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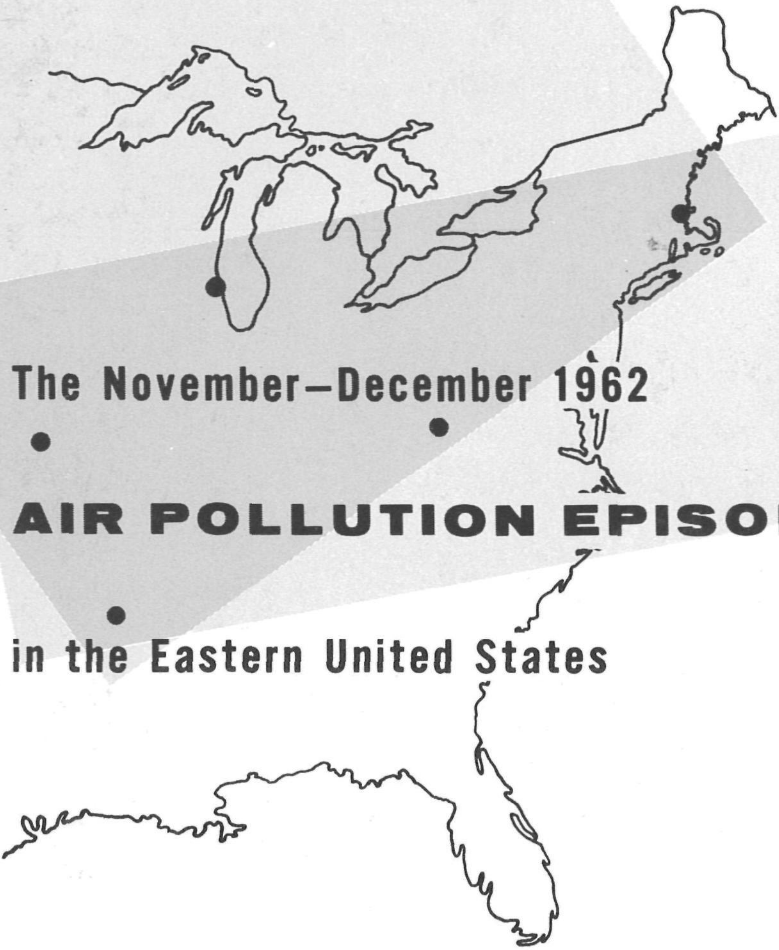
The November–December 1962 AIR POLLUTION EPISODE in the Eastern United States



U S DEPARTMENT OF HEALTH,
EDUCATION, AND WELFARE
Public Health Service

THE NOVEMBER-DECEMBER 1962

AIR POLLUTION EPISODE

IN THE EASTERN UNITED STATES

by

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U. S. DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
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ABSTRACT

This report documents the subject "episode" with respect to meteorology, air quality, and public reaction. Particulate and gaseous air quality data are reported and discussed. Meteorology and public reaction are discussed with reference to the Public Health Service program of Air Pollution Potential Forecasts. Epidemiological aspects are not considered.

THE NOVEMBER-DECEMBER 1962 AIR POLLUTION EPISODE IN THE EASTERN UNITED STATES

Introduction

Early in November 1962 a large continental polar anticyclonic high-pressure system began to form in northern Canada, almost 4000 miles northwest of the eastern United States. A second high-pressure system existed over the western Atlantic. By late November the Canadian high-pressure system merged with the Atlantic high-pressure cell and became stationary, producing stagnant air over most of New England, New York, and Pennsylvania. Before this system moved out over the Atlantic, it spread westward to Wisconsin and Iowa and south to Tennessee and Arkansas to become the largest and most persistent air stagnation observed since systematic studies began in 1955 to relate air pollution buildup to large-scale stagnating anticyclones. Air quality deteriorated rapidly in urban areas containing significant air pollution sources, and reaction to the situation by the public, the news media, and official air pollution and public health agencies was intense and prolonged. This report documents this air pollution "episode" with respect to meteorology, air quality, and public interest, and uses the occasion to review the Public Health Service Weather Bureau program of Air Pollution Potential Forecasts. Epidemiological aspects of the episode are not considered, although this report does provide air quality data that may be useful in retrospective studies of this type.

METEOROLOGY

The Air Pollution Potential Forecasts (APPF) were initiated in 1957 on an experimental basis for the portion of the United States east of the Rocky Mountains. Since initial operations proved the method to be feasible and worthwhile, an operational program on a regular basis was initiated in August 1960. The service was extended to the entire contiguous United States on October 1, 1963.

From a meteorological viewpoint, air pollution potential may be broadly defined as a sequence of specialized weather conditions conducive to accumulation of pollutants in the atmosphere. Although considerable judgment is necessary, experience[2,3] has indicated that the following meteorological conditions are indicative of such situations.

1. Surface wind speeds not more than 8 mph (usually represented by 24-hour average wind speeds less than 5 mph).
2. Winds at no level below 500 millibars (approximately 18,000 ft) greater than 25 knots.

3. The existence of subsidence, i. e., "sinking" in the air mass below the 600-millibar level (approximately 14, 000 ft).
4. No precipitation
5. An area involved that is larger than a 4-degree latitude square (about a 275-mile square).
6. Condition expected to persist at least 36 hours, i. e., not a normal case of diurnal nighttime pollution buildup and daytime ventilation.

Intensification of air pollution under such conditions can be significant. The APPF program attempts to provide advance warning so that the preventive and protective measures that are available can be utilized as early as possible.

The Office of Meteorological Research of the U. S. Weather Bureau maintains a complete weather station at the Robert A. Taft Sanitary Engineering Center in Cincinnati; this station is operated in conjunction with the programs in Cincinnati of the Division of Air Pollution, U.S. Public Health Service. A team of Weather Bureau meteorologists daily interprets synoptic weather maps in relation to the above criteria. When they recognize an existing air pollution potential situation, these meteorologists issue an Air Pollution Potential forecast at 12:17 p.m. (EST) over the Weather Bureau Service C teletype circuit to about 240 first-order weather stations. The station operators in turn notify air pollution and public health agencies, and others who have requested such service from their local Weather Bureau station.

During the period August 1960 through September 1963, the Air Pollution Potential program for the eastern United States issued advisories for 39 stagnation situations, a few of which were subsequently retracted when stagnation did not last the requisite 36 hours. Figures 1 and 2 indicate the geographical distribution of those stagnation situations that were verified and the total time of stagnation conditions (excluding the November-December 1962 episode. The usual duration of an alert is 2 to 3 days; a few alerts last as long as 5 days. Stagnation situations in the eastern United States concentrate in a long arc from Alabama to eastern Pennsylvania, roughly following the Appalachian highlands, with the greatest number and duration in the western Carolinas and northern Georgia. The concentration of stagnations in this area with buildup of naturally occurring aerosols presumably resulted in the generic name for the Smoky Mountains long before weather research and air pollution were considered.

It has been determined that most stagnation incidents occur when local weather patterns are dominated by a slow-moving or stagnating anticyclone. These cells of high pressure are characterized by small horizontal pressure gradients and by light surface winds in the central portion of the system. In the northern hemisphere the motion around the high-pressure system is clockwise and divergent in the surface layers of air. To effect a balance in the anticyclonic system as a whole, divergence in the lower layers results in subsidence, or sinking, of air from aloft. As the air subsides, a general warming and drying effect results, which is generally responsible for the clear, fine weather normally associated with anticyclones. From an air pollution standpoint, however, subsidence results in stabilization of the atmosphere and the formation of low-level inversions, which limit the vertical mixing of pollutants at the earth's surface. The low surface wind speeds associated with weak pressure gradients further hinder effective horizontal transport and dispersion of pollutants.

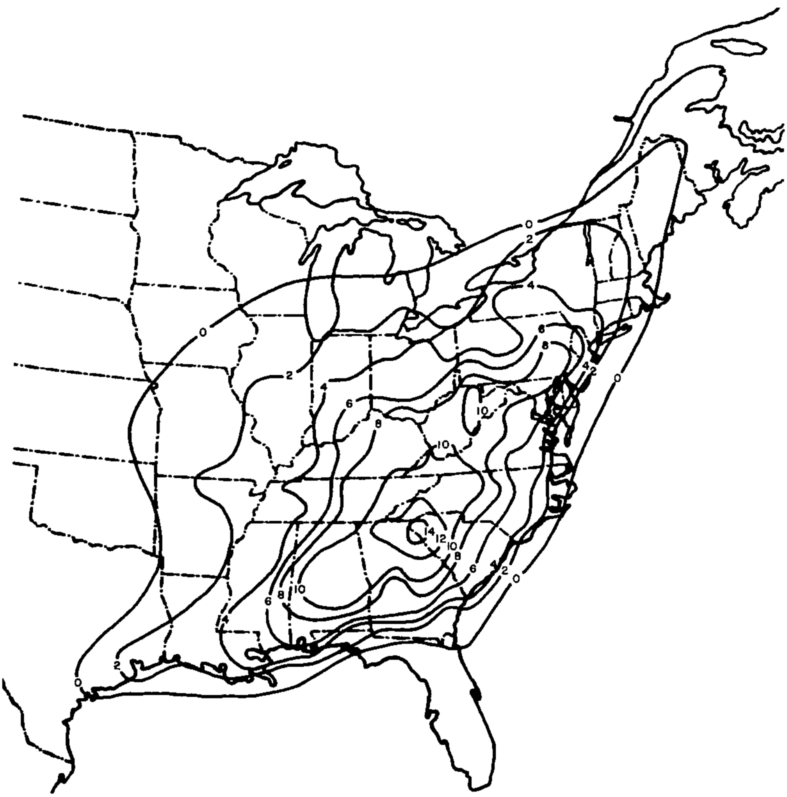

Figure 1. Isolines of total number of alerts called during period from August 1960 through September 1963.

When an anticyclone is slow-moving or quasi-stationary, poor dispersion conditions persist over a given area and result in buildup of pollutant concentrations if sources of pollution exist. The eastern portion of the country is normally subject to variable weather conditions as low and high pressure systems move through, but occasionally an anticyclone will stagnate and reduce ventilation over a large area. Such a slow-moving anticyclone developed in late 1962 and brought about the stagnation period that is the subject of this report.

The stagnation forecast for the November-December 1962 period was exceptional in at least three aspects. Its duration was the longest in the 3-year history of the Air Pollution Potential Forecast program; it covered by far the largest area under one stagnating system; and the area covered for the longest period of time included some of the most densely populated areas of the country, areas not usually subject to frequent or long stagnations.

Figure 2. Isolines of total alert days during periods from August 1960 through October 1962 and January 1963 through September 1963 (excludes November-December alert period).

The initial forecast was called on November 27, 1962, for an area from New England, through New York and Pennsylvania, into northern West Virginia. The forecast area expanded west and south to eventually include 22 states from Maine to Arkansas. Dissipation commenced along the western boundary so that the stagnant air mass covered Illinois and other areas to the west for only 2 or 3 days, while stagnant conditions persisted over portions of New England, New York, and Pennsylvania for as long as 7 1/2 days. Figure 3 indicates the duration of the stagnation in various sections of the country. The total area affected by this stagnation is inhabited by some 87 million people, 60 million of whom were in the area for 6 days or more. Table 1 lists 23 major cities, their populations, and the number of days they were encompassed by the alert.

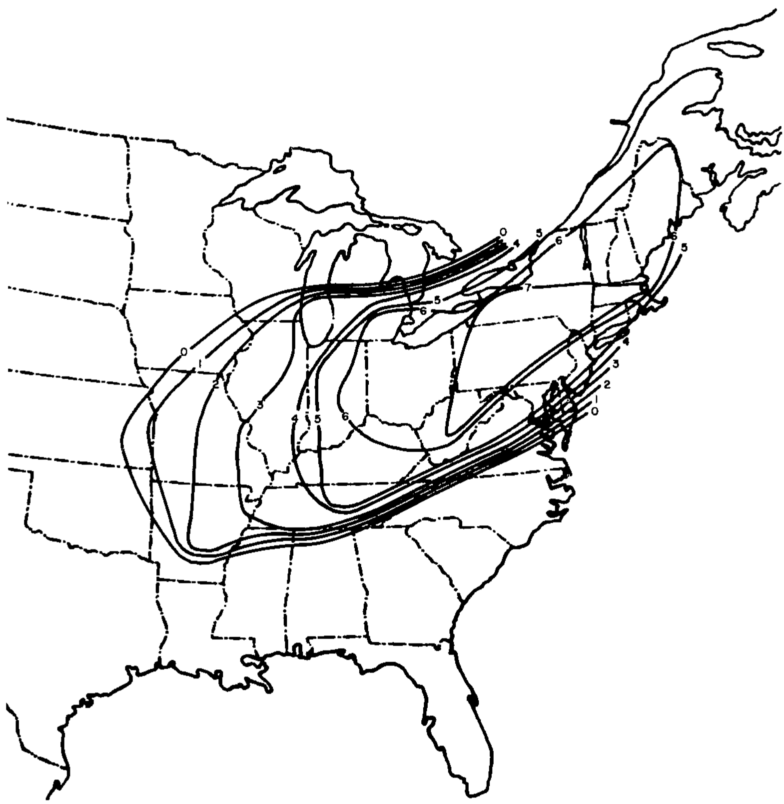

Figure 3. Isolines of number of days in alert - November 27 through December 5, 1962.

In Figure 4 the days of stagnation shown in Figure 2 have been increased by inclusion of the days of the November-December 1962 forecast. Comparison of the two figures shows that for areas in New York, Ohio, and Pennsylvania the days of stagnation during the November-December period exceeded the total days of stagnation during the remainder of the 3 years of the program; for areas to the northwest and in New England essentially all of the total stagnation time occurred during this period.

In a study of stagnation anticyclones during the period 1936-56, Korshover[4] found that while the high-frequency areas near northern Georgia had undergone four to six stagnations of 7 days or longer, the areas most affected during November-December 1962 had undergone only two or three such long stagnations during the 21-year period. Thus an episode of this magnitude can be expected in these areas about once every 10 years.

Table 1. PRINCIPAL CITIES AFFECTED BY STAGNATION

City or area	1960 Population	Dates affected	Number of days affected
New York Metropolitan Area	10,602,000	11/29-12/5	5 1/2
Chicago Metropolitan Area	6,172,000	11/29-12/2	3
Philadelphia Metropolitan Area	4,301,000	11/29-12/4	5
Detroit Metropolitan Area	3,743,000	11/28-12/4	6
Boston Metropolitan Area	2,567,000	11/27-12/5	7 1/2
Pittsburgh Metropolitan Area	2,392,000	11/27-12/5	7 1/2
St. Louis Metropolitan Area	2,046,000	11/30-12/4	3 1/2
Washington Metropolitan Area	1,968,000	11/29-12/4	5
Cleveland Metropolitan Area	1,787,000	11/28-12/4	6
Baltimore Metropolitan Area	1,707,000	11/29-12/4	5
Newark, N.J. Metropolitan Area	1,683,000	11/29-12/5	5 1/2
Buffalo, N.Y. Metropolitan Area	1,302,000	11/27-12/5	7 1/2
Milwaukee Metropolitan Area	1,185,000	11/29-12/2	3
Paterson, N.J. Metropolitan Area	1,184,000	11/29-12/5	5 1/2
Cincinnati, Ohio Metropolitan Area	1,068,000	11/28-12/4	6
Kansas City, Mo. Metropolitan Area	1,034,000	11/30-12/2	1 1/2
Indianapolis Metropolitan Area	690,000	11/28-12/4	6
Albany, N.Y. Metropolitan Area	652,000	11/27-12/5	7 1/2
Memphis, Tenn.	498,000	11/30-12/4	3 1/2
Louisville, Ky.	391,000	11/29-12/4	5
Hartford, Conn.	177,000	11/29-12/5	5 1/2
Nashville, Tenn.	171,000	11/29-12/4	5
Little Rock, Ark.	108,000	11/30-12/2	2
Charleston, W.Va.	86,000	11/27-12/4	7

An unusual and perhaps fortunate feature of this stagnation situation was a partial breaking of the stagnation over the Washington-New York area on December 2 and 3. On these dates a minor low-pressure system had moved briefly northward from the Cape Hatteras, North Carolina area and then receded, temporarily affording this small area along the coast with higher winds, which dissipated the stagnant air and the pollutants accumulated during 5 or 6 days of stagnation.

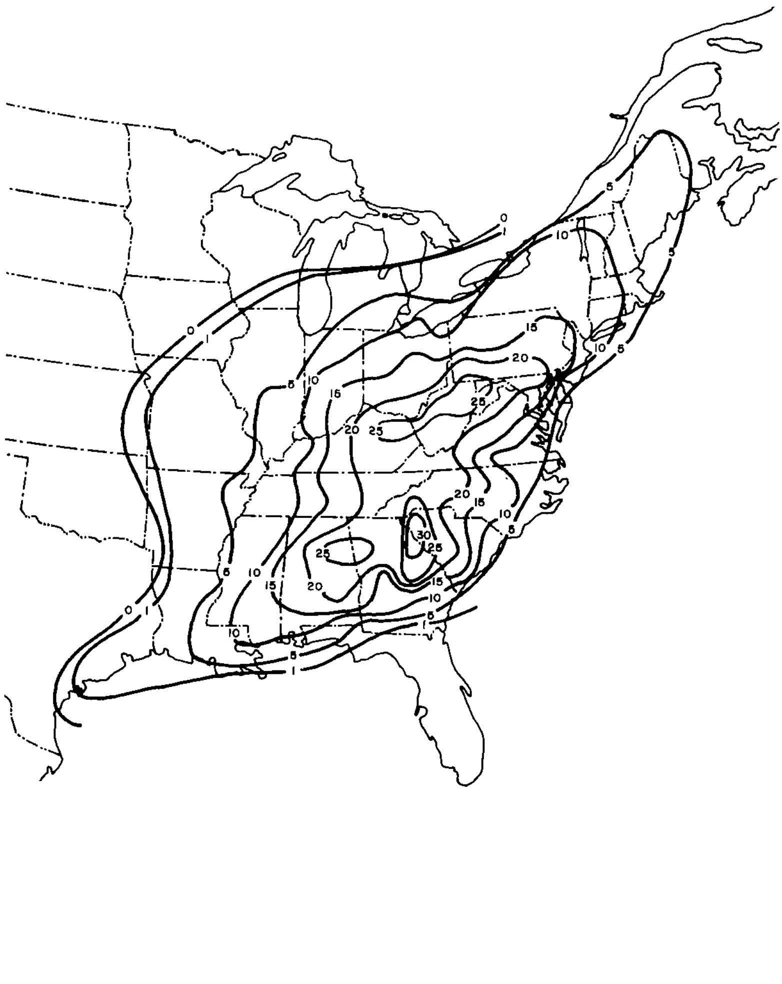

Figure 4. Isolines of total alert days from August 1960 through September 1963 (includes November-December alert period).

AIR QUALITY

Particulate Pollutants

During the 2-week period extending a few days before and after the Air Pollution Potential Forecast, 49 stations of the National Air Sampling Network (NASN) in the alerted area obtained 67 regularly scheduled particulate samples. Sampling and analytical techniques are described in an NASN summary publication.[5] An additional 59 samples were secured from 18 NASN stations, primarily special samples taken in the New York-New England area and at nonroutine sites in Cincinnati, Ohio. These 126 samples were classified as being obtained on the first, second, third, etc., day before the start of the period, during the period, or after the stagnation period in the local area.* The NASN samples were analyzed for total particulates and organic (benzene-soluble) particulates and compared with "normal" concentrations from each site. The normal used was the median concentration in previous September-November quarters, usually over the period 1957-61.[5] Stations for which such background data were not available have not been included in the study, nor are they included in the totals of samples enumerated above. NASN data on particulate concentrations are presented in Table A1 of the Appendix. The mean ratios (episode/normal) are presented graphically in Figure 5.

The curves in Figure 5 cannot be considered a precise quantitative description of the alert over an "average" station, since the mean for each day represents several (3-13) cities of diverse size and character. Figure 5 does illustrate, however, that during the alert the daily average particulate concentrations rose to 2 to 3 times normal, and that organic (benzene-soluble) particulates were especially affected, rising to as high as 6 times normal. For 40 of 51 (78%) samples obtained during the alert the episode/normal ratio was higher for benzene-soluble organics than for total particulates; comparable values were 21 of 43 (49%) before the alert and 8 of 28 (29%) after the alert. Also of note is the peaked nature of the curves in Figure 5. The decrease in pollutant levels on the 6th day of the alert is due to the previously mentioned temporary cleaning effect on December 2-3, when the eastern coastal states were in the 6th day of the local alert. The peak in the benzene-soluble curve on the first day of the forecast appears to be a local phenomenon. It represents data from East Chicago, Indiana, and Cincinnati, Ohio, and an extremely high ratio from one location in New England. With this one station excluded, the average ratio for the first day is 1.79, as indicated by the dashed curve.

Figure 6 depicts a similar analysis of data from stations in an elliptical area from New York to Boston. By exclusion of the western areas, where the stagnation was less severe, the curves give a clearer picture of the stagnation over a homogeneous area. In this area, weight of particulate rose to 3 to 4 times normal and of benzene-soluble organics to 7 times normal. The general decrease in pollution on December 2-3 is

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* Air pollution stagnation periods are usually called (begun) and ended at noon. Particulate sampling was begun and ended at random times, and the date given is the date that sampling began. Thus a sample designated at the beginning or end of the stagnation period may not lie entirely within the stagnation period as called by the USWB.

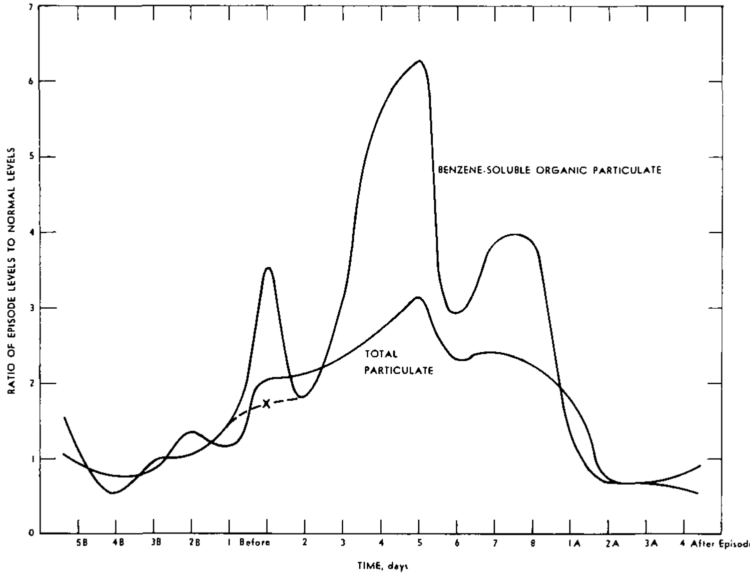

Figure 5. Ratio of pollutant levels during episode to normal pollutant levels.

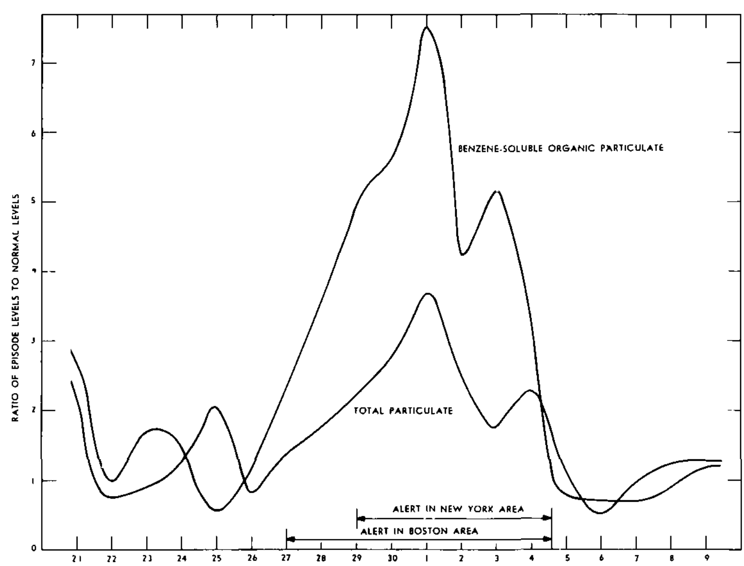

Figure 6. Ratio of pollutant levels during episode to normal pollutant levels in the Boston - New York area.

evident. These curves probably provide a good representation of the buildup of pollutants during a stagnation, since many stations obtained special daily samples during the alert. The low points immediately after the alert ended presumably are due to replacement of the large mass of stagnant air with an influx of unpolluted (fresh) air.

Gaseous Pollutants

During the alert, Continuous Air Monitoring Program (CAMP) stations[6] were operating in the stagnation area in Washington, Philadelphia, Cincinnati, and Chicago. Other continuous gas sampling equipment was operating in New York at the Christodoro House sampling station. The solid curves in Figures 7 through 11 are plots of hourly mean concentrations. The solid curve in Figure 12 represents the 2-hour mean data from New York Christodoro Station. The dotted lines in Figures 7 through 11 are 12-hour "rolling averages," i.e., each point plotted represents the mean of 12 hours, approximately 6 hours on each side of the point. This type of plot is intended to sort out the short-term fluctuations and, to some extent, the diurnal variations. For curves where rapid changes in concentration are minor we have omitted this plot. To provide background comparison, the "average day" is plotted for one day under some of the pollutant curves. This curve represents hourly concentrations averaged over the month for November or December 1962, or both, as available. In addition, Figures 7 through 12 include plots of daily average temperatures (including normal temperature) and percent of possible sunshine.

Data were obtained from Washington, D. C. (Figure 7) until the station was dismantled on December 4 for temporary relocation at the National

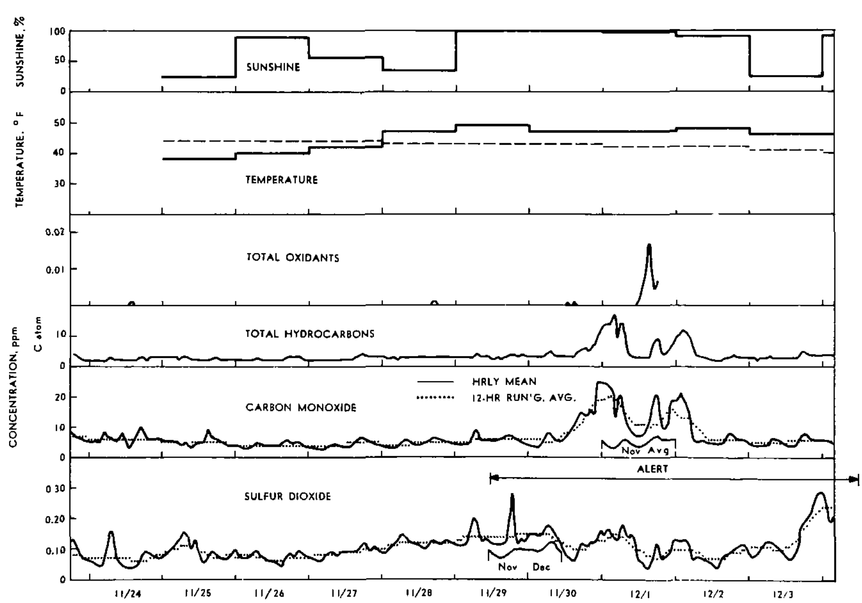

Figure 7. Data from CAMP station at Washington, D.C.

Conference on Air Pollution. In Washington the levels for carbon monoxide and total hydrocarbons are relatively constant prior to the stagnation, with twice-daily rush hour peaks and slightly lower levels over the weekends, as is expected where automobiles are the major source of these pollutants. About 24 hours after the alert began, on Friday, November 30, levels for carbon monoxide and total hydrocarbon rose in parallel to about 5 times normal, dropped on Saturday afternoon, then rose again Sunday morning and returned to normal under the improved ventilation conditions on December 2-3. Whether the levels again rose on the 4th, as the ventilation decreased, is undetermined. SO_2 concentrations in Washington began building to 1-1/2 times normal somewhat before the alert was called, decreased to nearly normal on December 2, and began to rise again on December 3, soon enough for the peak to be observed before the station was dismantled. Interpretation of total oxidant data in the presence of SO_2 is open to serious question, since SO_2 tends to interfere with the oxidation measurement.* The rare instances of measurable oxidant in Washington prior to the stagnation (each small peak represents one or two 5-minute values of 0.01 ppm) are contrasted with the peak to 0.02 ppm on December 1. Since SO_2 at this time was only a little below normal levels, it is presumed that oxidant concentration rose significantly to be able to overcome the interference. The discontinuous "hanging end" of the peak was due to a temporary instrument failure, and the next data obtained a few hours later were back to zero.

Figure 8 presents data from Philadelphia, Pennsylvania. The "bimodal" peaks are evident; the December 2 cleansing reduced the SO_2 to normal and the NO_2 and NO to zero for a few hours at a somewhat earlier time. Note also the persistence of SO_2 diurnal variations into the "rolling average" plots, not seen in Washington. Overall, the SO_2 levels during the alert were 3 to 4 times normal; the NO levels ranged from 4 to 8 times normal, and NO_2 concentrations were routinely twice normal; the hydrocarbon curve indicates that on 2 days the evening peaks rose to 3 to 4 times normal.

Total oxidant data showed only scattered 5-minute values above zero prior to the stagnation, but indicated a sustained value of nearly 0.01 ppm for 18 hours on December 1 and 2. Because the oxidants measured are largely photochemical reaction products, the persistence of this level through the night is unexpected. Occurrence of the peak at a time when other pollutants were being rapidly dispersed by increased ventilation is even more inexplicable, although some weight may be given to the lowering of SO_2 interference, which permitted the analyzer to record minimal amounts of oxidant.

Pollutant levels at Cincinnati, Ohio (Figure 9) increased slowly but uniformly to twice normal over the entire alert period and decreased rather rapidly immediately afterward. Noteworthy features were sharp peaks in the NO_x curves and the pronounced diurnal variations in the SO_2 curve. The morning peaks on November 30 appear to indicate a classical photochemical smog incident with decreasing NO and hydrocarbon levels,

* A precise evaluation of true oxidant levels is impossible when SO_2 is present. CAMP stations have recently been equipped with CrO_3 absorbers, which should eliminate this interference in total oxidant measurements.

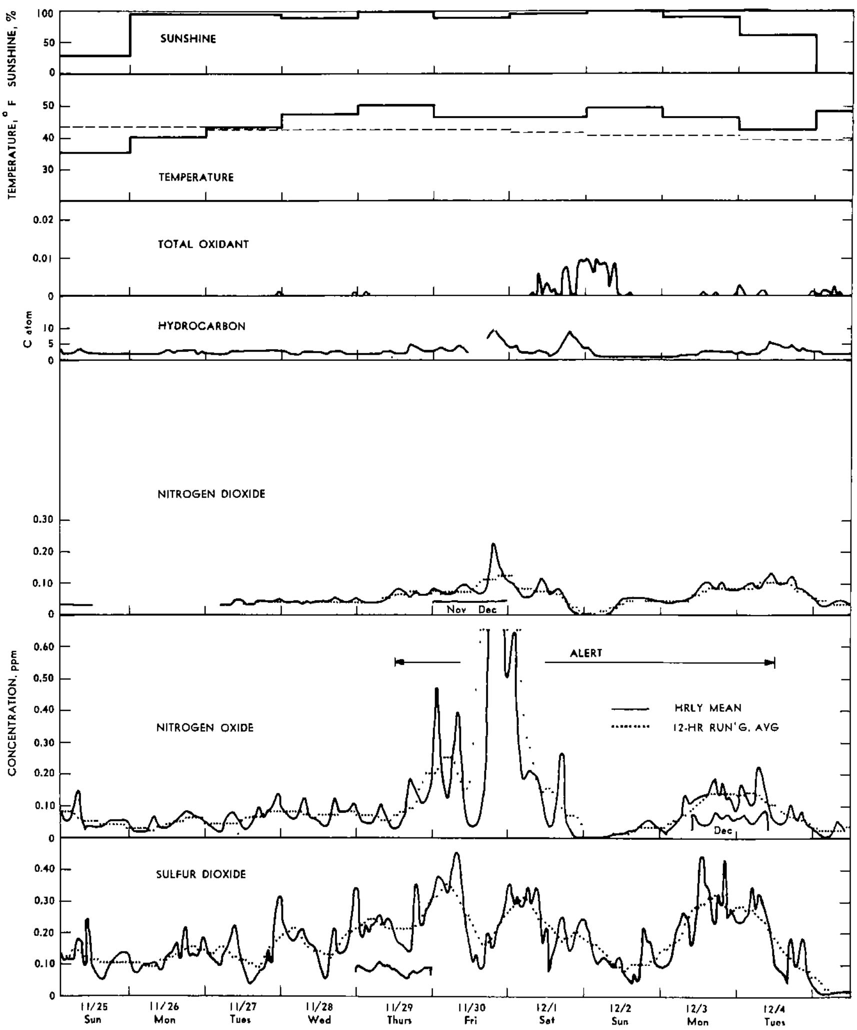

Figure 8. Data from CAMP station at Philadelphia, Pennsylvania.

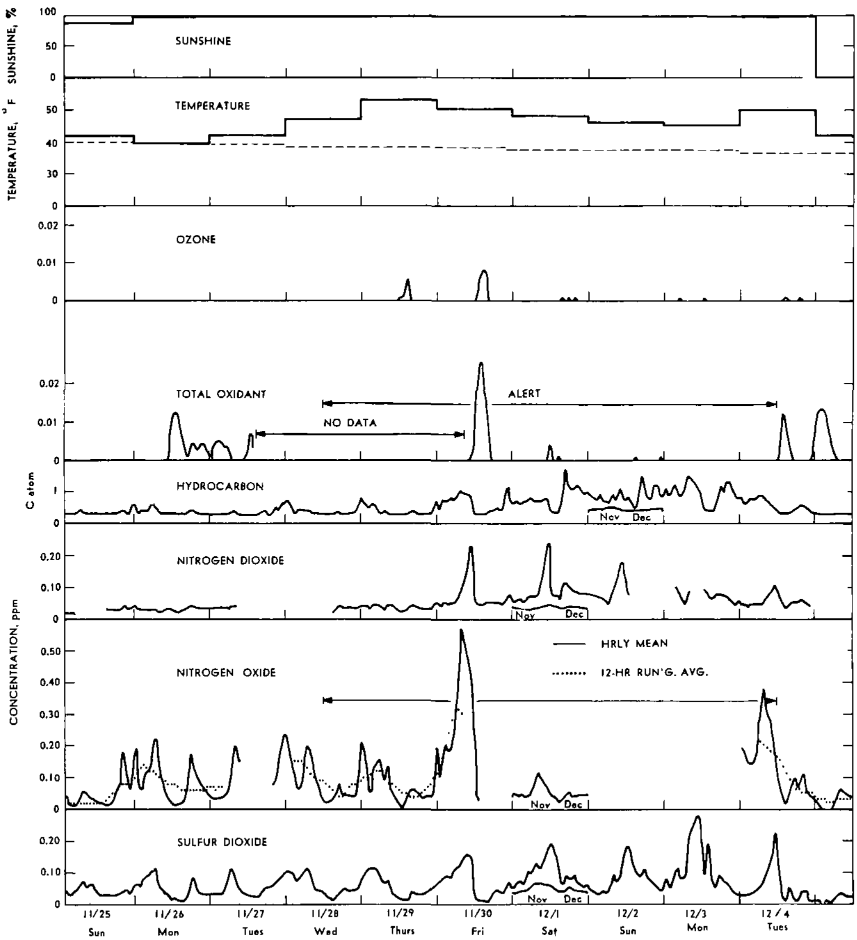

Figure 9. Data from CAMP station at Cincinnati, Ohio.

increasing NO_2 concentration, and oxidant buildup, shown in more detail in Figure 10. Two-hour sulfate analyses were obtained from AISI tape samples in an attempt to explain the rapid drop in SO_2 concentration during the photochemical incident. Because the wind data show no great change in total ventilation, it was postulated that the SO_2 may have been oxidized rapidly to sulfate. Table 2 lists sulfate concentrations during the period. There is not enough increase in $SO_4^=$ to account for the decrease in SO_2.

The data from Chicago (Figure 11) indicate some increase above usual levels, generally to about twice normal for most contaminants. Diurnal patterns in Chicago are much more distinct than in the other locations, and these were not modified greatly by the stagnation conditions.

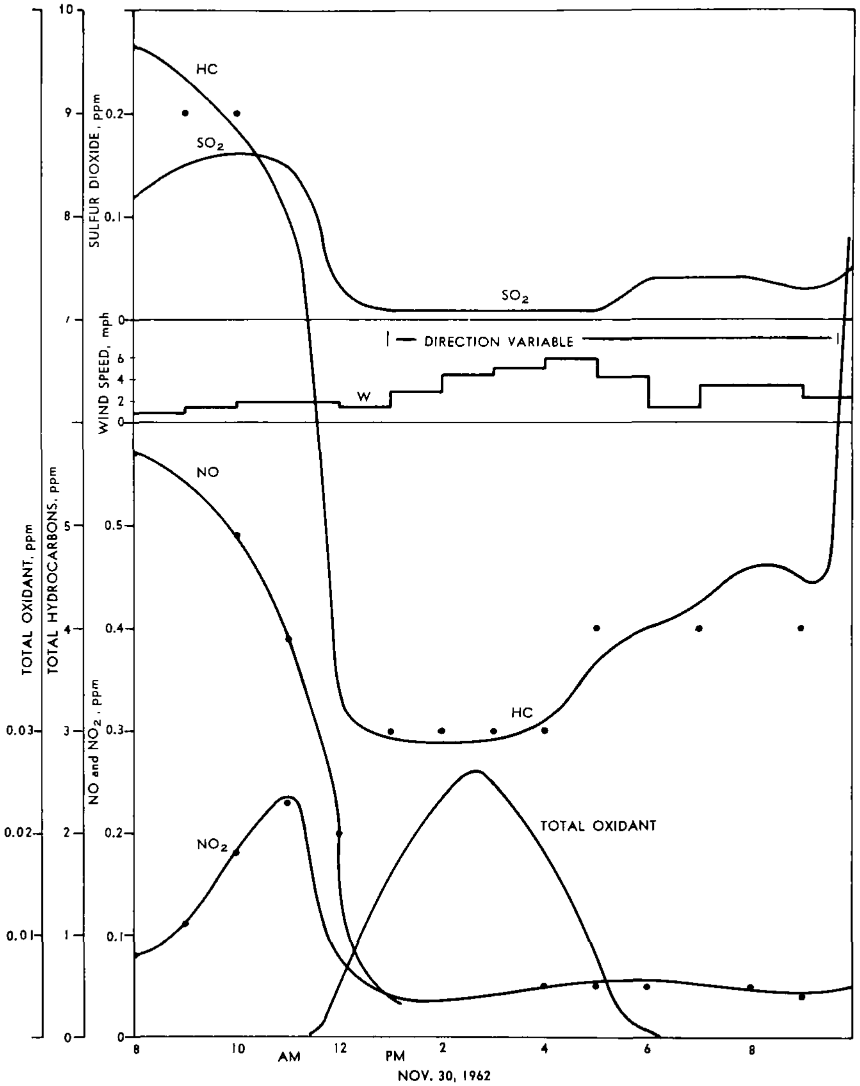

Figure 10. Photochemical smog incident - Cincinnati, Ohio.

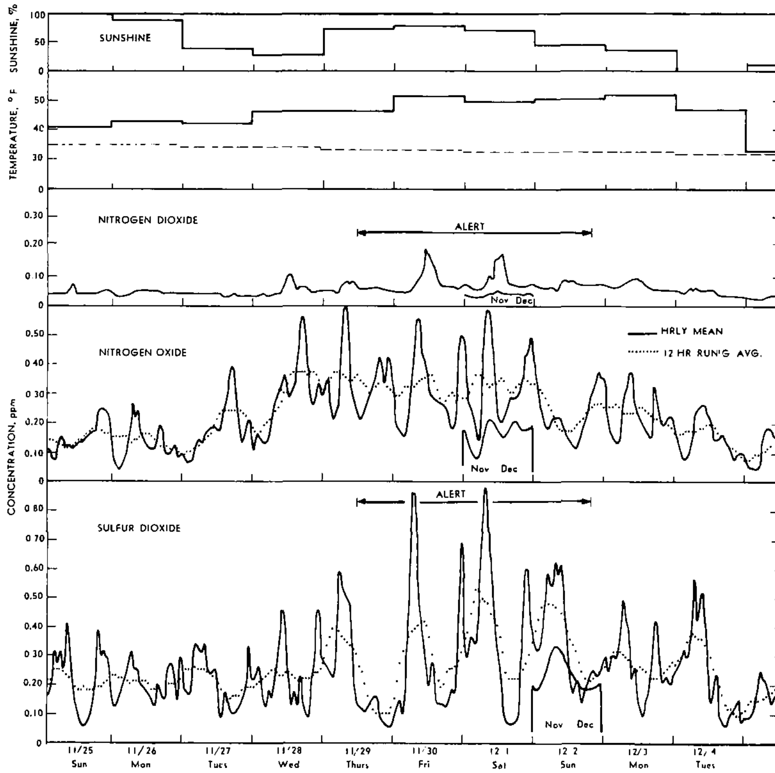

Figure 11. Data from CAMP station at Chicago, Illinois.

Table 2. SULFATE CONCENTRATION IN CINCINNATI DURING PHOTOCHEMICAL INCIDENT NOVEMBER 30, 1962

Time		$SO_4^{=}$ Concentration at CAMP Station, $\mu g/m^3$
6 a.m.	8 a.m.	22
8 a.m.	10 a.m.	31
10 a.m.	12 Noon	28
12 Noon	2 p.m.	33
2 p.m.	4 p.m.	13
4 p.m.	6 p.m.	13
6 p.m.	8 p.m.	9

This period could not be considered of major consequence in Chicago. Higher pollutant concentrations were observed at other times during the 1962-63 winter season.

Figure 12 shows the SO_2 concentration at Christodoro House in New York City, where the sampler is located at an elevation of 189 feet. The twin peaks bracketing the December 2-3 cleansing are pronounced. Unfortunately, background data for New York are not available.

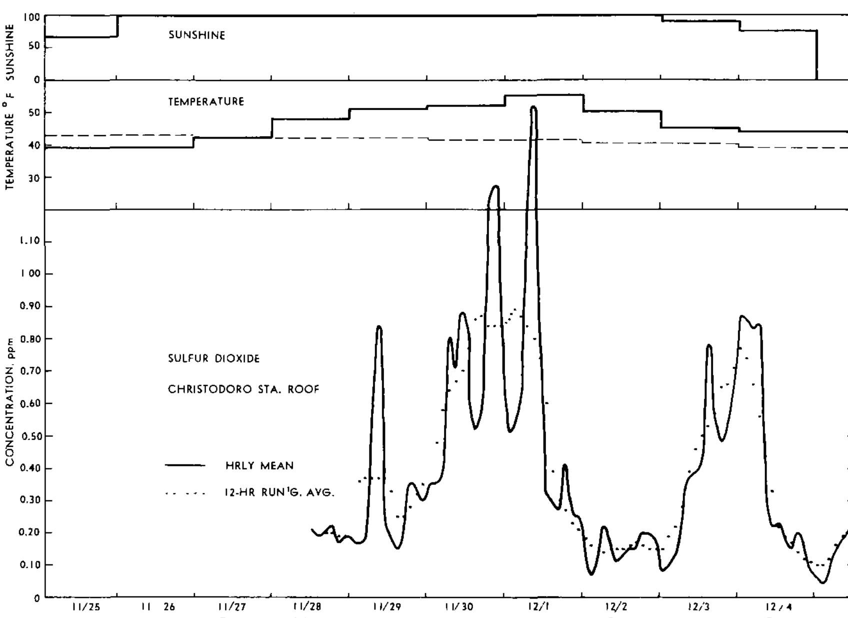

Figure 12. Data from New York City.

Figures 13 and 14 are "three-dimensional" representations of CAMP data during the episode, and are an attempt to illustrate pictorially the progress of the air pollution episode. These are essentially smoothed hourly mean plots set "behind" one another to facilitate visual elimination of diurnal fluctuations. We present the Cincinnati data because they best depict the nature of the onset, progress, and ending of the episode. SO_2 data for the first 2 days (Figure 13) show small morning and evening peaks due to fumigation. On November 28-30 the peaks become stronger and more drawn out as the decreased ventilation permits pollutants to accumulate. On Saturday and Sunday, December 1 and 2, the peaks appear later in the day and never decrease to the low values of the previous afternoon. The Monday peak shows still further increase in magnitude and duration, then on December 4 the morning peak declines steeply as the stagnation breaks, and the air for the subsequent 2 days is relatively very clean.

The total hydrocarbon data for Cincinnati are plotted in a similar way in Figure 14; we established the division at 3 p. m. rather than at midnight

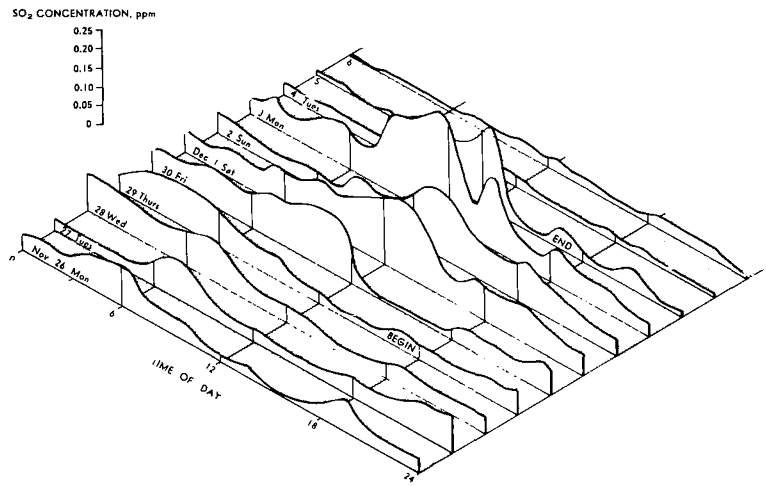

Figure 13. SO_2 levels recorded at Cincinnati CAMP station.

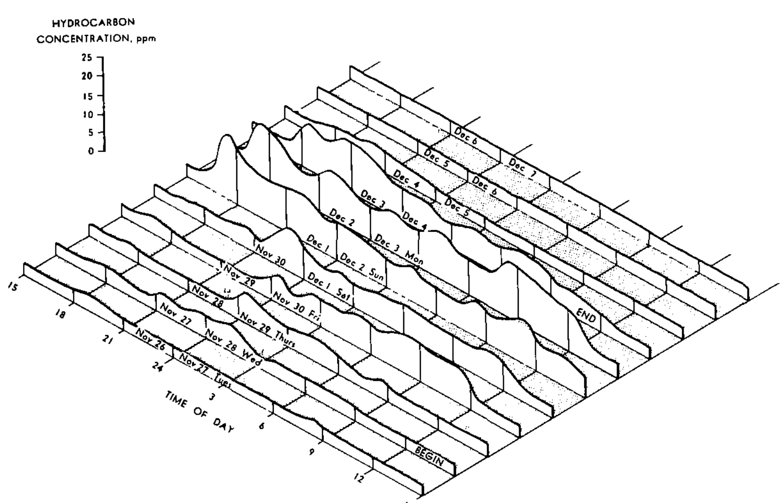

Figure 14. Hydrocarbon levels recorded at Cincinnati CAMP station.

to better illustrate the effect of the nighttime inversion. The front bar illustrates a 3-ppm "baseline" with small rush-hour accumulations. As the air mass begins to stagnate, the rush-hour peaks increase and pollutants are dispersed to a lesser extent, until December 1, when the concentration remains nearly constant at more than 3 times the levels recorded before the stagnation, through December 4. The hydrocarbon concentration returns to a uniform 3 ppm for several subsequent days.

Data for other pollutants and other cities are a good deal more variable and hence more difficult to visualize; in general, however, they all show normal diurnal peaks that increase in magnitude and duration during the episode. Only occasionally do these peaks grow sufficiently to blend into each other and yield a continuous daily high. This contrasts with the erroneous impression of a continuous buildup of pollutants gained from 24-hour average particulate data, as in Figures 5 and 6.

To gain further insight into the relative air quality during the alert, we scanned summaries of maximum 5-minute and hourly concentrations during 1962. Maximum hourly and maximum 5-minute NO concentrations for the year for CAMP stations at Philadelphia, Chicago, and Cincinnati (Washington analyzer inoperative) occurred during the episode, as did NO_2 maxima for Philadelphia and Cincinnati. Hydrocarbon hourly maxima for the year occurred during the episode in all three cities reporting (Chicago inoperative), but the 5-minute maximum occurred during the episode only in Washington. The hydrocarbon peak during the episode was exceeded only once in Philadelphia; in Cincinnati, however, the hydrocarbon levels during the episode were well down the list of peaks for the year. Peak levels of SO_2 during the episode generally were not among the highest for the year. The SO_2 maxima for the year occurred in October (Philadelphia), November (Cincinnati and Washington), and late December (Chicago). It appears that the decrease of space heating during the fair stagnation weather may preclude extreme SO_2 accumulations. CO data were available from Washington only; the maxima for the year were set during the episode.

With only four CAMP stations in the alert area, it is difficult to gain an overall view of the effect of the stagnation on gaseous pollutants. The only CO analyzer functioning routinely during part of the alert was in Washington; CO levels there rose to 3 to 4 times normal. SO_2 data were fairly complete for the four CAMP cities and for New York: the SO_2 levels were 1 to 1-1/2 times normal in Cincinnati, Chicago, and Washington; 4 times normal in Philadelphia; and similarly very high in New York. Stagnation in Washington, Philadelphia, and New York was much more extended than in Cincinnati or Chicago, and since Washington is not an industrial city, the general pattern of SO_2 increase seems logical. NO_x analyzers, operating in three cities, indicated daily peaks generally 3 to 8 times normal during the stagnation. Hydrocarbon data from Washington, Philadelphia, and Cincinnati indicate peaks 3 to 6 times normal; only Cincinnati data show prolonged buildup or great fluctuations. During the episode ozone appeared in measurable amounts only in Cincinnati, with low SO_2 levels and 100 percent sunshine. The only ozone peaks of more than 10-minute duration occurred during the episode, and the frequency of 5-minute periods with measurable ozone increased. Total oxidant was measured in Washington, Philadelphia, and Cincinnati; oxidant concentrations were higher than normal during the episode, but the occurrence of overnight peaks and the unknowns involved in SO_2 interference preculde conclusive evaluations.

"Dosage" values during the episode were calculated for some of the CAMP cities. Dosage is defined as the area (in ppm-hours) under the concentration curve when the concentration exceeds a specified level. It is probably a better measure of respiratory insult than simple concentration, since it takes into account the duration of exposure to high concentrations of pollutants.

Dosage calculations are summarized in Table 3. The normal (N) used for comparison is the November-December 1962 period, excluding the episode (E). Generally the 5 to 8 percent of the month represented by the episode period accounted for from 1/5 to over 1/2 of the dose received during the period, as shown in columns 6 and 7. The average daily dose varied from 1-1/2 to 6 times normal during the episode. Generally this is the result of increased duration of peak concentrations (a lengthening of the normal diurnal peaks) rather than striking increases in concentration (columns 2 and 3). Complete dose data are not yet available for all CAMP cities but are now part of routine CAMP data processing and will be presented in future CAMP annual reports.

Table 3. POLLUTANT DOSAGES NOVEMBER - DECEMBER 1962

Description	Period	No. of doses occurring	Average duration of dose period, hr min	Average concentration during dose, ppm	Average dosage per dose period, ppm-hr	Dosage per day, ppm-hr	Percent of 2-mo. total	
							Time	Dosage
		(Col. 1)	(2)	(3)	(4)	(5)	(6)	(7)
Chicago SO_2								
Dosages for Concentrations > 0.5 ppm	Normal	146	0 21	0.62	0.22	0.56	94.5	75.6
	Episode	10	1 36	0.66	1.05	3.14	5.5	24.4
Phila. SO_2								
Dosages for Concentrations > 0.3 ppm	Normal	59	0·19	0.44	0.14	1.46	91.8	44.9
	Episode	15	1 50	0.36	0.67	2.00	8.2	55.1
Wash. SO_2								
Dosages for Concentrations > 0.3 ppm	Normal	3	1 08	0.33	0.37	0.02	91.8	64.8
	Episode	4	0·26	0.35	0.15	0.12	8.2	35.2
Chicago NO								
Dosages for Concentrations > 0.2 ppm	Normal	147	2:13	0.26	0.57	1.46	94.5	79.8
	Episode	11	5:38	0.34	1.94	6.41	5.5	20.2

REACTION TO THE ALERT FORECAST

The length and scope of this stagnation episode provided an excellent opportunity to test public and official reaction to the incident and to survey the use made of the air pollution potential forecast service. We obtained information on these points by means of two polls. The Division of Air Pollution, Public Health Service, distributed one questionnaire to state and local public health and air pollution agencies in the large area covered by the forecast. The U.S. Weather Bureau sent a memorandum questionnaire to local weather stations participating in the forecast program.

We received about 70 replies to the PHS survey (Exhibit 1, Appendix) including 12 from state agencies. In general, knowledge of the episode and vigor of action followed a predictable pattern and varied directly with (1) length of time in the stagnation area, (2) severity of air pollution problems during normal weather conditions, and (3) size of local or state air pollution control program. Agencies in the western, southern, and northern New England portions of the stagnation area had little knowledge of the forecast, did not notice a particularly unusual air pollution situation, and hence undertook no special action. In the Atlantic seaboard states and into the midwest, many official agencies noted and used the forecast. Air quality deteriorated rapidly, and news media coverage and public reaction were vigorous, particularly in the large cities. Table 4 summarizes response to the PHS questionnaire.

Table 4. SUMMARY OF RESPONSE TO PHS QUESTIONNAIRE

	Days in forecast area								Total	
	0 - 2		3 - 5		6		7 - 8			
	Number replies	% Positive	Number replies	% Positive	Number replies	% Positive	Number replies	% Positive	Number replies	% Positive
1. Aware of forecast?	8	12	9	55	18	72	36	75	71	65
2. Obvious poor air quality?	8	12	6	33	18	50	34	59	66	49
3. News coverage?	8	12	8	12	18	50	34	74	68	53
4. Any official action taken?	8	0	9	0	18	33	36	28	71	23
5. Any special air analyses taken?	8	0	9	33	18	0	36	11	71	10
6. Are forecasts of value?	8	25	7	43	18	67	33	64	66	58

The finding that only 58 percent of those polled placed value on the forecasts reflects primarily the large number of agencies that were not aware of the forecast rather than lack of interest in the forecast program. Nearly all the agencies that were notified of the stagnation situation placed a strong value on continuation of the forecasting program.

Nearly one-third of the agencies that were aware of the forecast took some action as a direct result of the forecast. The most common official action was to place the air pollution agency in a posture of readiness; direct actions included extra inspection patrols, increased air sampling activities, preparation of news releases for publication in local papers and for use in answering complaints, and placement of calls to selected large air pollution sources requesting cooperation. The news releases generally informed the public of the existing or potential situation, provided some meteorological background, and requested citizens to curtail burning of leaves and trash for a few days. Only one agency issued specific health warnings in their release; this agency warned against unnecessary exertion by those with chronic respiratory or cardiac conditions.

Approximately 75 stations replied to the U.S. Weather Bureau questionnaire (Exhibit 2, Appendix). The character of the replies followed closely the geographical patterns discussed earlier for the PHS survey of the state and local air pollution agencies. Generally, only in the New England states, Pennsylvania, and New York were Weather Bureau stations involved in the air pollution situation. Normally they worked with the local or state air pollution or public health agency and received only

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a few air pollution complaints directly from the public. Nearly all stations in large cities or in the capitals of states with air pollution programs understand the forecast program clearly and relay alerts that affect their state. About 15 of the 75 stations that replied have received standing requests to relay the forecasts, sometimes to as many as four separate parties. Stations located in small towns or in areas not commonly concerned with air pollution have not used the forecasts, do not seem to understand their purpose, and generally ignore them. Exceptions usually involve requests by large industries for notification of the forecasts.

CONCLUSIONS

A primary purpose for studying the November-December 1962 episode was to review the PHS - Weather Bureau Air Pollution Potential Forecast Program. Replies to the questionnaires and analysis of available air quality data indicate that the Program criteria do effectively forecast periods of increased pollution, especially when the forecast continues for 2 or 3 days. It is also apparent that the forecasts are accepted by local and state air pollution agencies and have become an important and integral part of many control programs in areas concerned with air pollution. A few suggestions have been made for improvement of the Program, principally relating to communications and public announcements. These have been discussed in detail with those responsible for the Forecast Program and have been adopted where appropriate.

Analysis of air quality data during this particular stagnation also shows the need for augmenting the central forecast group in Cincinnati with field meteorologists in key areas. Forecasting out of Cincinnati the exact location of the edge of minor weather systems is difficult. Such a minor low-pressure system did, however, provide dramatic relief to a number of major cities along the east coast on the 5th or 6th day of the stagnation. Detailed knowledge of its existence, arrival, and effect would have greatly assisted local agencies in developing programs during the stagnation period. An Air Pollution Potential Forecast meteorologist has been established in New York for about the past year. Others are planned for three additional key areas in 1965 or 1966.

Some acute air pollution episodes have been associated with greatly increased mortality and morbidity. Recently published information indicates that periods of high air pollution not immediately identifiable as acute situations also may be associated with increased mortality.[7] The November-December episode was unusually extensive, affected many large population centers, and resulted in severe air pollution exposures for most contaminants. The size and duration of this episode period would seem to make it ideally suited for a comprehensive epidemiological study; this report should provide the basis for the design of such a study. A limited review of morbidity and mortality statistics for the November-December 1962 period has been made for New York City.[8] A significant increase was noted in occurrence of respiratory complaints in all of the city's homes for the aged. No significant increase in death rate was apparent during the episode period.

Aside from the documentation of the November-December episode, this study also points out interesting patterns of pollution buildup during extensive and severe stagnation periods and provides generally some indication of maximum dosage or exposure levels probable for a large segment of the population. Since these episodes may be important in understanding and determining the magnitude of air pollution effects, they should be studied routinely and at some depth. The Public Health Service has recently initiated a program to collect special samples of suspended particulate matter during all Air Pollution Potential Forecast periods. These samples will be taken by local cooperatives as an extension of the National Air Sampling Network. This program should be augmented with detailed analysis of gaseous contaminant data and special studies of changes in particulate characteristics during major episodes.

Acknowledgments

We acknowledge the assistance of Mr. Laurence Niemeyer, Chief of the Air Pollution Potential Forecast Program, and also the cooperation of state and local air pollution agencies, stations of the U. S. Weather Bureau, and stations of the National Air Sampling Network and the Continuous Air Monitoring Program.

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APPENDIX

Table AI. PARTICULATE LEVELS AT NASN STATIONS IN ALERT AREA

Station	Date	Day of alert	Total suspended particulate, μg/m³		Benzene-soluble organics, μg/m³	
			1962	Normal	1962	Normal
Hartford, Conn.	12/1	3	427	88	67.6	9.8
Hartford, Conn.	12/2	4	218	88	45.1	9.8
Hartford, Conn.	12/3	5	211	88	34.4	9.8
Hartford, Conn.	12/4	6	209	88	23.0	9.8
Hartford, Conn.	12/5	7	119	88	10.3	9.8
Hartford, Conn.	12/6	1A	28	88	3.3	9.8
Hartford, Conn.	12/7	2A	67	88	5.1	9.8
New Haven, Conn.	11/26	3B	90	72	12.1	9.8
New Haven, Conn.	12/4	6	122	72	17.2	9.8
Stamford, Conn.	11/26	3B	49	100	10.6	10.8
Bridgeport, Conn.	12/7	3A	102	127	7.5	10.3
Portland, Maine	11/26	1B	92	82	10.8	7.1
Portland, Maine	12/5	2A	96	82	8.0	7.1
Arcadia Nat'l. Pk., Me.	12/6	3A	24	23	0.4	2.1
Boston, Mass.	12/4	1A	162	117	19.6	10.3
Lynn, Mass.	11/25	2B	147	72	3.7	6.7
Lynn, Mass.	11/30	4	228	72	43.4	6.7
Lynn, Mass.	12/1	5	206	72	49.0	6.7
Lynn, Mass.	12/4	8	152	72	31.9	6.7
Somerville, Mass.	11/30	4	276	67	49.5	5.1
Somerville, Mass.	12/1	5	337	67	68.0	5.1
Somerville, Mass.	12/6	3A	62	67	9.6	5.1
Worcester, Mass.	12/6	4A	86	79	6.3	6.9
Brockton, Mass.	11/30	4	127	64	26.4	7.9
Brockton, Mass.	12/1	5	190	64	36.2	7.9
Brockton, Mass.	12/4	8	157	64	27.9	7.9
Brockton, Mass.	12/5	1A	117	64	4.7	7.9
Fall River, Mass.	11/26	1B	69	76	12.5	6.7
Fall River, Mass.	11/29	3	121	76	24.1	6.7
Fall River, Mass.	12/6	3A	20	76	1.7	6.7
Quincy, Mass.	11/30	4	155	82	33.7	8.9
Quincy, Mass.	12/1	5	220	82	40.6	8.9
Quincy, Mass.	12/4	8	176	82	29.9	8.9
Quincy, Mass.	12/8	4A	102	82	7.1	8.9
Springfield, Mass.	11/29	3	86	70	15.5	6.9
Springfield, Mass.	12/1	5	350	70	64.0	6.9
Springfield, Mass.	12/2	6	176	70	26.4	6.9
Springfield, Mass.	12/3	7	79	70	47.4	6.9
Springfield, Mass.	12/4	1A	140	70	16.2	6.9
Springfield, Mass.	12/5	2A	70	70	5.1	6.9
Cambridge, Mass.	12/7	4A	68	87	3.5	6.8
New Bedford, Mass.	11/24	5B	70	51	8.4	4.4
New Bedford, Mass.	11/29	1	197	51	40.1	4.4
New Bedford, Mass.	11/30	2	130	51	20.1	4.4
New Bedford, Mass.	12/1	3	193	51	50.6	4.4
New Bedford, Mass.	12/4	6	149	51	24.1	4.4
Coos County, N.H. [c]	12/4	1A	24	16	1.1	0.9
Burlington, Vt.	12/6	3A	54	40	4.0	2.4
Orange County, Vt. [c]	11/25	2B	27	40	1.1	1.7
Orange County, Vt.	12/6	3A	20	40	1.1	1.7
Wilmington, Del.	11/27	2B	196	127	11.2	9.1
Wilmington, Del.	12/7	3A	131	127	8.7	9.1
Elizabeth, N.J.	12/6	2A	85	151	7.3	14.4
Newark, N.J.	11/24	5B	100	90	9.5	9.6
Newark, N.J.	11/27	2B	124	90		9.6
Newark, N.J.	11/30	2	274	90		9.6
Newark, N.J.	12/4	6	318	90	34.9	9.6
New York, N.Y.	12/1	3	354	157	42.8	13.0
New York, N.Y.	12/5	1A	148	157	10.7	13.0
Binghamton, N.Y.	12/5	1A	96	73	13.9	5.8
Utica, N.Y.	11/25	2B	264	97	16.7	5.8
Utica, N.Y.	12/6	2A	43	97	3.4	5.8
Albany, N.Y.	11/30	4	292	64	37.7	2.7
Albany, N.Y.	12/5	1A	45	64	5.9	2.7
Rochester, N.Y.	11/25	2B	63	115	5.4	7.0
Rochester, N.Y.	12/7	3A	66	115	4.4	7.0

Table AI. (Continued)

Station	Date	Day of alert	Total suspended particulate, µg/m³ 1962	Total suspended particulate, µg/m³ Normal	Benzene-soluble organics, µg/m³ 1962	Benzene-soluble organics, µg/m³ Normal
Troy, N.Y.	12/7	3A	26	83	1.5	5.6
Elmira, N.Y.	12/6	2A	25	81	2.8	6.0
Philadelphia, Pa.	11/27	2B	130	193	7.3	13.5
Philadelphia, Pa.	12/4	6	255	193	29.7	13.5
Pittsburgh, Pa.	11/27	1	211	133		8.1
Pittsburgh, Pa.	12/5	1A	432	133	66.4	8.1
Reading, Pa.	12/5	1A	332	170	17.6	12.2
Washington, D.C.	12/7	3A	60	104	6.2	10.9
Baltimore, Md.	11/26	3B	90	105	6.9	11.1
Baltimore, Md.	12/4	6	197	105	15.4	11.1
Charleston, W.Va.	11/23	4B	93	180	3.9	8.8
Charleston, W.Va.	11/28	2	396	180	16.9	8.8
Charleston, W.Va.	12/2	6	413	180	26.0	8.8
Charleston, W.Va.	12/3	7	527	180	28.0	8.8
Nashville, Tenn.	12/2	4	245	135	44.2	12.8
Memphis, Tenn.	12/6	3A	66	101	4.0	8.1
Peoria, Illinois	11/29	1B	239	151	23.8	13.3
Peoria, Illinois	12/6	4A	80	151	3.0	13.3
E. Chicago, Ind.	11/29	1	309	180	19.2	9.0
Evansville, Ind.	12/6	3A	74	117	5.0	8.1
Indianapolis, Ind.	11/27	1B	151	160		
Indianapolis, Ind.	11/30	3	235	160		
Indianapolis, Ind.	12/4	7	270	160		
Detroit, Mich.	12/4	7	350	127	37.3	10.0
Lansing, Mich.	11/28	1B	141	76	12.7	6.0
Youngstown, Ohio	12/4	7	602	161	59.5	13.3
Cleveland, Ohio	12/6	2A	45	180	3.8	11.3
Dayton, Ohio	12/4	7	274	107	19.0	8.8
Springfield, Ohio	12/7	3A	61	127	3.1	8.1
Cincinnati, Ohio(1)	11/24	4B	62	129[d]	4.8	10.1[d]
Cincinnati, Ohio	11/27	1B	97	129	8.8	10.1
Cincinnati, Ohio	11/28	1	185	129	14.4	10.1
Cincinnati, Ohio	11/29	2	198	129	13.8	10.1
Cincinnati, Ohio	11/30	3	286	129	22.2	10.1
Cincinnati, Ohio	12/1	4	286	129	24.6	10.1
Cincinnati, Ohio	12/4	7	479	129	49.4	10.1
Cincinnati, Ohio	12/5	1A	298	129	18.5	10.1
Cincinnati, Ohio(2)	11/24	4B	62	102[d]	4.0	7.6[d]
Cincinnati, Ohio	11/27	1B	92	102	5.8	7.6
Cincinnati, Ohio	11/28	1	185	102	13.8	7.6
Cincinnati, Ohio	11/29	2	169	102	10.6	7.6
Cincinnati, Ohio	11/30	3	222	102	17.4	7.6
Cincinnati, Ohio	12/1	4	229	102	7.2	7.6
Cincinnati, Ohio	12/4	7	353	102	36.6	7.6
Cincinnati, Ohio	12/5	1A	259	102	13.1	7.6
Toledo, Ohio	11/23	5B	58	114	3.9	8.3
Toledo, Ohio	11/29	2	201	114		8.3
Toledo, Ohio	12/6	2A	42	114	3.7	8.3
Racine, Wis.	11/25	4B	147	180	20.7	11.3
Racine, Wis.	12/6	4A	82	180	4.5	11.3
St. Louis, Mo.	11/25	5B	135	180	17.5	13.3
St. Louis, Mo.	12/4	5	173	180	14.2	13.3
Shannon County, Mo.[a]	11/26	4B	45	30	1.4	1.5
Shannon County, Mo.	12/4	2A	57	30	2.4	1.5
Little Rock, Ark.	12/2	3	116	76	24.1	7.4
Little Rock, Ark.	12/6	4A	58	76	5.4	7.4

[a]B - before alert period began.
A - after alert period ended.

[b]Median concentration for each date in previous September-November quarters, usually from 1957 to 1961.

[c]Non-urban station.

[d]Cincinnati stations (1) and (2) are at the same location (U.S. Weather Bureau's Gest Street Experimental Facility). The normals used are means of about 40 samples taken during the quarter September - November 1962.

EXHIBIT 1: PUBLIC HEALTH SERVICE QUESTIONNAIRE

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE

PUBLIC HEALTH SERVICE

DIRECTOR
Robert A. Taft Sanitary Engineering Center
4676 Columbia Parkway
Cincinnati 26 Ohio

March 11, 1963

During the period November 27 through December 5, 1962, a combination of weather phenomena generally conducive to light winds and poor atmospheric diffusion affected a large section of the eastern and central United States. The situation was predicted and was reported via teletype to appropriate U. S. Weather Bureau stations (Service C network) as part of the daily air pollution potential forecasting service of the Division of Air Pollution, U. S. Public Health Service, in Cincinnati, Ohio.

Since this stagnation was of unusual duration and extent, we feel it should be studied in an effort to learn the value of our forecasting program and detect changes needed in present procedures. Therefore, we are attempting to document the incident as thoroughly as possible, so that a case history report can be prepared. We would plan to include sections on meteorology and air quality, as well as information on awareness of and reaction to the forecast notice by news media, industry, citizens, and State and local officials.

A complete, comprehensive report can be produced only through cooperation of State and local air pollution and public health officials. We would appreciate it, therefore, if you would supply us with the type of information indicated below for the period November 27 through December 5, 1962.

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1. Were you aware that high air pollution potential had been forecast for this period by the Division of Air Pollution, U. S. Public Health Service?

2. Did it appear that an unusual air pollution situation existed in your area during this period? (Any documentation, such as public inquiries, official reports, complaints, photographs, etc. would be helpful and appreciated.)

3. What was the extent of coverage by local news media? (Copies of newspaper articles and information on any radio or television coverage would be appreciated.)

4. Was any special action taken during this period? (Such as announcements or orders to discontinue open burning, changes in or postponement of industrial operations which pollute the air, etc.)

5. Were any air analyses made during the period? (If so, results or summaries would be appreciated for inclusion in the report.)

6. Was the air pollution potential forecast of any value to your agency?

7. Have you any recommendations for improving the value of the forecasting service?

We realize that conscientious evaluation of the situation might require considerable effort, but the study will result in increasingly useful forecasting services and better episode planning procedures of mutual benefit to everyone concerned with air pollution.

Yours very truly,

B. J. Steigerwald

B. J. Steigerwald
Assistant to the Chief
Laboratory of Engineering
and Physical Sciences
Division of Air Pollution

EXHIBIT 2: U.S. WEATHER BUREAU QUESTIONNAIRE

FORM CD 121 (4-22-58)
(PRES. BY A.O. 206 10)
UNITED STATES GOVERNMENT

U.S. DEPARTMENT OF COMMERCE
WEATHER BUREAU

Memorandum

TO Selected First Order Stations (listed on reverse)

DATE February 28, 1963
In reply refer to: R-3.5

FROM Chief, Forecast and Synoptic Reports Division

SUBJECT: Air Pollution Survey

During the period of November 27 to December 5, 1962 an extensive ridge of high pressure stagnated over the northern part of the Eastern United States and high air pollution levels were observed in a number of areas. The Weather Bureau Research Station in Cincinnati has been charged with the responsibility of evaluating this particular incident and would appreciate your help.

Specific answers to the following questions are requested, but please do not limit your comments to these questions only.

1. To what extent were you called upon to relay the Air Pollution Potential Forecasts?
2. Were you called upon to advise local authorities with respect to the persistence of the high pressure cell or local expectancies of air quality?
3. Did you receive any public complaint calls regarding air pollution levels?
4. Have you noted any increased interest in the air pollution potential forecasts since this period?
5. Has a scheduled time for these forecasts been beneficial?
6. Were restrictions to visibility a problem to: (a) air traffic at the airport, and (b) the area in general?
7. How would you evaluate the general air quality during this period? Excellent, Good, Poor, Occasionally Bad, or Bad

As a knowledgeable observer we are sure you can offer a valuable contribution to the Cincinnati Weather Bureau Research Station's report to the Public Health Service on this incident and any comments you may wish to offer will be gratefully received. Please forward all replies within 2 weeks, if possible, to the Central Office, ATTN: R-3.5.

Edward M. Vernon

Edward M. Vernon

GPO 814-836-2

BIBLIOGRAPHIC: Lynn, D.A., B.J. Steigerwald, and J.H. Ludwig. The November-December 1962 air pollution episode in the Eastern United States. PHS Publ. No. 999-AP-7. 1964. 30 pp.

ACCESSION NO.

KEY WORDS:

ABSTRACT: This report documents the subject "episode" with respect to meteorology, air quality, and public reaction. Particulate and gaseous air quality data are reported and discussed with reference to the Public Health Service program of Air Pollution Potential Forecasts. Epidemiological aspects are not considered.

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