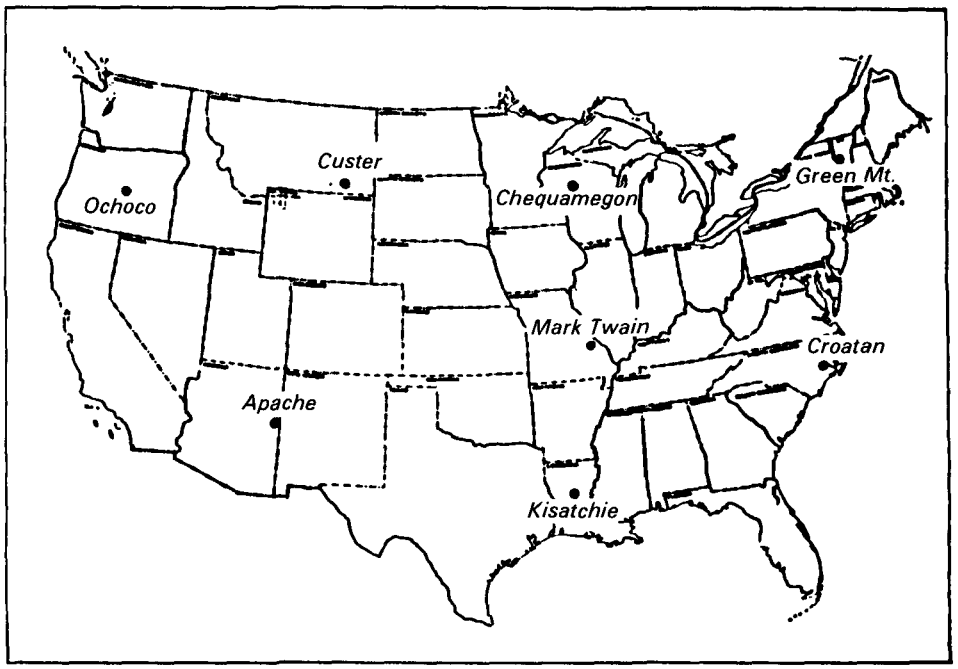

Figure 1. *Location of NAPBN Monitoring Sites.*

Table 1. *Description of NAPBN Monitoring Sites*

National Forest	State	Elevation Above MSL	Latitude/ Longitude	Start Date	End Date	SAROAD CODE
Apache	AZ	2500 M	33°45'00"N/ 109°00'00"W	9/16/79	12/31/83	030050110A08
Kisatchie	LA	65 M	31°30'00"N/ 92°28'20"W	5/26/76	9/30/82	191490101A08
Mark Twain	MO	350 M	37°28'00"N/ 90°11'00"W	12/18/78	12/31/83	262950001A08
Custer	MT	1250 M	45°14'00"N/ 106°15'00"W	6/23/76	12/22/83	270310101A08
Croatan	NC	13 M	34°59'05"N/ 77°11'24"W	3/13/78	12/31/83	340945101A08
Ochoco	OR	1350 M	44°13'30"N/ 119°42'25"W	10/04/79	12/05/83	380420111A08
Green Mountain	VT	390 M	43°56'00"N/ 73°02'00"W	10/24/76	9/28/82	470265101A08
Chequamegon	WI	440 M	45°12'00"N/ 90°37'00"W	8/10/78	9/30/82	510490001A08

Results and Discussion

Annual summary statistics for the ozone data collected at each NAPBN site are presented in Table 2. Statistics tabulated include the annual percent data

Table 2. *Annual Summary Statistics for NAPBN Ozone (ppb)*

	Year	% Data	Mean	StdDev	50-%ile	95-%ile	Max	%>80	%>120
Arizona	1979	27.7	49.3	9.8	50	65	80	0	0
	1980	95.6	47.4	13.0	45	70	90	0.3	0
Apache NF	1981	94.7	35.3	7.4	35	50	65	0	0
	1982	91.1	41.2	9.2	40	55	75	0	0
	1983	89.6	37.9	9.0	35	55	70	0	0
Louisiana	1976	39.4	31.5	21.4	30	70	125	2.6	0.03
	1977	74.3	33.7	23.5	30	80	135	4.4	0.08
Kisatchie NF	1978	47.7	37.9	21.0	35	75	125	2.8	0.07
	1979	79.8	26.8	14.7	25	55	100	0.1	0
	1980	50.7	27.7	16.1	25	60	105	0.3	0
	1981	30.7	30.1	16.7	30	60	95	0.3	0
	1982	41.7	28.3	16.8	25	60	90	0.2	0
Missouri	1978	6.1	25.7	9.8	25	40	50	0	0
	1979	95.6	39.3	18.2	35	75	125	2.4	0.01
Mark Twain	1980	53.9	45.4	20.8	45	80	155	4.5	0.08
NF	1981	89.6	31.7	14.3	30	55	115	0.4	0
	1982	96.9	37.5	16.3	35	65	95	0.5	0
	1983	92.7	38.5	18.3	35	70	110	1.8	0
Montana	1977	86.8	40.2	11.1	40	60	80	0	0
	1978	51.8	41.6	8.9	40	55	75	0	0
Custer NF	1979	71.6	36.2	9.9	35	50	70	0	0
	1980	88.5	36.8	11.9	35	55	70	0	0
	1981	72.6	30.1	9.0	30	45	70	0	0
	1982	64.7	30.7	8.4	30	45	55	0	0
	1983	90.9	35.2	9.0	35	50	65	0	0
North	1978	49.1	33.2	18.8	30	65	105	0.3	0
Carolina	1979	94.3	27.8	16.8	25	60	85	0.1	0
Croatan NF	1980	87.6	28.5	18.9	25	65	150	0.9	0.07
	1981	84.2	27.4	15.4	25	55	90	0.1	0
	1982	81.0	25.2	15.6	25	55	95	0.2	0
	1983	89.6	25.2	16.1	25	55	85	0.1	0
Oregon	1979	23.9	29.2	6.7	30	40	50	0	0
	1980	88.5	38.5	9.3	40	55	80	0	0
Ochoco NF	1981	88.7	31.2	7.6	30	45	75	0	0
	1982	89.0	34.1	8.0	35	50	65	0	0
	1983	83.2	34.4	7.5	35	50	60	0	0
Vermont	1976	12.1	29.3	11.5	30	45	60	0	0
	1977	74.0	37.6	21.5	35	75	145	4.8	0.23
Green Mt. NF	1978	41.9	29.0	17.9	25	65	105	1.4	0
	1979	73.3	31.6	16.6	30	65	105	1.0	0
	1980	97.9	32.3	17.5	30	65	115	1.5	0
	1981	83.7	28.5	14.4	30	55	105	0.2	0
	1982	59.5	28.5	16.4	30	55	100	0.5	0
Wisconsin	1978	27.2	32.7	13.0	30	60	100	0.1	0
	1979	87.7	35.2	14.8	35	60	110	0.7	0
Chequamegon	1980	72.2	38.8	19.3	35	75	115	2.7	0
NF	1981	92.6	33.1	12.3	30	55	80	0	0
	1982	69.2	35.7	11.7	35	55	90	0.1	0

(the number of valid hourly ozone values divided by the number of possible hours expressed as a percentage), mean, standard deviation, 50th percentile (or median), 95th percentile, maximum hourly value, and the percentage of valid hours with ozone concentrations greater than both 80 and 120 parts per billion (ppb).

EPA established in 1971 the first National Ambient Air Quality Standard for photochemical oxidants (primarily ozone) at a 1-hour average of 80 ppb which was not to be exceeded more than once in any given year. In 1979, EPA promulgated a revised standard which stated that the expected number of days per calendar year with daily maximum ozone concentrations exceeding 120 ppb must be less than or equal to one. This new standard differs from the original in several important ways, including the specific designation of ozone, the emphasis on the daily maximum concentration, and the statistical interpretation of "expected exceedances." The most obvious difference, however, is the change in the level of the standard from 80 to 120 ppb.

As may be seen from Table 2, exceedances of the 80 ppb level did occur during most years at the five NAPBN sites located in the eastern half of the U.S., but in all cases the frequency of such exceedances was less than 5 percent of valid hours. At four of these sites (Kisatchie, Mark Twain, Croatan, and Green Mountain), exceedances of the 120 ppb level were observed. These instances, however, were quite rare (<0.25% of valid hours) and were confined to the first half of the study period (1976 through 1980). Technically, then, the NAPBN sites have been in compliance with the current ozone standard since 1980.

Ozone data from each site were stratified by quarter and averaged by hour-of-day to evaluate seasonal and diurnal cyclical behavior (examples are shown for the sites at Custer NF, MT and Croatan NF, NC in Figures 2 and 3, respectively). Significant seasonality is apparent in the data with the second quarter (April through June) exhibiting the maximum mean ozone concentration. Maximum hourly concentrations generally occur in the early afternoon (1-3 p.m.). Both seasonality and diurnality are more pronounced at the sites located in the eastern half of the U.S.

Statistical trend analysis was applied to the mean ozone values at each site, and in no case was there evidence of either an increasing or decreasing systematic pattern. However, it is clear from Table 2 that, with the possible exception of the Mark Twain site, the frequency of elevated ozone episodes (hourly ozone concentrations >80 ppb) decreased over the duration of the study period. It should be noted that although many urban sites were affected by an ozone calibration change in 1979, such was not the case for these data where the UV calibration technique was employed throughout the study.

Conclusions

- Although exceedances of the original level (80 ppb) and the revised level

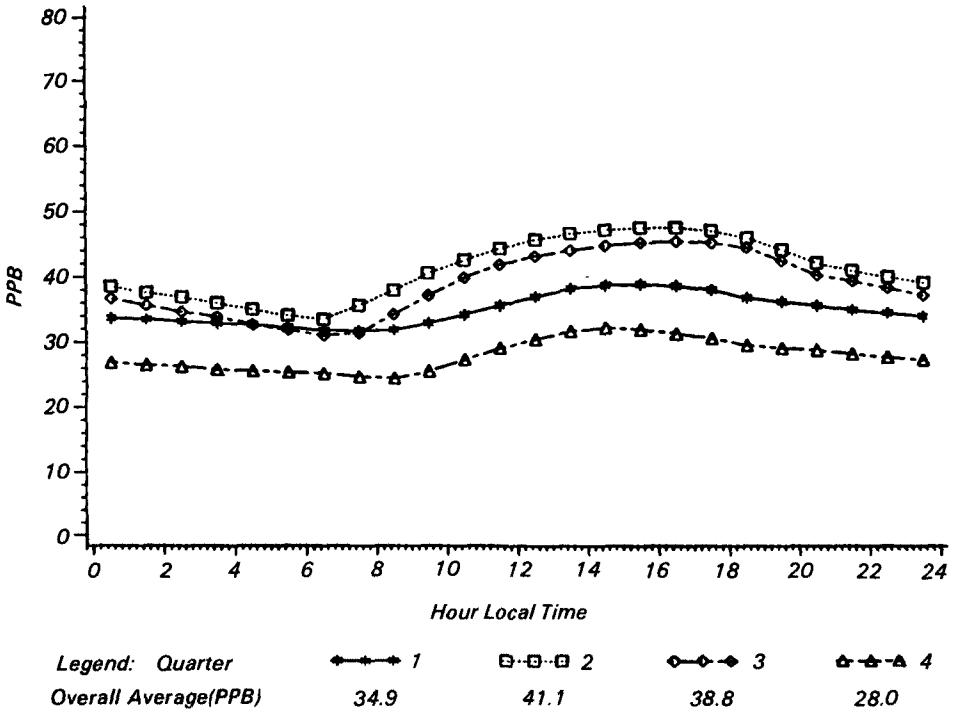

Figure 2. *Hourly mean ozone concentration by quarter—Custer NF, MT.*

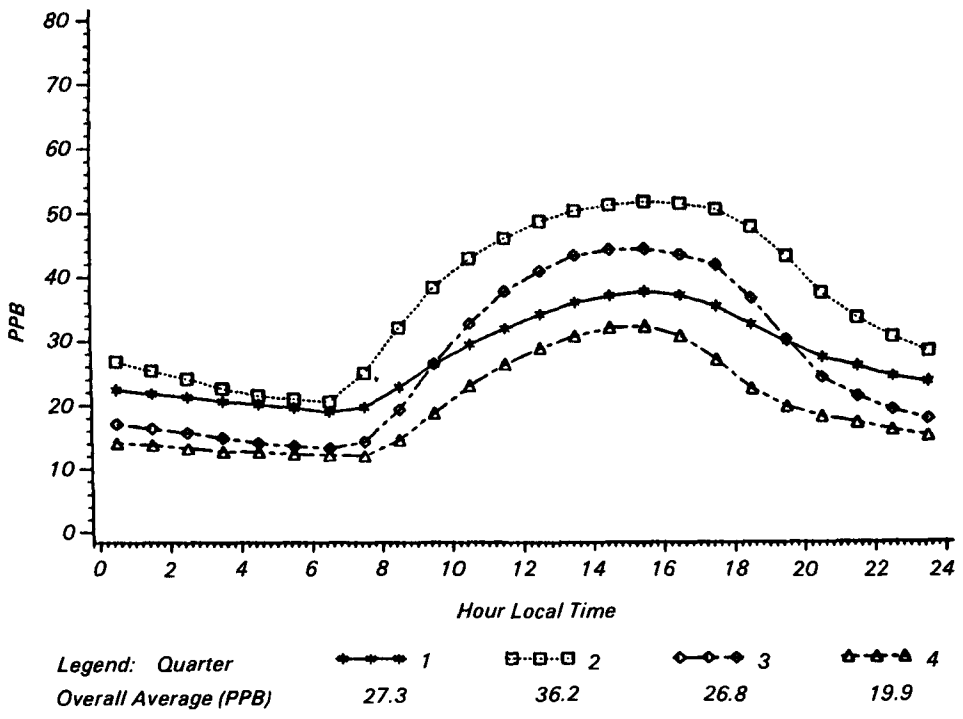

Figure 3. *Hourly mean ozone concentration by quarter—Croatan NF, NC.*

(120 ppb) of the NAAQS for ozone were occasionally observed at the NAPBN remote monitoring stations, the latter were rare occurrences and observed only during spring and early summer months and at sites in the eastern half of the U.S.

- The frequency of exceedances of the 80 ppb level was less than 5 percent of valid hours for all site years, and no exceedances of the 120 ppb level were observed after 1980.
- Annual mean ozone concentrations fell within a range of 25 to 50 ppb with sites in the western U.S. recording higher mean levels, but lower variances that those in the east.
- Diurnal maximum hourly ozone concentrations occurred most frequently in the early afternoon (1 to 3 p.m.), and the maximum quarterly mean occurred in the spring (April through June).
- Although statistical tests for trend revealed no significant increases or decreases in mean ozone concentrations, there were decreases in the frequency of exceedances of the NAAQS level(s) during the course of the study.

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The complete report, entitled "The National Air Pollution Background Network Final Project Report," (Order No. PB 85-212 413/AS; Cost: $8.50, subject to change) will be available only from:

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