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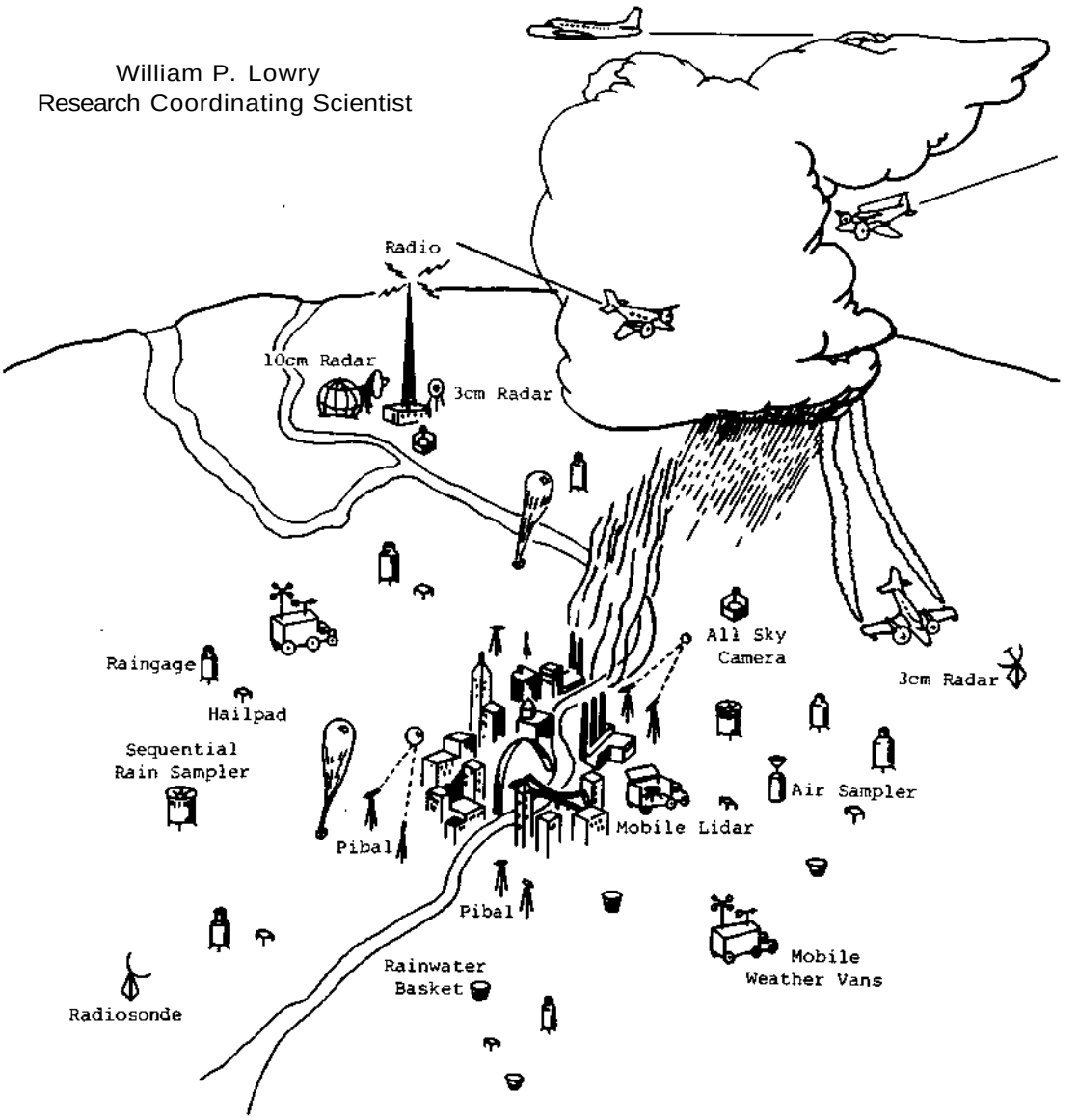
1973 OPERATIONAL REPORT
FOR
METROMEX

William P. Lowry
Research Coordinating Scientist



A Joint Program involving groups from Argonne National Laboratory, Battelle Pacific Northwest Laboratories, University of Chicago, Illinois State Water Survey, Stanford Research Institute, and University of Wyoming

Illinois State Water Survey
Urbana, Illinois 61801
December, 1973

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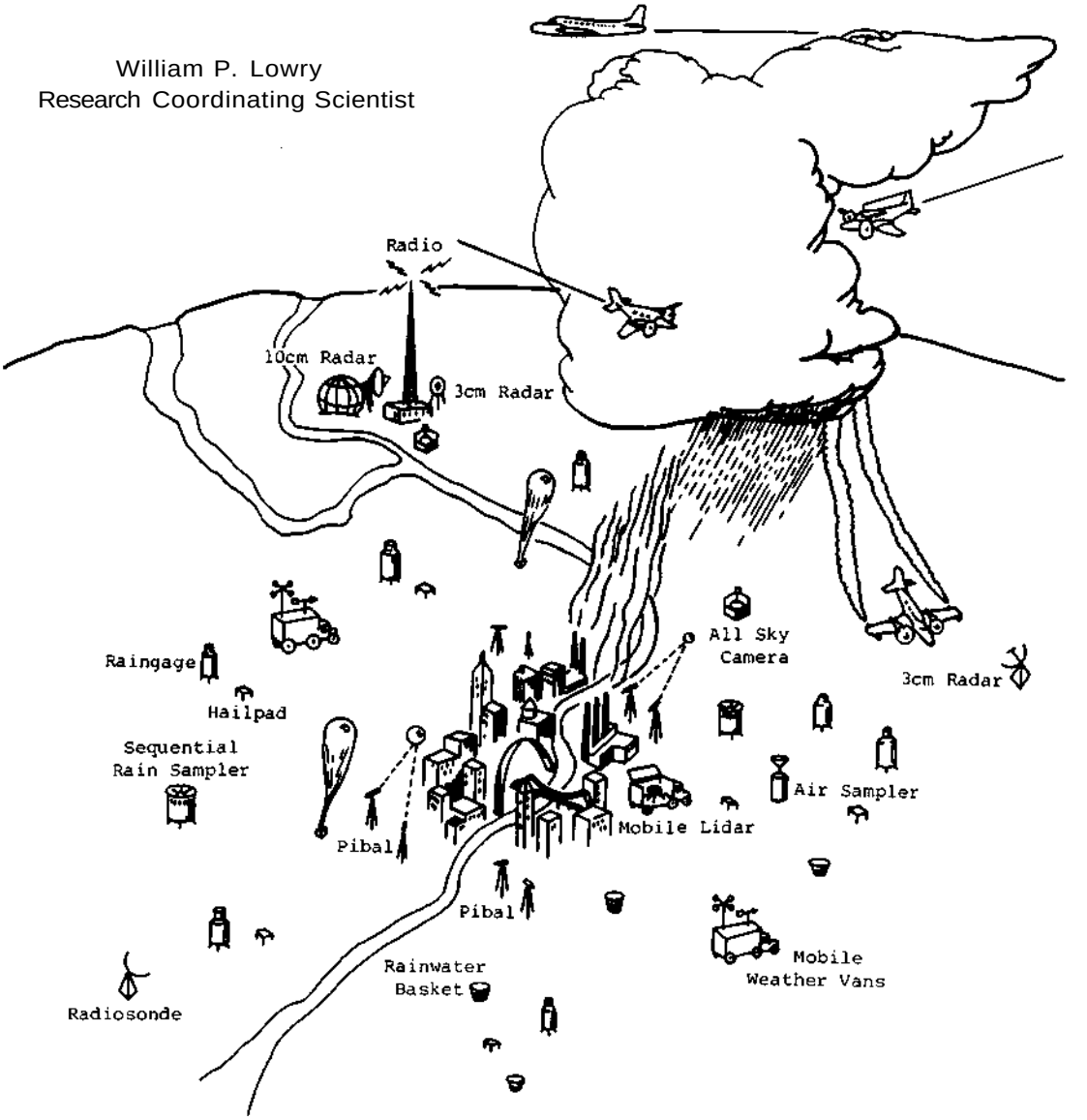

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RESEARCH COORDINATION OF METROMEX

William P. Lowry
Department of Geography, University of Illinois

1. GENERAL

Project METROMEX is a federation of individual scientists with diverse sources of funding but complementary research objectives. The impetus leading to the federation grew out of a series of meetings held in the summer of 1969 among scientists, from four agencies, interested in the effects of urbanization on precipitation-related processes.

The four agencies were Argonne National Laboratory, University of Chicago, Illinois State Water Survey, and University of Wyoming. The structure they developed for METROMEX has been described since then in several publications, among them:

(a) S. Changnon, F. Huff, and R. Semonin. METROMEX: an investigation of inadvertent weather modification. Bull. Amer. Meteor. Soc. 52(10): 958-967: October 1972;

(b) S. Changnon, R. Semonin, and W. Lowry. Results from METROMEX. Proceedings, Conference on Urban Environment and Second Conference on Biometeorology, Philadelphia, October 31-November 2, 1972. American Meteorlogical Society, Boston. pp. 191-197. 1972.

(c) W. Lowry. Project METROMEX: its history, status, and future. Bull. Amer. Meteor. Soc. 55: In press. 1974.

Following the initial meetings in 1969, funding led to the first field program in the summer of 1971. Between June 1971 and August 1973 there have been three summer field programs and two winter field programs. In all three summers, Battelle Northwest Laboratories and Stanford Research Institute have participated with the original four agencies.

During winters, the Illinois State Water Survey's ground network and the University of Chicago's aircraft program have constituted the observational base.

From the outset, continuity and research planning in METROMEX have been carried out by the principal investigators assembled into the Group Atmospheric Science Panel. Coordination of the work of that panel and representation of the panel outside METROMEX has been accomplished through an individual acting as coordinator.

Between September 1970 and September 1972, the coordinator was elected yearly from among the members of the panel: S.A. Changnon through August 1971 and R.G. Semonin through August 1972. In June 1972, a grant from the National

Science Foundation to the Illinois State Water Survey through the University of Illinois (GI 34797) provided funds to search for and employ a full-time, continuing coordinator for METROMEX (to be designated Research Coordinating Scientist, RCS). In September 1972 Dr. William P. Lowry assumed that position with offices in the Water Survey and a joint appointment in the Department of Geography, University of Illinois. The grant and the RCS's tenure elapsed at the end of September 1973, whereupon the task of coordination reverted to the member designated by the Group Panel.

During the period October-November 1972, the RCS obtained the services of three distinguished scientists as members of the METROMEX Advisory Panel: Drs. Barry Commoner (Washington University), Glenn Hilst (ARAP, Inc.), and James D. McQuigg (University of Missouri and NOAA). Dr. Commoner resigned from the Panel in June 1973, and was replaced in September 1973 by Dr. Horace Byers (Texas A&M University).

2. CALENDAR OF FIELD OPERATIONS IN 1973

An attached Table presents, in general terms, the calendar of field observations conducted under METROMEX in the Greater St. Louis area during June-August 1973. Greater detail on the calendar will be found in the reports of individual cooperators in this report.

During this summer, the participation of the University of Missouri at Rolla was added to that of the six groups present in earlier years. UMR instrumentation is described briefly as part of their report herein.

In the summer of 1972, prearranged observational activities were conducted simultaneously and cooperatively by all participants on previously selected dates, called METRODATA Days. The types of observations depended upon the nature of the weather situation on that day. During the summer of 1973, the scheme was changed to one wherein prearranged, cooperative schedules of observations were followed on those dates, within a prescribed period, on which the weather situation was appropriate to the observations planned.

This scheme for weather-determined dates resulted in selection of 6 and 10 August, 1973, as METRODATA Days. An attached Table lists these dates, along with others on which weather events presented opportunities which were taken and on which comparison flights involving pairs of aircraft were made.

As noted previously, winter field programs involved Chicago's aircraft and the Water Survey's ground networks operating at roughly half the mid-summer density. In 1973, this winter program was between 6 March and 1 April.

3. WITHIN-PROGRAM MEETINGS DURING 1973

Two meetings were conducted by the cooperators during 1973 in addition to their annual planning meeting held in April. These two meetings were held in order to enhance the ultimate value of the Project's results by scrutinizing those results in consultation with selected scientists from outside the program.

The first meeting was held on 23-24 August, 1973. The discussion was limited to the mathematical modeling programs of METROMEX in consultation with Drs. Glenn Hilst (ARAP, Inc.), Joseph Knox (Livermore Laboratories), and Daniel Olfe (University of California-LaJolla).

The second meeting was held during 5-9 November, 1973. The discussion included evaluation of current tentative conclusions and planning of optimal programming for the remainder of the Project's life through mid-1976. The cooperators were joined in these discussions by the three members of the Advisory Panel (Byers, Hilst, and McQuigg).

4. RELATIONSHIP OF THIS REPORT TO PREVIOUS OPERATIONAL REPORTS

The 1971 Operational Report for METROMEX was much more sought after than anticipated. As a result, copies are no longer available for distribution. Details from that report may be obtained by directly approaching principal investigators who were in the program in 1971.

Copies of the 1972 Operational Report are available at the time of this writing from:

Research Coordinating Scientist/METROMEX
Atmospheric Science Section
Illinois State Water Survey
Box 232
Urbana, Illinois 61801.

This 1973 Operational Report contains primarily calendars, and depends on previous Reports for presentation of both instrumentation and techniques. Anyone obtaining this Report who believes he should be added to the Project mailing list for similar Reports in the future should make such a request to the address just above.

5. SUPPLEMENTARY PUBLISHED MATERIALS ON METROMEX

As already mentioned previously in this section, several published papers permit an overview of the change and progress in the structure of METROMEX. In addition, clusters of papers containing research results from METROMEX appear in Preprint volumes of conferences held by the American Meteorological Society:

Third Conference on Weather Modification, Rapid City, South Dakota, 26-29 June 1972, and

Conference on Urban Environment, Philadelphia, Pennsylvania, 31 October - 2 November, 1972.

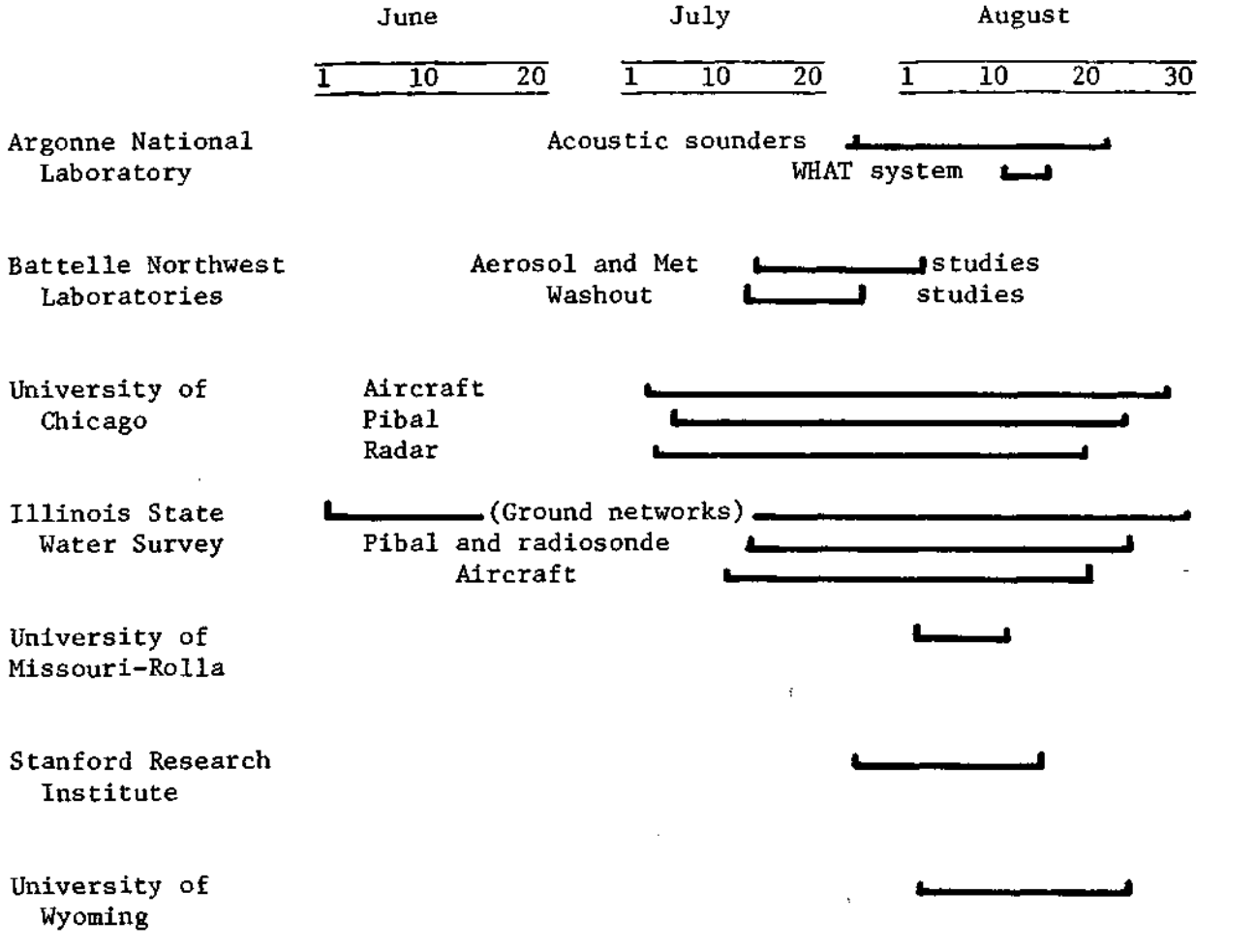
During 1973 two reports have become available which present substantial summaries of research results from METROMEX:

Interim Progress Report, Project METROMEX, Department of Atmospheric Resources, University of Wyoming, January 31, 1973.

Summary Report of METROMEX Studies, 1971-1972, F.A. Huff, Editor, Illinois State Water Survey, Urbana, 1973.

Finally, a group of research summary papers has been prepared by METROMEX scientists during 1973, to be published together in the Bulletin of the American Meteorological Society for February 1974. This group contains not only research summaries but also references to other conference papers and summary documents not listed herein.

CALENDAR OF METROMEX FIELD OPERATIONS - SUMMER 1973



1973 DATES TO BE GIVEN PRIORITY BY METROMEX PARTICIPANTS
FOR DATA REDUCTION, PROCESSING, AND ANALYSIS

Date	Reason(s) for selection
Jul 14	Cumulus initiation and development apparently urban-related.
23	Severe local storm; chemical tracers released.
30	Cumulus apparently urban-related; tracers released.
31	Comparison flight: Chicago and penn State aircraft.
Aug 6*	Minimal boundary layer convection; severe episode of pollutant accumulation.
10*	Thunderstorm development over ground networks.
13	Cumulus growth and dissipation over ground networks, followed by squall line and frontal passages.
14	Comparison flight between Chicago and NCAR Buffalo; independent flight by Wyoming.
21	Minimal boundary layer convection; comparison flight: Chicago and Wyoming.

* Dates selected for highest priority as case studies, based on criteria of (a) amounts of data available and (b) representativeness of an important class of synoptic situation.

ARGONNE PARTICIPATION IN METROMEX 1973*

Edward L. Miller

Argonne National Laboratory

Radiological and Environmental Research Division

Acoustic Sounders

The program of acoustic sounding as a part of Metromex, begun by Argonne National Laboratory in 1972, was expanded in 1973 to include acoustic sounders at three widely spaced locations, shown by the accompanying map. The expansion to three sounders operating simultaneously adds two more dimensions to the "picture" of the structure of the atmosphere provided by these instruments.

The spatial information makes it possible to study the effects of differences in the kind of terrain at each location. In particular, it is possible to see urban-rural differences in such things as the height and time behavior of inversion layers. This ability to see differences at multiple locations simultaneously and continuously under the same synoptic condition greatly furthers the objective of studying urban influences on various meteorological phenomena. Inversion heights and other features that would affect dispersion are of particular interest to us. However, the sounder usually depicts a large amount of turbulent structure associated with the passage of thunderstorms and may be able to provide information

* Work sponsored by the U. S. Atomic Energy Commission, Division of Biomedical and Environmental Research.

about urban influences on their behavior.

Another consequence of multiple sites is that the changes in the observed patterns can be more readily attributed either to time-varying structure or to a moving system with fixed structure, resolving an ambiguity associated with operation at only a single location.

A description of the acoustic sounder equipment and an example of the data obtained are in the 1972 Operational Report. Argonne's capability for planetary boundary layer measurement was also expanded this year by a new high-resolution radiosonde system described below.

WHAT System

The WHAT System is a semi-automatic, digitized radiosonde and double-theodolite balloon-tracking apparatus developed by Argonne National Laboratory in order to obtain measurements of wind and temperature profiles through the planetary boundary layer with improved resolution and accuracy. The equipment consists of two manually-operated, optical theodolites of otherwise standard design, modified by the manufacturer (Warren-Knight eo.) to include high-resolution, pulse-type shaft encoders (0.036 angular deg. per pulse) directly coupled to the elevation and azimuth axes of each instrument. Associated digital counters and control circuitry (Electronics Division, ANL) automatically record the four sighting angles in computer compatible form on magnetic tape at preset intervals, as often as once each second. Standard 30-gm pilot balloons tracked for winds also carry transistorized radiosonde transmitters (403 MH_z; based on a circuit developed by the Atmospheric Environment Service of Canada) whose continuous temperature signals (0.02 deg. C sensitivity) are recorded on the tape along with the tracking data. A computer program subsequently averages several successive sets of

sighting angles to smooth operator tracking errors, and calculates average winds, heights, and temperatures (hence the acronym), typically over periods of 15 seconds or through atmospheric layers 50 m. thick. The equipment is fully portable, operating from storage batteries in the field. Base lines up to 600 m. long are used.

Because of the greatly increased facility with which field data can be reduced and the relatively small cost of the miniaturized radiosondes, the WHAT system makes feasible closely-spaced serial soundings capable of detecting developing boundary layer phenomena. In field tests conducted during METROMEX 1973 from a site near Granite City, a method was developed to cut the transmitter free from the balloon after 10 or 15 minutes of ascent. Descending parachutes were successfully tracked on a number of occasions, thus doubling the effective number of boundary layer observations in these runs by this "structure-sonde" technique.

SUPPORT DATA

Surface values for temperature, humidity, and wind speed and direction were obtained at each of the three sites using Bendix-Friez hygrothermographs and Aerovanes. Solar radiation was measured with an Eppley pyranometer at the Granite City site only.

OPERATIONS SCHEDULE

The times of operation for all equipment are indicated on the accompanying chart. A dashed line indicates that the data are incomplete, inaccurate, or of poor quality and footnotes give necessary details.

The acoustic sounder data at ARCH were limited to heights of about 500

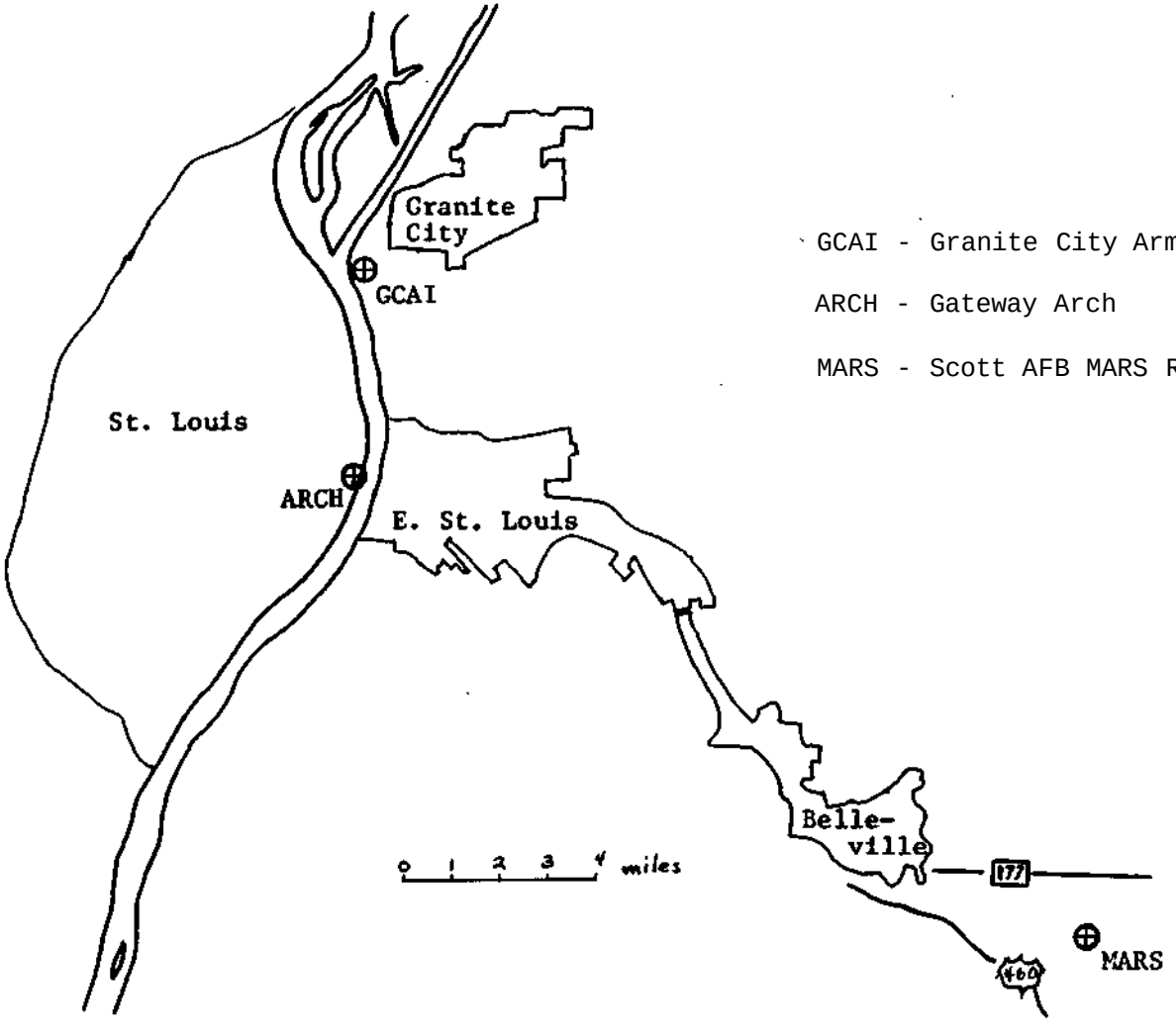
meters and lower by high ambient noise levels. Echoes from buildings also obscured some atmospheric echoes below that height.

A detailed schedule of balloon launch times for the WHAT System are given in the table. Early morning hours were chosen in order to examine the lifting and destruction of nocturnal, ground-based inversions.

Acknowledgments

The sites were made available by the co-operation of the Granite City Army Installation, Scott Air Force Base, and the National Park Service. Help in the acoustic sounder program by M. L. Wesely, F. C. Kulhanek, and G. A. Zerbe is gratefully acknowledged. The WHAT system program is directed by Paul Frenzen. Participating in that program in St. Louis were B.B. Hicks, R. L. Hart, M. L. Wesely, and A. Kittle.

ARGONNE Acoustic Sounder Locations
METROMEX 1973

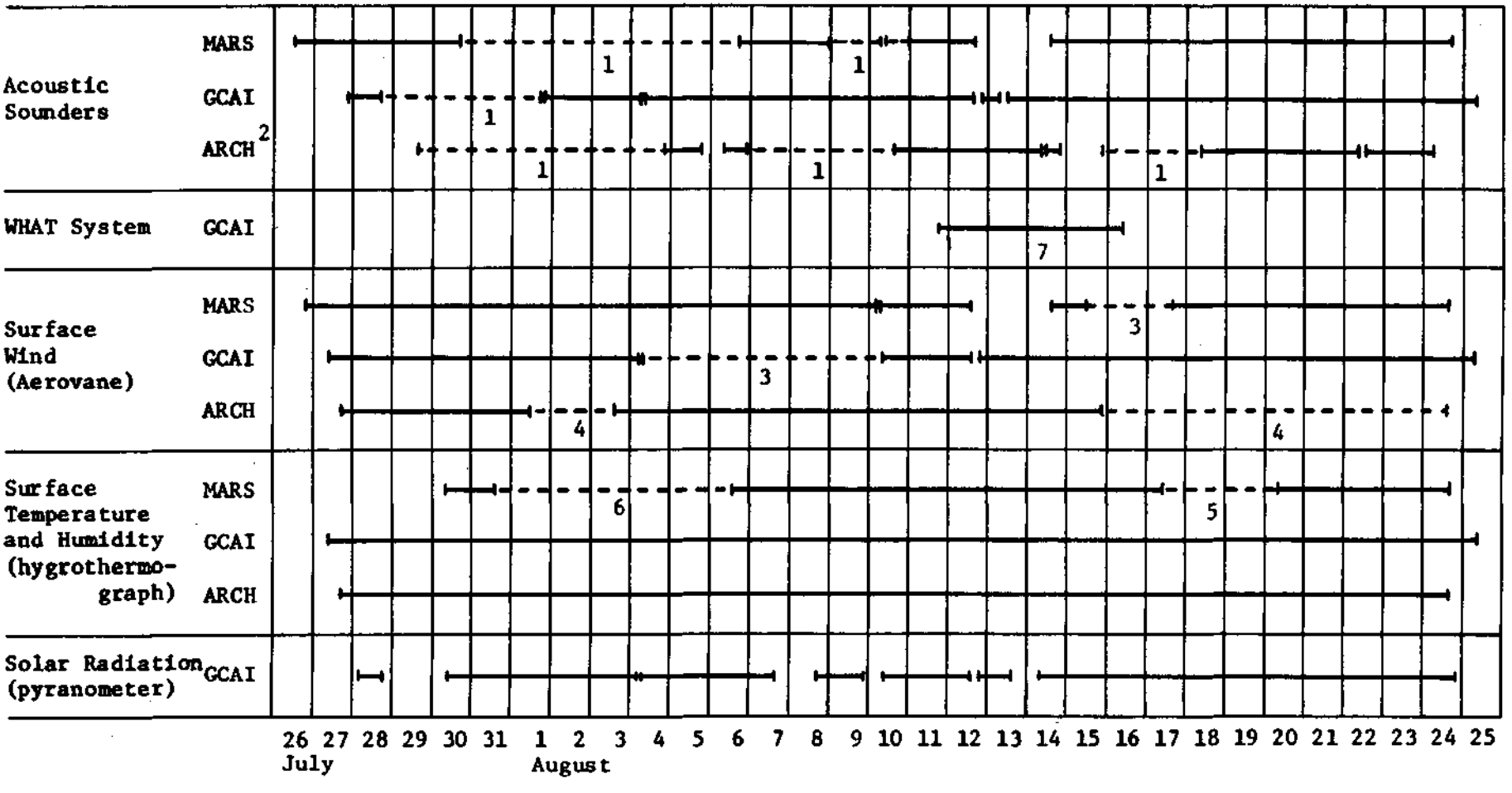


GCAI - Granite City Army Installation

ARCH - Gateway Arch

MARS - Scott AFB MARS Radio Station

Argonne National Laboratory
1973 METROMEX Operations Schedule



1. equipment malfunction 2. All data limited - see text. 3. speed only 4. direction only
5. temperature only 6. relative humidity only 7. See table.

WHAT System Balloon Release Times
METROMEX 1973

Date	Release Time CST	Date	Release Time CST
11 Aug	1830*	15 Aug	0512*
	1905		0557*
	1940		0719
12 Aug	0543		0812*
	0632*		0937*
	0739*		1035*
	0826*		1116*
	0912*	16 Aug	0532*
	1001		0610
13 Aug	0558*		0713*
14 Aug	0547*		0813
	1046		0929*
	1210*		
	1257*		

* On these runs separation was achieved and the descent of the sonde was also tracked.

Battelle
Pacific Northwest Laboratories
Batteile Boulevard
Richland, Washington 99352
Telephone (509)
Telex 36921

BATTELLE OPERATIONS CALENDARS

For details regarding instrumentation, see Section 4 page 3 of this report.

TRACE CONSTITUENT MONITORING FLIGHTS

Date	Location	Measurements
July 16, 17, 22	Downwind	High volume filters for trace metals
July 27, 28	Metropolitan area	Ice nuclei and aerosol size distributions
July 30, 31, August 1	Metropolitan area and downwind	NO, NO_x, Aitken nuclei
August 2, 3	Metropolitan area and downwind	Aerosol size distributions

GROUND LEVEL TRACE CONSTITUENT MONITORING

Date	Location	Measurement
July 15	Arc 20 miles downwind	Trace metals
July 16, 22, 30	Arcs 20, 40, 60 miles downwind	Trace metals, CO, Freons, SO_2
July 17	Arcs 20, 40 miles downwind	Trace metals, CO, Freons, SO_2
July 27	Arcs 20, 40, 80 miles downwind	Trace metals, CO, Freons, SO_2
July 28	Arcs 20, 50, 80 miles downwind	Trace metals, CO, Freons, SO_2
July 12-22	Fort Leonard Wood	24-hour filter samples Trace metals
July 16-18, 27, 29	Wood River	Trace metals, SO_2
July 15-18	Richmond Heights	Trace Metals, SO_2

WASHOUT MEASUREMENTS

Date	Approximate Time Of Precipitation Sampled	Radiosonde Release Time (CST)
July 14	Early Evening	None
July 18-19	Overnight	1329 (7/19)
July 20	None	1241
July 21	Early Morning	9028
July 22-23	Overnight	None
July 23	Evening	1323
July 24	Afternoon	1256
July 25	Evening	1308
July 25-26	Overnight	None

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UNIVERSITY OF CHICAGO OPERATIONS CALENDARS

For details regarding instrumentation, see Section 4 page 3 of this report.

Operations Calendar - University of Chicago in Metromex - 1973

Winter Operations

Date	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
6 Mar	162 1606-1641 CST 1719-1739	Equipment check flight and air samples over GRE.	1	1 BW
7 Mar	163 1017-1232	Pace pressure calibration to 10K. Air sample 1.5K over STL.	1	
	164 1455-1611	Ice nuclei filters and air samples 1.5K along three N - S lines across STL.	4	16 MF 4 BW
8 Mar	165 0943-1157	Pace pressure calibration to 10K. Ice nuclei filters and air samples 1.5K along three N - S lines across STL.	4	18 MF 4 BW
10 Mar	166 1052-1215	Study of replicator decellerator and Pace pressure system to 20K over GRE.		
12 Mar	167 0928-1129	Pace pressure calibration to 10K. Ice nuclei filters and air samples 1.5K along three N - S lines across STL.	4	15 MF 4 BW
13 Mar	168 1019-1153	Ice nuclei filters and air samples 1.5K along three NE - SW lines across STL.	4	17 MF 4 BW
14 Mar	169 1014-1156	Ice nuclei filters and air samples 1.5K along three E - W lines across STL.	3	18 MF 4 BW
15 Mar	170 0908-1031	Ice nuclei filters and air samples 1.5K along three N - S lines across STL.	4	16 MF 4 BW

Date	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
18 Mar	171 1132-1343 1517-1741	Midway to Jeffco (NCAR) via Omaha.		
20 Mar	172 1042-1256	NCAR Tower flyby (28 passes) for instrument check.		
21 Mar	173 1327-1609	Flyup to 20K with NCAR Buffalo 326D.		
23 Mar	174 1216-1456 1724-1948	Jeffco (NCAR) to Midway via Sioux City.		
27 Mar	175 1443-1612	Ice nuclei filters and air samples 1.5K along three N - S lines across city.	4	20 MF 4 BW
28 Mar	176 1058-1123	Ice nuclei filters and air samples 1.5K along three E - W lines across STL.	4	16 MF 3 BW
29 Mar	177 0901-1029	Ice nuclei filters and air samples 1.5K along three NW - SE lines across STL.	4	18 MF 4 BW
	178 1428-1525	Replicator decellerator check. Ice nuclei filters and air samples over GRE.	4	6 MF 4 BW
30 Mar	179 1103-1229	Ice nuclei filters and air samples upwind downwind of Labadie and Portage de Sioux Power Stations.	4	8 MF 4 BW
	180 1701-1841	Ice nuclei filters and air samples upwind downwind of Labadie and Merrimac Power Stations.	4	8 MF 4 BW

Date	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
1 Apr	181 0917-1041	Ice nuclei filters and air samples 1.5K along three NW - SE lines across STL.	4	16 MF 4 BW
7 May	182 1122-1710	Midway to Jeffco (NCAR) via Huron, S. D.		
12 May	183 1001-1026	Pace system check-out.		
14 May	184 1315-1553	NCAR Tower flyby (25 passes) for instrument check.		
17 May	185 1720-2006	Knollenberg Probe check flight.		
18 May	186 1113-1744	Jeffco (NCAR) to Midway via Des Moines.		

Summer Operations

Date	TPS-10 Radar Film	PIBAL Release Time	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
3 Jul	1051-1909 CDT		187 1418-1531 CDT	Equipment check to 17.5K over GRE. SASOL flow meas. Replicator check. No ARIS tape.		
6 Jul		1625 CDT	188 1839-1936	Ice filters and air samples on single west to east run across city at 2K.	4	15 MF 4 BW
8 Jul	1227-2024	1336	189 1332-1536	19 penetrations 16-17K through CG, CB 30-50 mi south STL.		
9 Jul	1057-2210	1401				
10 Jul	1000-1609	1354 1412	190 1440-1736	Formation flight with Penn. State N6927B. Grid of 6 east-west passes at 2K across city for ice filters, state parameters and aerosol. South to north across city for air samples. Time reset due OPA.	4	36 MF 4 BW
12 Jul		1327 1356	191 1548-1621	OPA check flight over GRE.		

Date	TPS-10 Radar Film	PIBAL Release Time	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
13 Jul		1335	192 1501-1754	Grid of 7 passes at 2K on 310 - 130 headings across city for ice filters, aerosol, radiation. Air sample upwind of, and three samples within, Labadie plume. B2 solarimeter moved to right wing. ARIS analog malf.	4	42 MF 3 BW
14 Jul	1000-2139	1406	193 1413-1603	18 penetrations at 11-17K through 14 CG and CB, starting STL, ending up 50 mi east. ARIS analog malf.		
15 Jul		1349	194 1341-1551	Grid of 6 east-west passes at 2K over STL for ice filters and aerosol. Air samples on pass from Merrimac Power Station to Alton Civic Airport. No ARIS. 16 Jul replaced A/D converter.	4	26 MF 4 BW
16 Jul		1334				
17 Jul		1339	195 1342-1425 1635-1712	Equipment check and calibrations. SCA airflow meas. Wet bulb inop.		
19 Jul	1009-2245	1345	196 1515-1712	SCA and replicator ck in Cu clds north Vandalia. Ice filters and air samples on south to north pass along Miss. River, Merrimac to Alton at 2K.	4	12 MF 4 BW

Date	TPS-10 Radar Film	PIBAL Release Time	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
20 Jul	1206-2330	1326 1348	197 1307-1520	Attempted two-plane with Penn. State N6927B for cu penetrations, broken off due radio problems. 7 penetrations 17.5K through 3 CG near Vandalia.		
21 Jul	1000-2245	1323	198 1307-1520	14 penetrations 9-12K through 12 CG over and near STL. 5 penetrations 18K through 4 CG-CB well south of STL.		
22 Jul		1401 1416	199 1339-1547	Cross-section TOY to 10 MTS 270 at levels 2K, 3.1K, 3.6K and 4.2K to study doming of inversion over city. Air samples on west to east pass over city at 2K. No SCA, OPA, SASOL ref 1v.	4	4 BW
23 Jul	1000-2323	1259	200 1338-1613	24 penetrations 8K through 24 cu over and near STL. 11 penetrations 18K through 11 CG over STL.		
24 Jul	1000-2040	1349 1405	201 1348-1526	6 penetrations at 19K in 4 CG near Bi State. Terminated due excessive engine vibration.		

Date	TPS-10, Radar Film	PIBAL Release Time	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
26 Jul	1509-1730	1312-1333				
27 Jul	2040-2455	1311				
28 Jul	1000-1333	1344-1408	202 2010-2145	Speed runs and calibration flight over GRE.		
29 Jul	1227-2154	1300	203A 1514-1547	SCA calibration in 5 small cu over Lake Carlyle. SCA reinstalled, OPA off, SASOL inop due memory COP.		
			203B 1701-1743	Ice nuclei filters and air samples at 2K upwind and downwind steel mills and refineries.	3	4 MF 3 BW
30 Jul	1000-2238	1418	204 1425-1634	21 penetrations at 16K through 11 CG - CB west then east of city. Terminate altitude flying due heavy load of ice made it difficult to maintain A/S. 2 runway passes GRE for pitot check, pitot o.k., SCA taped.		
31 Jul	1930-2020	1314-1344	205 1451-1746	Formation flight with Penn. State N6927B. Grid of 6 passes over city on headings 060 - 240 at 2K. Comparative ice nuclei counts at 2K. A pass from SE to NW across city for air samples at 2K.	4	39 MF 4 BW

Date	TPS-10 Radar Film	PIBAL Release Time	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
2 Aug		1320	206	Administrative flight to Chicago.		
3 Aug		1325				
4 Aug	1106-1636	1353	207 1358-1532	Two passes across city 5.2 - 5.8K for base micro-structure in broken strato-cu, 22 clouds total. Pass across city south to north for air samples at 2K. Gatz filter. JW inop.	4	12 MF 4 BW
5 Aug	1314-1407	1434	208 1425-1620	Mlcrostructure data on 40 small cu (tops 8 - 12K) over and around STL. Flight level 6.8K. South to north pass over city at 2K for air samples. Wet bulb removed. Gatz filter.	4	12 MF 4 BW
6 Aug		1335	209 1340-1558 1622-1701	4 level cross-sections normal to winds over city on 120 radial STL at levels 2, 4, 6, 8K for radiation, ice nuclei filters, aerosol and inversion structure. Pass at 2K Cedar Hill to Alton Civic Arpt for air samples. 2 Gatz filters. First flight with increased SASOL range.	4	33 MF 4 BW
7 Aug	1313-1857	1344 1359				

Date	TPS-10 Radar Film	PIBAL Release Time	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
9 Aug	0921-2328	1400	210 1602-1825	17 penetrations 16 - 17K through 14 CG - CB. First cloud penetrations were 30 mi west STL VOR, on upwind end of storm that remained nearly stationary over St. Charles. Because of ATC gradually moved north and east until final passes were near SPI. Thunderstorm (35K top) penetration 20 mi north PMQ approx 1745.		
10 Aug	1317-2012	1410 1430	211 1415-1659	Metrodata Day study of developing Cu - CG - CB over STL. 42 penetrations into 39 CG - CB over STL except ca 8 clouds 25 mi south MTS approx 1500 - 1530. All passes 9K. Two air samples 9K in cloud and two below cloud 2.5 - 3.9K for nuclei analysis. Gatz filter.	4	4 BW
11 Aug	1718-1935	1330	212 1544-1650	Series of spirals up to 6K and straight line descent to 2K north to south over STL for air samples, filters, aerosol and radiation. Dew point operational. Gatz filter.	4	9 MF 3 BW

Date	TPS-10 Radar Film	PIBAL Release Time	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
12 Aug	1301-0027	1422	213 1518-1553	Air samples in vertical profile in downwind plume from STL. Gatz filter. Main mission for Cu scrubbed because of transponder failure.	4	4 BW
13 Aug	1442-2240					
14 Aug	1000-2128	1349 1452	214 1507-1801	Formation with NCAR Buffalo N326D for ice nuclei mapping. Complex pattern of 6 runs across city at 2K. Air samples across city NW to SE on 320 - 140 radials STL. Gatz filter. Rosemount probe malf. and removed for remainder of season.	4	56 MF 3 BW
16 Aug	0957-2200	1324				
17 Aug	0936-1936	1434	215 1350-1635	Grid of 7 passes across city at 2K for ice nuclei. aerosols and radiation. Air samples in vertical profile over city south Forest Park, (4K, 3.5K, 2.7K, 2K). Gatz filter.	4	60 MF

Date	TPS-10 Radar Film	PIBAL Release Time	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
18 Aug	1515-1526	1356 1410	216 1353-1651	Two vertical sections (2K, 4.5K, 6K) at right angles across city to study inversion, ice nuclei, aerosols. Several scud cu intercepted on 4.5K level. Air samples in vertical profile over Forest Park (6K, 4K, 3K, 2K).	4	49 MF 4 BW
19 Aug	1315-1327	1404	217 1348-1626	Ice nuclei filters, aerosol structure in vertical. Two series of holding patterns 1K steps between 10K and 2K. Air samples at 2K upwind-downwind St. Charles; upwind-downwind Refinery area.	4	24 MF 4 BW
20 Aug			218 1612-1706	Runway transit measurements at GRE for airspeed - altitude calibrations.		
20 Aug			219 2005-2158	Speed runs for recovery coefficient calibrations.		
21 Aug		1422 1438	220 1459-1743	Formation with Univ. Wyoming N100W for ice nuclei, aerosol and radiation measurements. Two two-level cross-sections at right angle across city followed by spirals at Mellstadt and Portage de Sioux and three samples within plume.	4	4 MF 4 BW

Date	TPS-10 Radar Film	PIBAL Release Time	Lodestar Flight No. T.O. and Lndg.	Flight Mission	CCN Samples	Ice Nuclei Samples
23 Aug		1335	221	Aborted due magneto malf. rt. engine.		
25 Aug			222A 0930-1330	Flight to STL for VOR check.		
			222B 1448-1710	Radar calib. passes at 10K and 20K.		
			223 1717-1807	Air samples in SW - NE line across STL at 2K.	4	
26 Aug			224 1401-1505	Air samples vertical profile Chain of Rocks, 8K, 6K, 4K, 2K.	4	8 MF
28 Aug			225 1140-1315	Radar calibration runs at 18K and 10K.		
29 Aug			226 1145-1255	Administrative flight GRE - Midway.		
31 Aug			1011-1150	Continuation of Adminis-trative flight 226: Midway - STL.		

1973 METROMEX OPERATIONAL REPORT

PROJECTS OF THE ILLINOIS STATE WATER SURVEY

by

Staff, Atmospheric Sciences Section
Illinois State Water Survey
Urbana, Illinois

Introduction

The Water Survey has several extensive projects within the framework of METROMEX, and the overriding goal of the Water Survey research effort is to define, understand, and evaluate the urban-induced precipitation increases in the St. Louis area with respect to the quality and quantity of the water resources of the State. A specific example of the local problem relating to precipitation change at St. Louis is the fact that the primary groundwater supply area for the urban-industrial complex in Illinois east of St. Louis, and where the rainfall increases exist, is where groundwater recharge depends heavily upon rainfall. However, the Water Survey interests go beyond St. Louis inasmuch that it is a state with other major metropolitan areas wherein such alterations could exist.

The interest of the Survey in inadvertent precipitation modification is an outgrowth of 15 years of climatological and meteorological research pertinent to Illinois weather as related to the industrial, commercial, agricultural demands for weather information. The sub-goals of the Survey METROMEX projects reflect the historical interest of our atmospheric research group in the areas of rainfall, severe weather, climatology, cloud physics, and atmospheric chemistry.

The Survey projects in METROMEX actually consist of 14 sub-goals involving a) field operations and data collection, b) analysis and research, and c) application of the results to various users. These 14 sub-goals and "activity" areas of the Water Survey METROMEX program appear in Figure 1 which is a flow chart depicting these areas and how they inter-relate. The means of information exchange and transmission are indicated. The field oriented sub-goals include: 1) study of surface rainfall and severe weather to define their time and space distributions; 2) measurement and study of basic surface weather conditions; 3) investigation of the low-level airflow and turbulence to define circulation patterns; 4) study of the aerosol budgets and rainfall scavenging of pollutants and tracer materials; and 5) the investigation of the effects of increased rainfall and polluted rainfall on surface and groundwater quality. The sub-goals within the framework of our analytical projects (sub-goals 6-8 on Fig. 1) include 1) investigations of the atmospheric and mesoscale synoptic weather conditions to define those conditions when alterations occur; 2) delineation of the potential causes for the observed anomalies; and 3) definition of the critical measurements for METROMEX in other cities through cloud and mesoscale numerical modeling. Sub-goals 9-14 are delineated on Figure 1, and these relate to the users and the applications of the information derived out of the eight data collection-analytical sub-goals.

Instrumentation

The scope and size of the effort to meet these goals in 1973 was sizeable and comparable to those in 1971 and 1972. The primary 1973 field operations were in summer, June-August, although the rain and surface weather networks (Fig. 2) have been maintained on a continuous basis since June 1971.

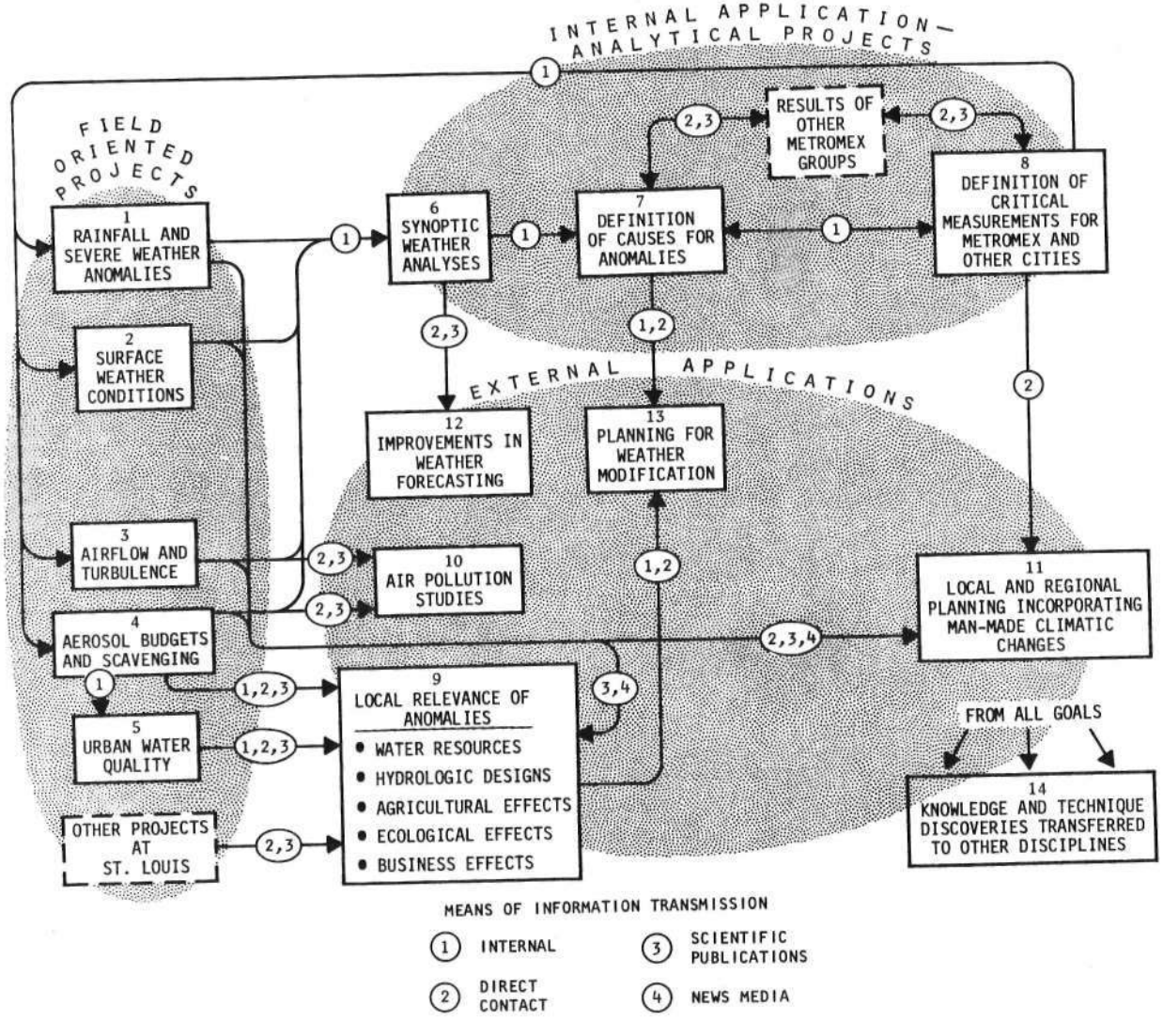

Figure 1. Interaction Water Survey's goal-oriented projects with their internal and external applications.

The 1973 field effort involved 49 employees in the field (Fig. 3), including 20 fulltime staff members and 29 students, and 15 staff members in the analysis center in Champaign. The facilities supporting the 1973 METROMEX projects of the Water Survey, which are heavily oriented to surface measurements, add up to about 500 individual meteorological instruments, plus our project operations and radar site northwest of St. Louis.

The 1973 instrumentation array in the St. Louis area is shown in Figure 2. The 250 sites, each with a recording raingage plus a hailpad, form the World's largest recording raingage network (3800 mi^2) with 225 raingages in the densely instrumented research circle (2000 mi^2). The 24 recording (temperature-humidity) weather stations were located throughout the research circle with 7 wind instruments installed to surround the metropolitan area. The monitoring of severe weather involved a network of 6 thunder recorders plus standard weather station observations at 4 sites. The airflow program involved single theodolite-pibal operations at 11 sites plus operations of 3 radiosondes (Fig. 2).

The extensive atmospheric chemistry program involved the use of several instruments (wet-dry automatic samplers, sequential rain samplers , Andersen impactors, and air filters) at a few sites plus total storm rainwater samplers at 81 sites in the rectangular area shown in Figure 2. The cloud physics and storm studies were aided by the use of 2 radar systems, a 3-cm RHI radar and a 10-cm PPI radar collecting scope photographs and digital echo data at a site northwest of St. Louis (Fig. 2), plus 2 cloud cameras and a network of 8 raindrop spectrometers. In addition to the extensive surface networks and equipment shown on Figure 2, another portion of the project involved an aircraft used over a 6-week period to 1) release unique tracers into convective storms on 7 days, 2) to measure cloud characteristics in the urban and rural areas on

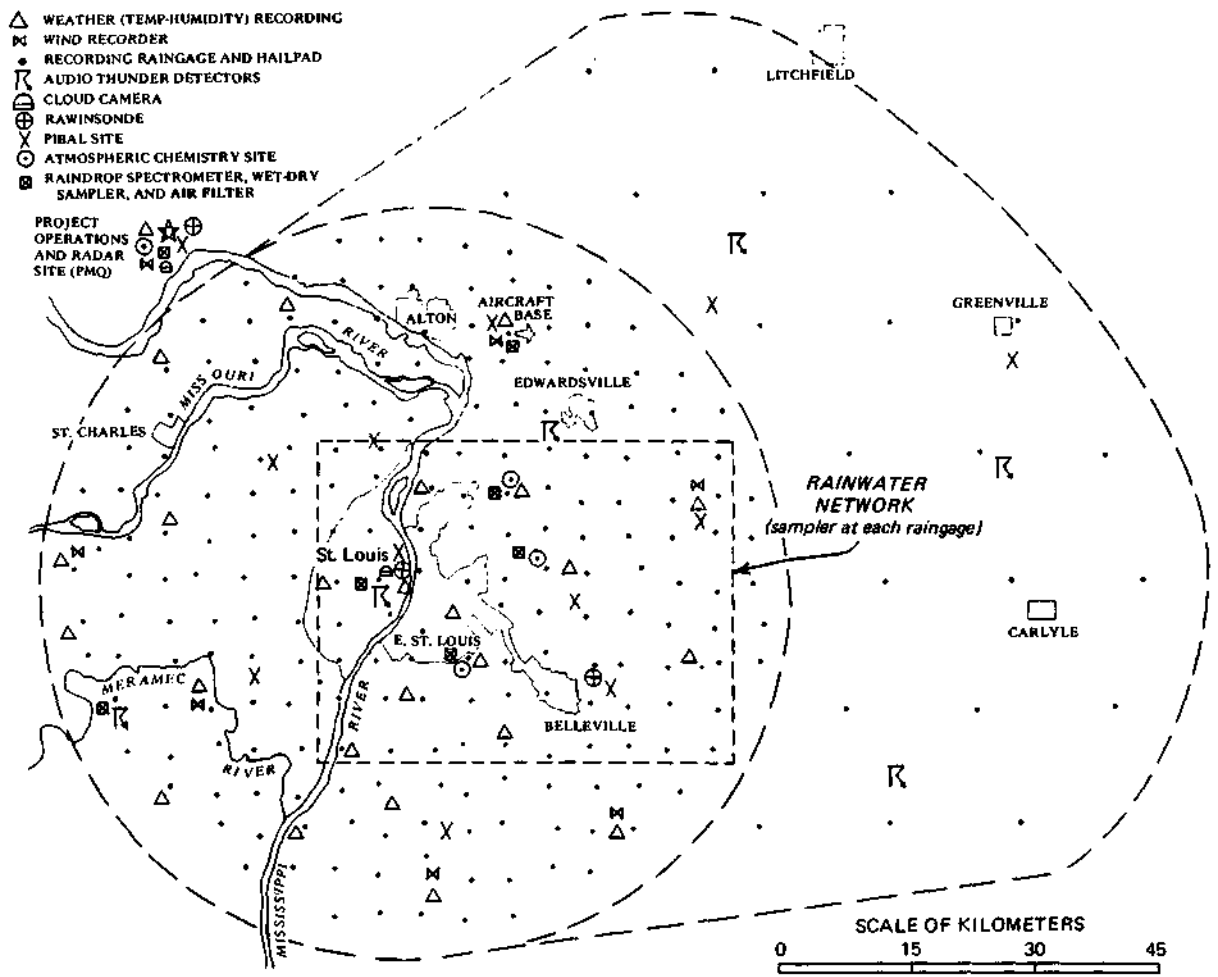

Figure 2. METROMEX networks, instruments, and facilities of the Illinois State Water Survey, for summer of 1973.

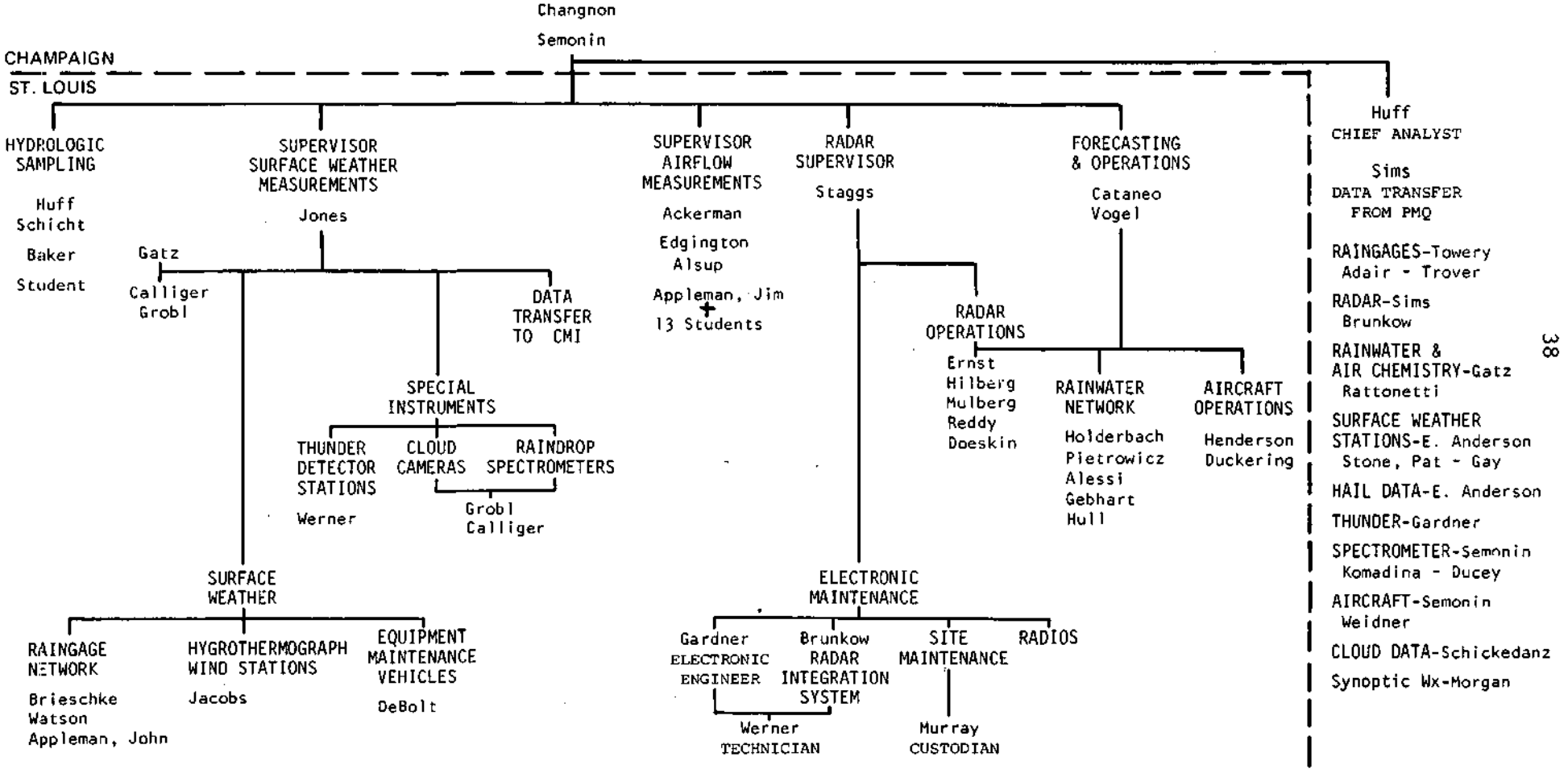

Figure 3. Water Survey Staff involved in METROMEX field and analytical efforts during summer of 1973.

9 days, and 3) to do cross-sectional urban-rural flights to measure differences in standard meteorological parameters and nuclei on 6 days.

The groundwater and surface water sampling program consisted of two efforts. First, there was once-a-week sampling of 1) groundwater taken from 6 wells in the Edwardsville-East St. Louis area (Fig. 2), and 2) of streamwater from 2 small streams with basins east of St. Louis and Alton. In addition, a concentrated effort involving daily sampling of 50 wells was conducted in two 2-week periods, and samples of streamflow were taken on 1-hour sequences on 5 heavy rain days.

Analysis and Results

The analyses of the vast amount of data generated by this operational system in 1973 are being conducted at the Water Survey research center at the University of Illinois in Champaign (Fig. 3). Much of the 1973 data are either digitized or will be digitized, and all analog records are being microfilmed. Efforts to be "real-time" in data processing and in preliminary analyses have allowed us to redesign our METROMEX projects from year-to-year, as shown by the feed-back loop at the top of Figure 1. For instance, the raingage and weather station networks were enlarged in 1972; the pibal program was redesigned in 1973 to meet new research interests; and the 1973 flight program was assigned some new prorities to meet the needs defined by our 1971-72 results.

Since the start of METROMEX, the Survey staff has generated 5 reports on METROMEX and a total of 22 scientific papers, either published or in the process of publication. Four papers summarizing some of the key results to date will appear in the January 1974 issue of the AMS Bulletin.

Acknowledgments

The accomplishment of the aforementioned extensive field programs, analytical efforts, and production of results is a credit to many organizations and people. The support for the Water Survey projects in METROMEX have come from three sources: the State of Illinois, the National Science Foundation (grants GA-28189X, GI-33371, GI-38317, GI-39213, and GK-38329), and the Atomic Energy Commission (AEC-1199). The funding from each of these sources in 1973 represented about 1/3 of the total support. This sizeable program of the Water Survey has been made possible by exceptional efforts of many scientists and field technicians. The principal investigators of the various grants and contracts enumerated are Stanley A. Changnon, Jr., Richard G. Semonin, Floyd A. Huff, and Harry T. Ochs. Other senior staff members have made exceptional contributions including Donald F. Gatz, Dr. Bernice Ackerman, Dr. Paul Schickedanz, Douglas M. A. Jones, Donald W. Staggs, Robert Cataneo, and John Vogel. The operational and analytical tasks of these people and other staff members are shown on Figure 3.

The considerable contribution of Thomas J. Henderson and Donald Duckering of Atmospherics Incorporated has been a positive factor in our METROMEX program, and the assistance of several other groups including the Environmental Protection Agency and the Air Weather Service in supplying facilities have also contributed greatly to our projects. The contributions to project planning, field coordination, and collection and exchange of data of the 6 other METROMEX participants can not be underestimated in assessing the Survey's METROMEX program.

Operational Calendar

The basic purpose of the remaining portions of this document is to list the instrument operational periods in 1973 so that an inventory of METROMEX data will be available to those who may wish to utilize these data in the future.

The presentation of our 1973 operational efforts is a tabular listing, for each set or piece of equipment, of the dates when operations began and ended and the type of operation, either continuous or sporadic. For equipment essentially operated in a "sporadic mode", such as aircraft flights, individual dates and times of operation are listed where pertinent. The listing of operations are divided into two categories: network type operations and special instrument operations.

OPERATIONAL PERIODS FOR 1973

NETWORKS

	Operational Period Begin	End	Type of Operation
Raingages (250 gages in June-Aug, 125 in all other months).	1/1/73	12/31/73	Continuous
Hailpads (240 sites)	6/1/73	8/31/73	Continuous
Hygrothermograph stations (24 sites)	6/1/73	8/31/73	Continuous
Wind recording stations (7 sites)	6/1/73	8/31/73	Continuous
Total rainwater samplers (81 sites)	7/9/73	8/30/73	Continuous, with rain samples on 14 days and dry samples on 5 days. Tracer releases and samples on 7/9, 23, 30, and 8/9, 10, 12, and 13.
Groundwater sampling (6 wells)	6/4/73	12/31/73	Continuous, (1/week) with 50 well daily samples collected in 6/4-15/73 and 9/10-21/73 period.
Surface water sampling (2 streams)	6/4/73	12/31/73	Continuous, (1/week) with special hourly sequential samples on 6/26, 7/23, 7/29, 8/12, and 8/13.
Pibal network (11 sites)	7/11/73	8/23/73	Continuous, on all days except Sundays with balloon releases at 1130, 1200, 1330, 1400, 1530, and 1600 CDT. Sporadic - special added releases (1 to 6 per day) on 7/30 and 8/9, 10, 12, 13, and 14.
Radiosonde network (3 sites)	7/11/73	8/23/73	Continuous, at 0700 and 1330 CDT. Sporadic - 1 to 6 added releases at 1 or more sites on 7/15, 19, 20, 23, 24, 26, 27, 29, 30, and 8/3, 4, 6, 8, 9, 10, 12, 13, 14, 15, 18, and 19.
Thunder audio recorders (6 sites)	6/1/73	8/31/73	Continuous (operational in all thunder periods).
Spectrometers (8 sites)	6/15/73	8/21/73	Continuous (in all rains), 3 sites (KMOX, gage 117, and PMQ) opened later on 7/18/73.
Wet-dry samplers (8 sites)	6/12/73	8/21/73	Continuous (more than 1 rain sample on certain days).

SPECIAL INSTRUMENTS

	Operational Period Begin	End	Type of Operation
Sequential rain samplers (3 sites)	7/6/73	8/14/73	Continuous (samples on all 13 rain days).
Air filters			
Surface (7 sites)	6/12/73	8/14/73	Continuous, with 1 to 3-day sampling intervals
Airborne	8/4/73	8/17/73	Sporadic, (samples collected on 8/4, 5, 6, 10, 13, 14, and 17).
Andersen Impactors (3 sites)	7/13/73	8/5/73	Sporadic, with 9 sampling periods (7/14-15, 7/18-19, 7/22-23, 7/23-24, 7/24-25, 7/25-26, 7/29-30, 7/30-31, and 8/8-9.
FPS-18 (PPI) radar	6/11/73	8/30/73	Continuous, for 0800-2400 CDT on each day with echoes, with scope photographs every 2 to 4 minutes and digital echo data when echoes were within with research circle (Fig. 2).
TPS-10 (RHI) radar	6/15/73	8/19/73	Sporadic, scope photos for 0800-2400 CDT on days when echoes were in the research circle (no data for 7/9-17 because of lightning damage).
	8/20/73	8/30/73	Continuous, scope photos over research circle for 0900-2100 CDT period each day.
Cloud cameras (2 sites)	6/5/73	8/30/73	Continuous, time-lapse photographs, daylight periods.
Aircraft operations (1 aircraft)	7/9/73	8/19/73	Sporadic, see following sheet.

FLIGHTS PERFORMED BY ATMOSPHERICS INCORPORATED FOR
ILLINOIS STATE WATER SURVEY DURING METROMEX '73

Flight Date	Flight Time (CDT)	Purpose
9 Jul '73	1653-1812	Tracer Mission
12 Jul	1103-1300	Instrument Package Flight Test
14 Jul	1651-1746	Observation Flight
17 Jul	1709-1739	Instrument Package Flight Test
20 Jul	1307-1447	Observation Flight
23 Jul	1345-1634	Observation Flight - Inflow Measurements
23 Jul	1730-1909	Tracer Mission
25 Jul	1604-1810	Observation Flight - Inflow Measurements
25 Jul	1850-2030	Observation Flight - Inflow Measurements
29 Jul	1604-1809	Observation Flight
30 Jul	1555-1902	Tracer Mission
3 Aug	1025-1042	Flight Test - Tracer Delivery System
3 Aug	1058-1115	Flight Test - Tracer Delivery System
3 Aug	1135-1147	Flight Test - Tracer Delivery System
3 Aug	1420-1443	Flight Test - Tracer Delivery System
3 Aug	1511-1535	Flight Test - Tracer Delivery System
3 Aug	1625-1651	Flight Test - Tracer Delivery System
4 Aug	1453-1517	Flight Test - Tracer Delivery System
4 Aug	1536-1557	Flight Test - Tracer Delivery System
5 Aug	1115-1139	Flight Test - Tracer Delivery System
6 Aug	1156-1627	Air Sampling Flight
7 Aug	1404-1751	Air Sampling Flight
8 Aug	1055-1150	Air Sampling Flight
8 Aug	1356-1622	Air Sampling Flight
9 Aug	0932-1125	Observational Flight
9 Aug	1626-1916	Tracer Mission
10 Aug	1403-1817	Tracer Mission
11 Aug	1614-1848	Observation and Cloud Measurement
12 Aug	1510-1733	Tracer Mission
13 Aug	1751-2026	Tracer Mission
15 Aug	1427-1710	Cloud Measurement
18 Aug	1348-1646	Air Sampling Flight
18 Aug	2150-0053	Air Sampling Flight
	33 flights 59:47	7 Tracer Flights

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UNIVERSITY OF MISSOURI-ROLLA OPERATIONS CALENDAR

The following instrumentation was mounted on a Bonanza single-engine aircraft:

Climet CI 201/205 particle analyzer/counter sampling in two size bands: 0.15 to 0.3 and 0.3 to 1.3 micrometers equivalent polystyrene radius; recording at either 7 1/2 or 15-second intervals.

Technology/Versatronics thermoelectric dewpoint hygrometer; recording continuously.

Time (LDT)	Type of Flight*	Altitude K ft.	Location**
8-1-73			
1055-1108	V	8.0-1.5	Sullivan, Mo.
1115-1228	H	2.5	360° circuit of St. Louis; approximately 40 km radius from arch
1228-1258	H	2.5	MTS (I-40) arch (→) Greenville
1431-1437	V	3.5-0.75	Carlinville, Ill.
1441-1655	H	1.5	360° circuit of St. Louis; 80 km from arch
1715-1742	H	2.5	TOY (→) arch (→) Weiss airport (I-44) St. Clair, Mo.
8-3-73			
0651-0725	V	1.5-8.0	Arch
1023-1036	V	0.6-4.5	Waterloo, Ill.
1116-1124	V	4.5-0.5	Waterloo, Ill.
1132-1215	H	2.5	Waterloo (→) TOY (I-55) Ill. Rte. 140 (→) Highland (→) 5 E. Highland (→) Baldwin power plant
1401-1541	H	2.5	Evansville, Ill. (→) 5 E. Highland (→) Carlyle (→) VLA (→) Taylorville (→) TOY (→) arch (I-40) Olive Boulevard
1643-1654	V	1.0-4.5	Lambert (→) Six Flags
1654-1715	H	4.5	Six Flags (I-44) Cuba, Mo.
8-8-73			
1258-1325	V(2)	11.5-1.5 1.5-5.6	Arch
1333-1409	H	3.5	TOY (I-70) Greenville (80 km arc) Greenfield
1414-1445	V	0.75-11.5	Greenfield (out of plume)
1451-1506	V	11.5-0.7	Litchfield (in plume)
1514-1540	H	3.5	Litchfield(Rte. 16) Piasa (→) TOY
1658-1733	H	2.5	Staunton (→) Troy, Mo. (→) Wright City, Mo.
8-9-73			
0912-0919	V	4.7-1.5	Jefferson Barracks Bridge
1430-1501	V	1.5-11.5	Arch
1512-1528	V	11.5-0.7	Piasa, Ill.
1536-1603	H	3.5	Jerseyville (Rte. 16) Gillespie (Rte. 16) Shipman (→) Alton airport
8-10-73			
1217-1300	V	1.5-12.5	Arch to 9.5 (→) 2 NW junction of Missouri and Mississippi Rivers
1300-1320	V	12.5-0.8	2 NW of junction of Missouri and Mississippi Rivers
1449-1511	H	1.5	Arch (I-40) MTS (250°, Missouri River) Washington, Mo.

*V - vertical; H - horizontal
**Location (route) location; (→) - direct flight

SRI OPERATIONAL REPORT

Edward E. Uthe

During the 1973 METROMEX field program, Stanford Research Institute collected data for study of the urban aerosol structure and its relation to atmospheric processes leading to regional weather modification. Atmospheric observations were obtained with high spatial and temporal resolution over extended atmospheric volumes and time periods. The program consisted of data collection at a fixed site, in addition to both stationary and mobile operation of the SRI Mark IX lidar system.

During stationary operation, the lidar van was located near the Gateway Arch. The Mark IX system is capable of analog recording and processing of lidar data in terms of two-dimensional cross sections of aerosol structure (see 1971 METROMEX Operational Report). In addition to the lidar, other supplementary instrumentation was installed in the mobile van: an MRI integrating nephelometer for measurement of the near-surface aerosol content, a solar radiometer viewing a 90° vertical atmospheric sector, and wet- and dry-bulb temperature sensors. Table 1 presents a summary of lidar data collection. Data collection with the other sensors was conducted during most of the lidar operation times given in Table 1.

The fixed-site instrumentation was located on the roof-top of a 16-story Holiday Inn approximately 1.4 miles west of the Gateway Arch. The instrumentation included:

(1) The SRI multiwavelength sunphotometer used for observation of solar intensities at 380, 500, 686, 850, 940, 1060, and 1230 nm.

(2) An Epply pyheliometer for observing the wavelength-integrated solar intensity.

* The SRI program is supported by the National Science Foundation, Weather Modification Program, under Grant GI-38363.

(4) A digital data-acquisition system to record the output of the above sensors at one-minute intervals.

(5) A Nuclepore filter sampler to collect suspended particulate matter for analysis of aerosol physical and optical properties.

The location for the above instrumentation was chosen such that the sun position would traverse an arc from the direction of the Arch (location of the lidar) to the direction of St. Louis University (location of the all-sky camera). Clouds are normally absent during early morning hours, and the sunphotometer data collected during this time can be used to characterize the optical properties of aerosol layers observed with the lidar (see 1972 METROMEX Operational Report). Information content about cloud microstructure derived from the solar intensities and the direct and diffuse solar components during the afternoon hours can be related to cloud macrostructure observed by the camera.

The data collection at the fixed site was limited in quantity by problems with the data-acquisition system. However, data were collected during most of the daylight hours from 29 July to 9 August. The observational period was terminated when a lightning discharge damaged the data system. Table 2 presents the times of aerosol sampling and preliminary results of mass concentration analyses.

Table 1

DATA SUMMARY

SRI MARK IX LIDAR OBSERVATIONS
METROMEX 1973, ST. LOUIS, MO.

Date	Time	Mode (Fixed or Mobile)	Pulse Rate (P/Min; P/Mi.)	Total Firings	Video Atten-uation	Location, Route, Remarks
24 Jul	0921-1320	F	5	1280	odb	I270 and US67 N, Ramada Inn
25 Jul	0903-1437	F	5	1600	0	Gateway Arch Parking Lot
26 Jul	0723-1707	F	5	2880	0	Arch
27 Jul	0746-1058	F	5	960	0	Arch
	1152-1434	F	5	800	0	Arch
	1509-1629	M	-	-	-	Mobile checkout--generator failure
28 Jul	0740-0916	F	5	640	5	Arch, rain at 0839
	1303-1335	F	5	160	0	Arch, generator failure
29 Jul	0735-1121	F	5	1120	0	Arch
	1135-1150	M	-	-	-	Mobile checkout--program unit failure
	1155-1227	F	5	160	0	Holiday Inn, 23rd and Market
	1235-1257	F	5	160	0	Roadway Inn, Market Street and Jefferson Avenue
	1310-1828	F	-	-	-	Arch, attenuation experiments
30 Jul	0642-1915	F	5	3680	10	Arch, rain at 1702 hours
31 Jul	0833-0905	F	20	160	10	Broadway and Dock Street International Garage
	0910-0942	M	20	597	10	North on Hwy I70 to I244, south on I244 to Gravios Rd. speedometer failure at Lindbergh and I55
	1020-1235	F	20	640	10	Lindbergh/55, Howard Johnson Inn
	1300-1308	M	10	160	10	Lindbergh/I55, heading No. east on I55 to Arch
	1338-1442	F	5	320	10	Jefferson/Washington speedometer shop
	1510-1602	M	20	800	10	Jefferson/US40 heading East on US40 to I244, No. on I244 to I70, south on 70 to Arch
	1620-1652	F	5	160	10	Arch parking lot

Table 1 (continued)

Date	Time	Mode (Fixed or Mobile)	Pulse Rate (P/min; P/mi.)	Total Firings	Video Atten-uation	Location, Route, Remarks
1 Aug	0741-0917	F	5	640	10	Arch lot
	1000-1208	M	20	1600	10	Market/170, 2-1/2 Rd. Trips to Mason Rd. along US40, gas stop 1115-1130
	1224-1420	F	5	480	10	Shopping center, I244, US40
	1420-1452	M	20	320	10	Mason Rd. east on US40 to Arch
	1522-1658	F	5	480	10	Arch parking lot
2 Aug	0741-1722	F	5	2560	10	Arch parking lot
3 Aug	0716-0816	F	10	480	10	Arch parking lot
	0816-1337	M	20	4675	10	Start W. on US40 at 14th St. E. to Mason Rd. and return. 7 round trips and return to Arch
	1337-1441	F	5	320	10	Arch parking lot
4 Aug	0902-0934	F	5	160	10	Arch lot
	0937-1438	F	5	1453	0	Arch lot, experiment with ND filter and RCVR iris
	1439-1511	F	5	160	10	Arch lot. 10db ND back in
	1510-1923	F	5	1280	5	Arch lot. 5db filter in
5 Aug	0754-0904	F	5	640	10	Arch parking lot
	1024-1320	M	20	3040	10	US40 and I55, west on US40 to Lindbergh Blvd. and return to I55 and US67, 5 round trips
6 Aug	0715-0851	F	5	480	lOdb	Arch parking lot
	0925-1243	M	20	~ 3150	10	So. on I55 at 14th Street to Reavis Barracks Rd., No. on I55 to I70 and Florissant Rd. and return. 3 round trips.
	1840-1912	F	5	160	10	Arch parking lot
7 Aug	0507-0856	F	5	1120	10	Arch parking lot
	0909-1346	M	20	5240	10	Walnut St. at I55 So. to Reavis Barracks Rd., No. on I55 to I70 at Lucas and Hunt Rd. 4 round trips. Return to East St. Louis to Onan Gen. Repair Shop. MRI nephelometer failure at 1112 hours

Table 1 (continued)

Date	Time	Mode (Fixed or Mobile)	Pulse Rate (P/min; P/mi.)	Total Firings	Video Atten-uation	Location, Route, Remarks
8 Aug	0653-0908	F	5	640	10	Arch parking lot
	0918-1326	M	20	3840	10	Walnut St. I55 So. to Loughborough Ave. No. on I55 to I70 at Lucas and Hunt Rd. 6 round trips. End at Riverview Drive
	1328-1355	M	20	240	10	So. on US67 at I270 to I70 and return to Arch
	1422-1454	F	10	320	10	Arch parking lot
	1457-0028*	F	5	2880	10	Arch lot, power plant smoke plume data. Cloud formations at 2253 hrs. *date change
9 Aug	0028-1546	F	5	4640	10	Arch lot, interesting cloud formations, rain at 1059 hrs
10 Aug	0915-1541	F	5	1920	15	Arch lot, rain at 1421 hrs
	1754-1827	F	5		15	Demonstration for visitors. Heavy rainfall
11 Aug	0806-0819	F	5	66	15	Arch parking lot
	0853-09--	M	20		15	Lucas and Hunt Rd. at I70 So. on I70 to Loughborough Ave. fire inside laser energy storage unit on return route. Fast bleeder dischg. resistor open
	1503-1535	F	5	160	10	Replaced 2K/160W resistor with 1.4K/160W resistor
12 Aug	0800-0832	F	5	320	10	Arch lot
	0835-0907	F	5	160	0	Remove 10db ND filter
	0930-1403	M	20	~ 4160	0	Loughborough Ave. & I55 No. to I70 at Lucas and Hunt Rd. 6 round trips and return to Arch lot. Gas stop at 1328-1333. First clouds at 1010
	1403-1708	F	5	960	0	Arch lot. Heavy rain in from north, cell moving east at 1543 hrs. Approx. 25,000 firings 7/24 to 8/12, disc rotated

Table 1 (Concluded)

Date	Time	Mode (Fixed or Mobile)	Pulse Rate (P/min; P/mi.)	Total Firings	Video Atten-uation	Location, Route, Remarks
13 Aug	0820-0924	F	5	320	20	Arch parking lot
	0925- --	F	5	320	10	Scan at 45o
	1455- --	-	-	-	-	Data taken off disc. cell developing during this period
14 Aug	0842-0858	F	20	320	20	Very low clouds, rain fall, shut down to change lamp and ruby rod.

Table 2

NUCLEPORE FILTER PARTICLE SAMPLE DATA

Filter Number	Time Start	Time Stop	Total Time (hours)	Weight Gained (mg)	Mass Conc. ($\mu g/m^3$)	Comments
1	7/31 0945	8/1 0800	20.16	0.451	41.4	Discontinuous sample time
2	8/1 0800	8/2 0800	24.00	0.541	41.8	
3	8/2 0800	8/3 0740	23.67	0.688	53.8	
4	8/3 0740	8/4 0835	24.42	0.779	59.1	Upstream pressure exceeded 25-in Hg at end
5	8/4 0840	8/4 2145	13.75	0.468	63.0	Pressure exceeded 9.8-in Hg
6	8/4 2146	8/5 1625	18.65	0.805	79.9	Same as above
7	8/5 1630	8/6 0600	14.50	0.524	66.9	Pressure 10.2-in Hg at end of sample
8	8/6 0600	8/6 1700	11.00	0.511	86.0	
9	8/6 2230	8/7 0730	9.00	0.413	85.0	Teflon tape found inside plumbing at 2240 hrs
10	8/7 0735	8/7 1710	9.58	0.386	74.6	
11	8/7 2130	8/8 0630	7.00	0.220	58.2	
12	8/8 0630	8/8 1607	9.55	0.180	34.9	Rain expected shortly
13	8/10 0900	8/10 1442	5.70	0.370	120.2	Filters #13-18 preweighed at St.Louis University and post-weighed at Monsanto Co.
14	8/10 1422	8/11 0750	17.13	0.656	70.9	14-in Hg at end of sample
15	8/11 0753	8/11 1700	9.12	0.128	26.0	High visibility observed
16	8/11 1710	8/11 2400	6.83	0.229	62.1	
17	8/12 0005	8/12 0812	8.28	0.180	40.3	
18	8/12 0815	8/12 1556	7.68	0.011	2.7	Very small gain in weight just before rair

THE UNIVERSITY OF WYOMING

COLLEGE OF ENGINEERING

DEPARTMENT OF ATMOSPHERIC RESOURCES

P. O. BOX 3038, UNIVERSITY STATION

LARAMIE, WYOMING 82070

UNIVERSITY OF WYOMING OPERATIONS CALENDARS

For details regarding instrumentation, see Section 4 page 3 of this report.

UNIVERSITY OF WYOMING, METROMEX 1973
PIBAL LOG (30 gm balloons unless otherwise noted)

Date AUG	Launch Time CDT	Location	Duration of Track, min
1	1500	Alton Civic Memorial Airport	10:30
2	1705	I-244 & US-40	12
	1725	Arch	34
	1825	Alton Civic Memorial Airport	8
3	0855	Pacific	22
	1330	Pacific	6
	1330	I-270 & US-67	11
	1330	Collinsville, Illinois	11
	1340	1 NW Lambert Field	8
	1340	Pacific	10
	1345	Arch	11
	1525	1 W Mo-725 & US-40	13
	1530	Pacific	12
	1600	0.5 N I-70 & I-270	9
	1700	Carondelet Park	13
	1700	1 NW Lambert Field	7
4	0520	Weiss Alport	16
	0530	1.5 N Lambert Field	15:30
6	0625	Pacific	11:30
	0800	Alton Civic Memorial Airport	10
	0815	Arch	11:30
	0835	2 W I-244 & US-40	11:10
	0925	Pacific	8:30
	1030	I-270 & US-67	5:30
	1035	I-55 & I-255	5
	1045	I-55 & I-255	5
	1205	I-270 & US-67	5*
	1215	Arch	8:50
	1215	Pacific	9:30
	1245	1 S Hartford, Illinois	7
	1425	1 S Hartford, Illinois	7:30
	1505	Pacific	12:30

*
100 gram pilot balloon

Date AUG	Launch Time CDT	Location	Duration of Track, min
6	1555	I-55 & I-255	10:15
	1605	I-55 & I11-I11	6:30
	1640	Arch	9
	1735	1 S Hartford, Illinois	7:30
	1820	Gravois Road & I-244	9
7	0410	Godfrey, Illinois	7
	0530	1 S Hartford, Illinois	6:30
	0635	Pacific	10:30
	0635	Hampton Ave & I-44	10:30
	0725	Weiss Airport	11
	0825	Pacific	8:30
	1020	I11-3 & I-55/70	9:20
	1025	1 S Hartford, Illinois	3:30
	1035	1 S Hartford, Illinois	3:30
	1035	2 S Roxana, Illinois	3:30
	1045	2 S Roxana, Illinois	5
	1115	I11-I11 & I11-162	9:30
	1130	Alton Civic Memorial Airport	8:30
8	0720	Pacific	22
	1150	I-55 & I-255	8:35
	1315	Pacific	9
	1430	Weiss Airport	11:45
	1450	Weiss Airport	25**
	1640	Gravois Ave & I-55	13:30
9	0650	Pacific	7
	0915	Pacific	2
	1040	Pacific	9
	1445	1 W I-244 & US-40	15
	1523	US-67 & Parker Road	25
	1710	Page Blvd & I-244	11:30**
	1725	Pacific	8:30
	1840	Pacific	3:30
10	0705	Pacific	11
	0745	Pacific	9:30
	1145	Roxana Oil Refinery	5
	1205	Roxana Oil Refinery	9:30
	1550	Pacific	13:30
13	0650	Pacific	18
	1715	Columbia, Illinois	2:40
	2000	Horseshoe Lake	1:25
14	0655	Pacific	4
	1340	Brown Road & I-270	10:15
	1435	I11-3 & I-270	7:15
	1455	Bi-State Airport	7:25

** Radiosonde Track.

Date AUG	Launch Time CDT	Location	Duration of Track, min
15	0635	Pacific	3:30
	1055	Arch	15
	1110	I-70 & I-270	8:30
	1205	I-55 & I-255	4
	1215	Arch	14
	1215	Mo-140 (Lindberg) & AC (New Halls Ferry Road)	5**
	1335	I-244 & US-40	20
	1345	Mo-140 (Lindberg) & AC (New Halls Ferry Road)	3**
	1410	I-70 & I-270	9
	1435	Mo-140 (Lindberg) & AC (New Halls Ferry Road)	3:30
	1600	Mo-140 (Lindberg) & AC (New Halls Ferry Road)	3:30**
	1640	Arch	11:40
	1700	Mo-140 (Lindberg) & AC (New Halls Ferry Road)	6
	1730	I-55 & I-255	20
	1755	I-70 & I-270	9
	1800	Mo-140 (Lindberg) & AC (New Halls Ferry Road)	8**
	1815	I-244 & US-40	22
	1830	Mo-140 (Lindberg) & AC (New Halls Ferry Road)	9:30
16	0520	Jennings, Missouri	13
	0520	Lindberg Blvd & I-270	11*
	0600	Lindberg Blvd & I-70	11*
	0610	Jennings, Missouri	16**
	0655	Pacific	7:30*
	0740	Mo-140 (Lindberg) & Mo-340	15
	0825	Mo-140 (Lindberg) & Mo-340	11:30
	0830	Jennings, Missouri	7:30
	0915	Lambert Field	12:55
17	0655	Pacific	4:30*
	1315	Pacific	17
18	0700	Pacific	9:30*
19	1700	Godfrey, Illinois	24:30**
	2020	I11-203 & I-55	14**
	2215	I-44 & I-244	12
	2315	I11-203 & I-55	12**
20	0010	I-55 & I-255	12
	0110	I-244 & US-40	12

*100 gram pilot balloon

**Radiosonde Track

Data AUG	Launch Time CDT	Location	Duration of Track, min
20	0200	I-70 & I-270	12
	0210	I11-203 & I-55	12**
	0225	Pacific	14:30
	0410	Arch	4:30
	0520	Pacific	11:30
	0530	I11-203 & I-55	12**
	0630	I11-203 & I-55	8
	0640	Webster Groves, Missouri	11
	1500	Alton Civic Memorial Airport	13:30
	1700	1 S Dupo, Illinois	7*
21	0700	Pacific	22*
	1435	Pacific	5:30
	1445	Pacific	17:30
	1500	Alton Civic Memorial Airport	2
	1510	Alton Civic Memorial Airport	26:30*
	1530	Bi-State Airport	12:30*
	1540	1 S Edwardsville, Illinois	14
	1630	Pacific	15:30
	1630	I-44 & I-244	15*
	1640	Alton Civic Memorial Airport	18:30
22	0700	Pacific	28*
	1640	Arrowhead Airport	15*
	1655	Bi-State Airport	8

* 100 gram pilot balloon

** Radiosonde Track

UNIVERSITY OF WYOMING, METROMEX 1973
SOUNDING LOG (all soundings from the surface unless otherwise noted)

Date AUG	Time CDT	Location	Type of Equipment	Height
2	1625	I-270 & I-55/70	Aircraft	10,000 ft MSL
3	1300	2 S St. Charles, Mo	Aircraft	10,000 ft MSL
	1500	Bi-State Airport	Aircraft	10,000 ft MSL
	1630	Brown Road & I-270	Radiosonde	451 mb
4	0530	6 S-SW Scott AFB	Aircraft	8,500 ft MSL
	1540	Pacific	Radiosonde	412 mb
6	0745	I-270 & I-55/70	Aircraft	10,000 ft MSL
	0755	Pacific	Radiosonde	285 mb
	1005	Pacific	Radiosonde	103 mb
	1100	Weiss Airport	Aircraft	9,400 ft MSL
	1200	1 S Hartford, I11	Radiosonde	468 mb
	1305	Pacific	Radiosonde	284 mb
	1330	Horseshoe Lake	Aircraft	10,000 ft MSL
	1345	1 S Hartford, I11	Radiosonde	490 mb
	1545	Pacific	Radiosonde	590 mb
	1600	Weiss Airport	Aircraft	8,000 ft MSL
	1645	1 S Hartford, I11	Radiosonde	497 mb
	1745	2 W Arch	Aircraft	7,000 ft MSL
	1800	Horseshoe Lake	Aircraft	7,000 ft MSL
7	0530	Alton Civic Memorial Airport	Aircraft	8,500 ft MSL
	0630	1 S Hartford, I11	Radiosonde	497 mb
	0700	I-55 & I-255	Aircraft	6,000 ft MSL*
	0735	Pacific	Radiosonde	451 mb
	0930	Alton Civic Memorial Airport	Aircraft	8,000 ft MSL
	0930	Pacific	Radiosonde	112 mb
	1000	1 S Hartford, I11	Radiosonde	497 mb
	1040	I-55 & I-255	Aircraft	6,000 ft MSL*
8	0700	Pacific	Radiosonde	325 mb
	1120	I-270 & I-55/70	Aircraft	10,000 ft MSL
	1255	Pacific	Radiosonde	101 mb
	1415	Weiss Airport	Radiosonde	498 mb
	1700	Jefferson Barracks	Aircraft	5,500 ft MSL

Sounding began at 2,000 ft MSL

Date AUG	Time CDT	Location	Type of Equipment	Height
8	1720	Forest Park	Aircraft	5,500 ft MSL
	1750	I-270 over Mississippi River	Aircraft	8,000 ft MSL
9	0635	Pacific	Radiosonde	98 mb
	1710	Page Blvd & I-244	Radiosonde	555 mb
	1815	Pacific	Radiosonde	278 mb
10	0655	Pacific	Radiosonde	133 mb
	1215	7 NE Alton Civic Memorial Airport	Aircraft	8,000 ft MSL
	1455	Pacific	Radiosonde	201 mb
	1615	I-244 & US-40	Radiosonde	545 mb
	1800	3 S Columbia, I11	Aircraft	4,000 ft MSL
13	0635	Pacific	Radiosonde	238 mb
	1825	Pacific	Radiosonde	721 mb
	1845	I-244 & US-40	Radiosonde	"in rain"
14	0635	Pacific	Radiosonde	305 mb
	1320	4 N St. Charles, Mo	Aircraft	8,000 ft MSL
	1400	3 S Bi-State Airport	Aircraft	10,000 ft MSL
15	0605	Pacific	Radiosonde	497 mb
	1100	Dupo, I11	Aircraft	10,000 ft MSL
	1215	Mo-140 (Lindberg) & AC (New Halls Ferry)	Radiosonde	500 mb
	1330	Dupo, I11	Aircraft	12,000 ft MSL
	1345	Mo-140 (Lindberg) & AC (New Halls Ferry)	Radiosonde	500 mb
	1600	Dupo, I11	Aircraft	,10,000 ft MSL
	1600	Mo-140 (Lindberg) & AC (New Halls Ferry)	Radiosonde	500 mb
	1800	Dupo, I11	Aircraft	10,000 ft MSL
	1800	M0-140 (Lindberg) & AC (New Halls Ferry)	Radiosonde	500 mb
16	0520	3 S Portage des Sioux	Aircraft	10,000 ft MSL
	0600	Jennings, Mo	Radiosonde	500 mb
	0610	2 SW Jefferson Barracks	Aircraft	8,000 ft MSL**
	0625	Pacific	Radiosonde	336 mb
	0845	3 S Portage des Sioux	Aircraft	8,000 ft MSL
17	0640	Pacific	Radiosonde	298 mb
	1300	Pacific	Radiosonde	100 mb
18	0635	Pacific	Radiosonde	398 mb
19	1700	Godfrey, I11	Radiosonde	500 mb

**Sounding began at 3,500 ft MSL

Date AUG	Time CDT	Location	Type of Equipment	Height
19	2000	I-270 & I-55/70	Aircraft	7,000 ft MSL
	2030	I11-203 & I-55	Radiosonde	500 mb
	2315	I11-203 & I-55	Radiosonde	500 mb
20	0000	I-270 & I-55/70	Aircraft	7,000 ft MSL
	0200	Pacific	Radiosonde	516 mb
	0210	I11-203 & I-55	Radiosonde	500 mb
	0500	I-270 & I-55/70	Aircraft	8,000 ft MSL
	0500	Pacific	Radiosonde	590 mb
	0530	I11-203 & I-55	Radiosonde	500 mb
	1615	I11-3 & I-255	Aircraft	8,000 ft MSL
	1715	4 N Godfrey, I11	Aircraft	8,000 ft MSL
21	0635	Pacific	Radiosonde	521 mb
	1630	4 E Troy, I11	Aircraft	6,000 ft MSL
	1710	7 SW Weiss Airport	Aircraft	6,000 ft MSL
22	0635	Pacific	Radiosonde	560 mb
	1610	4 W-SW O'Fallon, I11	Aircraft	5,000 ft MSL
	1630	1 W Arrowhead Airport	Aircraft	5,000 ft MSL

UNIVERSITY OF WYOMING, 1973 METROMX
AIRCRAFT OPERATIONS LOG

Date AUG	Plight Time CDT	Main purpose of Flight
2	1615 - 1750	CCN Monitoring
3	1245 - 1600	Energy Budget
4	0505 - 0645	Aerosol Heating
6	0605 - 0835	CCN Monitoring
	1045 - 1400	Energy Budget
	1540 - 1815	Energy Budget
7	0510 - 0715	Aerosol Heating
	0900 - 1100	Aerosol Heating
8	1110 - 1240	Cumulus Study
	1635 - 1825	CCN Monitoring
9	1455 - 1630	CCN Monitoring
	1730 - 1900	Cumulonimbus Study
10	1120 - 1235	Cumulus Study
	1350 - 1840	Cumulonimbus Study
13	1730 - 2040	Cumulonimbus Study
14	1310 - 1515	CCN Monitoring and Cumulus Study
15	1030 - 1430	Energy Budget
	1545 - 1845	Energy Budget
16	0500 - 0705	Aerosol Heating
	0835 - 1000	Aerosol Heating
19-20	1945 - 2135	Aerosol Cooling
	2350 - 0155	Aerosol Cooling
	0450 - 0635	Aerosol Cooling
20	1600 - 1740	CCN Monitoring
21	1500 - 1745	Comparison flight with University of Chicago aircraft; air flow; CCN Monitoring
22	1555 - 1700	CCN Monitoring