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CROSS-APPALACHIAN TRACER EXPERIMENT (CAPTEX '83) FINAL REPORT

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CROSS-APPALACHIAN TRACER EXPERIMENT (CAPTEX '83) DATA REPORT

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ABSTRACT. The Cross-Appalachian Tracer Experiment (CAPTEX '83) was a major field study using a perfluorocarbon tracer to simulate the long-range transport and diffusion of pollutants in the atmosphere. The experiment consisted of 7 tracer releases, 5 from Dayton, Ohio, and 2 from Sudbury, Ontario, during mid-September through October 1983. Automatic, sequential ground-level samplers were operated at 80 sites in the northeastern United States and southeastern Canada at distances of 300 to 1100 km from the release sites. About 3000 3- and 6-hour-long samples were collected in the sampling network during CAPTEX. To determine the vertical distribution of tracer, seven aircraft collected over 1600 samples at various plume transects from 200 to 900 km from the releases. The regular rawinsonde observations in the CAPTEX sampling area were increased to 4 times daily following each release, and 10 additional rawinsonde stations were established to fill spacial gaps in the regular network while operating on a similar time schedule. In addition, constant-level balloons were released at the sources and tracked for distances up to 1000 km. Tracer from each of the seven releases was successfully sampled at the ground and in the aircraft. Ground concentrations over 300 times background were measured at the closest sites and over 30 times back-ground at the outer sites. Concentrations over 300 times background were also measured by the sampling aircraft. This report describes CAPTEX and includes all ground-level measured concentrations in tabular form, and a discussion and a concentration map for each release along with data quality assurance and sampling performance results. The report also includes aircraft-measured concentrations in tabular form, and maps of the flight paths over which the data were collected.

1. INTRODUCTION

Atmospheric transport and dispersion models are being used extensively to simulate the behavior of air pollutants and to estimate regional pollutant concentrations. Increased concern over regional and international aspects of air pollution and acid deposition has created a need for model calculations as far as 1000 km from pollutant sources. Experimental verification of these calculations is essential for environmental assessments based on model simulations.

The Cross-Appalachian Tracer Experiment (CAPTEX '83) was a major field study to simulate long-range transport of pollutants in the atmosphere. The experiment was a cooperative effort carried out by scientists in the United States and Canada from mid-September through the end of October 1983. The main objectives were to test the tracer technology for application to 1000-km-scale studies, to provide data to evaluate and improve computer models of pollutant dispersion, and to provide insight into the mechanisms involved in long-range transport and dispersion.

The experiment was directed by the NOAA Air Resources Laboratory (ARL). Participants in the United States included the National Weather Service (NWS); the Department of Energy (DOE) and associated laboratories--Environmental Measurements Laboratory (EML), Brookhaven National Laboratory (BNL), Battelle Pacific Northwest Laboratory (PNL), and Los Alamos National Laboratory (LANL); the Environmental Protection Agency (EPA); and the Electric Power Research Institute (EPRI). In Canada, the experiment was coordinated by the Atmospheric Environment Service (AES) of Environment Canada, with participation by the Ministries of Environment of Ontario and Quebec and the National Aeronautical Establishment of the National Research Council.

Development of a tracer system suitable for long-range atmospheric dispersion experiments was begun jointly by the Department of Energy and the NOAA Air Resources Laboratory in 1975. After investigation of many candidate tracers, a perfluorocarbon (perfluoro-monomethyl-cyclohexane [PMCH]: C_7F_{14}) was chosen. Released as a gas, it is inert, harmless, and can be accurately measured at its ambient background concentration of about 3 parts in 10^{15} parts of air. Tracer was released from Dayton, Ohio, on five separate occasions and from Sudbury, Ontario, on two occasions. These locations were chosen, in part, because the Ohio Valley and Sudbury are pollutant source areas that may significantly affect air quality and acid deposition in the northeastern United States and southeastern Canada.

Automatic sequential air samplers were operated at 86 sites in Ohio, Pennsylvania, New Jersey, New York, New England, and southeastern Canada, at distances from 300 to 1100 km from the release site. The tracer was released at ground level over a 3-h period on days when the lower atmosphere wind flow was forecast to carry it over the sampling network. In the United States, most of the samplers were operated by volunteers in the NWS Cooperative Observer Network. In Canada, most were located at government-operated monitoring stations. After each tracer release, the samplers collected six consecutive air samples, from 3 to 6 hours long, to provide a time history of the arrival, peak, and departure of the plume at each site. About 3000 samples collected by this network have been analyzed by EML and BNL.

Seven aircraft were flown by BNL, PNL, and the National Aeronautical Establishment of Canada to gather data on the vertical distributions of the tracer. Over 1600 samples were collected in plume transects from 200 to 900 km downwind of the release point.

NWS and Canadian rawinsonde stations in the CAPTEX area increased their upper-air soundings from twice daily to four times per day whenever tracer material was in the air. Ten additional upper-air sites were established and operated on the same schedule as the NWS stations by PNL under contract to EPRI. The NOAA Wave Propagation Laboratory operated an Upper-Air Profiler at Glens Falls, New York, and auxiliary meteorological tower data were made available by power companies in the CAPTEX area. Also, constant-level balloons were released when the tracer was released, and they were tracked for distances up to about 1000 km.

Tracer concentrations were measured as far as 1100 km away and up to 3 days after release. The data reveal a variety of transport and dispersion patterns--some simple, others more complex--that provide a unique testing ground for validation of the transport and dispersion components of long-range pollution models. The CAPTEX data are available on magnetic tapes from the CAPTEX Data Center at BNL.

This report updates and expands the CAPTEX '83 preliminary report (Ferber and Heffter, 1984).

2. TRACER RELEASES

The tracer, PMCH, is liquid at normal temperature and pressure, so the release system is designed to vaporize the tracer and accurately measure the amount released into the atmopshere. The PMCH is mixed with a stream of nitrogen gas to evaporate it and carry it through the system. The N_2-PMCH mixture then flows through a tube furnace that is kept at a temperature of about 105°C to ensure that the tracer is completely vaporized. The tracer gas passes through a mass flowmeter where the volume is accurately metered and recorded on both a mass flowmeter totalizer and a stripchart recorder. The mass flowmeter provides both instantaneous and totalized volumes. The recorded release rate shows the constancy of release of the tracer and total output over the time of release. The system also includes a large set of crane scales (0-454 kg) and a small balance (0-40 kg) to weigh the tracer reservoir accurately before and after the release, thus providing a check on the total amount released.

The location, date, time, and amount of each of the seven CAPTEX tracer releases are given in Table 1. Release sites are designated by an "R" in Figure 1. The first release from Dayton, Ohio (DAY) was done at Wright-Patterson Air Force Base; the other Dayton releases were at the Dayton International Airport. Note in Table 1 that all releases were 3 hours in duration except for #6, a release of only 32 kg over a half-hour period. This small release amount was intentional, so as to avoid any possible interference with measurements of the tracer plume from a planned Sudbury, Ontario (SUD) release about 12 hours later.

Releases were planned for the early afternoon to assure good vertical mixing of the tracer. However, both Sudbury releases took place after midnight behind cold fronts (also with good vertical mixing) that provided northwesterly winds required to carry the plumes over the sampling array. All CAPTEX tracer releases were at ground level.

Table 1. CAPTEX tracer releases

Release (#)	Release (Site)	Lat. (°N)	Long. (°W)	Date (1983)	Release Period (GMT)	Amount (kg)
1	DAY	39.80	84.05	Sept. 18	1700-2000	208
2	DAY	39.90	84.22	Sept. 25	1705-2005	201
3	DAY	39.90	84.22	Oct. 2	1900-2200	201
4	DAY	39.90	84.22	Oct. 14	1600-1900	199
5	SUD	46.62	80.78	Oct. 26	0345-0645	180
6	DAY	39.90	84.22	Oct. 28	1530-1600	32
7	SUD	46.62	80.78	Oct. 29	0600-0900	183

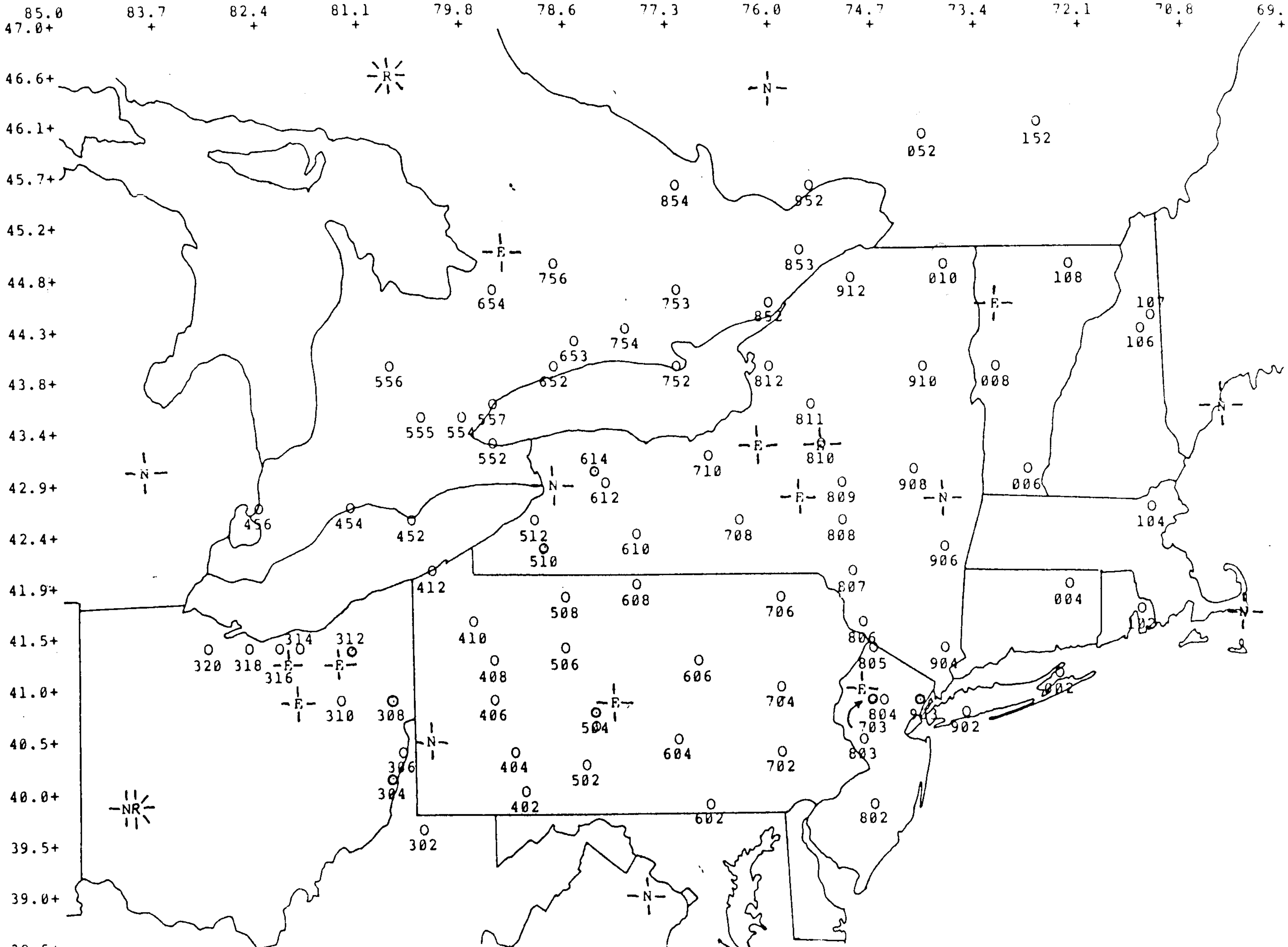


Figure 1. CAPTEX '83 release sites (R), surface sampling sites (circles with site number), network rawinsondes (N), and EPRI rawinsondes (E).

3. GROUND-LEVEL AIR SAMPLING

The CAPTEX sampling sites are shown by the circles in Figure 1. The sites were arrayed in arcs, at approximately 100-km intervals, from 300 km to 1100 km from the Ohio release point. A three-digit number identifies each site. The first digit indicates the distance of the arc from Dayton, in hundreds of kilometers. The last two digits indicate position along the arc from south to north (sites in the United States start from 02 and Canadian sites start from 52). For example, site 406 is a U.S. station on the 400-km arc, and site 454 is a Canadian site on that arc. The location, elevation above mean sea level (msl), latitude, and longitude of each sampling site are listed in Table 2.

The spacing of samplers along each arc approximates expected two plume standard deviations (intended to ensure plume measurements at two or more sites along each arc) and increases linearly with distance from Dayton. The density of sampling sites on the 800-km arc, passing through New York and New Jersey, was doubled to provide more detail on plume structure. Several additional sites were placed just north of Lake Ontario to ensure that plumes from Sudbury would be measured at about 300 km, where the plume could still be fairly narrow.

The automatic sequential sampler used at each site consists of an air flow module (lid) and a power control module (base). The entire unit measures 36x25x20 cm and weighs 7 kg (15 lbs). The lid contains 23 sampling tubes filled with 150 mg of Ambersorb that traps all the perfluorocarbons in the air flowing through the tube. The base contains a constant-volume pump that draws air through each sampling tube in a sequence controlled by an internal digital clock. Flow rates, controlled by critical orifices, are selectable from 2 to 50 cm^3/min. The 50 cm^3/min orifice was used for CAPTEX. The base also contains a digital printer that records the tube number, start time, and number of pump strokes (which are later converted to air volume) for each sample. Controls in the base can be set for automatic start at a preselected day and time and for a preselected number of samples and duration of sampling (1 minute to 1 week per tube). The controls also permit automatic analysis with a gas chromatograph. Power is supplied by internal rechargeable batteries, or the sampler can be connected to an ordinary 110 VAC line. After 23 samples have been collected, the lid can be replaced by a fresh lid to continue the sampling program.

At the time of each tracer release, each sampling site was notified by telephone when to start sampling. Samplers nearest the release point were started a few hours before the expected arrival of the plume; the next group of samplers were started either 3 or 6 hours later; and samplers farther downwind were started at 6-h intervals thereafter. Usually, six consecutive 6-h samples (total duration of 36 hours) were taken at each site; however, sites closest to the release point generally took 3-h samples (total duration of 18 hours) for better definition of the plume. All operable samplers were used in each experiment regardless of the forecast direction of travel, with two exceptions: the 300-km-arc samplers were not used on release #5 from Sudbury, and the Canadian sites were not used on release #6 from Dayton.

The CAPTEX ground sampling data for the seven tracer releases are presented in Tables 3-9. Sampling sites are listed by arcs, beginning with the 300-km arc and ending with the 1100-km arc. Measured concentrations in femtoliters per liter (parts in 10^{15}) are shown for the nearest 3-h period during which sampling was done. Sample duration, either 3 hours or 6 hours, is indicated immediately following the site number. Concentrations measured in a 6-h sample are reported

Table 2. CAPTEX sampling sites

Site (#)	Site (location)	Elevation (m, msl)	Latitude (°N)	Longitude (°W)
A. United States				
302	Hundred, W.VA	354	39.65	80.42
304	Wheeling, W. VA	198	40.07	80.73
306	Steubenville, OH	303	40.38	80.63
308	Lisbon, OH	333	40.77	80.75
310	Akron-Canton AP, OH	369	40.92	81.43
312	Hiram, OH	375	41.30	81.15
314	Cleveland (WSFO), OH	235	41.42	81.87
316	Oberlin, OH	249	41.30	82.22
318	Norwalk, OH	204	41.27	82.62
320	Fremont, OH	183	41.33	83.12
402	Somerset, PA	640	40.00	79.08
404	Blairsville, PA	561	40.43	79.15
406	Kittanning Lock, PA	241	40.82	79.53
408	Clarion, PA	340	41.20	79.43
410	Titusville, PA	372	41.63	79.70
412	Erie (WSO-AP), PA	223	42.08	80.18
502	Saxton, PA	238	40.20	78.25
504	Tyrone, PA	265	40.67	78.23
506	Weedville, PA	538	41.30	78.48
508	Bradford, PA	652	41.80	78.63
510	Little Valley, NY	480	42.25	78.80
512	Gowanda, NY	262	42.48	78.93
602	York, PA	119	39.92	76.75
604	Newport, PA	116	40.48	77.13
606	Williamsport WSO, PA	186	41.25	76.92
608	Westfield, PA	61	41.98	77.57
610	Haskinville, NY	500	42.42	77.57
612	Pavilion, NY	287	42.88	78.03
614	Batavia, NY	278	43.03	78.18
702	Reading, PA	82	40.37	75.93
703	Chester, NJ	289	40.78	74.67
704	Freeland, PA	580	41.02	75.90
706	Montrose, PA	475	41.83	75.87
708	Ithaca, NY	293	42.45	76.45
710	Clyde, NY	128	43.07	76.83
802	Pemberton, NJ	16	39.93	74.70
803	Wertsville, NJ	49	40.45	74.80
804	West Wharton, NJ	223	40.90	74.60
805	High Point Park, NJ	430	41.30	74.67
806	Mongaup Valley, NY	380	41.63	74.80
807	Downsville Dam, NY	396	42.08	74.97
808	Oneonta, NY	427	42.47	75.07

Table 2. (cont.)

Site (#)	Site (location)	Elevation (m, msl)	Latitude (°N)	Longitude (°W)
809	Chepachet, NY	403	42.92	75.12
810	Griffiss AFB, NY	148	43.23	75.40
811	Highmarket, NY	546	43.58	75.52
812	Watertown, NY	97	44.00	76.02
902	Merrick, Ny	6	40.67	73.52
903	Ft. Lee, NJ	70	40.85	73.97
904	Yorktown Hts, NY	204	41.27	73.80
906	Hudson St. School, NY	18	42.25	73.80
908	Broadalbin, NY	256	43.05	74.20
910	Newcomb, NY	506	43.97	74.10
912	Norfolk, NY	70	44.80	75.00
002	Greenport, NY	5	41.10	72.37
004	Stafford Sprgs., CT	139	41.95	72.30
006	Wardsboro, VT	424	43.03	72.80
008	Cornwall, VT	150	43.95	73.22
010	Ellenburg Depot, NY	262	44.90	73.80
102	Providence, RI	16	41.73	71.43
	Lawrence, MA	17	42.70	71.17
106	Mt. Washington, NH	1910	44.27	71.30
107	Gorham, NH	261	44.40	71.18
108	Newport, VT	234	44.93	72.20
B.	Canada			
452	Long Point	175	42.60	80.50
454	Port Stanley	213	42.67	81.15
456	Wilkesport	183	42.70	82.35
552	Vineland	79	43.18	79.40
554	Milton	221	43.52	79.92
555	Waterloo A.	314	43.47	80.38
556	Mt. Forest	415	43.98	80.75
557	Toronto Is. A.	77	42.63	79.40
558	CN Tower	288*	43.65	79.38
559	CN Tower	426*	43.65	79.38
652	Bowmanville	99	43.92	78.67
653	Peterborough A.	191	44.23	78.37
654	Coldwater	280	44.62	79.53
752	Bloomfield	91	43.98	77.22
753	Kaladar	244	44.68	77.15
754	Campbellford	175	44.28	77.78
756	Minden	274	44.93	78.72

42h

Table 3. Ground-level measured concentrations (fl/l) for release #1

START DAY/HR (GMT)

RELEASE	SAMPLING SITE	DURATION (HRS)	18 00	03	06	09	12	15	18	21	19 00	03	06	09	12	15	18	21	20 00	03	06	09	12	15	18	21	21 00	03	06	09	12	15	18
1	302	3							0	1	0	0	0	0																			
1	306	3							0	0	1	0	0	0																			
1	308	3							0	0	0	0	0	0																			
1	310	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	312	3							0	0	0	0	0	0																			
1	314	3							0	197	64	0	0	0																			
1	316	3							22	1586	30	2	0	0																			
1	318	3							0	425	37	0	0	0																			
1	320	3							0	1	1	1	2	0																			
1	402	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	404	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	408	6								0	0	0	0	0	0	0	0	0	0														
1	410	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	412	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	452	6							1	1	26	26	9	9	1	1	1	1	2	2													
1	454	6							0	0	121	121	0	0	0	0	0	0	0	0													
1	456	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	502	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	504	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	508	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	510	6									0	0	0	0	0	0	0	0	0	0	0	0											
1	512	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	552	6							0	0	21	21	89	89	33	33	0	0	0	0													
1	554	6							0	0	0	0	0	0	0	0	6	6	1	1													
1	556	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	602	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	606	6							0	0			0	0	0	0	0	0	0	0													
1	608	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	612	6									26	26	0	0	0	0	0	0	0	0	0	0											
1	614	6							0	0	65	65	2	2	0	0	0	0	0	0													
1	652	6							0	0	0	0																					
1	654	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	702	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	703	6									0	0	0	0	0	0	0	0	0	0	0	0											
1	704	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	706	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	708	6							0	0	0	0	0	0	0	0	0	0	0	0													
1	710	6													19	19	6	6	3	3	0	0	0	0									
1	752	6									0	0	40	40	0	0	0	0	0	0	0	0											
1	753	6									0	0	0	0	0	0	0	0	0	0	1	1											
1	754	6									0	0	0	0	0	0	0	0	0	0	0	0											
1	802	6									0	0	0	0	0	0	0	0	0	0	0	0											
1	804	6									0	0	0	0	0	0	0	0	0	0	0	0											
1	806	6									0	0	0	0	1	1	0	0	0	0	1	1											
1	807	6													0	0	0	0	0	0	0	0	0	0	0	0							
1	809	6									0	0	0	0	5	5	9	9	3	3	2	2											
1	811	6									1	1	17	17	21	21	16	16	5	5	0	0											
1	812	6									21	21	88	88	4	4	16	16	13	13	0	0											
1	852	6									0	0	24	24	0	0	0	0	0	0	0	0											
1	853	6									0	0	0	0																			
1	854	6									0	0	0	0	0	0	0	0	0	0	0	0											
1	902	6									0	0	0	0	0	0	0	0	0	0	0	0											
1	904	6									0	0	0	0	0	0	0	0	0	0	0	0											
1	908	6									4	4	1	1	9	9	7	7	6	6	5	5											
1	910	6									0	0	21	21	16	16	13	13	14	14	12	12											
1	912	6									0	0	25	25	0	0	0	0	1	1	5	5											
1	952	6													0	0	0	0	0	0	0	0	1	1									
1	2	6																	0	0	0	0	0	0	0	0	0	0	0	0			
1	4	6									0	0	0	0	3	3	0	0	0	0	0	0											
1	6	6									0	0	13	13	11	11	7	7	2	2	2	2											
1	8	6									0	0	2	2	9	9	10	10	6	6	5	5											
1	10	6									0	0	29	29	0	0	0	0	0	0	4	4											
1	52	6										0	0	0	0	0	0	0	0	0	0	0	0										
1	102	6									0	0	0	0	2	2	1	1	0	0	0	0											
1	106	6									0	0	12	12			9	9	3	3	0	0											
1	107	6									0	0	0	0	47	47	16	16	14	14	10	10											
1	108	6									0	0	8	8	23	23	0	0	0	0	1	1											
1	152	6																0	0	0	0	0	0	1	1	0	0	0	0				

Table 4. Ground-level measured concentrations (fl/l) for release #2

Release	Sampling site	Duration (hrs)	25/00	25/03	25/06	25/09	25/12	25/15	25/18	25/21	26/00	26/03	26/06	26/09	26/12	26/15	26/18	26/21	27/00	27/03	27/06	27/09	27/12	27/15	27/18	27/21	28/00	28/03	28/06	28/09	28/12	28/15	28/18
2	306	3							0	0	0	0	1	1																			
2	308	3							0	0	0	0	0	0																			
2	310	3							0	0	0	6	0	10																			
2	312	3							0	0	0	0	0	12																			
2	314	3							0	0	0	87	407	329																			
2	316	3							1	1	44	293	483	768																			
2	318	3							0	0	228	1348	1575	1399																			
2	320	3							0	0	2	2	28	64																			
2	402	6								0	0	0	0	0	0	0	0	0	0	0	0												
2	404	6								0	0	0	0	0	0	0	0	0	0	0	0												
2	406	6								0	0	0	0	0	0	2	2	0	0	0	0												
2	408	6								0	0	0	0	0	0	23	23	19	19	19	19												
2	410	6								0	0			0	0	84	84	58	58	59	59												
2	412	6								0	0	3	3	72	72	200	200	2	2	2	2												
2	452	6								1	1	39	39	27	27	1	1	2	2	1	1												
2	454	6								0	0	47	47	0	0	0	0	0	0	0	0												
2	456	6								0	0	0	0	0	0	0	0	0	0	0	0												
2	502	6							0	0	0	0	0	0	0	0	0	0	0	0													
2	504	6								0	0	0	0	0	0	1	1	1	1	2	2												
2	508	6								0	0	0	0	6	6	93	93	93	93	64	64												
2	510	6														59	59	86	86	64	64	41	41	4	4	0	0						
2	512	6								1	1	1	1	7	7	92	92	4	4	16	16												
2	552	6										0	0	60	60	0	0	2	2	0	0	1	1										
2	554	6								0	0	0	0	13	13	0	0	0	0	0	0												
2	556	6								0	0	0	0	0	0	0	0	0	0	0	0												
2	602	6										0	0	0	0	0	0	0	0	0	0	0	0										
2	604	6										0	0	0	0	5	5	10	10	4	4	3	3										
2	608	6										1	1	17	17	115	115	67	67	42	42	7	7										
2	612	6										0	0	113	113	108	108	2	2	2	2	1	1										
2	614	6										0	0	111	111	93	93	0	0	2	2	0	0										
2	652	6										0	0	0	0	0	0	0	0	0	0	0	0										
2	653	6										0	0	0	0	0	0	0	0	0	0	0	0										
2	654	6										0	0	0	0	0	0	0	0	0	0	0	0										
2	702	6																2	2	1	1	1	1	12	12	4	4	5	5				
2	703	6																0	0	1	1	20	20	16	16	5	5	2	2				
2	704	6												3	3	5	5	25	25	17	17	22	22	10	10								
2	706	6												0	0	0	0	1	1	12	12	96	96	36	36								
2	708	6												0	0	94	94	96	96	63	63	46	46	1	1								
2	710	6													40	40	133	133	39	39	43	43	13	13	0	0							
2	752	6												2	2	22	22	0	0	0	0	0	0	0	0								
2	753	6												0	0	0	0																
2	754	6												0	0	0	0	0	0	0	0	0	0	0	0								
2	802	6												0	0	0	0	0	0	0	0	4	4	34	34								
2	803	6												0	0	0	0	0	0	0	0	4	4	16	16								
2	804	6												0	0	0	0	0	0	0	0	15	15	14	14								
2	805	6												0	0	0	0	0	0	7	7	20	20	7	7								
2	806	6												1	1	1	1	1	1	2	2	31	31	22	22								
2	807	6												0	0	0	0	9	9	27	27	39	39	12	12								
2	808	6												0	0	7	7	32	32	73	73	72	72	11	11								
2	810	6												0	0	11	11	28	28	33	33	42	42	7	7								
2	811	6												0	0	7	7	93	93	43	43	7	7	1	1								
2	812	6												0	0	2	2	18	18														
2	852	6												0	0	35	35	0	0	0	0	0	0	0	0								
2	902	6														0	0	0	0	0	0	19	19	36	36	27	27						
2	904	6																0	0	0	0	18	18	39	39	15	15	0	0	0	0		
2	908	6														1	1	0	0	3	3	21	21	4	4	0	0						
2	910	6																19	19	50	50	7	7	0	0	0	0	0	0				
2	912	6														16	16	57	57	22	22	3	3	0	0	0	0						
2	952	6														1	1	0	0	1	1	0	0	0	0	0	0						
2	2	6																0	0	0	0	16	16	43	43	44	44	2	2				
2	6	6																0	0	31	31	31	31	3	3	3	3	0	0				
2	8	6																2	2	2	2	27	27	10	10	0	0	0	0				
2	10	6																26	26	27	27	1	1	0	0	0	0	0	0				
2	52	6																		12	12	0	0	0	0	0	0	0	0	0	0		
2	102	6																		0	0	7	7	10	10	4	4	[illegible]	1	0	0		
2	107	6																		4	4	32	32	10	10	0	0	0	0				
2	108	6																		10	10	29	29	2	2	0	0	[illegible]	1	0	0		
2	152	6																		23	23	9	9	0	0	0	0	0	0	0	0		

Table 5. Ground-level measured concentrations (fl/l) for release #3

Release	Sampling site	Duration (hrs)	2/00	2/03	2/06	2/09	2/12	2/15	2/18	2/21	3/00	3/03	3/06	3/09	3/12	3/15	3/18	3/21	4/00	4/03	4/06	4/09	4/12	4/15	4/18	4/21	5/00	5/03	5/06	5/09	5/12	5/15	5/18
3	306	3								0	0	1	1	1	1																		
3	308	3								0	0	0	0	0	0																		
3	310	3								0	0	0	0	0	0																		
3	312	3								0	0	0	0	0	0																		
3	314	3								0	0	0	0	0	0																		
3	316	3								0	0	1	2	2	3																		
3	318	3								0	0	0	0	0	0																		
3	320	3								1	71	304	21	3	1																		
3	402	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	404	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	406	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	408	6									0	0	0	0	0	0			0	0	0	0											
3	410	6									0	0	0	0	0	0	0	0	0	0													
3	412	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	452	6									1	1	1	1	1	1	2	2	1	1	1	1											
3	454	6									0	0	1	1	0	0	1	1	3	3	0	0											
3	456	6								0	0	0	0	15	15	0	0	0	0	0	0												
3	502	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	504	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	508	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	510	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	512	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	552	6									0	0	0	0	0	0	0	0	0	0	0	0											
3	554	6															0	0	1	1	0	0											
3	556	6									0	0	18	18			0	0	0	0	0	0											
3	602	6											0	0	0	0	0	0	0	0	0	0	0	0									
3	604	6											0	0	0	0	0	0	0	0	0	0	0	0									
3	606	6											0	0							0	0	0	0	0	0	0	0			0	0	
3	608	6											0	0	0	0	0	0	0	0	0	0	0	0									
3	612	6											7	7	0	0	0	0	0	0	1	1	0	0									
3	614	6											5	5	0	0	0	0	0	0	0	0	0	0									
3	652	6													2	2	0	0	4	4	5	5	0	0									
3	653	6											0	0	0	0	0	0	0	0	0	0	0	0									
3	654	6											0	0	13	13	1	1			4	4	0	0									
3	702	6											0	0	0	0	0	0	0	0	0	0	0	0									
3	703	6													0	0	2	2	0	0	0	0	0	0	0	0							
3	704	6											2	2	2	2	4	4	3	3	2	2											
3	706	6											1	1	0	0	8	8	3	3	8	8	10	10									
3	708	6											0	0	0	0	0	0	0	0	0	0	0	0									
3	710	6													3	3	0	0	0	0	0	0	0	0	0	0							
3	752	6											0	0	11	11	1	1	0	0	0	0	0	0									
3	753	6											0	0	1	1	0	0	0	0	0	0	0	0									
3	754	6											0	0	0	0	0	0	1	1	0	0	0	0									
3	802	6													0	0	0	0	0	0	0	0	0	0	0	0							
3	803	6																						0	0	0	0	0	0	0	0		
3	804	6													0	0	8	8	4	4	0	0	0	0	0	0							
3	805	6													0	0	9	9	0	0	0	0	0	0	0	0							
3	807	6													18	18	68	68	77	77	49	49	19	19	3	3							
3	808	6													6	6	5	5	2	2	0	0	0	0	1	1							
3	809	6													63	63	3	3	2	2	2	2	2	2	1	1							
3	810	6													35	35	3	3	0	0	0	0	0	0	0	0							
3	811	6													23	23	10	10	1	1	2	2			3	3							
3	852	6													7	7	0	0	0	0	0	0	0	0	0	0							
3	902	6													0	0	0	0	0	0	0	0	0	0	0	0							
3	904	6													0	0	1	1	0	0	0	0	0	0	0	0							
3	908	6													2	2	23	23	0	0	0	0	1	1	1	1							
3	910	6													1	1	7	7	6	6	0	0	0	0	0	0							
3	912	6													9	9	6	6	1	1	1	1	0	0	0	0							
3	952	6													1	1	5	5	1	1	0	0	0	0	0	0							
3	2	6																					0	0	0	0							
3	4	6														0	0	0	0	0	0	0	0	0	0	0	0						
3	6	6													0	0	53	53	162	162	12	12	0	0	0	0							
3	8	6													0	0	13	13	82	82	79	79	28	28	0	0							
3	10	6													1	1	6	6	0	0	0	0	0	0	0	0							
3	52	6										0	0	0	0	3	3	1	1	1	1	0	0										
3	102	6															0	0	0	0	0	0	0	0	0	0	0	0					
3	106	6															3	3	5	5	4	4	0	0	0	0	0	0					
3	107	6																4	4	20	20	14	14	3	3	1	1	0	0				
3	108	6															1	1	29	29	3	3	1	1	0	0	1	1					
3	152	6															1	1	1	1	0	0	0	0	0	0	0	0					

Table 6. Ground-level measured concentrations (fl/l) for release #4

6 9 12 15 18 21 24 30 36 42 48

RELEASE	SAMPLING SITE	DURATION (HRS)	START DAY/HR (GMT) 14/00	03	06	09	12	15	18	21	15/00	03	06	09	12	15	18	21	16/00	03	06	09	12	15	18	21	17/00	03	06	09	12	15	18
4	306	3							0	0	0	0	0	1																			
4	308	3							0		33	25	18	13																			
4	310	3							0	935	1350	248	216	100																			
4	312	3							0		0	0	1	9																			
4	314	3							0	0	0	0	0	0																			
4	318	3							0	0	0	0	0	0																			
4	320	3							0	0	0	0	0	0																			
4	404	3								0	0	0	3	2	5																		
4	406	3								0	0	2	0	0	1																		
4	412	3								0	0	0	0	0	0																		
4	454	3								0	0	0	0	0	0																		
4	456	3								0	0	0	0	0	0																		
4	502	6								2	2	6	6	8	8	3	3	8	8	12	12												
4	504	6								0	0	0	0	44	44	9	9	37	37	28	28												
4	506	6								0	0	198	198	158	158	12	12	0	0	0	0												
4	508	6								0	0	0	0	0	0	0	0	0	0	0	0												
4	510	6								0	0	0	0	0	0	0	0	0	0	0	0												
4	512	6								0	0	0	0	0	0	0	0	1	1	0	0												
4	554	6								0	0	0	0	0	0	0	0	0	0	0	0												
4	556	6								1	1	0	0	0	0	0	0	0	0	0	0												
4	602	6								0	0	21	21	7	7	13	13	23	23	21	21												
4	604	6								0	0	139	139																				
4	606	6								0	0	11	11	158	158	8	8	0	0	2	2												
4	608	6								0	0	0	0	1	1	0	0	0	0	1	1												
4	612	6								0	0	1	1	1	1	0	0	0	0	1	1												
4	614	6								0	0	0	0	0	0	0	0	0	0	0	0												
4	652	6								0	0	0	0	0	0	0	0	0	0	0	0												
4	654	6								0	0					0	0	1	1	1	1												
4	702	6								0	0	90	90	162	162	40	40	21	21	11	11												
4	703	3								0	0	0	31	210	156	10	0	0	0														
4	706	6														0	0	0	0	0	0	0	0	0	0	0	0						
4	708	6								0	0	0	0	1	1	0	0	1	1	1	1												
4	710	6													0	0	0	0	0	0	0	0	0	0	0	0							
4	752	6								0	0	0	0	0	0	1	1	0	0	0	0												
4	753	3										0	0	0	0	0	0																
4	754	6								0	0	0	0	0	0	0	0	0	0	0	0												
4	756	6								1	1	1	1	0	0	0	0	0	0	2	2												
4	802	6								0	0	0	0	42	42	26	26	16	16	3	3												
4	803	6								0	0	18	18	155	155	24	24	0	0	0	0												
4	804	6								0	0	4	4	133	133	3	3	0	0	0	0												
4	805	6								0	0	0	0	2	2	0	0	0	0	0	0												
4	806	6								0	0	0	0	0	0	0	0	0	0	0	0												
4	807	6													0	0	1	1	0	0													
4	809	6										0	0	0	0	0	0	0	0	0	0	0	0										
4	810	6										0	0	0	0	0	0	0	0	0	0	0	0										
4	811	6										1	1	0	0	0	0	0	0	0	0	0	0										
4	852	6														0	0	0	0	0	0	0	0										
4	902	6								0	0	0	0	91	91	6	6	0	0	0	0												
4	903	6								0	0	2	2	115	115	0	0	0	0	0	0	0	0										
4	904	6											0	0	0	0	0	0	1	1	0	0	0	0									
4	908	6										0	0	0	0	0	0	0	0	1	1												
4	910	6										0	0	0	0	0	0	0	0	0	0	0	0										
4	912	6										1	1	0	0	0	0	0	0	0	0	0	0										
4	952	6										0	0	0	0	0	0	0	0	0	0	0	0										
4	2	6										0	0	0	0	0	0	0	0	0	0	0	0										
4	4	6										0	0	0	0	0	0	0	0	0	0	0	0										
4	6	6												0	0	0	0	0	0	0	0												
4	10	6												0	0	0	0	0	0	0	0	0	0	0	0								
4	52	6												0	0	0	0	0	0	0	0	0	0	0	0								
4	102	6										0	0	0	0	0	0	0	0	0	0	0	0										
4	104	6										0	0	0	0	0	0	0	0	0	0	0	0										
4	106	6										0	0	0	0	0	0	0	0	0	0	0	0	0	0								
4	108	6										0	0	0	0	0	0	0	0	0	0	0	0	0	0								

Table 7. Ground-level measured concentrations (fl/l) for release #5

RELEASE	SAMPLING SITE	DURATION (HRS)	START DAY/HR (GMT) 26 00	03	06	09	12	15	18	21	27 00	03	06	09	12	15	18	21	28 00	03	06	09	12	15	18	21	29 00	03	06	09	12	15	18
5	404	6								0	0	0	0	0	0	0	0	1	1	0	0												
5	406	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	408	6						0	0	0	0	0	0	0	0	0	0	0	0														
5	412	6						0	0	0	0	0	0	0	0	0	0	0	0														
5	454	6				0	0	0	0	0	0	0	0	0	0	0	0																
5	502	6								0	0	0	0	0	0	0	0	1	1	0	0												
5	504	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	506	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	508	6						0	0																								
5	510	6						0	0	0	0	0	0	0	0	0	0	0	0														
5	554	6				0	0	0	0	0	0	0	0	0	0	0	0																
5	556	6				1	1	0	0	1	1	1	1	1	1	2	2																
5	602	6								0	0	0	0	1	1	1	1	0	0	0	0												
5	606	6								0	0	2	2	2	2	0	0	1	1	1	1												
5	608	6						1	1	0	0	1	1	1	1	1	1	1	1														
5	610	6						0	0	0	0	0	0	0	0	0	0	0	0														
5	614	6						0	0	0	0	1	1	1	1	1	1	1	1														
5	652	6				0	0	0	0	0	0	0	0	0	0	0	0																
5	653	6				167	167	220	220	0	0	0	0	0	0	0	0																
5	654	6				13	13	0	0			0	0	0	0	0	0																
5	702	6								0	0	0	0	0	0	0	0	0	0	1	1												
5	703	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	704	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	706	6					0	0	1	1	2	2	0	0	2	2	0	0															
5	708	6						0	0	1	1	0	0	1	1	0	0	1	1														
5	710	6						0	0	0	0	0	0	0	0	0	0	0	0														
5	752	6				3	3	453	453	4	4																						
5	753	6								0	0	0	0	0	0	0	0																
5	754	6				0	0	431	431	0	0	1	1	1	1	2	2																
5	756	6				162	162	460	460	4	4	5	5	2	2	7	7																
5	802	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	803	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	804	6						0	0	0	0	0	0	0	0	0	0	0	0														
5	805	6						0	0	0	0	0	0	0	0	0	0	0	0														
5	806	6						0	0	0	0	0	0	0	0	0	0	0	0														
5	807	6						0	0	0	0	0	0	0	0	1	1	1	1														
5	808	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	809	6						2	2	10	10	7	7	5	5	3	3	2	2														
5	810	6						59	59	73	73	6	6	0	0	0	0		0	0													
5	811	6								328	328	0	0	0	0	0	0	0	0														
5	852	6				0	0	0	0	0	0	0	0	0	0	1	1																
5	902	6								0	0	0	0	0	0	0	0	0	0	1	1												
5	904	6					0	0	0	0	0	0	0	0	0	0	0	0															
5	908	6						5	5	384	384	12	12			0	0	0	0														
5	910	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	912	6						0	0	0	0	0	0	0	0	0	0	0	0														
5	952	6				0	0	0	0	0	0	0	0	0	0	0	0																
5	2	6								0	0	0	0	0	0	1	1	0	0	0	0												
5	4	6						0	0	1	1	2	2	3	3	2	2	0	0														
5	10	6						0	0	0	0																						
5	52	6		0	0	0	0	0	0	0	0	0	0	0	0																		
5	102	6								0	0	3	3	2	2	10	10	0	0	0	0												
5	104	6								1	1	33	33	125	125	4	4	0	0	0	0												
5	106	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	107	6								0	0	0	0	0	0	0	0	0	0	0	0												
5	108	6						0	0	0	0	0	0	0	0	0	0	0	0														

Table 8. Ground-level measured concentrations (fl/l) for release #6

15:30 x6

RELEASE	SAMPLING SITE	DURATION (HRS)	START DAY/HR (GMT) 28 00	03	06	09	12	15	18	21	29 00	03	06	09	12	15	18	21	30 00	03	06	09	12	15	18	21	31 00	03	06	09	12	15	1[illegible]
6	306	3						0	0	0	0																						
6	308	3						0	0	0	0																						
6	310	3						0	7	0	0																						
6	312	3						1			0																						
6	314	3						0	0	0	0																						
6	318	3						0	0	0	0																						
6	320	3						0	0	0	0																						
6	404	3							1	0	0																						
6	406	18							0	0	0	0	0	0																			
6	412	3								0	0	0																					
6	454	3							0	0	0																						
6	456	3								0	0	0																					
6	502	6							0	0	0	0																					
6	504	6							0	0	0	0																					
6	506	6							0	0	0	0																					
6	508	6							8	8	0	0																					
6	510	6							0	0	0	0																					
6	602	6							0	0	0	0																					
6	606	6								0	0	1	1																				
6	608	6							10	10	7	7																					
6	614	6							0	0	0	0																					
6	702	6								0	0	0	0																				
6	703	6									0	0	0	0																			
6	704	6							0	0	0	0	0	0																			
6	706	6							0	0	2	2	1	1																			
6	708	6									0	0	0	0																			
6	710	6									0	0																					
6	802	6									0	0	0	0																			
6	803	6										0	0																				
6	804	6									0	0	0	0																			
6	805	6								0	0	0	0																				
6	806	6									1	1	0	0																			
6	807	6									4	4	0	0																			
6	808	6								0	0	0	0																				
6	810	6									0	0	0	0																			
6	811	6									0	0																					
6	902	6									0	0	0	0																			
6	904	6										0	0	0	0																		
6	908	6									0	0	0	0																			
6	910	6									0	0	0	0																			
6	912	6									0	0	0	0																			
6	2	6										0	0	0	0																		
6	4	6									0	0	0	0																			
6	102	6									0	0	0	0																			
6	104	6									0	0	0	0																			
6	106	6									0	0	0	0																			
6	107	6									0	0	0	0																			
6	108	6									0	0	0	0																			

Table 9. Ground-level measured concentrations (fl/l) for release #7

RELEASE	SAMPLING SITE	DURATION (HRS)	START DAY/HR (GMT) 29 00	03	06	09	12	15	18	21	30 00	03	06	09	12	15	18	21	31 00	03	06	09	12	15	18	21	01 00	03	06	09	12	15	18
7	306	3		0	0	1	0	0	0	0	0																						
7	308	3		0	0	0																											
7	310	3		0	0	0	0	0	0	0	0																						
7	312	3		0	0																												
7	314	3		0	0	0	0	0	0	0	0																						
7	318	3		0	0	0	0	0	0	0	0																						
7	320	3		0	0		0	0	0	0	1																						
7	404	3		1	1	1																											
7	406	18		0	0	0	0	0	0	0	0	0	98	98	98	98	98	98	71	71	71	71	71	71	13								
7	412	3			0	0	0																										
7	454	3		0	0	0	0	0	0	0	0	0	0	0	0	0	2	2															
7	456	3			0	0	0																										
7	502	6			0	0	0	0	0	0	62	62																					
7	504	6			0	0	0	0	0	0	273	273																					
7	506	6			0	0	0	0	15	15	349	349																					
7	508	6			0	0	0	0	277	277	553	553																					
7	510	6			0	0	107	107	546	546	238	238																					
7	552	3					309	536																									
7	554	3		0	0	0	169	239	0																								
7	556	3		0	0	0	0	0	0																								
7	602	6			0	0	0	0	1	1	0	0																					
7	606	6				1	1	1	1	112	112	20	20																				
7	608	6			1	1	8	8	114	114	332	332																					
7	614	6			0	0	17	17	128	128	326	326																					
7	652	3		0	0	0	0	0	0																								
7	653	3		0	0	0	0	0	0																								
7	654	3		0	0	107	56	202	0																								
7	702	6				0	0	0	0	17	17	3	3																				
7	703	6			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0											
7	704	6			0	0	0	0	2	2	0	0																					
7	706	6			1	1	0	0	2	2																							
7	708	6			0	0	0	0	0	0	0	0	1	1																			
7	710	6					0	0	0	0	0	0	1	1																			
7	753	3		0	0	0	0	0	0																								
7	754	3		0	0	0	0	0	0																								
7	802	6			0	0	0	0	0	0	0	0	0	0																			
7	803	6				0	0	0	0	0	0	0	0	0	0																		
7	804	6			0	0	0	0	0	0	0	0	0	0																			
7	805	6		0	0	0	0	0	0	0	0	0	0																				
7	806	6			0	0	0	0	0	0	0	0	0	0																			
7	807	6			0	0																											
7	808	6		0	0	0	0			0	0	0	0																				
7	810	6			0	0	0	0	0	0	0	0	0	0																			
7	852	3		0	0	0	0	1	1																								
7	902	6			0	0	0	0	0	0	0	0	1	1																			
7	904	6				0	0	0	0	0	0	0	0	0	0																		
7	908	6			0	0	0	0	0	0																							
7	910	6			0	0	0	0	0	0	0	0	0	0																			
7	912	6			0	0	0	0	0	0	0	0	0	0																			
7	952	3		0	0	0	0	0	0																								
7	2	6				0	0	1	1	0	0	0	0	1	1																		
7	4	6			0	0	0	0	0	0	0	0	0	0																			
7	52	3		0	0	0	0	0	0																								
7	102	6			0	0	0	0	0	0	0	0	0	0																			
7	104	6			0	0	0	0	0	0	0	0	0	0																			
7	106	6			0	0	0	0	0	0	0	0	0	0																			
7	107	6			0	0	0	0	0	0	0	0	0	0																			
7	108	6			0	0	0	0	0	0	0	0	0	0																			

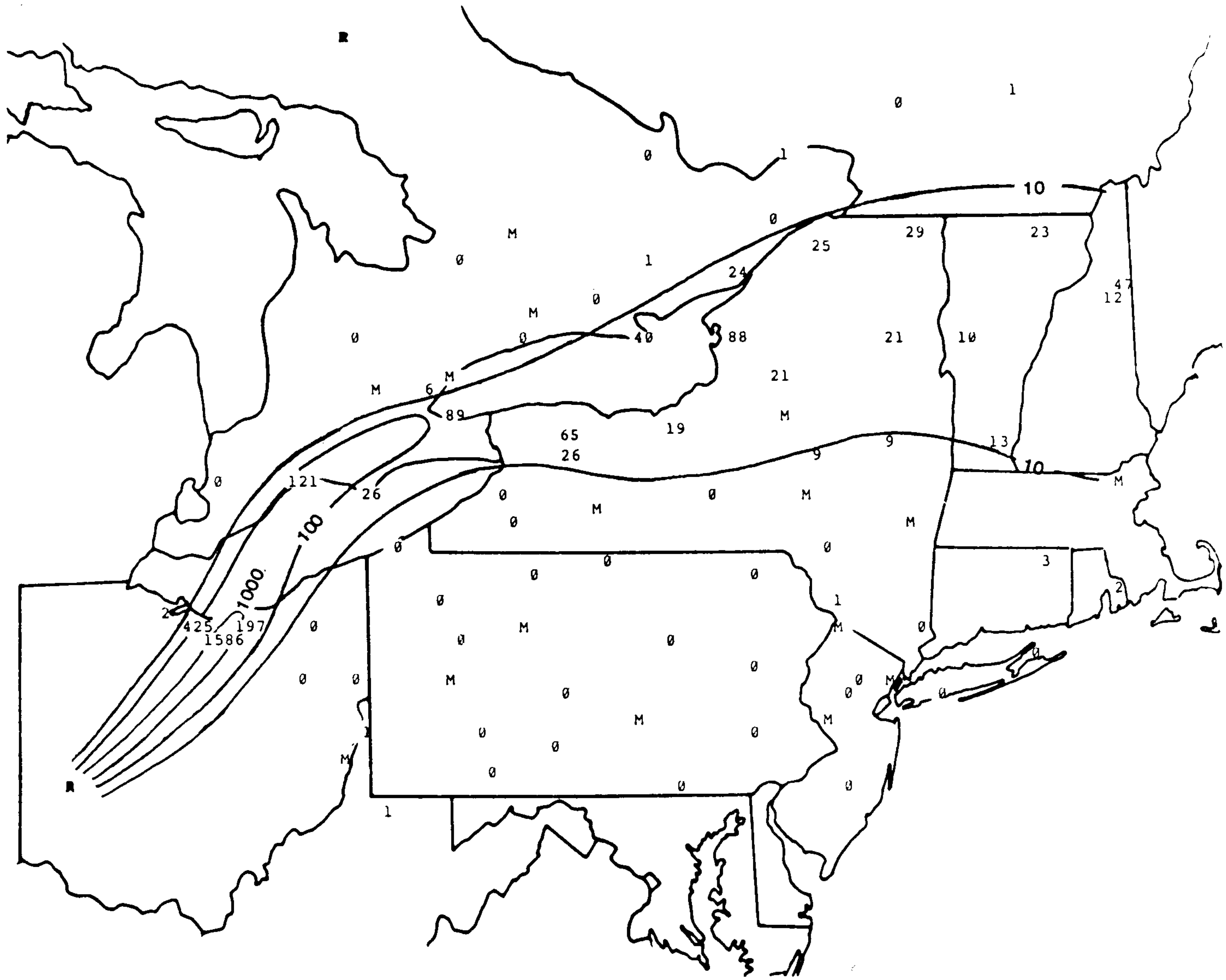


Figure 2. Maximum tracer concentration (fl/l) measured at each sampling site after release #1.

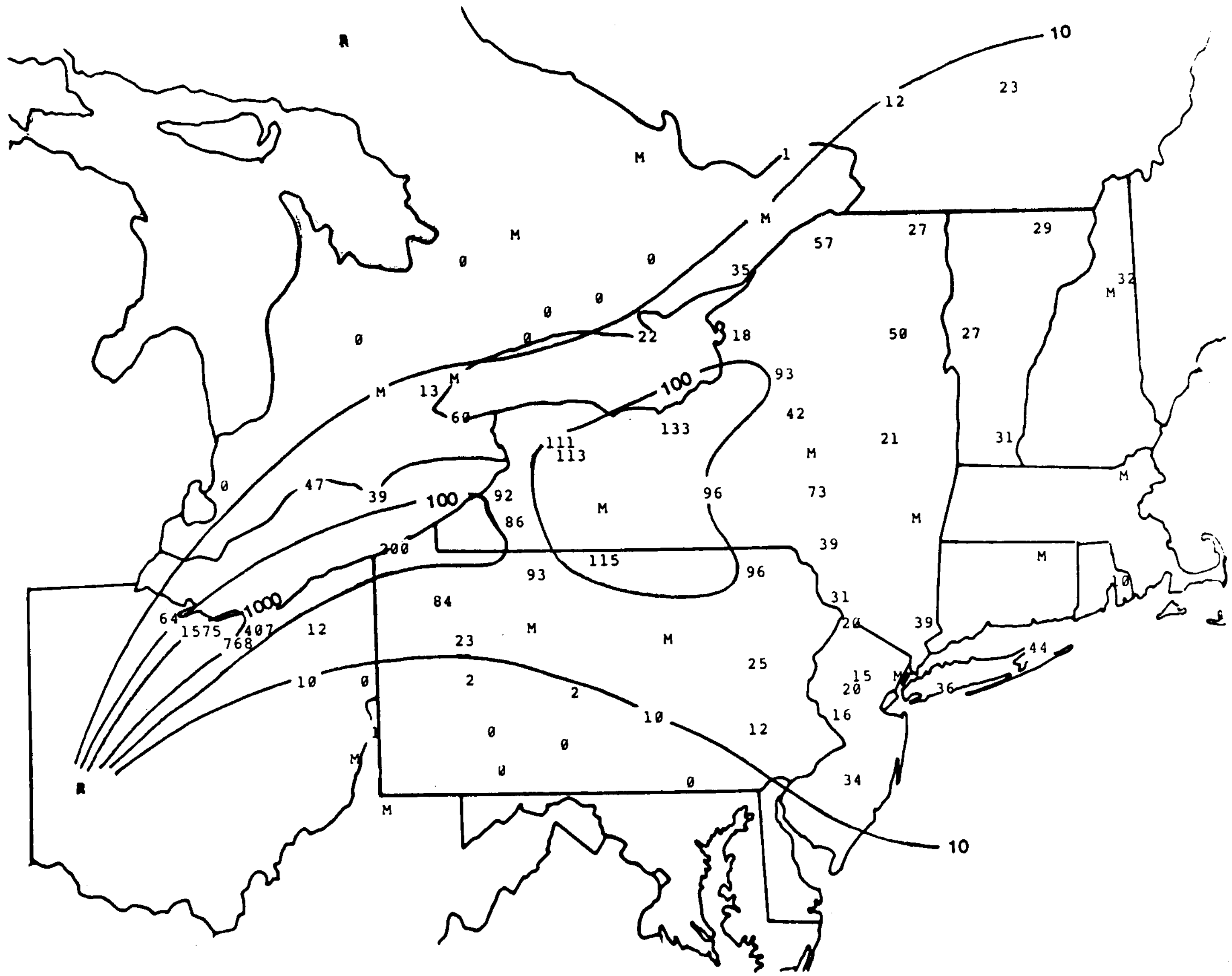


Figure 3. Maximum tracer concentration (fl/l) measured at each sampling site after release #2.

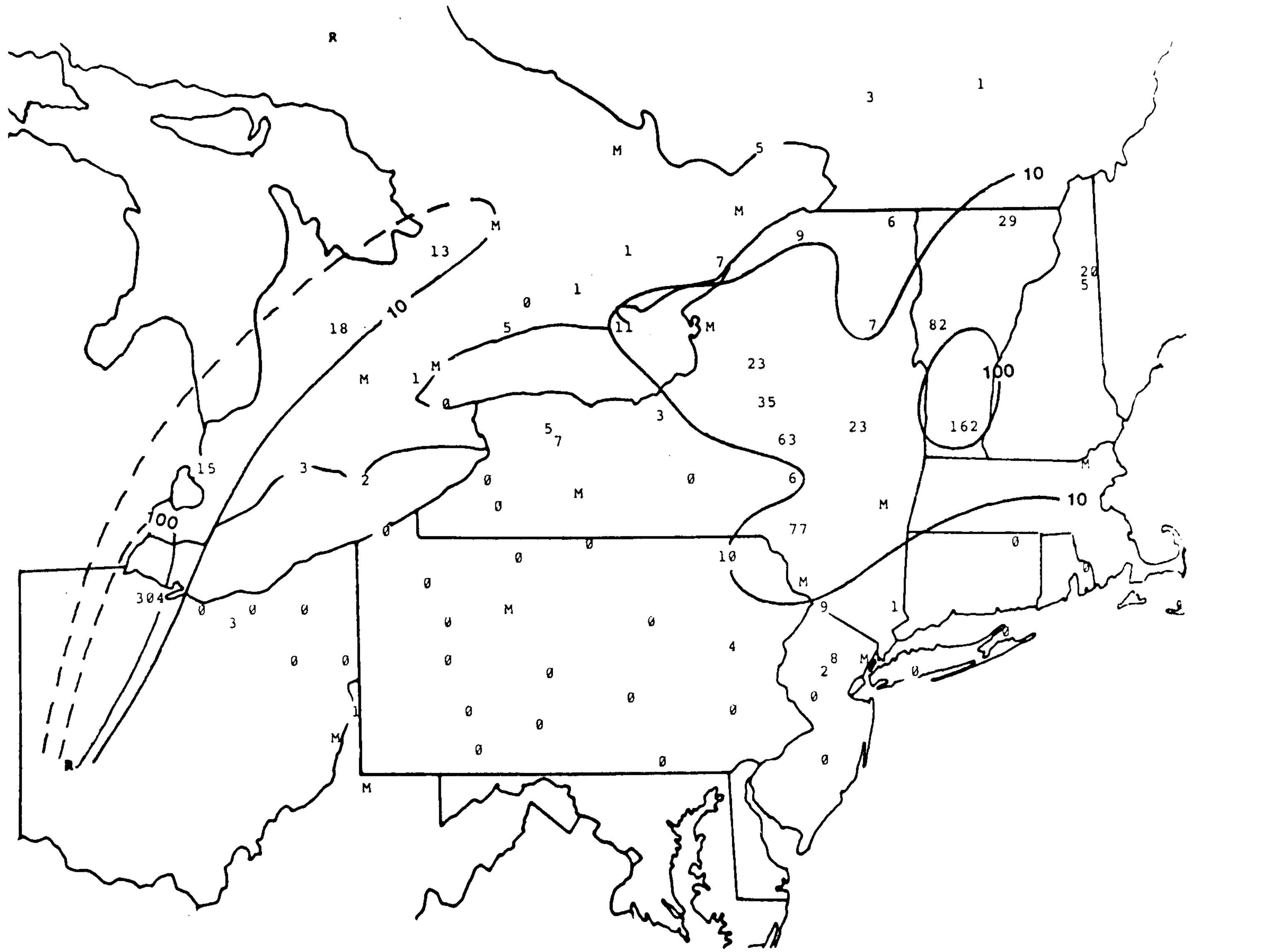


Figure 4. Maximum tracer concentration (fl/l) measured at each sampling site after release #3.

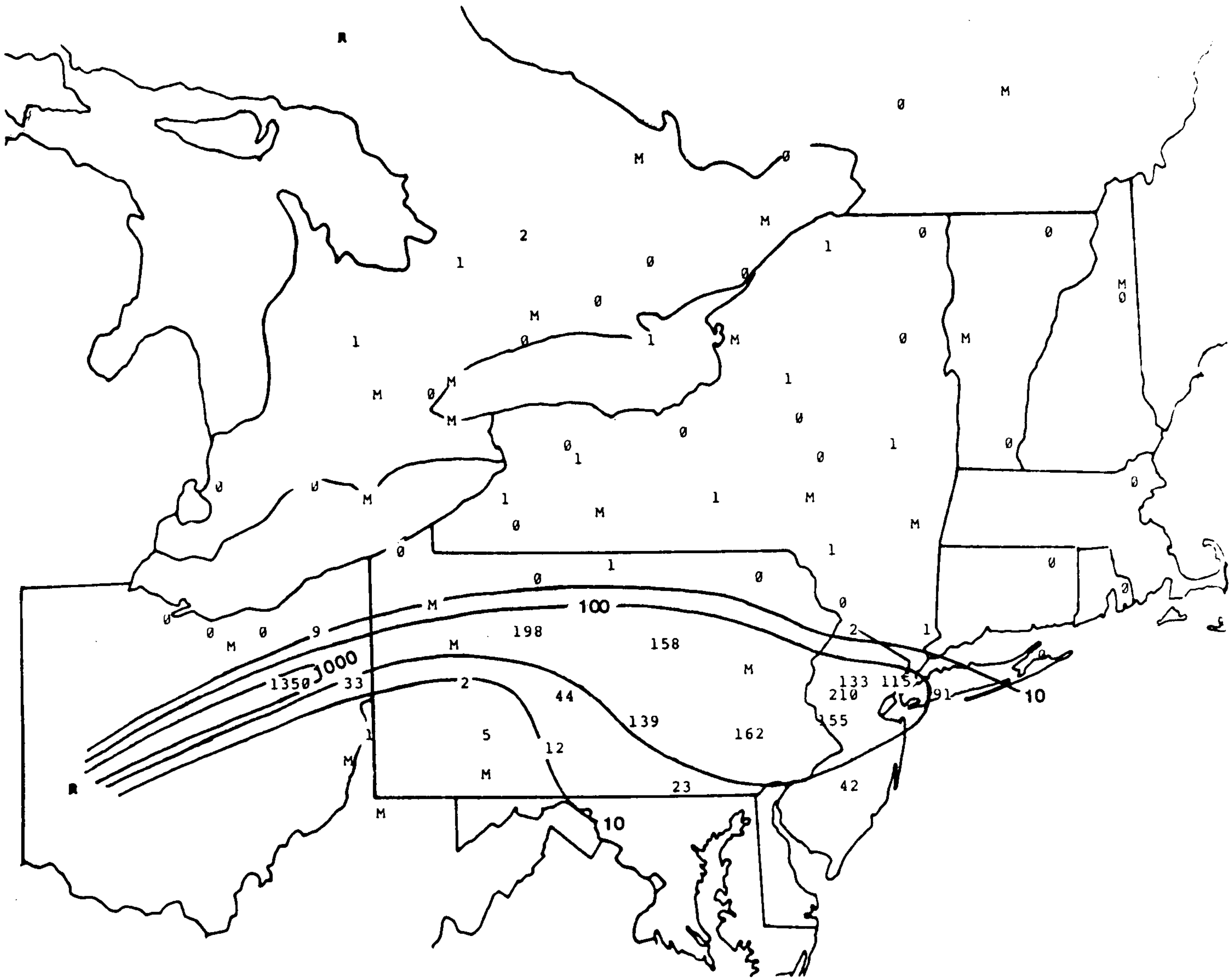


Figure 5. Maximum tracer concentration (fl/l) measured at each sampling site after release #4.

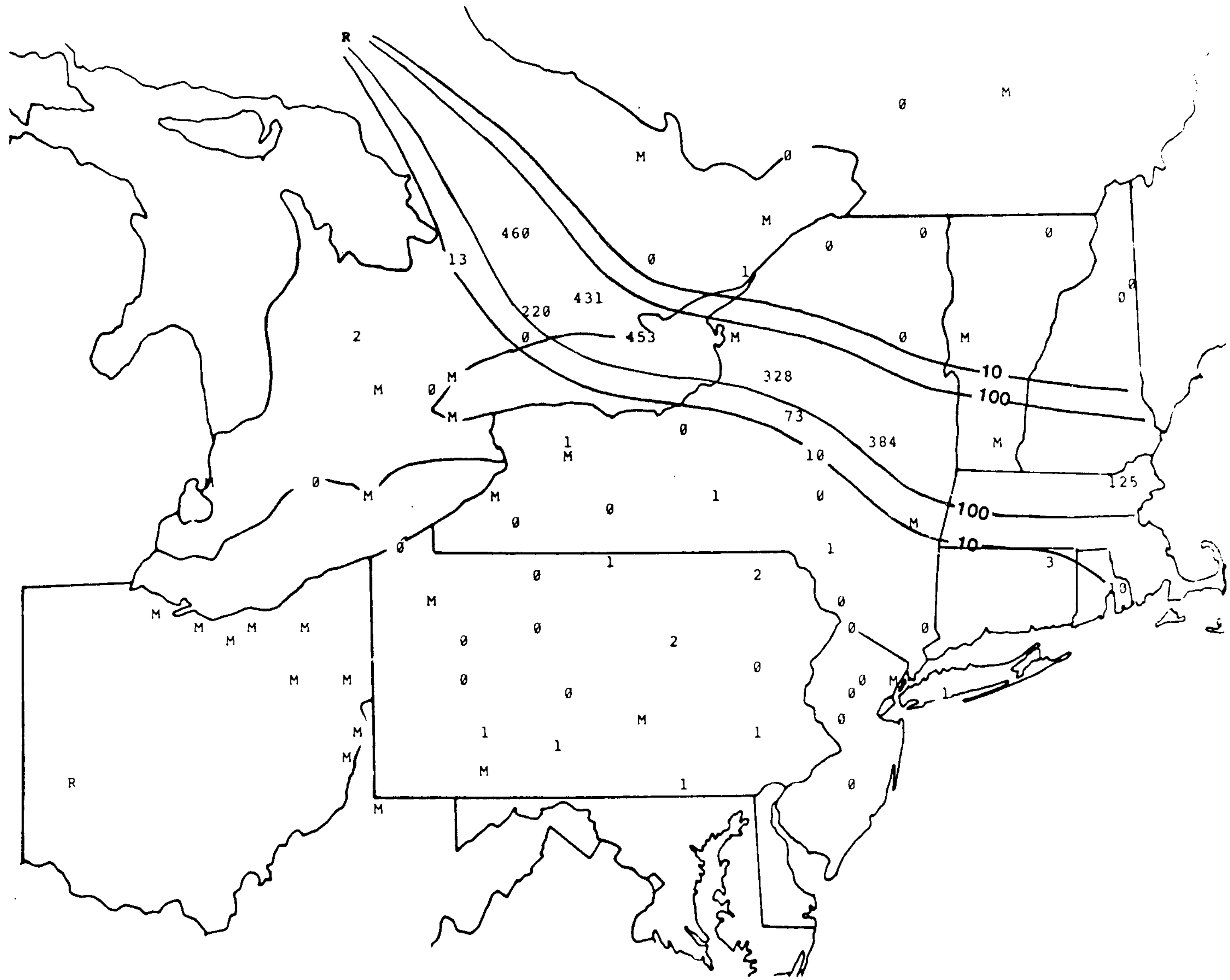


Figure 6. Maximum tracer concentration (fl/l) measured at each sampling site after release #5.

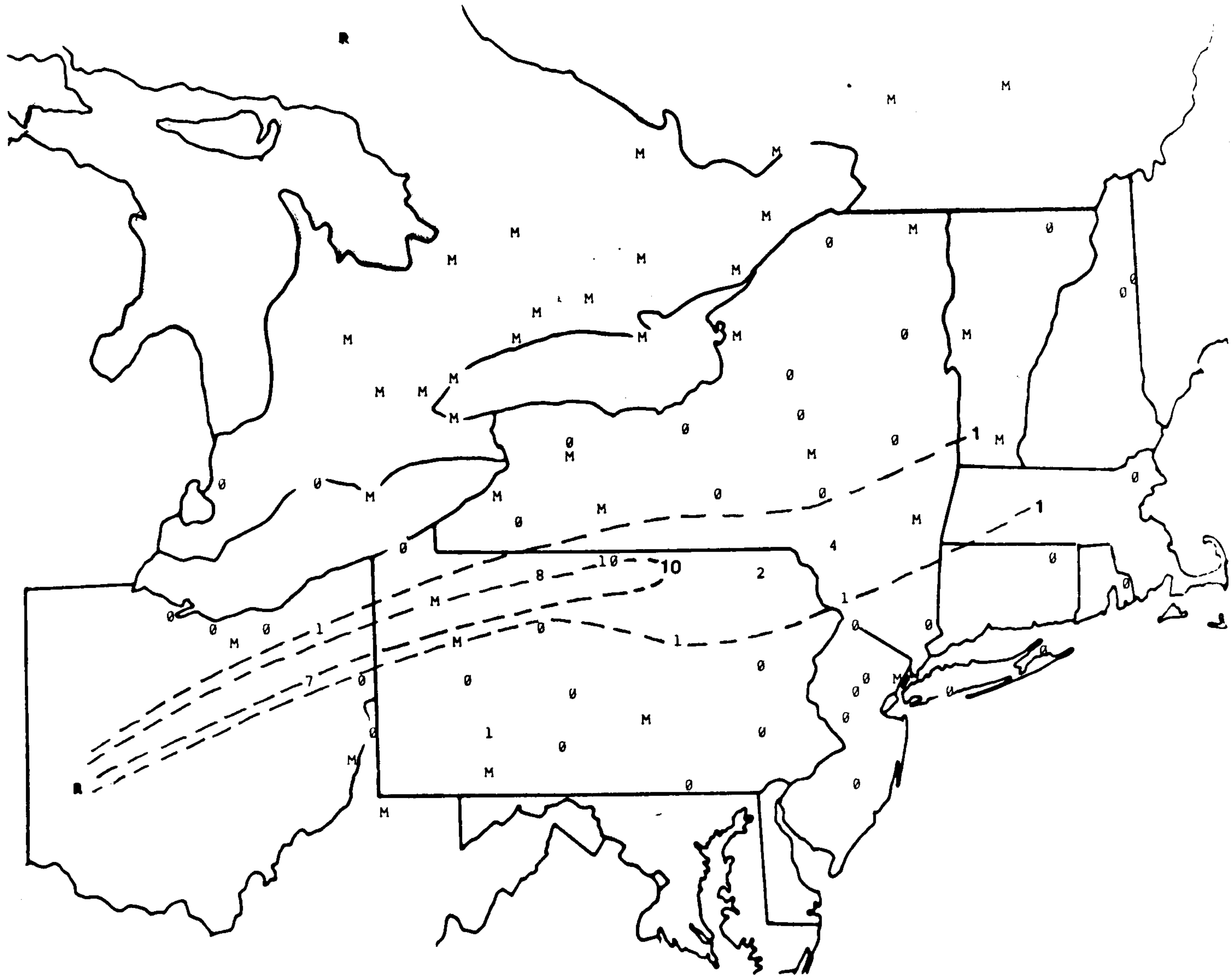


Figure 7. Maximum tracer concentration (fl/l) measured at each sampling site after release #6.

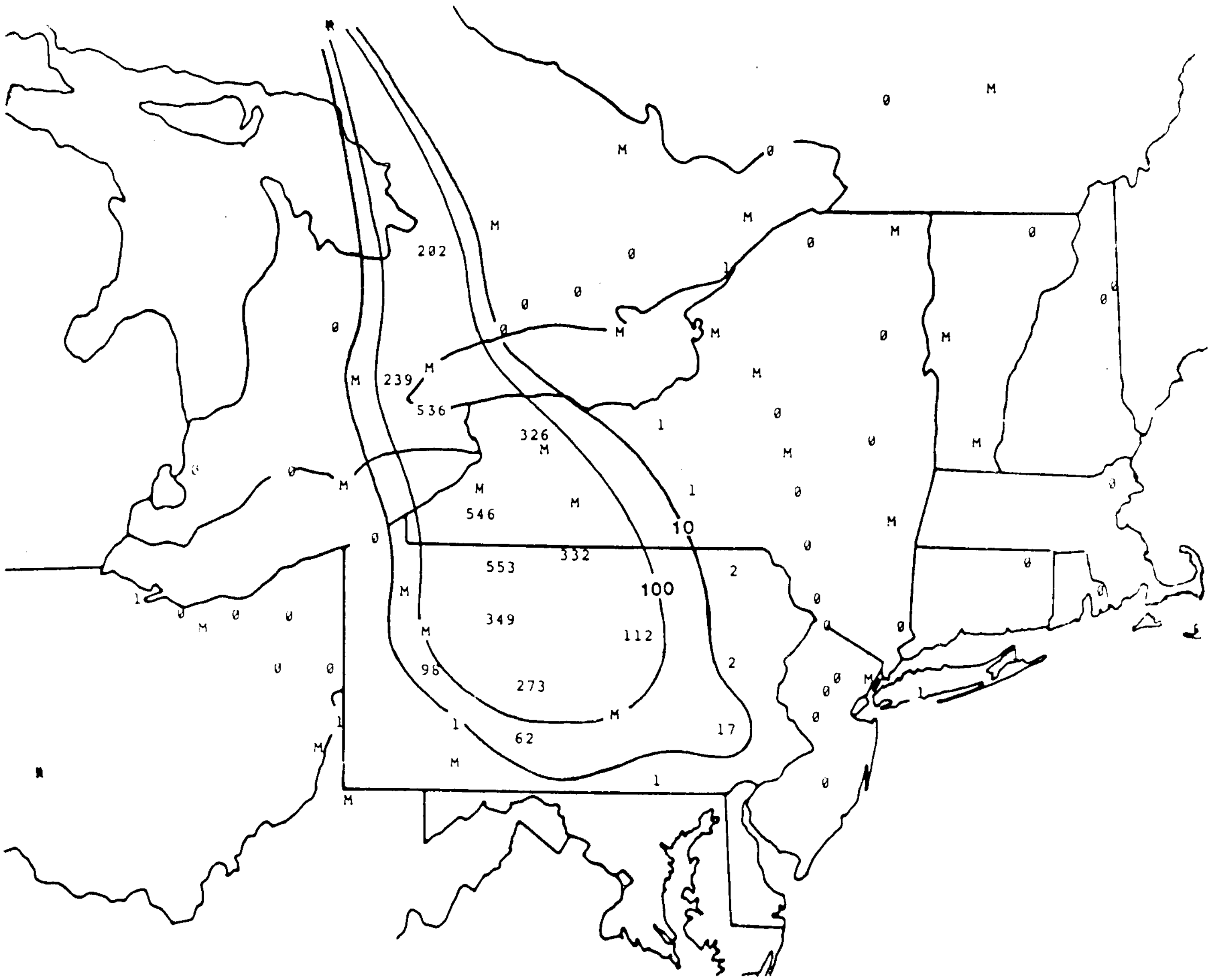


Figure 8. Maximum tracer concentration (fl/l) measured at each sampling site after release #7.

The fourth release (Figure 5), from Dayton, provides a case of fast transport of a rather narrow plume across the southern portion of the sampling array. Concentrations were 100-200 fl/l across Pennsylvania and New Jersey.

The fifth release, the first one from Sudbury, took place about midnight in the northwesterly flow immediately after a cold-front passage (Figure 6). A narrow plume was transported rapidly across Lake Ontario, New York, and New England. Concentrations were above 100 fl/l all the way to the East Coast.

The sixth release (Figure 7), from Dayton, was only a half hour in duration so that the total amount of tracer was about one-sixth that of the other CAPTEX releases. The transport winds were very strong, over 20 m/s, and there was little directional shear with altitude, resulting in a very narrow plume. Although concentrations above the ambient background level were measured at only a few sites, they serve to define the path of the plume very well out to the 800-km arc. Because of the narrow plume, it is quite likely that the peak concentration was not measured at any of the arcs.

The last tracer release took place at Sudbury, again behind a cold front. The plume had been forecast to be transported rapidly toward the East Coast over New York, southern New England, and New Jersey. However, it appears that the plume became caught up in the clockwise circulation about the high-pressure center pushing eastward behind the front. The plume traveled more slowly and in a more southerly direction than anticipated (Figure 8), and it appears to have stagnated in central Pennsylvania.

The samplers in this area and western New York had been started on the afternoon before the Sudbury release, primarily to sample the plume released from Dayton rather than the Sudbury plume, which was expected to be seen in the samplers farther to the east. Unfortunately the 36-h total sampling period was insufficient to catch the entire Sudbury plume. This can be seen in Table 9 where high concentrations are reported in the last samples taken on the 500-km and 600-km arcs. The sampling record at site 406 should also be noted. Through human error, this sampler took a series of 18-h samples instead of the intended 3-h samples (set for 1080 minutes instead of 180 minutes). It was still sampling at 1900 GMT on October 31, when it was turned off manually by the technician who had come to retrieve the samplers at the end of the experiment. Fortuitously, this mishap provides evidence that the Sudbury plume lingered in this area for at least 37 hours after the other samplers in the area closed down.

An example of the more detailed picture provided by the sequential sampling data is shown in Figures 9-14 for the second tracer release. This sequence of maps shows the tracer concentration patterns as measured over consecutive 6-h sampling periods. Figure 9 shows the average concentrations at each site from 0300 to 0900 GMT on September 26, 10-16 hours after the start of the 3-h tracer release. At this time all sampling at the 700-km arc and beyond is indicated as missing (M) because these samplers have not yet been turned on. The leading edge of the plume is approaching Lake Ontario and western New York, but the peak measured concentrations are at the 300-km arc.

Figure 10 shows the concentrations for the next sampling period (0900-1500 GMT). Concentration data on the 300-km arc are indicated as missing on this computer-drawn plot because these sites completed their sampling schedule midway

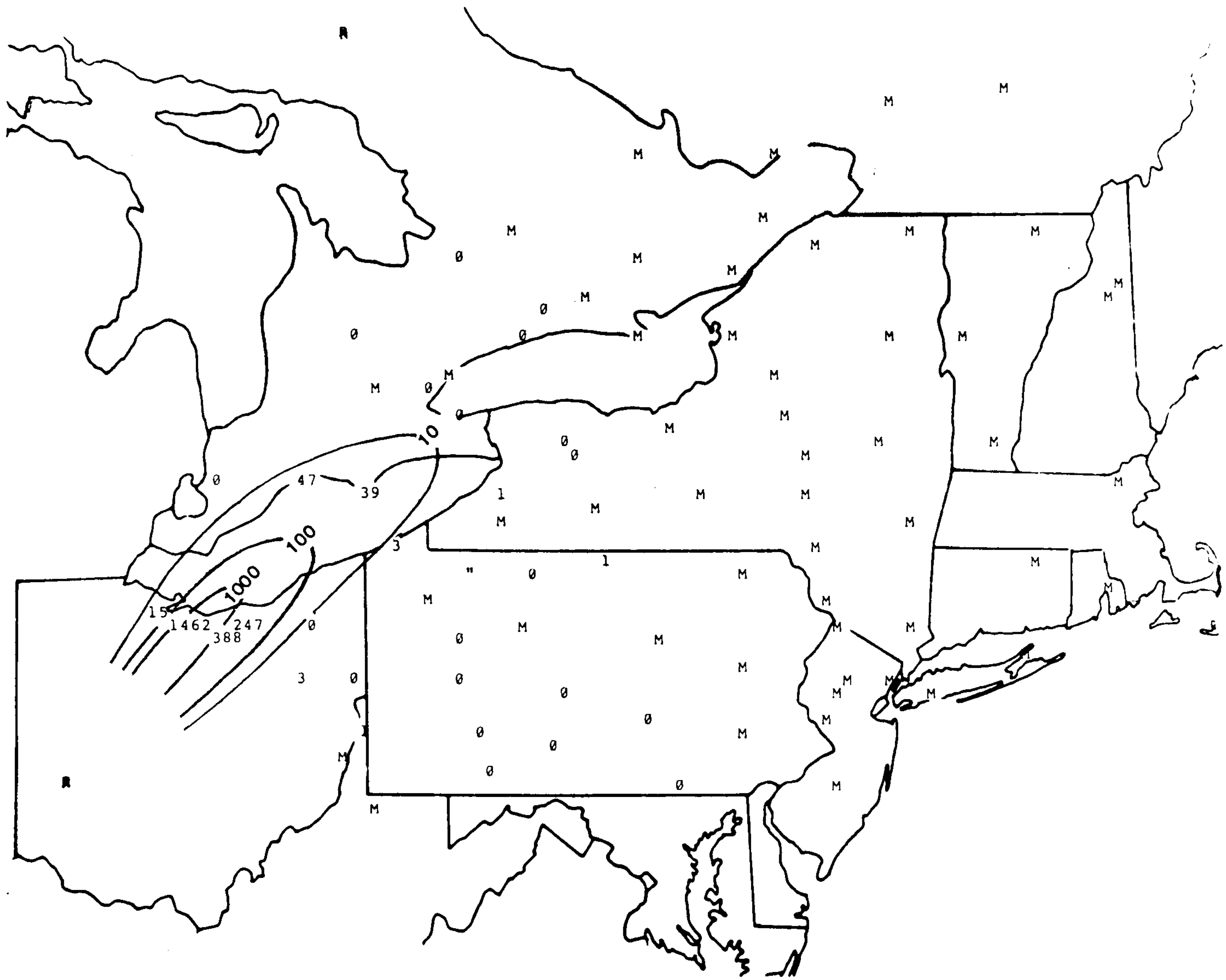


Figure 9. Tracer concentrations (fl/l) measured September 26, 0300-0900 GMT; 10-16 hours after the start of release #2.

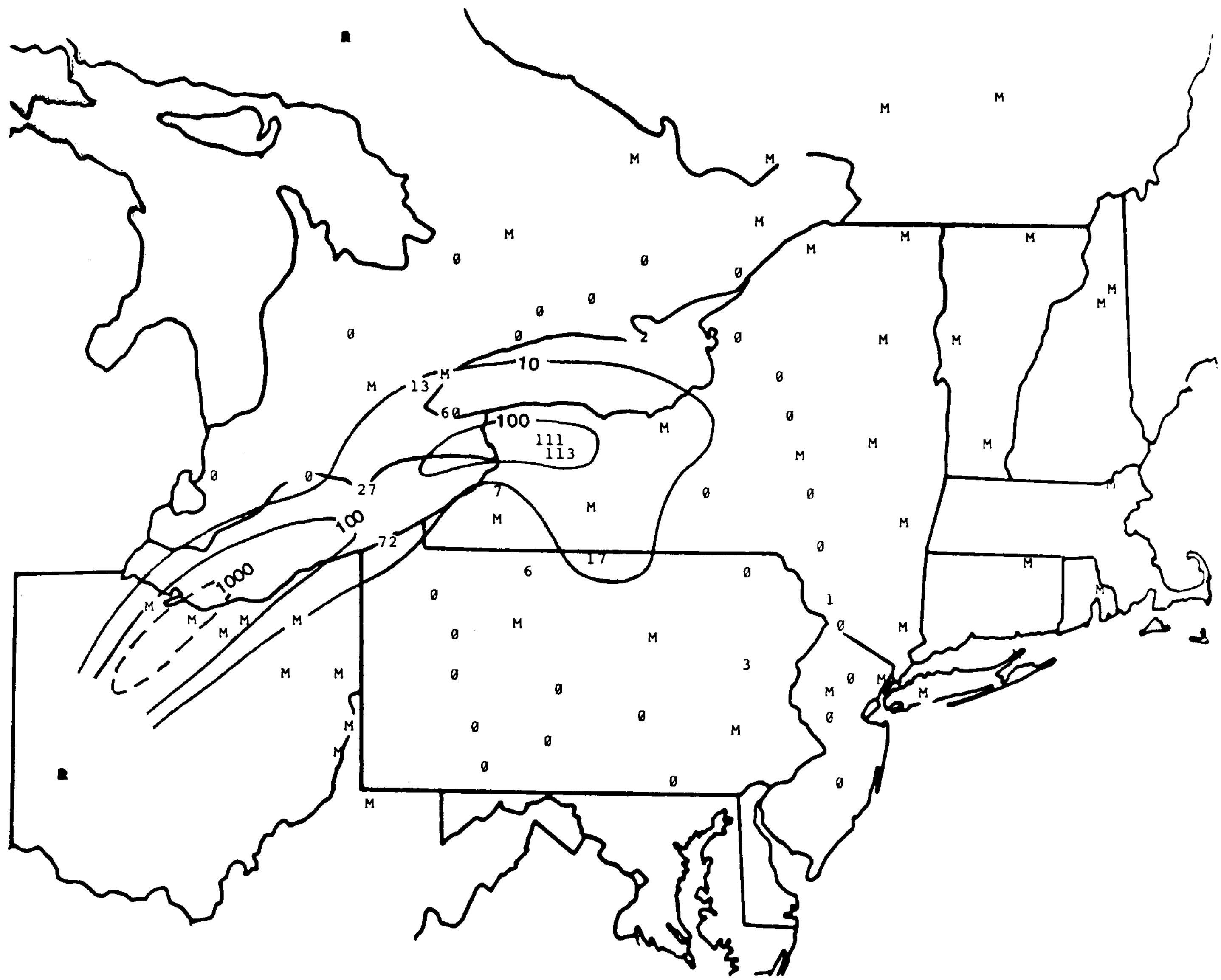


Figure 10. Tracer concentrations (fl/l) measured September 26, 0900-1500 GMT; 16-22 hours after the start of release #2.

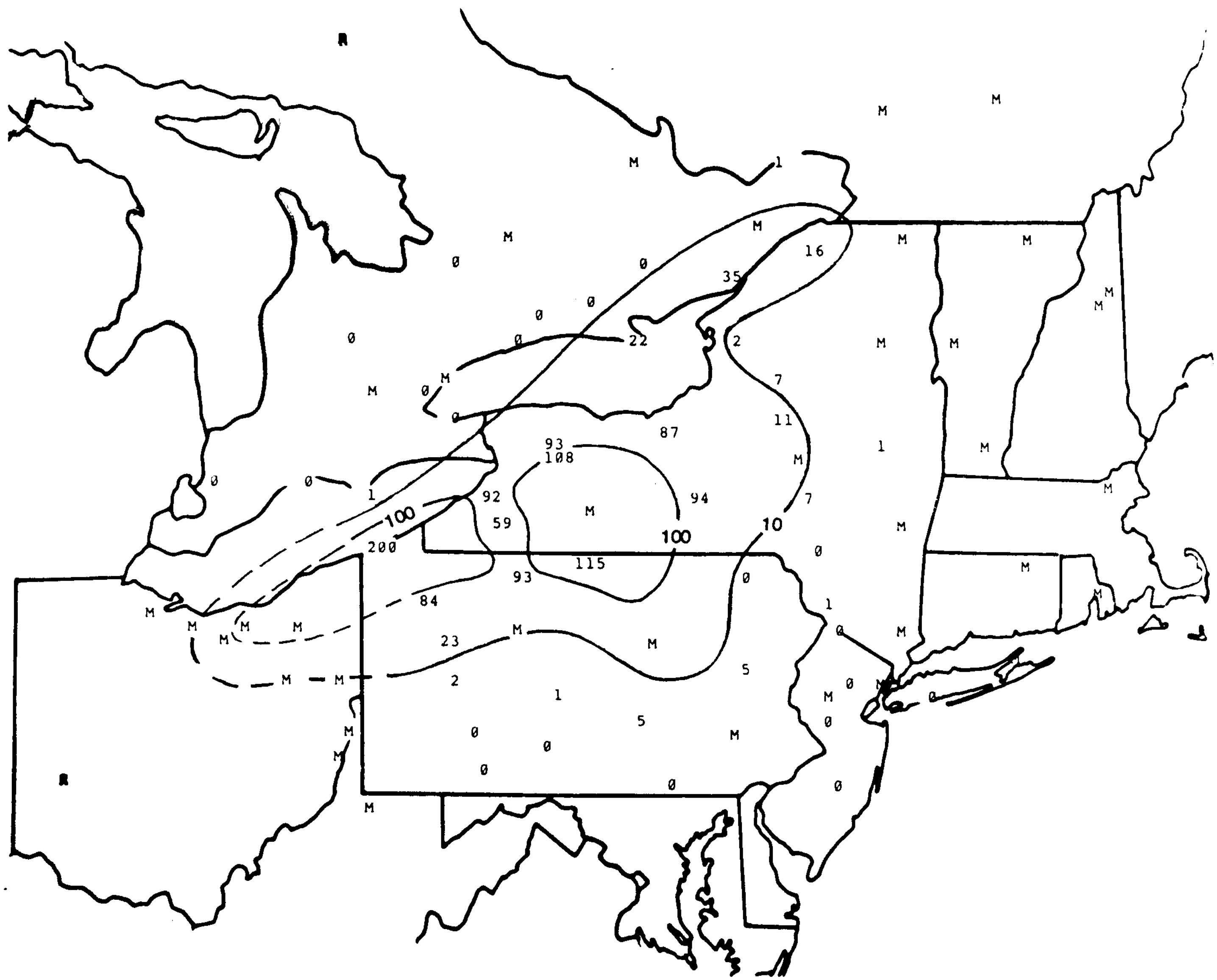


Figure 11. Tracer concentrations (fl/l) measured September 26, 1500-2100 GMT; 22-28 hours after the start of release #2.

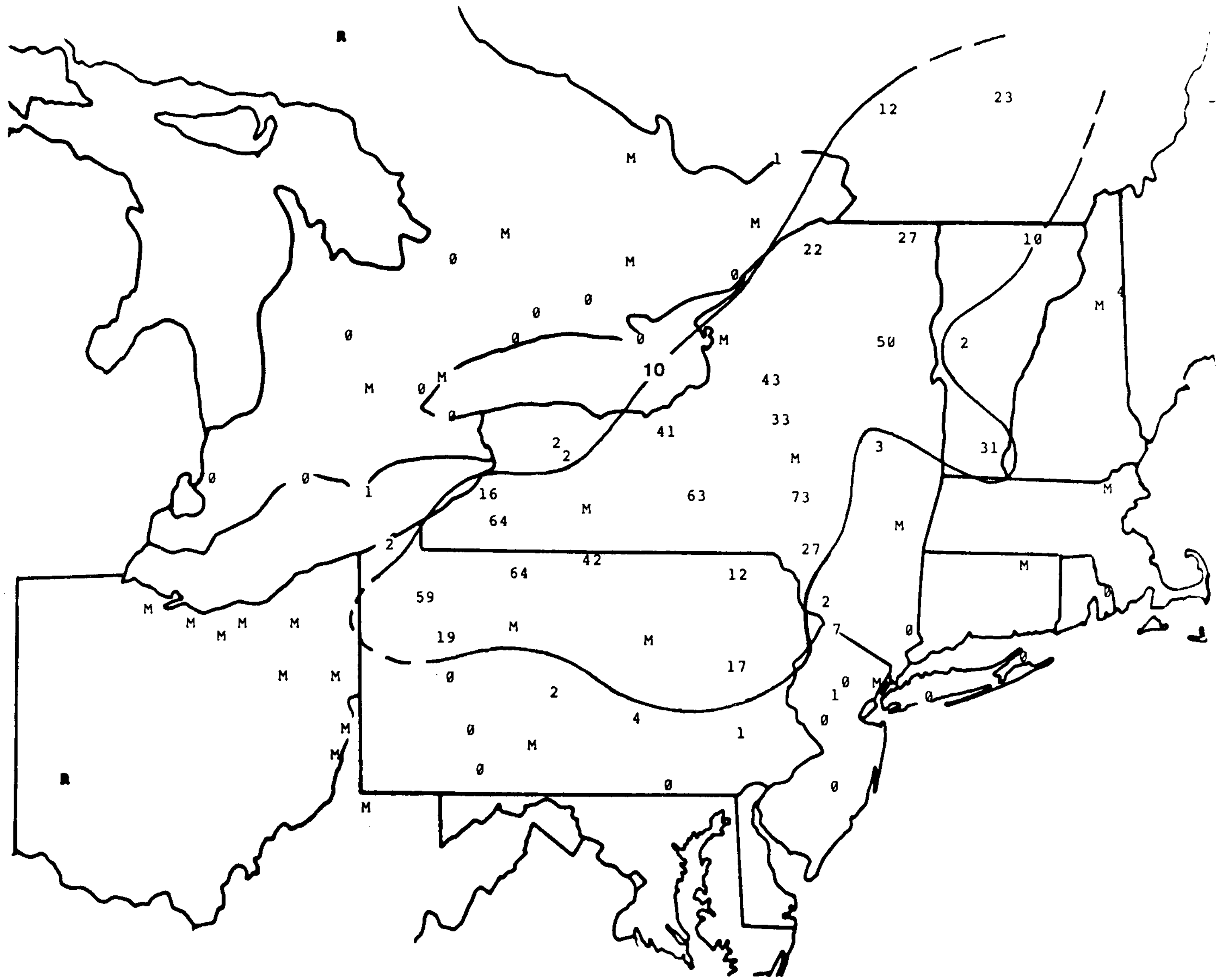


Figure 12. Tracer concentrations (fl/l) measured September 27, 0300-0900 GMT; 34-40 hours after the start of release #2.

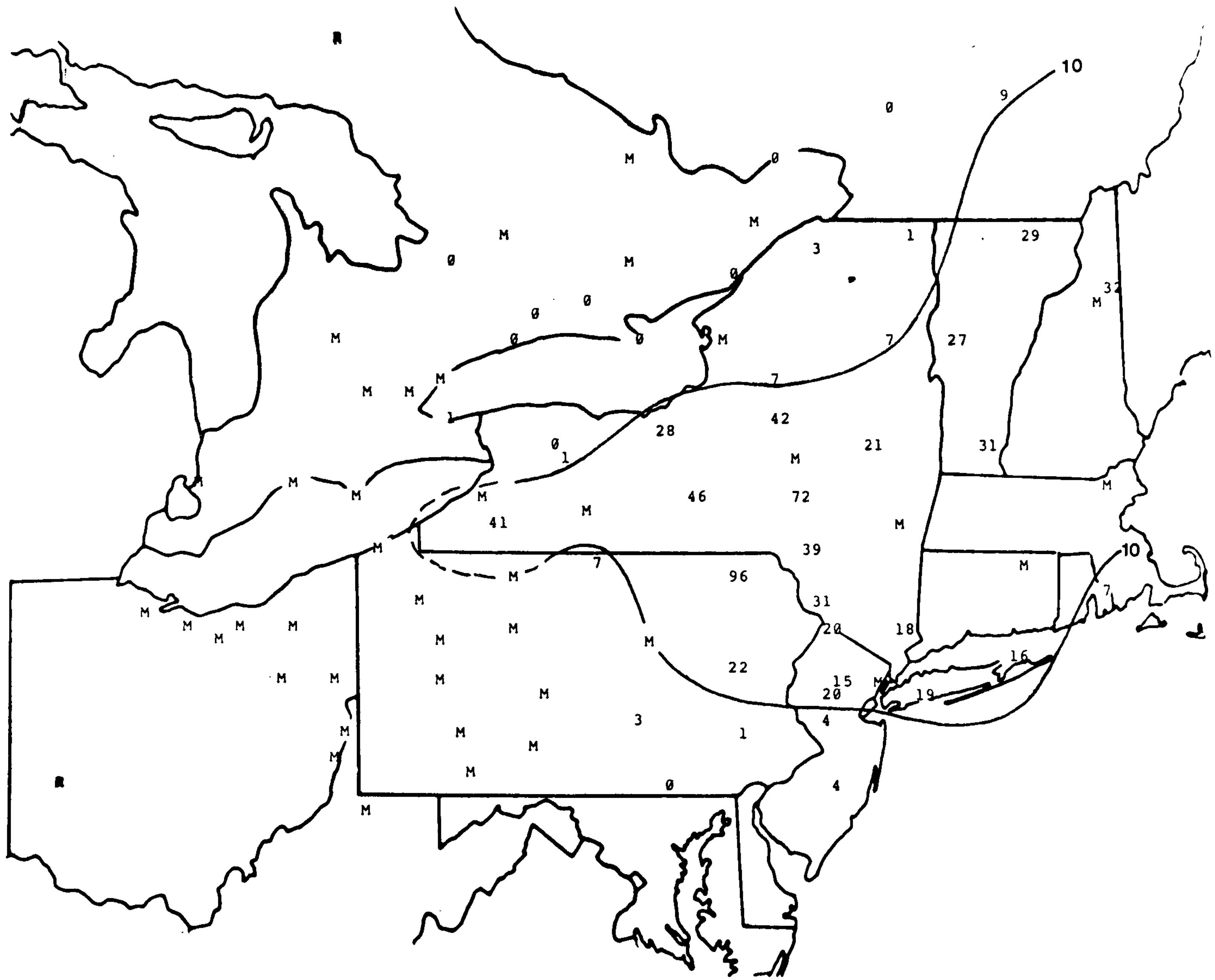


Figure 13. Tracer concentrations (fl/l) measured September 27, 0900-1500 GMT; 40-46 hours after the start of release #2.

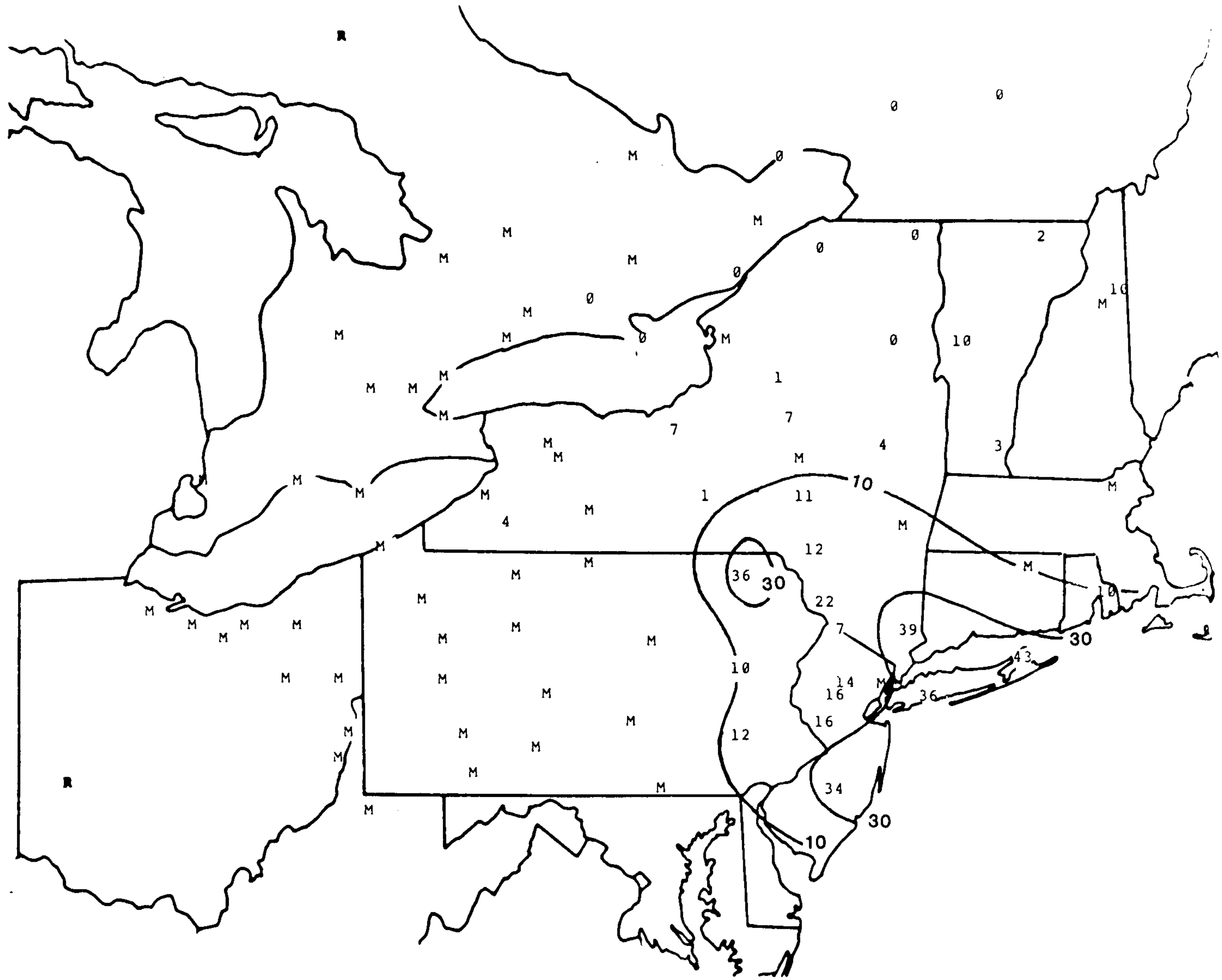


Figure 14. Tracer concentrations (fl/l) measured September 27, 1500-2100 GMT; 46-52 hours after the start of release #2.

through this sampling period. Contours in this area are based on the high concentrations measured on the 300-km arc between 0900 and 1200 GMT. The plume is being stretched in the along-wind direction as the leading edge advances into central New York. A bulge toward the south is indicated by two stations in northern Pennsylvania. Samplers beyond 800 km have not yet been started.

Figure 11 shows the tracer concentration pattern during the 1500-2100 GMT period. The leading edge of the plume is still spreading slowly eastward across New York State and northeastward along the Canadian border. At the same time, tracer is slowly spreading southward across Pennsylvania. Note that the highest concentration measured at this time (200 fl/l) is at Erie, in northwestern Pennsylvania, while the leading edge is about 500 km farther to the northeast.

During the next 6-h sampling period (not shown) tracer continued to spread slowly toward the east and northeast with slowly diminishing concentrations. Figure 12 shows the tracer concentrations during the 0300-0900 GMT period on September 27. All measured concentrations are now below 100 fl/l as the tracer continues to drift slowly eastward covering a large area from western Pennsylvania to Quebec. Note the area of relatively high concentrations still hanging back in western New York and Pennsylvania.

Figure 13 shows the pattern for the 0900-1500 GMT period. The plume continues its slow eastward progression, now covering northern New Jersey, Long Island, and all of New England while still persisting all across New York State.

Figure 14 shows the pattern for the 1500-2100 GMT period. The highest measured concentrations (30-40 fl/l) are now seen in the southeastern portion of the array. The final sampling period, 6 hours later (not shown) indicates the remnants of this plume drifting off the coast and out into the Atlantic; the highest measured concentration (44 fl/l) is at site 002 near the eastern tip of Long Island.

4. QUALITY ASSURANCE FOR GROUND SAMPLING DATA

Extensive efforts were made to assure the quality of the CAPTEX sampling data. These efforts included preparation of the samplers, calibration of the sampler pumps before and after CAPTEX, loading of a tracer standard into the last tube of 130 of the sampling lids for analysis along with the CAPTEX samples, and operation of two samplers side by side at several sites. Quality control and calibration procedures and results have been reported by Lagomarsino et al. (1985).

4.1 Duplicate Sampling Results

The results of duplicate sampling provide the best overall evaluation of the quality of a sampling data set, since they incorporate the uncertainties in sampling as well as uncertainties in the analytical laboratory procedures. Duplicate samplers were operated at five CAPTEX sites (Akron, Ohio; Erie and Williamsport, Pennsylvania; Chester, New Jersey; and Campbellford, Ontario), providing a total of 161 pairs of samples. Some of the samples at Chester (a regional baseline station operated by DOE/EML) were 90 minutes in duration, all other duplicates were either 3-h or 6-h samples.

The analyses of CAPTEX samples were divided into the following three groups for the purpose of quality assessment. For each group, the mean standard deviation (i.e., the square root of the mean variance of duplicate pairs) is the most appropriate estimate of the precision of sampling and analysis.

(1) This group represents samples that had been contaminated with PMCH tracer prior to delivery to the sampling sites in Canada. The precision, as determined from 6 duplicate pairs, is ±65%.

(2) This group represents samples containing an unknown contaminant in the PMCH peak. The mean standard deviation of 40 duplicate pairs is ±35%.

(3) The majority of sample analyses were in this group in which no contaminant in the PMCH tracer chromatographic peak was observed. The mean standard deviation estimated from 115 duplicate pairs is ±10.8%.

The data reported from the contaminated samplers in Canada are believed to be more accurate than indicated above, since concentrations were reported only for those samples where the tracer plume concentration stood out well above the contaminant level (see Section 4.2). This is in contrast to the six duplicate pairs, all of which had concentrations of less than 5 fl/l.

4.2 Samples Contaminated with Tracer

Most of the samplers that were deployed in Canada were found to be contaminated with 100 to 1000 fl of PMCH tracer per sampling tube, including tubes never exposed for sampling. This compares with a range of 40 to about 10,000 fl of tracer expected to be collected in the samples during plume passage. The only plausible way that this level of contamination could have occurred, would be if, at some point, the samplers had been close to the supply of liquid tracer. Although precautions were taken to avoid this possibility, it appears that when the tracer and samplers arrived in Canada, they were stored adjacent to each other for a few days in the receiving area at AES. Thereafter, they were always at separate locations at least several miles apart.

Once the problem was diagnosed, the contaminated samples were examined very carefully to extract as much useful information as possible. Each sample concentration was examined in relation to that in adjacent tubes and in relation to concentrations at nearby sampling sites. Fortunately, the level of contamination usually varied by less than 50% among the tubes in any one sampler. Plume concentrations above about 30 fl/l could generally be distinguished from the contamination. In some cases, where the contamination was low and nearly constant from tube to tube, it could be ascertained with fairly high confidence that no plume was present. However, in many cases, possible plume concentrations below 30 fl/l could not be reliably distinguished from the variable contamination levels, and no concentration data are reported in these instances.

Table 10 lists the sites where concentrations have been reported from PMCH-contaminated samples. Reported values above 30 fl/l are believed to be accurate to about ± 25% or better.

Table 10. Sites where concentrations are reported from contaminated samples

Site	Release #						
	1	2	3	4	5	6	7
052				X	X		X
552	X	X	X				
556	X	X	X	X	X		X
652	X	X	X	X	X		X
653		X	X		X		X
654	X	X	X	X	X		X
752	X	X	X	X	X		
753	X	X	X	X	X		X
754	X	X	X	X	X		X
756				X	X		
852	X	X	X	X	X		X
854	X						

5. SAMPLING PERFORMANCE

Over 2900 ground-level air samples were scheduled to be collected during CAPTEX, not including duplicate samples and a few non-network special sites. Tracer concentrations have been reported for 75% of these samples. The remaining 25% were lost primarily because of sampler malfunction or sample contamination. A very small number of samples were lost because of operator error or failure to contact the operator. Table 11 shows the percentage of scheduled samples for which a tracer concentration was reported for each release.

Table 12 provides a summary of CAPTEX sampler failures which include duplicate samplers, two non-network samplers operated on the CN tower at Toronto, and a special sampler operated at Kejimkujik, Nova Scotia. Unfortunately, no usable data were obtained from the latter three samplers because of malfunctions and contamination. The causes of failure are listed along with the approximate number of samples affected by each, as deduced from records kepts by the field personnel. The most common cause of failure was trouble in the Power Control Module (PCM) electronics, followed by pump failure and then printer problems. It should be noted that not all failures caused the loss of samples; printer and display problems, for example, were not always fatal.

More detailed information on the operation of the sampling network is provided in another report (Ferber, 1985).

6. AIRCRAFT SAMPLING

Seven aircraft (two PNL, four BNL, one AES) were used during CAPTEX to measure the vertical tracer distribution at various times after release. Each aircraft used an automatic sequential sampler modified to collect tracer over a short time interval (i.e., 6 to 10 minutes). In addition, one BNL aircraft was equipped with a real-time dual-trap analyzer. Prior to each tracer release, the aircraft were staged to one or several locations where the tracer plume was forecast to pass. Various flightpaths using two or more aircraft were flown depending on many factors such as time and distance from the staging locations to the forecast plume center, flightpath length to traverse the forecast plume width, total permissible sampling duration, number of sampling tubes and sample duration, weather restrictions, FAA flight restrictions, terrain height, and boundary layer height.

The aircraft data consist of information on each collected sample, such as the release number, aircraft identifer, sortie, pass, tube, date, start and end time and position (latitude, longitude, and altitude), and concentration. The PMCH background has been subtracted from all concentrations. Wind measurements were also taken on the BNL Islander and the AES aircraft and are discussed by Michael et al. (1984). Preliminary quality assurance of the aircraft data resulted in the elimination of some samples because of unresolved aircraft positions or sample analysis uncertainties. No farther quality assurance of the concentration data has been performed besides eliminating obviously contaminated samples.

Aircraft sampling flight paths for each release are shown in Figures 15-20. An "S" indicates the approximate location of the vertical sampling profile measured by the AES aircraft.

Table 11. Scheduled samples for which a concentration was reported

Release	Scheduled Samples	Concentration Reported	Percent Reported
1	498	386	78
2	498	398	80
3	498	399	80
4	504	355	70
5	438	319	73
6&7	498	339	68
TOTAL	2934	2196	75

Table 12. Summary of sampler failures (total of 3222 scheduled samples)

Cause of Failure	Number of Samples Affected	Percent of Total
General PCM Failure	380	11.8
Pump Failure	178	5.5
Printer Failure	84	2.6
Jammed Printer Tape	37	1.1
Display Problems	73	2.3
Clock Malfunction	56	1.7
Resampled Same Tube	21	0.7
Tube Stepping	14	0.4
Operator Error	36	1.1
TOTAL	879	27.2

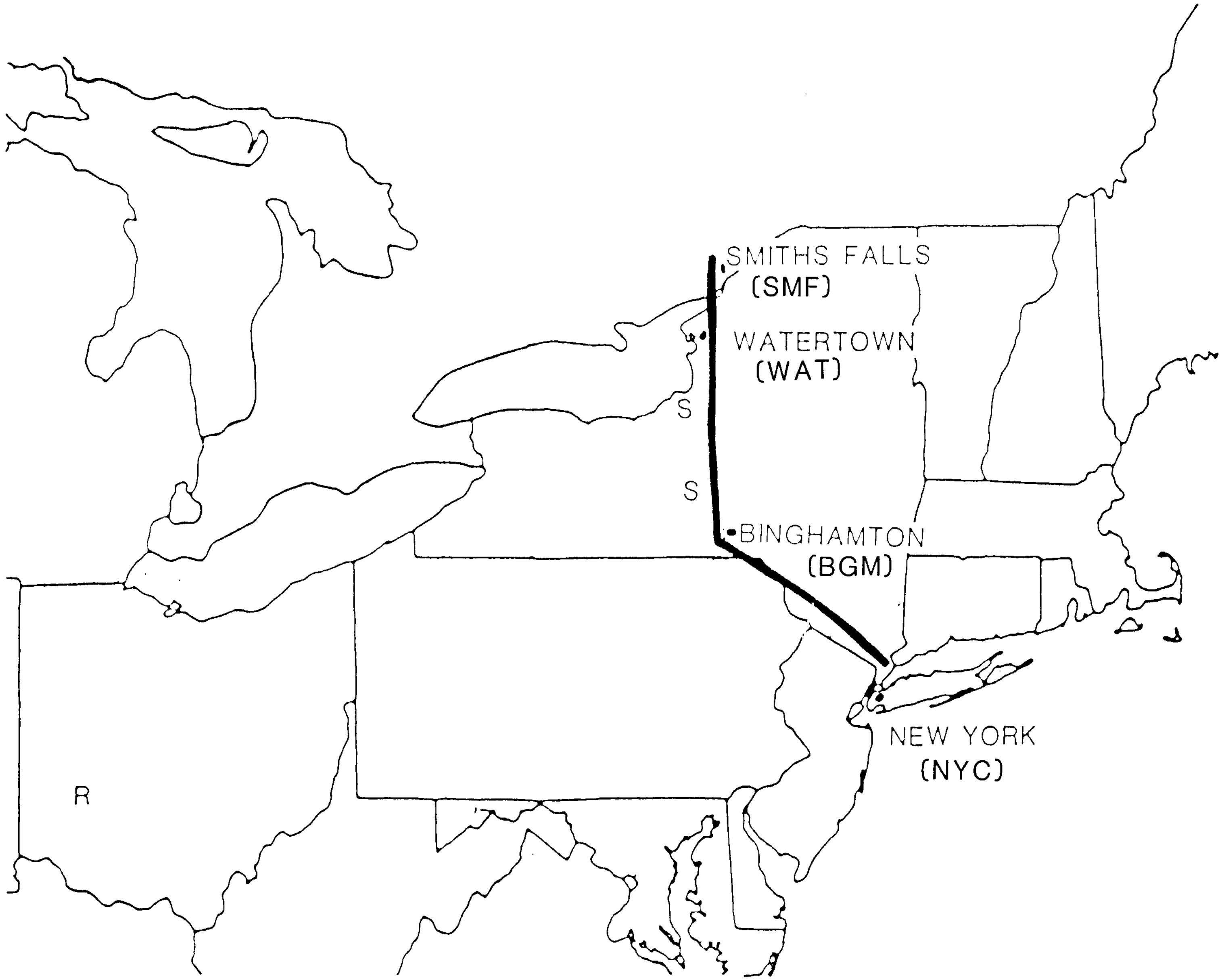


Figure 15. Sampling aircraft flightpaths for release 1. An "S" indicates the approximate location of the vertical profile measured by the AES aircraft; an "R" indicates the release site.

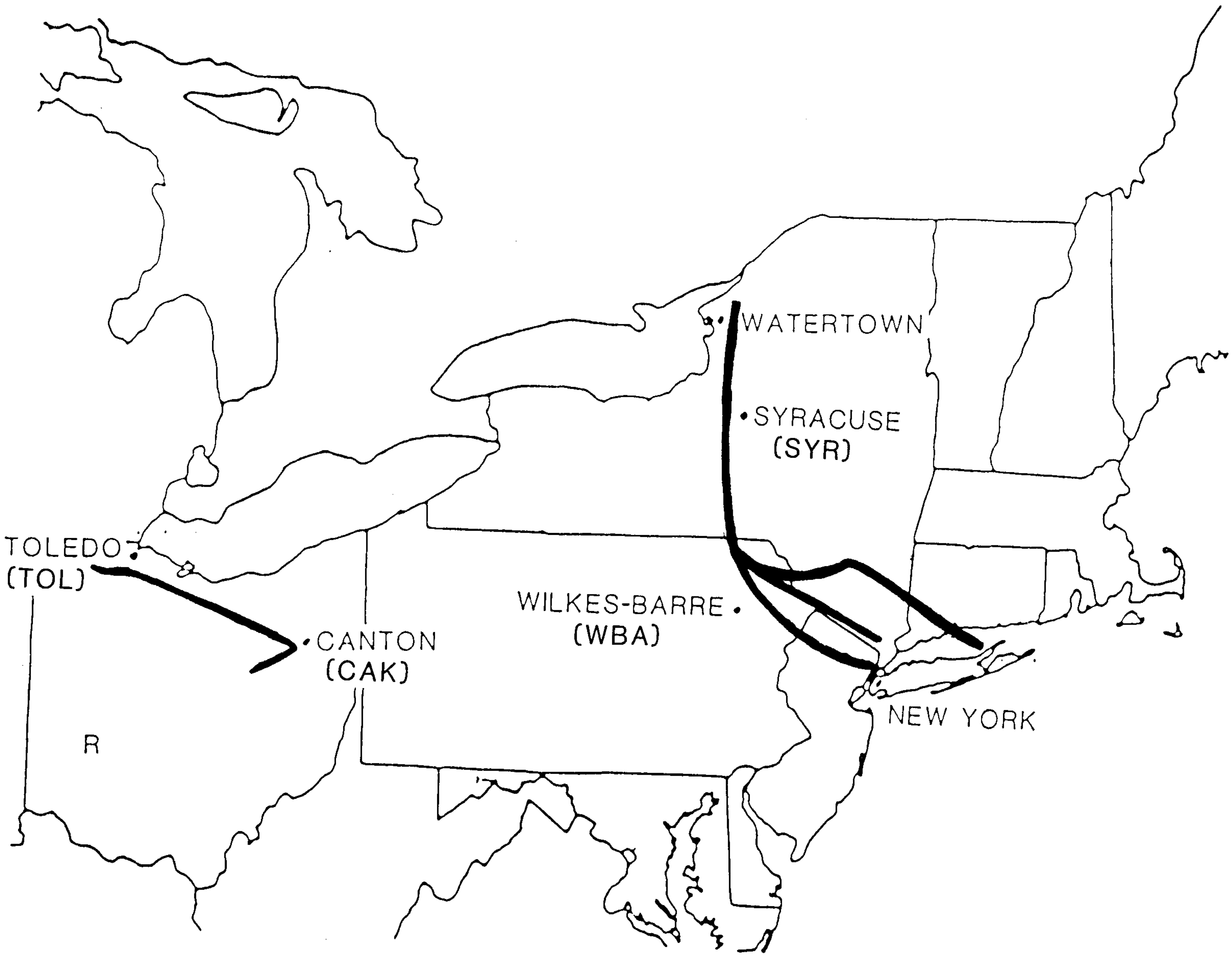


Figure 16. Sampling aircraft flightpaths, as in Figure 15, but for release 2.

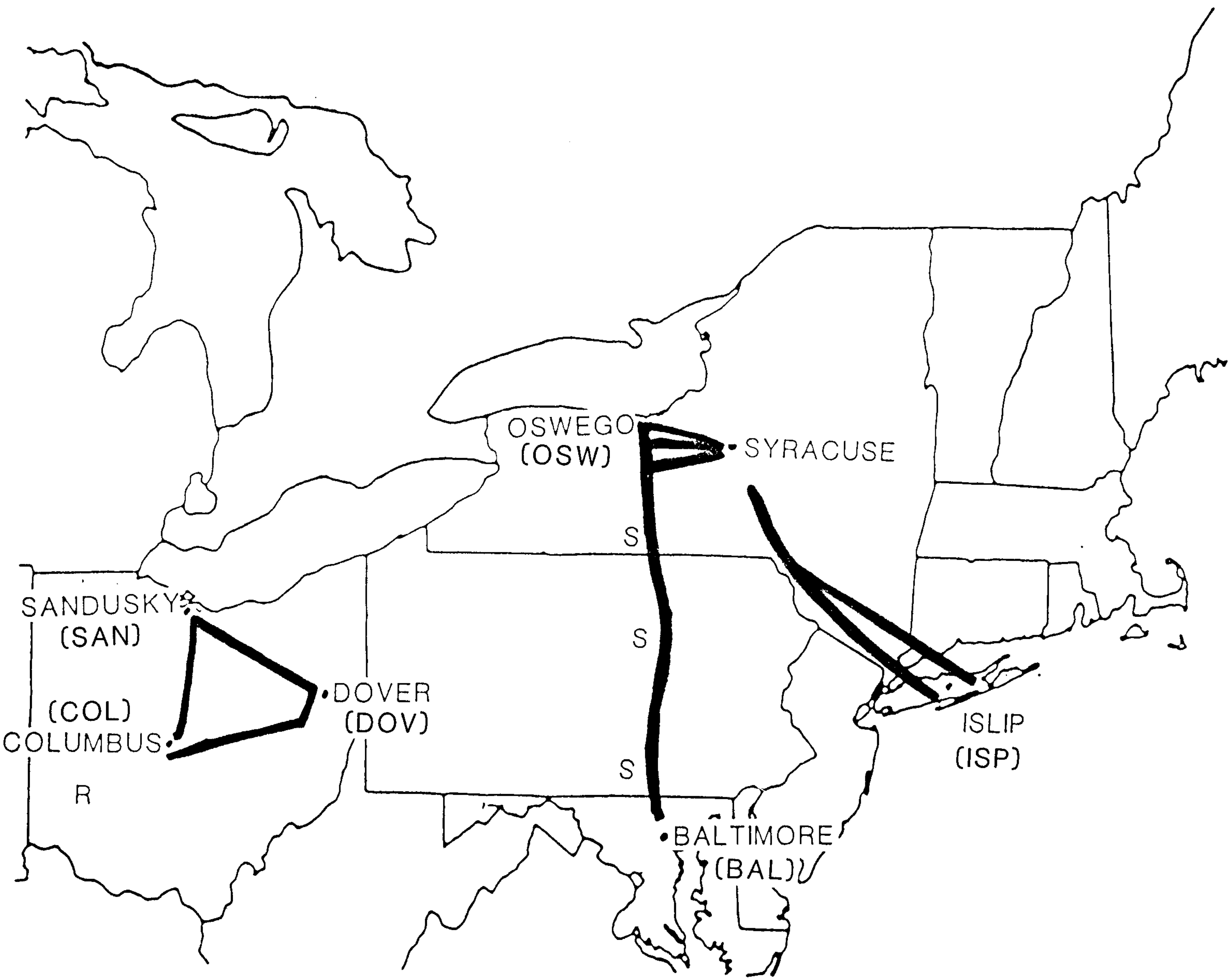


Figure 17. Sampling aircraft flightpaths, as in Figure 15, but for release 3.

Figure 18. Sampling aircraft flightpaths, as in Figure 15, but for release 4.

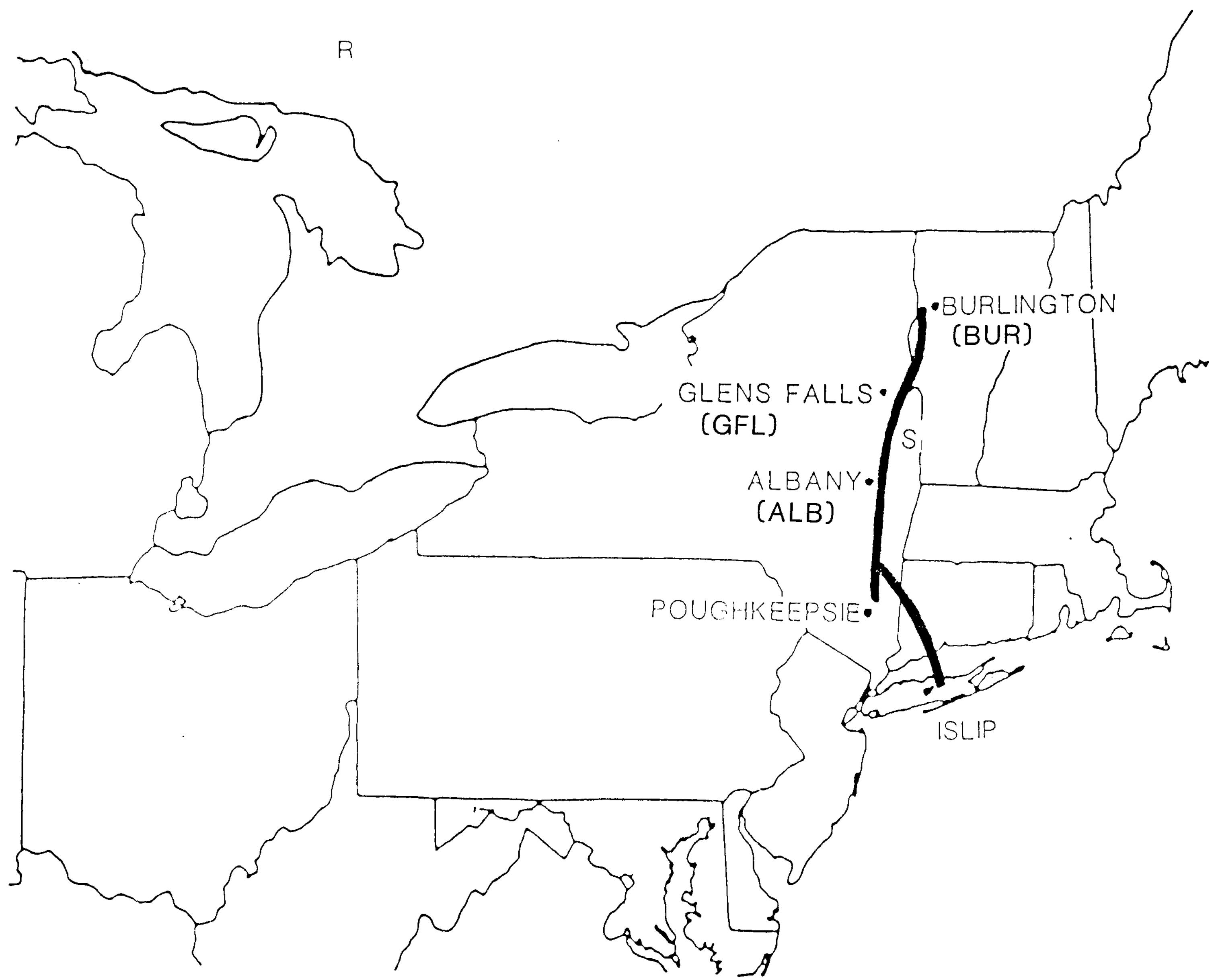


Figure 19. Sampling aircraft flightpaths, as in Figure 15, but for release 5.

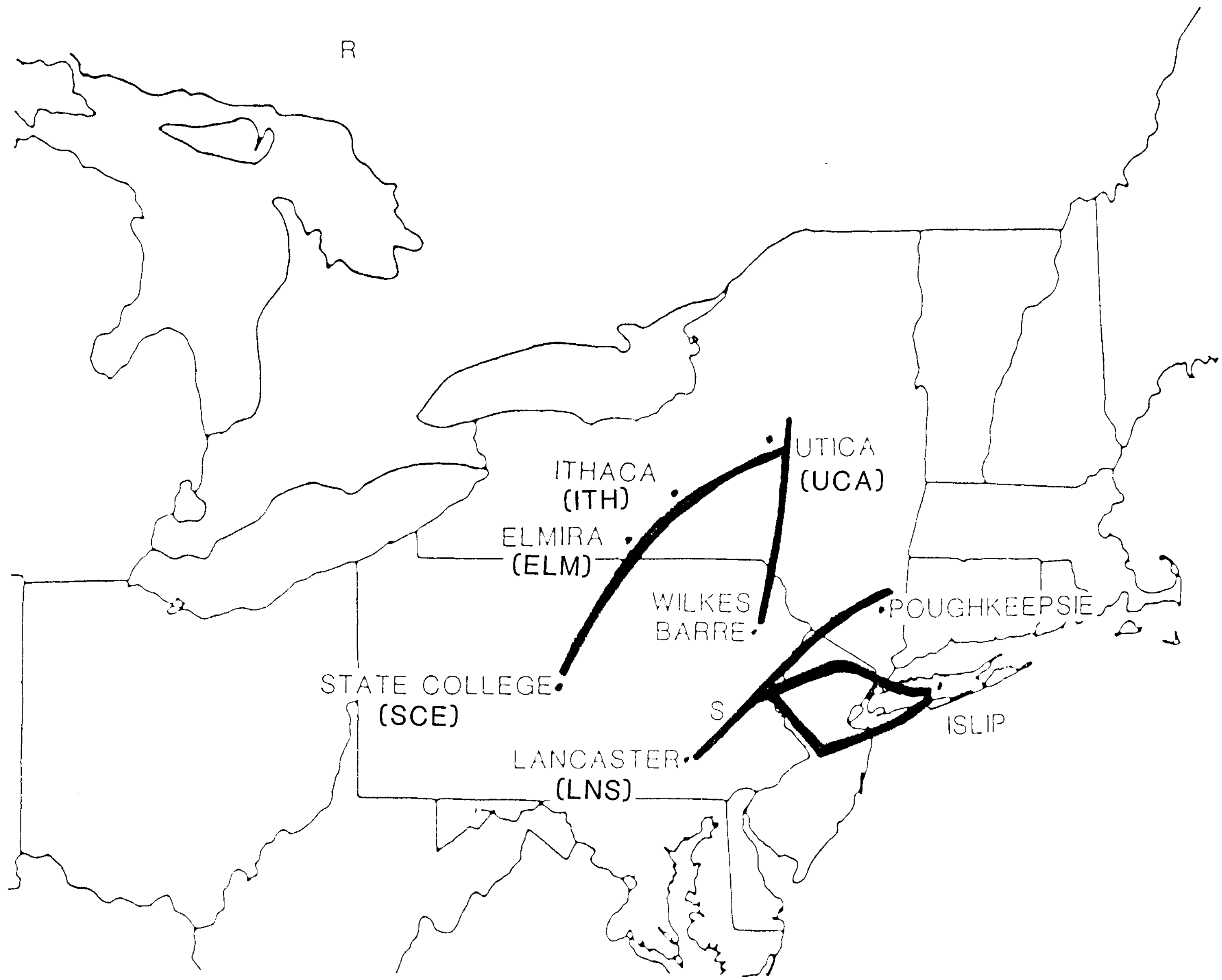


Figure 20. Sampling aircraft flightpaths, as in Figure 15, but for release 7.

Concentration (fl/l) data for each release are shown, for general visual inspection, in Tables 13-18 as functions of height above sea level and time. Day, time (GMT), and nearby city are given on the top line. A concentration is printed in 6- or 10-min increments depending on the sampling time. Thus, several concentrations in a single column reflect measurements by aircraft sampling in proximity in time and horizontal space but at different altitudes. The data shown are not complete since some of the concentration values in the available data set would overly complicate the visual aspects of the tables. Data are not included if aircraft were ascending or descending during a sample and data from spiraling aircraft are not included. Also, data from the real-time sampler on the BNL aircraft are not shown since they were unavailable for inclusion in this report.

Figure 21 is a calculated "snapshot" (2100 GMT) vertical cross-section showing the tracer measured by four constant-altitude and one spiraling aircraft for release 3. It was obtained by advecting sampled air parcels with the wind as measured on the spiraling aircraft or as estimated from nearby rawinsonde data. "Snapshots", such as the one shown, are a useful method of combining concentration measurements from several aircraft taken at different times and locations to visually depict vertical tracer plume distributions.

7. METEOROLOGY

A summary of the meteorological conditions for each CAPTEX release and sampling periods that follow is available (Brown et al., 1984). The summary references six volumes of complete weather documentation for the experiment.

7.1 Upper-Air Data

The NWS upper-air meteorological data (United States and Canadian network rawinsondes, N) were augmented by adding EPRI rawinsondes, E, (Hadley et al., 1985) to fill spatial voids in the network (see Figure 1), and by increasing the frequency of soundings from two to four per day during each sampling period. The network and EPRI rawinsonde stations that took four soundings a day at 0000, 0600, 1200, 1800 GMT are given in Table 19. In addition, a rawinsonde schedule was established at each release site to take soundings for several hours before and during the 3-h tracer releases. Release-site rawinsonde stations are included at the bottom of Table 19.

7.2 Tower Data

Meteorological data are available from several tall towers in the CAPTEX area (see Table 20) for the time period of the experiment. The data are in the form of hourly averages, and the heights of the data, in meters above the tower base, are given for principal meteorological categories.

7.3 Tetroon Data

The ARL Field Research Division released tetroons simultaneously with the tracer releases at Dayton and Sudbury to serve as markers of the tracer plume and to provide additional information on atmospheric transport and dispersion. Tetroons are small tetrahedral balloons (about 1 m^3 in volume) superpressured to float at a specific atmospheric density level as they drift

Table 13. Aircraft concentrations (fl/l) for release 1

RELEASE= 1	BGM						WAT			SMF				WAT				
z(m) 19/09Z			19/10Z						19/11Z						19/12Z			
3000																		
2700			0	0	0	0	0	0	0	0	0	0	0	0				
2400																		
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	9
1800			0	0	0	0	0	0	0	0	0	0	0	0	0			
1500																		
1200	0	0	0,21*	17	1	0	0	0	0	0	0	0	0	0	0	5		
900					69	108	2	0	0	0	0	0	0	0	75	1	12	
600																		35
300																		
0																		

		WAT					BGM							NYC
z(m) 19/14Z		19/15Z						19/16Z						19/17Z
3000														
2700	0	0	0	0	0	0	0							
2400														
2100	0	0	0	0	0	0	0	0	0	0	0	0	0	1
1800	0	0	0	0	0	1	1							
1500														
1200		0	0	9	11	3	0	0	0					
900		42	30	7	35	23				0				
600														
300														
0														

*Measured concentrations from two aircraft.

Table 14. Aircraft concentrations (fl/l) for release 2

```
RELEASE= 2         CAK                         TOL             CAK                       TOL
   26/00Z                 26/01Z                   26/02Z                  26/03Z
      3000
      2700
      2400
      2100                                     0  0  0  0  0  6  2  0
z(m)  1800
      1500             0  65 180  4  3  0  0  0  0  0  1  0  0
      1200
       900     0  0  0 131  73  4  5  0  0  0  0                       30 759 1144 1919 1312 90 0 0 0 0
       600
       300
         0

                          CAK
   26/04Z                       26/05Z
      3000
      2700
      2400
      2100
z(m)  1800
      1500   0  0 221  3  9  0  0  0  0  0
      1200
       900
       600
       300
         0
```

Table 14. (cont.)

z(m)	RELEASE= 2SYR 26/18Z					WBA 26/19Z			SYR			WAT 26/20Z		
3000														
2700														
2400														
2100		11	43	23	0	1	32	48	40	68	45	4	0	12
1800	22	54	50	19	10	17	45	75	51	69	51	9	0	0
1500		76	51	27	84	59	54	62	69	97	32	5	0	23
1200	54	88	52	47	125	77	59	90	91	118	39	2	28	98
900														
600														
300														
0														

z(m)	WAT 26/22Z					SYR 26/23Z				WBA 27/00Z			NYC			
3000																
2700																
2400																
2100	19	6	1	6	21	28	20	12	6	24	32	2	1,14*	5	0	
1600		2	1	13	19	19	16	13	17	12	19	21 }				
1500	19	22	12	0	9	16	28	14	23	37	37	33* }	30	17		
1200	66	37	4	27	28	42	598	21	59	31	43					
900																0
600																
300																
0																

*Measured concentrations from two aircraft.

Table 15. Aircraft concentrations (fl/l) for release 3

RELEASE= 3	DOV							SAN									DOV									SAN		SAN						DOV				COL COL
	3/04Z									3/05Z										3/06Z										3/07Z								
3000																																						
2700																																						
2400																																						
2100				0	0	0	0	0												0	0	0	7	0	0	0	0	0	0	0	0	0	6	0				
1800																																						
1500	1014	311	1	1	0	0	0	0	0	1	0	0	0	1	895	1466	44									2	1	1	1	1	1	1	1	0	0	1	1	1
1200																																						
900										0	0	0	0	0	0	0	0		0	0	0	1	1	1														
600																																					0	
300																																						0
0																																						

z(m)

				OSW											BAL
	3/15Z				3/16Z						3/17Z				
3000															
2700															
2400	3	0	0	0	0	0	0	0	0	0	0				
2100													7		
1800	0	0	0	0	0	0	0	0	5	65	93	55	14	24	
1500	0	0	0	0	1	0	0	0	0	0	5	394	2961	754	168
1200	0	0	0	0	0	0	0	0	0	0	0	306	2	11	0
900															
600															
300															
0															

z(m)

		BAL												OSW					SYR						~							ISP
	3/20Z				3/21Z						3/22Z						3/23Z						4/00Z						4/01Z			
3000																																
2700																																
2400		0	0	0	0	0	0	0	0	1	0	0	0	1																		
2100	0																								0	0	0	0				
1800	0	3	4	0	0	0	0	1	0	0	0	0	0	0																		
1500	2	2	3	0	4	4	3	3	2	2	1	1	1	0	1	0	0						0	0	0	0	0	0				
1200	1	1	1	1	1	1	0	0	1	1	0	.0	0	0																		
900																																
600																															2	2
300																																
0																																

z(m)

Table 16. Aircraft concentrations (fl/l) for release 4

RELEASE= 4

z(m)	14/22Z	CON					CLA 14/23Z							JMS		15/00Z						CLA					15/01Z		CON							
3000																																				
2700																																				
2400																																				
2100																																				
1800				0	0	0	0	0	0	0	0	0																66	16		11	0	0	0	0	0
1500		0	0	0									0	0	0	0	0	0	0	0	0	0	5	5	1	0		3		44	59	140	420			
1200						0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	96	118		71	22	41	19						226	381	522	1168
900																																				
600																																				
300																																				
0																																				

z(m)	CLA 15/02Z			-OCY					CON		15/03Z		
3000													
2700													
2400													
2100													
1800													
1500	83	27	0	0	0	0	0	[215, 9]	[215, 24]	[193, 174]	[206, 152]	109	36
1200	2080	2559	1413	461	176	94							
900													
600													
300													
0													

Measured concentrations from two aircraft in a 300 m altitude increment are indicated by a bracket.

Table 16. (cont.)

RELEASE= 4

PHL, CMY, POU, HFD

Times: 15/04Z, 15/05Z, 15/06Z, 15/07Z, 15/08Z, 15/09Z

z(m)																	
3000																	
2700																	
2400																	
2100																	
1800																	
1500	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0		
1200	5	4	1	2	9	85	3	0	0	0	0	0	0	0	0	0	0
900	11	3	0	1	3	112	197	41	11	1	0	0	0	0			
600																	
300																	
0																	

WBA, PHL, PHL, CMY, POU, HFD

Times: 15/04Z, 15/05Z, 15/06Z, 15/07Z, 15/08Z, 15/09Z

z(m)																										
3000																										
2700																										
2400																										
2100																										
1800																										
1500																										
1200	*0	14	202	47								182	31	3	16	72	35	0	0	0	0	0	0	0	0	0
900																										
600																										
300																										
0																										

*The aircraft went on a "scout" mission and trailed the other three aircraft.
No plume was found after 10Z as the aircraft completed their flights between Hartford and Islip or Cape May.

Table 17. Aircraft concentrations (fl/l) for release 5

RELEASE= 5 26/19Z	POU				GFL 26/20Z	GFL 26/21Z	ALB		GFL 26/22Z		BUR
z(m)											
3000											
2700											
2400											
2100											
1800											
1500											
1200	0	0	1	16	19	161	234	47	8	1	0
900											
600											
300											
0											

POU 26/21Z							26/22Z		GFL			26 23Z			POU
z(m)															
3000															
2700															
2400															
2100															
1800								0	0	1	241				
1500		0	1	58	204	34	3					30	1		
1200									9	2	7				
900	0	0	0	8	35	252	313	35				365	44	5	2
600															
300															
0															

27/01Z	GFL				27/02Z	POU					GFL 27/03Z				ALB	
z(m)																
3000																
2700																
2400																
2100																
1800	*0		51	138	14	0	3	16	80	219	20					
1500												17	267	40	0	
1200		89	205	7	0	0	0	7	172	180	2	0	70	329	67	3
900																
600																
300																
0																

27/00Z	POU 27/01Z							GFL 27/02Z			POU			27/03Z	ISP
z(m)															
3000															
2700															
2400															
2100															
1800															
1500	*0	0	0	17	64	199	206	69	228	51	0	0			
1200															
900		0	1	2	23	238	37	170	191	1	0	0	0	0	0
600															
300															
0															

*These aircraft flew in opposing directions.

Table 18. Aircraft concentrations (fl/l) for release 7

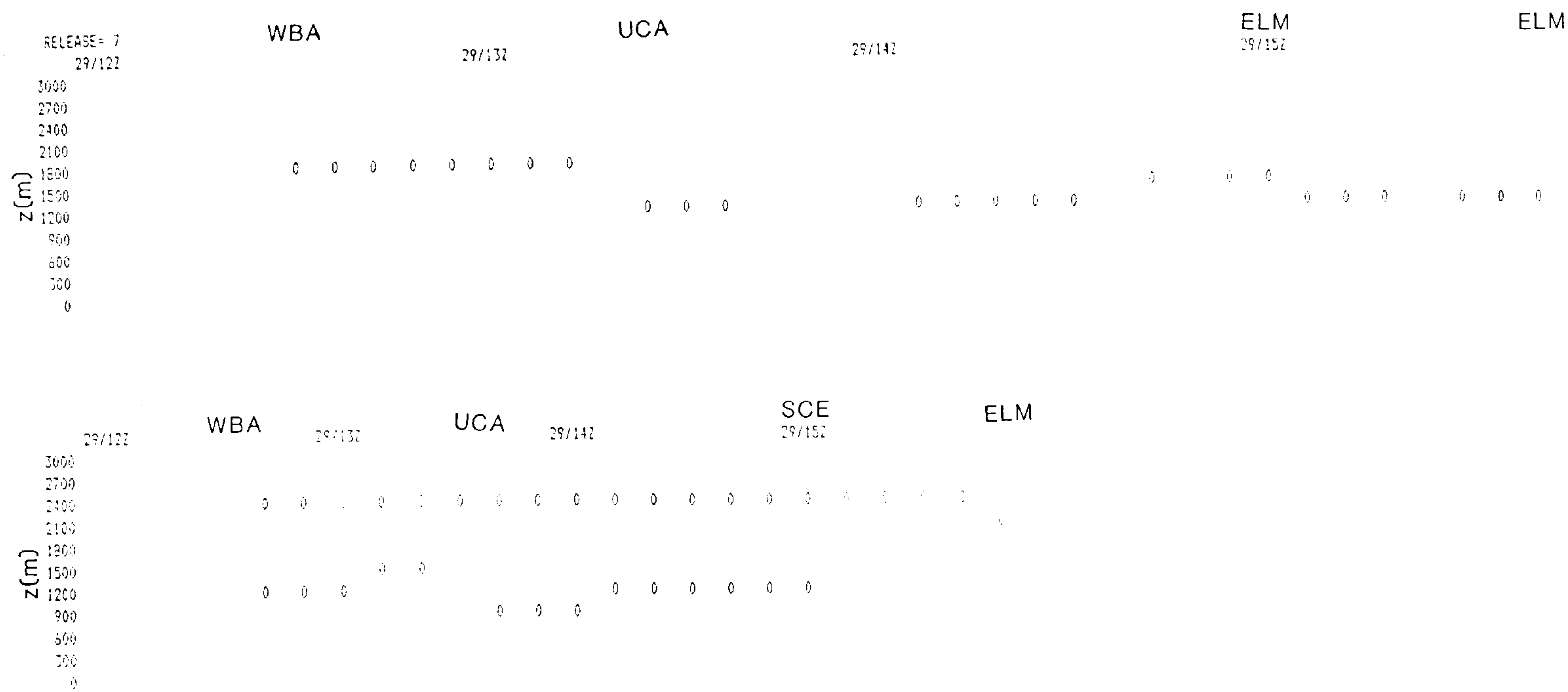
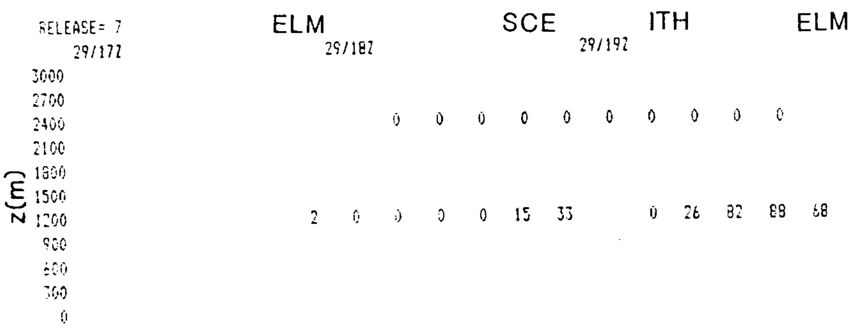
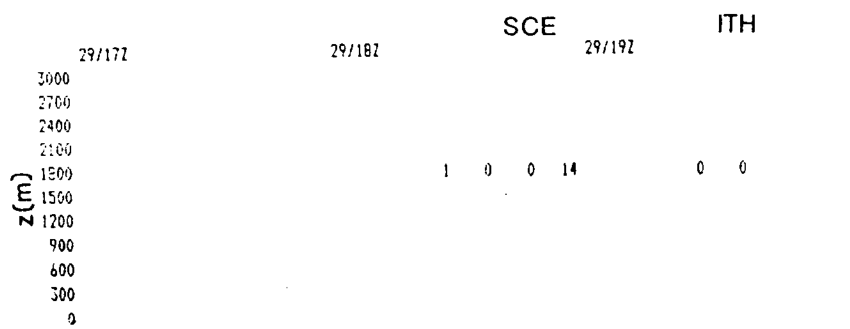


Table 18. (cont.)





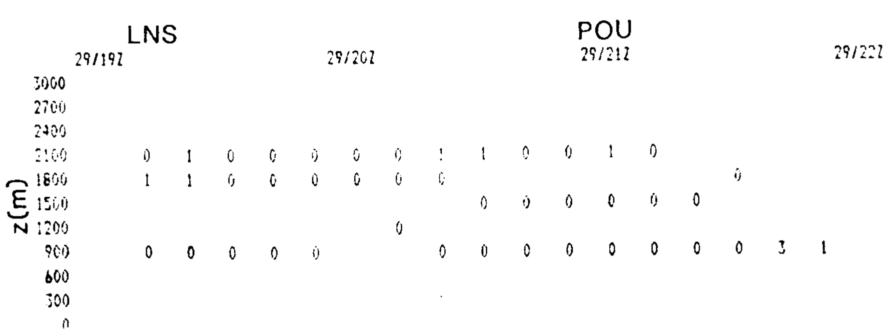


Table 18. (cont.)

RELEASE= 7

z(m)	29/21Z						29/22Z										29/23Z							
	ELM										SCE								ELM				
3000																							
2700																							
2400	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0				
2100																							
1800	0	0	0	1	0	0	0	39	125	10	0				0	0	0	0	0	0	0		
1500																							
1200																							0
900																							
600																							
300																							
0																							

z(m)	29/21Z					29/22Z						29/23Z		
		ELM						SCE						ELM
3000														
2700														
2400														
2100														
1800														
1500														
1200	1	0	0	12	390	264	24	21	239	460	15	0		
900														
600														
300														
0														

z(m)	30/00Z				30/01Z						30/02Z			
		LNS												ISP
3000														
2700														
2400														
2100	0	0	0	1	0	0	0	0	1					
1800														
1500	1	12	7	17	0	0	0	0	0	0	0	0		
1200								0				0		
900	51	42	52	55	6	0					0	1		5
600														
300														
0														

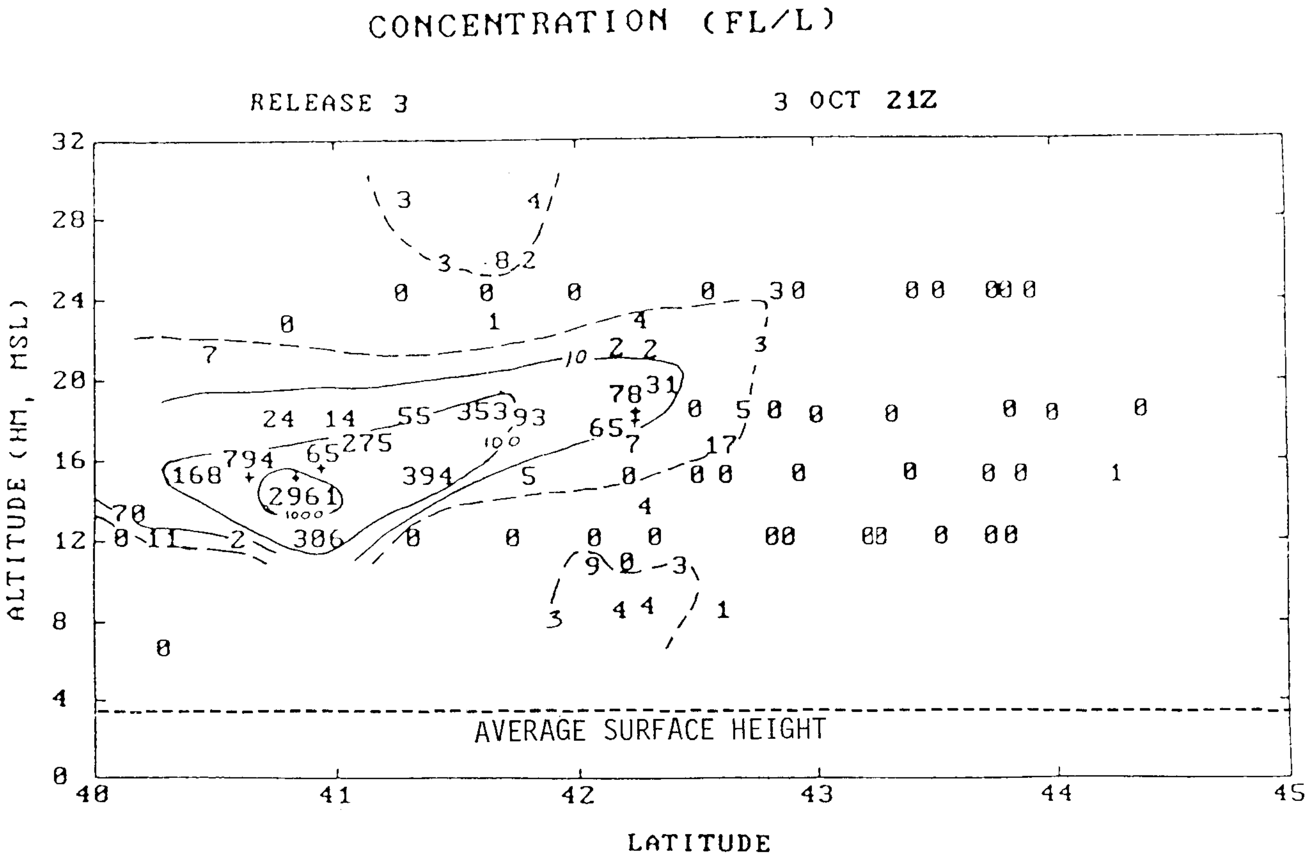


Figure 21. A calculated "snapshot" (2100 GMT) vertical cross section for release 3.

Table 19. Rawinsonde stations

Network Rawinsonde Stations

WMO #	WMO ID	Elevation (m,msl)	Latitude (°N)	Longitude (°W)
71722	MWE	170	46.37	75.98
72403	IAD	085	38.98	77.47
72518	ALB	086	42.75	73.80
72520	PIT	359	40.53	80.23
72528	BUF	218	42.93	78.73
72606	PWM	020	43.65	70.32
72637	FNT	236	42.97	83.73
74494	CHH	016	41.67	69.97

EPRI Rawinsonde Stations

Assigned #	Assigned ID	Elevation (m,msl)	Latitude (°N)	Longitude (°W)
72001	OCA	226	43.15	75.37
72002	HAM	345	42.83	75.55
72003	SYR	127	43.18	76.08
72004	BRL	102	44.47	73.15
72005	GRV	219	45.00	79.28
72006	WCA	346	40.87	81.88
72007	KSU	350	41.15	81.42
72008	MOA	257	41.20	82.12
72009	PSU	378	40.80	77.90
72010	ADR	178	41.00	74.80

Release Site Rawinsonde Stations

71730	SUD	348	46.62	80.78
72429	DAY	298	39.87	84.12

Table 20. Tall towers in the CAPTEX area, and heights of meteorological data (meters above tower base)

Tower Location	Latitude (°N)	Longitude (°W)	Height at Which Data Were Taken				
			Temperature	Dewpoint	Wind Direction and Speed	σ_θ	Precipitation
Sudbury, ONT	46.50	81.02	10,30,230	--	10,230	--	--
Susquehanna, PA	41.10	76.15	10,60	10	10,60	10,60	Ground
Albany, NY	42.60	73.77	10,50,100	--	30[a,b],100	30,100	--
Indian Point, NY	41.27	73.93	10,60,122	--	10,60,122	--	Ground
Davis Besse, OH	41.60	83.08	10,75,100	10	10,75,100	10,75,100	Ground
BNL, NY	40.87	72.88	Ground	--	11,88	--	Ground
Dunkirk, NY	42.45	79.40	10,50,100	--	10[a],100	--	--
Nine Mile Point, NY	43.52	76.40	9,30,61	--	9,61	--	--

a Speed only.
b Also vertical wind speed.

with the wind. A transponder carried by the tetroon receives radio signals from Loran-C (Long-Range Navigation) transmitters and retransmits the signals along with information from its own pressure sensor to a tracking aircraft withing a radius of about 50 miles.

The base station on board the tracking aircraft consists of a 403-mHz receiver, a Loran-C navigator, a data acquisition/control unit, and a computer that interprets the signals to compute the location (latitude, longitude, altitude) of the tetroon at any moment.

A total of 16 tetroons were released during the seven tracer releases, and 13 of them were tracked with varying degrees of success. The maximum distance to which individual tetroons were tracked is given in Table 21. Complete tracking data (time, latitude, longitude, altitude, and pressure) are available (Heard, 1985).

Table 21. Tetroons tracked during CAPTEX tracer experiments

Tracer Release #	Tetroons Tracked	Maximum Distances Tracked (km)
1	0	---
2	1	120
3	4	480, 50, 50, 240
4	3	600, 600, 500
5	2	80, 130
6	1	930
7	2	460, 450

8. DATA FILES

A CAPTEX data tape containing data files for upper-air and tower meteorology, terrain elevation, and ground-level and aircraft measured tracer concentrations are available, on written request, from the following:

Carmen Benkovitz
Bldg. 51
Brookhaven National Laboratory
Upton, NY 11973

8.1 Upper-Air Meteorological Data Files

Upper-air data for September and October 1983 are available to researchers on magnetic tape in NAMER-WINDTEMP format described in Table 22. The tape combines the National Weather Service network and EPRI rawinsondes during the 2-month period and contains all mandatory and significant levels from the surface to 500 mb.

Table 22. CAPTEX upper-air meteorological data files

FILE CHARACTERISTICS AND ORGANIZATION

TWO FILES: SEPTEMBER 1983, OCTOBER 1983
RECORD LENGTH: 25
BLOCK SIZE: 10000
4 observation times per day plus one or more special observation times for release site on the day of release

DATA ORGANIZATION FOR EACH OBSERVATION TIME

```
TIME REC (FOR WINDS)
     STA REC (STATION 1)
            WIND REC (HEIGHT 1)
            WIND REC (HEIGHT 2)
            ETC.
     STA REC (STATION 2)
            WIND REC (HEIGHT 1)
            WIND REC (HEIGHT 2)
            ETC.
     ETC.
TIME REC (FOR TEMPERATURES)
     STA REC (STATION 1)
            TEMP REC (HEIGHT 1)
            TEMP REC (HEIGHT 2)
            ETC.
     STA REC (STATION 2)
            TEMP REC (HEIGHT 1)
            TEMP REC (HEIGHT 2)
            ETC.
     ETC.
```

DATA FORMAT

TIME REC:	YEAR	MONTH	DAY	HOUR	NUMBER OF REPORTS	NUMBER OF RECORDS	MET FIELDS
	I2	I2	I2	I2	I4	I5	I2 1 = WINDS 2 = TEMPS

STA REC:	BLOCK STATION	LATITUDE (DEG*100)	LONGITUDE (DEG*100)	STATION HGT (M,MSL)	NUMBER OF LEVELS
	I5	I5	I6	I4	I3

WIND REC:	WIND HGT (M, MSL)	WIND DIRECTION (DEG)	WIND SPEED (M/S*10)	[MISSING = 9999]**
	I4	I4	I5	

TEMP REC:	TEMPERATURE HGT (M, MSL)	PRESSURE (MB)	TEMPERATURE (DEG K*10)	DEWPOINT (DEG K*10)	[MISSING= 9999]**
	I4	I4	I5	I5	

**All RECS following a STA REC may contain missing data

8.2 Tower Meteorological Data File

The details of the format for the tall-tower meteorological data file (see Table 20) will be made available at the time that the file is requested.

8.3 Terrain Elevation Data File

Terrain elevations were obtained using the Defense Mapping Agency (DMA) topographic data. The DMA determines elevation values at every 30 seconds of latitude and longitude (about 1 km) from 1/250,000 scale maps for the United States.

These elevation data were spot-checked by comparing the DMA elevation values at certain points to elevations taken from a topographical map. The 30-s elevation values (120x120 per degree square of latitude and longitude) were averaged to yield 0.25-degree elevation averages (4x4 per degree square of latitude and longitude). The CAPTEX terrain elevation data file contains these elevation averages for the region from 35 degrees north to 50 degrees north and from 65 degrees west to 90 degrees west reported in meters above mean sea level.

8.4 Ground-Level Measured Tracer Concentration Data File

Ground-level-measured concentration data are available on a tape file organized as follows:

Release # (1X,I1)
Sampling Site # (1X,I3)
Start Day - Hour (GMT) (1X,2I2)
Sample Duration (hours) (I2)
Measured Concentration (fl/l) (1X,I4,2X)
(record length = 20)

Concentration values are rounded to the nearest whole fl/l. Missing concentrations are omitted from this data set.

8.5 Aircraft Measured Tracer Concentration Data File

Aircraft measured concentration data are available on a tape file organized as follows:

Release # (1X,I1)
Aircraft ID (1X,I2)
Sortie/Pass (1X,2I2)
Lid Indicator (1X,I1)
Tube # (I2)
Date (1X,3I2)
Start Hour/Min (GMT) (2X,2I2)
Start Altitude (MSL) (I5)
Start Latitude (°Lat*100) (I5)
Start Longitude (°Lon*100) (I5)
End Hour/Min (GMT) (2X,2I2)
End Altitude (MSL) (I5)
End Latitude (°Lat*100) (I5)
End Longitude (°Lon*100) (I5)
Measured Concentration (fl/l) (I6)

Wind Direction (deg) (2X,I3)
Wind Speed (m/s) (1X,I3)
(record length = 78)

9. ACKNOWLEDGEMENTS

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10. REFERENCES

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