

JOINT EPA-EPRI
COLD WEATHER PLUME STUDY (CWPS)
Overview of Measurements and Data Base

ATMOSPHERIC SCIENCES RESEARCH LABORATORY
OFFICE OF RESEARCH AND DEVELOPMENT
U.S. ENVIRONMENTAL PROTECTION AGENCY
RESEARCH TRIANGLE PARK, NC 27711

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Overview of Measurements and Data Base**

by

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EPA Co-operative Agreement No. CR-809713

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NOTICE

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ABSTRACT

The Cold Weather Plume Study (CWPS) was a field measurement program carried out in February 1981 under the joint sponsorship of the U.S. Environmental Protection Agency and the Electric Power Research Institute. Its objective was to generate a data base suitable for quantitative analysis of the mesoscale physical dynamics and SO_x , NO_x chemistry of the plume of the 1320 MW coal-fired Kincaid power plant near Springfield, IL. The data base was intended to complement similar measurements made by other EPA and EPRI studies in the same region during other seasons. Measurements included in-situ chemical measurements from two instrumented aircraft, remote-sensing lidar measurements from an aircraft, meteorological measurements from a surface station, two met towers, and from vertical soundings. This report provides a brief overview of the measurement platforms, the measured parameters, and the daily experiments, and describes and documents the data base available on magnetic tapes and in hard copy form.

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LIST OF ABBREVIATIONS

AV	=	AeroVironment Inc.
Battelle	=	Battelle Columbus Labs
EMI	=	Environmental Measurements, Inc.
EPA-LV	=	Environmental Protection Agency, Las Vegas
EPA-RTP	=	Environmental Protection Agency, Research Triangle Park
EPRI	=	Electric Power Research Institute
ISWS	=	Illinois State Water Survey
MRI	=	Meteorology Research, Inc.
NWS	=	National Weather Service
Rockwell	=	Rockwell International
SRI	=	SRI International

ACKNOWLEDGMENTS

We are grateful to all the participants of the Cold Weather Plume Study for their co-operation in the compilation of the CWPS data base. This work was supported by EPA Co-operative Agreement CR-809713.

EXECUTIVE SUMMARY

A Cold Weather Plume Study (CWPS) was carried out from a St. Louis base in February, 1981 under the joint sponsorship of the Environmental Protection Agency (EPA) and the Electric Power Research Institute, Inc. (EPRI). The main objective of the field measurement program was to generate a data base appropriate for quantitative characterization of the mesoscale transport and chemical transformations of SO_x and NO_x in the plume of the 1320 MW, coal-fired Kincaid power plant near Springfield, IL, under winter conditions. The measurements included in-situ airborne chemical sampling in the plume and its background, as well as a variety of meteorological measurements characterizing the PBL structure and dynamics of the wind, temperature and humidity fields. Previous extensive power plant plume measurements had been carried out in power plant plumes in the same region in summer and spring periods. Analyses of the data of these previous studies had already yielded valuable quantitative empirical descriptions of the plume atmospheric transmission processes, particularly for SO_x . A more specific objective of the winter study was to test the validity of such quantitative parameterizations under winter conditions and, if necessary, to revise the formulations to make them seasonally more general. Another important aspect of the winter study was a more balanced emphasis on SO_x as well as NO_x atmospheric chemistry. This report overviews the measurement program, identifies other reports which contain more detailed program description and data, and most importantly, describes and documents the formal overall centralized data base of CWPS.

There were two teams of participating groups in the field program, one supported by EPA and the other by EPRI. Each participating group had a specific role in the study, yet all measurements of a given daily mission were performed within the context of a co-ordinated overall mission plan. The two teams shared the same overall program objectives, but emphasized different specific objectives. The EPA team's focus was more on SO_x chemistry, while the EPRI team placed greater emphasis on NO_x chemistry. Overall, the measurement strategy was focused on detailed aircraft chemical sampling in the plume over a mesoscale range; two primary sampling aircraft were typically deployed in each experiment. Supporting measurements included stack sampling, monitoring of ambient meteorological parameters, and remote sensing of PBL aerosol structure and dynamics.

The participating groups and their principal roles are outlined below:

EPA Team

EPA - RTP : technical direction
EPA - LV : airborne lidar measurements
EMI : program planning; in-situ
: aircraft measurements
AV : field program management;
: meteorological support
SRI : meteorological support
WU : on-site data processing and review;
: program data management;
: data interpretation

EPRI Team

BATTELLE : program planning;
: on-site organic sample analysis;
: MRI aircraft instrumentation for NO_x and HNO_3 ;
: data management for EPRI team;
: data interpretation
MRI : in-situ aircraft measurements
ROCKWELL : Stack sampling;
: meteorological support

The in-situ aircraft measurements included continuous monitoring of gas concentrations (SO_2 , NO , NO_x , N_{Total} , O_3), aerosol parameters (ANC, Charge, B_{scat}), meteorological variables (temperature, humidity, pressure, turbulence, solar radiation), and navigational parameters (altitude, VOR, DME). Integrated filter samples were collected and analysed for aerosol sulfate, nitrate, chloride and ammonium; for gaseous ammonia and nitric acid; and for elemental composition. Automatic bag samples were also collected nearly instantaneously at regular intervals and analysed on-line for aerosol size distribution. In addition, integrated samples were collected in Teflon bags and analysed daily at a ground laboratory for detailed speciation of organic vapors, including PAN.

Stack measurements of SO_2 , NO , O_2 and exit gas velocity and temperature were made at Kincaid. Meteorological support measurements included measurements near the power plant by ROCKWELL, and at downwind locations near prevailing plume transport trajectory by AV. Measurements near the power plant were made at a surface station (pressure, temperature, net/solar/sky radiation, cloud cover and precipitation), from 10 and 100m meteorological towers (mean temperature, dewpoint, wind speed/direction, and u,v,w components of the wind field), and from tracked T-sondes (T, wind speed/direction). Downwind meteorological measurements by AV included frequent pibal (wind speed/ direction) and airsonde (temperature and relative humidity) soundings during the experiment periods. Synoptic weather data were gathered

and interpreted by SRI at the local NWS forecasting office. SRI provided weather forecasts and summaries tailored to the needs of the daily missions.

PBL and plume structure and dynamics were "visualized" by remote sensing of atmospheric aerosol distribution based on lidar returns of aerosol backscattering monitored in the lidar aircraft (EPA-LV) flying well above the PBL.

The Kincaid power plant has two generating units rated at 660 MW each, both feeding into a single 187 meter tall stack. During the CWPS period, however, one of the units was inoperative.

The field study period was 9–21 February, 1981. During this period, a total of six independent field experiments were carried out on five separate days (February 12, 13, 14, 16 and 20). There were two separate experiments on the 20th. In four of these experiments, both primary sampling aircraft (EMI and MRI) performed co-ordinated measurements. In three separate missions, the two aircraft flew side-by-side to provide data for cross-comparison. The first three experiments were conducted under very cold daytime winter conditions. Ambient conditions were unseasonably warm during the last three experiments. One of these experiments was during the night. During the first and the last experiments, the Kincaid plume was sampled within the convective daytime mixing layer; bulk plume transport was in the stable layers aloft during all other sampling missions. Plume background was fairly clean during all field missions.

Each participating group was responsible for quality assurance, post-processing, and validation of its own data. The final data of the EPA team was centralized at the WU-ME Special Studies Data Center at Washington University in St. Louis. The data of the EPRI team was centralized at Battelle, Columbus Labs. The EPA and EPRI data bases were formally exchanged in 1984. Subsequently, both these subsets of the overall data base were reformatted and standardized into a single unified CWPS data base at our data center. All data files in this CWPS data base conform to the standard STATE formats common also to three other data bases of major EPA-sponsored Studies (MISTT, Tennessee Plume Study, and PEPE-NEROS). This report provides a full documentation of the final CWPS data base. Future distribution of the data base will be administered by EPA.

1. INTRODUCTION

Electric power generating stations using coal and oil as fuel constitute a major source of SO_x and NO_x emissions into the atmosphere of the eastern United States. Atmospheric transmission processes (transport, transformation, removal) acting on these emissions determine their atmospheric residence time, their contribution to ambient air pollution, their range of transport, location of impact, and form of deposition. In the past decade, many field studies have been carried out with the objective of quantitative investigation of the mechanisms and rates of the atmospheric transmission processes. The vast majority of these field measurements were carried out during the summer season when the chemical transformation processes leading to the formation of noxious secondary products from the precursor emissions are more rapid and secondary pollutant levels (air concentrations and depositions) are more pronounced. Such summer field studies include the EPA-sponsored Projects MISTT (St. Louis, 1974-1976) and STATE-Tennessee Plume Study (Tennessee, 1978), and the EPRI-sponsored SURE Plume Study (Indiana, Michigan, Mississippi, 1977) and the Plume Model Validation Study (PMV: Kincaid, IL, 1980). In February 1981, EPA and EPRI jointly sponsored the field program of the Cold Weather Plume Study (CWPS). The measurements of this study were made in plume of the Kincaid power plant.

EPA's principal objectives in the interpretation of the CWPS data included characterization of winter transport of tall-stack plumes, the quantitative assessment of mechanisms and rates of SO_2 -to-sulfate conversion in power plant plumes in winter, and the testing of an empirical parameterization of plume sulfur conversion rate originally formulated based on summer data. EPRI's prime objectives were to study the details of the NO_x chemistry of the plume during near-field transport, to test a detailed reactive plume model, and to extend the simple-terrain short-range plume dispersion study of PMV to broader seasonal coverage. Such data analyses have been carried out at WU for EPA and at BATTELLE for EPRI.

Two detailed reports describe the CWPS measurement program: one is by EMI (EMI, 1984)*, the EPA prime contractor for CWPS; the other is by BATTELLE (Battelle, 1983), the EPRI prime contractor for CWPS. Both describe the full range of CWPS measurements, but each is focused more on activities of its respective team. Since these reports adequately cover the details of the measurement program, platforms, data processing and validation, quality assurance, etc., this report contains only a brief program overview and a description and documentation of the final data base. Five hard copy data volumes, one for each of the five mission days of CWPS, were prepared in conjunction with this report. Each data volume contains a daily meteorological summary, and graphical plots of complete meteorological and aircraft data (EMI and MRI). The daily data volumes thus collectively contain a compilation of almost all the available data of CWPS in graphical or tabular form. The data volume contents are described further in chapter four, "CWPS Data Base".

* References are listed in section 4.1.

2. SUMMARY OF CWPS MEASUREMENTS

2.1 In-situ Aircraft Sampling

Two instrumented aircraft performed in-situ plume and background measurements. They were the EMI and the MRI aircraft. Tables 2.1 and 2.2 summarize the instrumentation packages of the two aircraft. The common parameters monitored in the continuous mode in the two aircraft were: SO_2 , NO/NO_x , O_3 , Aitken nuclei count, aerosol charge, light scattering coefficient (B_{scat}), ambient and dew point temperatures, aircraft altitude and the VOR/DME position co-ordinates. In addition, the MRI aircraft also monitored broadband and UV solar radiation from an upward-looking sensor, and small-scale atmospheric turbulence (expressed in terms of the turbulent energy dissipation rate, ϵ). The MRI NO_x chemiluminescence analyzer was specially modified by BATTELLE to measure NO , NT ($=\text{NO} + \text{NO}_2 + \text{HNO}_3 + \text{NO}_3 + 2\text{N}_2\text{O}_5 + \text{PAN}$), and NO_x ($=\text{NT} - \text{HNO}_3$). The difference ($\text{NT} - \text{NO}_x$) is reported in the data base as HNO_3 . The EMI aircraft also had a fast response sulfur monitor specially modified to monitor continuously the particulate sulfur component (S_p). The instrument operation, performance, and data for S_p have, however, been judged of unacceptable quality, and have been excluded from the data base. The absence of acceptable S_p data is a critical shortcoming of the chemical data base of CWPS. Another critical shortcoming of the CWPS data of EMI was due to the malfunction of the nephelometer (B_{scat}) in the first three EMI missions (Feb. 12, 13, 14). A replacement was in place for the last two experiments (Feb. 16, 20) and performed well. The data logger in the MRI aircraft malfunctioned in the first mission (Feb. 12). However, most of the continuous data were recorded on strip charts and were later digitized and incorporated into the permanent data base.

The two aircraft also made some aerosol size distribution measurements. The EMI aircraft had an electrical aerosol analyzer (EAA, for .0032 to 1 μm size range) and a ROYCO optical particle counter (OPC for .56-5.6 μm range). The data of these measurements have not been processed and are not available in the current data base. The MRI aircraft instrumentation package for aerosol size distribution measurements is summarized in Table 2.3.

Both aircraft also collected some time-integrated samples for post-facto chemical analyses. The EMI integrated sampling included a cyclone separator system for collection of fine aerosols ($<3 \mu\text{m}$), and a tungstic acid tube system for collection and later analysis of gaseous and particulate ammonia and nitric acid. The filter sampling of aerosols was on washed nylon filters (analysed for sulfate and nitrate), and on prepared cellulose nitrate filters (analysed for chloride). The integrated sample collections and analyses pertinent to the MRI aircraft sampling are outlined in Table 2.4. They include bag samples for hydrocarbons and PAN, and filter samples for inorganic gaseous and aerosol species.

Table 2.1 EMI Aircraft (Chem-1) Instrumentation Summary for CWPS. (Taken from EMI, 1984, Table 3.1)

Category	Parameter	Instrument Make and Model	Nominal Operating Range	Sensitivity	Response Time (sec)
Air Quality Continuous Analyzers	O ₃	CSI 2000	0-200 0-500ppb	3%	1
	SO ₂	Meloy 285 FR and Hydride Cylinder	0-500ppb depending on distance. 0-100ppb	1ppb	3
	NO/NO _x	Monitor Labs 8440E modified for fast response	0-500ppb depending on distance. 0-200	3ppb	1
	SO ₄ ⁼ , H ₂ SO ₄	Meloy 285 FR modified for SO ₂ scrubbing and aerosol heating	0-50ppb	1ppb	3
	b _{scat}	MRI 1567 modified for aircraft.	0-10x10 ⁻⁴ m ⁻¹	0.1x10 ⁻⁴ m ⁻¹	2
	Aitken nuclei	Environment One Aitken Nuclei Counter modified for high pressure inlet.	0-100k CN/ml	3k CN/ml	5
	Electronic Aerosol Analyzer	Thermo-Systems, Inc.	.0032-1 micron		Time integrated.
	Aerosol Charge Acceptance Optical Particle Counter	Washington Univ. Royco 220	0.01-0.1micron 0.56-5.6micron		1 Time integrated/

continued on next page

Table 2.1 (Continued) EMI Aircraft (Chem-1) Instrumentation Summary for CWPS.
(Taken from EMI, 1984 , Table 3.1)

Category	Parameter	Instrument Make and Model	Nominal Operating Range	Sensitivity	Response Time (sec)
Air Quality Integrated Samplers	SO ₄ ⁻ , NO ₃ ⁻ Cl ⁻	cyclone filter pack			
	Gaseous-Ammonia and Nitric Acid Particulate- Ammonium and Nitrate.	Tungstic Acid hollow tube precon- centrator (Univ.of S.Florida)			
Meteorology	Temperature	Type J thermocouple	-300 to +300°F	0-1°C	2
	Dewpoint	General Eastern 1110	-40 to 49°C	±0.5°C	3
Data Acquisition	all	Fluke 2240		-40 to +40V	1 scan/2 sec.
Position	VOR	King KN53	0-360°	±1°	5
	DMZ	King KN62A	0-50 n.mi.	±0.1 n.mi.	1
	Altitude	Aerosonic	feet msl	± 50 ft.	0

Table 2.2 MRI Aircraft (Queen Air) Instrumentation
Summary for CWPS. (Taken from BATTELLE '83
Table 4.2)

Parameter	Sampler Manufacturer and Model	Analysis Technique	Normal Measure- ment Ranges (Full Scale)	Time Response (to-90%)	Approximate Resolution
SO ₂	Meloy 285	Flame Photometric	100, 500, 1000 ppb	30 s	1 ppb
NO/NO _x HNO ₃	Monitor Labs 8440	Chemiluminescence Modified by 8CL	200, 500, 1000 ppb	5 - 10 s	<5 ppb
O ₃	Monitor Labs 8410	Chemiluminescence	500 ppb	5 s	5 ppb
Light Scattering	MRI 1569	Integrating Nephelometer	10 ⁻⁴ and 10 ⁻³ m ⁻¹	<1 s	10 ⁻⁶ m ⁻¹
Condensa- tion Nuclei	Environment One Rich 100	Light Attenuation in an Expansion Chamber	10 ⁵ cm ⁻³	3 s	10 ³ cm ⁻³
Aerosol Charge Acceptance	Washington University	Aerosol Charge Acceptance	Primarily responds to .01 - .1u particles	<1 s	--
Broad Band Radiation	Eppley PSP	Pyranometer	0 - 1026 w/m ² Cosine response	1 s	2 w/m ²
Ultraviolet Radiation	Eppley	Barrier-Layer Photocell	295 - 385 mu 0 - 34.5 w/m ² Cosine response	1 s	0.1 w/m ²
Turbulence	MRI 1120	Pressure Fluctuations	0 - 10 cm ^{2/3} s ⁻¹	3 s (to 60%)	0.1 cm ^{2/3} s ⁻¹
Temperature	YSI/MRI	Bead Thermister/ Vortex Housing	-55° to +45° C	5 s	0.5° C
Dew Point	Cambridge Systems 137	Cooled Mirror	-50° to +50° C	0.5 s/° C	0.5° C
Altitude	Validyne	Absolute Pressure Transducer	0 - 3000 m msl	1 s	6 m
Indicated Airspeed	Validyne	Differential Pressure Transducer	23 - 68 m s ⁻¹	1 s	0.1 ms ⁻¹
Position	King KX1708/ HTI OVOR	Aircraft DME/VOR	0 to 359° and 0 to 150 km from the station	1 s	1° (bearing), 0.2 km (distance)
Data Logger (includes time)	MRI Data System	9-Track Tape - 6 hour capacity in continuous operation	+9.99 VDC	Records data once per second	0.01 VDC
Stripchart Recorder	Linear Instruments	Dual Channel	0.01, 0.1, 1, 10 VDC	<1 s	--
Printer	Axiom	--	80 character lines	Prints out data every 10 seconds and at every event code or data flag change	

Table 2.3 Aerosol Size Distribution Measurements on Queen Air. (Taken from BATTELLE '83, Table 4.3)

<u>Instrument</u>	<u>Size Range</u>	<u>Method</u>
TSI 3030 ^a	0.006-0.56	Aerosol Charger/Mobility Analysis
PMS ASASP-X ^b		
Range 3	0.090-0.195	Optical Particle Counter Illumination in Laser Cavity and 35° to 120° Collection
Range 2	0.15-0.30	
Range 1	0.24-0.84	
Range 0	0.60-3.0	
PMS FSSP-100 ^b		
Range 3	0.5-8	Forward Scattering Spectrometer Probe
Range 2	1-16	
Range 1	2-32	
Range 0	2-47	

^aAutomatic bag sampling system for TSI 3030; bagfill takes place in about 3 seconds and occurs automatically every 5 minutes or on command.

^bThe Particle Measuring Systems (PMS) optical particle counters can be manually set to any range, or can be set to automatically cycle through the ranges with 1 second in each range.

Table 2.4 Integrated Sample Collections and Analysis for Queen Air. (Taken from BATTELLE '83 Table 4.4)

<u>Determination</u>	<u>Collection Medium</u>	<u>Particle Size Segregation</u>	<u>Nominal Flow Rate (lpm ambient)</u>	<u>Analysis Method</u>
PAN C ₁ -C ₁₀ Hydrocarbons	Teflon bags	None	<1 (ram flow)	Cryogenic preconcentration/ gas chromatography
SO ₄ ²⁻ , NO ₃ ⁻	2 µm Zefluor 47 mm	Bendix 240 cyclone (2.5 µm cut)	50	Ion chromatography
Elemental Carbon	Pallflex Quartz 47 mm	Bendix 240 cyclone (2.5 µm cut)	20	GRALE: C light absorption
Elemental Composition	2 µm Teflo 25 mm	Bendix 240 cyclone (2.5 µm cut)	40	X-ray fluorescence
Total Inorganic Nitrate HNO ₃ as NO ₃ ⁻	1 µm Zefluor/1 µm prewashed nylon 47 mm	None	30	EC-GC
Ammonia	2 µm Zefluor/oxalic acid impregnated glass fiber	None	10	colorimetry
Elemental Composition	2 µm Teflo after filter	Impactor (50% cut at 4, 2, 1, and 0.5 µm)	10	PIXE

The sampling missions and times for the two aircraft are summarized in Table 3.1. Each aircraft had five flight missions, four being common to both aircraft. During three of these common missions (viz. February 12, 16, 20), single-traverse, side-by-side and simultaneous flights were made by the two aircraft for the purpose of inter-comparison of data. Data plots showing such inter-comparison of common continuous monitors are included in the EMI data volume (EMI, 1983).

2.2 Meteorological Measurements

Meteorological support for the program was provided by three organizations: ROCKWELL, AV and SRI. ROCKWELL's measurements were made at a surface station, from 10 m and 100 m meteorological towers, and from vertical soundings, all at a site about 1 km east of the Kincaid power plant. The ROCKWELL measurements and instrumentation are outlined in Table 2.5. The vertical soundings were based on T-sondes which were tracked by double theodolites, and which measured vertical profiles of temperature and wind speed and direction.

Solar radiation is, of course, a crucial parameter for data analyses, for both dispersion and chemistry interpretations. The only radiation data collected directly under CWPS auspices were at the ROCKWELL surface station at Kincaid, and the continuous measurements of UV and broadband radiation in the MRI aircraft. Unfortunately, good surface data were obtained only on February 20. Consequently, a substitute set of total radiation data for the mission days was obtained in the form of continuous strip chart recordings made at the Illinois State Water Survey (ISWS) facility in Champaign, IL, about 80 km to the northeast of Kincaid. The ISWS solar radiation data for each day were digitized by us, and have been incorporated into the CWPS data base.

AV provided additional upper air soundings for the wind, temperature and humidity vertical profiles in the PBL. A mobile minisonde platform was used to launch pilot balloons equipped with pressure, temperature and relative humidity sensors. By tracking the pilot balloon from a single theodolite, vertical profiles of horizontal wind speed and direction were also determined. The AV minisonde was located at a different downwind fixed site under the plume trajectory for each mission. The site was typically about 40–60 km downwind of Kincaid, the actual location being selected based on the prevailing wind data obtained from the ROCKWELL soundings which commenced shortly before the start of the aircraft mission. The AV site locations and pibal launch periods are summarized in Table 2.6. Further details of the AV measurements and data are contained in the AV data volume (AV, 1983).

SRI provided meteorological support pertaining to synoptic and local weather review and forecasting tailored to the daily mission needs. An experienced weather forecast meteorologist, utilizing the extensive resources of the local NWS weather forecast office in St. Peters, MO, (near St. Louis) monitored the weather conditions and provided frequent weather bulletins and forecasts to guide mission planning and execution. Some of the raw materials (weather maps, etc.) used by SRI are included in our daily data volumes (appended to this report). Also included in those data volumes are 3-hourly tabulations of pertinent data collected at the NWS surface weather

Table 2.5 Source Emmissions and Meteorological Monitoring During CWPS. (Taken from BATTELLE '83, Table 4.5)

<u>Variable</u>	<u>Number of Measurement Locations</u>	<u>Frequency of Measurements</u>	<u>Equipment or Method Used</u>
<u>Source Emmissions</u>			
SO ₂ and NO	Stack	Continuous	Lear Siegler SM810
O ₂	Stack	Continuous	Lear Siegler CM50
Velocity	Stack	Continuous	Kurz 455 (Hot Wire)
Temperature	Stack	Continuous	Kurz 455
<u>Meteorological</u>			
<u>100 m Tower</u>			
Wind Direction	10 m, 30 m, 50 m, 100 m	Continuous	Teledyne Geotech 15658
Wind Speed	10 m, 30 m, 50 m, 100 m	Continuous	Teledyne Geotech 15648
Temperature, T	10 m-50 m; 10 m-100 m	Continuous	Teledyne Geotech T-200
uvw Winds (Gill)	100 m	Continuous	R. M. Young 27004
Dewpoint	100 m	Continuous	Teledyne Geotech 00-200
<u>10 m Tower</u>			
Temperature, T	2 m-10 m	Continuous	Teledyne Geotech T-200
<u>Surface Station</u>			
Atm̄s. Pressure	1	Hourly	Teledyne Geotech 5P-100
Cloud Cover	1	Hourly	Visual Observations
Precipitation	1	Hourly	Teledyne Geotech PG2 00H
Surface Temperature	1	Continuous	Barnes PRT-S
Net Radiation	1	Continuous	Science Associates 622-1
Solar Radiation	1	Continuous	Eppley NIP
Sky Radiation	1	Continuous	Eppley 8-48

^aAdapted from Table 3-1, Reference 3.

Table 2.6 AV Airsonde Launch Schedule. (Taken from
AV, 1983)

<u>Date</u>	<u>Location</u>	<u>Launch Period</u> LST
2-12-81	Rock Springs Center, Decatur, ILL	1215 - 1225 1308 - 1316 1404 - 1414 1533 - 1535 1626 - 1632
2-13-81	Mount Pulaski, ILL	0838 - 0849 0939 - 0952 1046 - 1051 1144 - 1158 1243 - 1254 1340 - 1354 1443 - 1457 1543 - 1554 1642 - 1651
2-14-81	Boody, ILL	1249 - 1303 1339 - 1347
2-16-81	Decatur Airport, ILL	1129 - 1141 1243 - 1257 1338 - 1352 1441 - 1455 1536 - 1549 1632 - 1646 1744 - 1759
2-20-81	Pana, ILL	0252 - 0308 0346 - 0401 0444 - 0500 0539 - 0553 0644 - 0658 0733 - 0748 0935 - 0948 1032 - 1047 1131 - 1145 1233 - 1246 1332 - 1346

observation stations in about a 100 km radius of Kincaid.

2.3 Aircraft Lidar Measurements

A two-frequency (I.R. and Green), downward-looking, airborne lidar system was flown and operated by EPA-LV. The aircraft lidar typically flew at about 3 km altitude in a pattern of cross-plume traverses at several downwind arcs. In normal operation, the lidar emitted laser pulses downward and the return signal, representing aerosol backscattering, thus provided a measure of aerosol distribution below. The return signals were recorded on magnetic tapes. The data provide vertical profiles of aerosol concentration (at 3 m vertical resolution) at approximately 10 m horizontal resolution. The lidar data provide a visual depiction of the PBL and plume aerosol structure and dynamics with broad spatial coverage.

The lidar aircraft flew missions on all five days. The lidar data complement the other aircraft data of all experiments except the last one during daytime on February 20.

2.4 Stack Sampling

ROCKWELL performed continuous stack sampling for stack SO_2 , NO and O_2 , as well as continuous monitoring of stack exit temperature and velocity. The single 187 m stack at Kincaid has an inner diameter of 9.0 meters. The measurements and instrumentation for stack sampling are summarized in Table 2.5. The data are included in the CWPS data base.

3. CWPS MISSIONS

CWPS experiments were conducted on five separate days, viz. February 12, 13, 14, 16 and 20. Table 3.1 summarizes the times, prevailing atmospheric conditions, and aircraft mission times for EMI, MRI and EPA-LV aircraft for all five days. The EMI aircraft flew on all five days; The MRI aircraft did not fly on February 14, but flew a complete predawn mission on February 20 (the only night mission of CWPS) preceding their full daytime mission on the same day. The lidar aircraft flew all missions except the daytime mission of February 20. Plume transport was mostly in the elevated stable layers in all but the first and the last experiments (February 12 and 20 daytime experiments). In these two leading and trailing experiments, the plume was well-mixed within the convective daytime mixing layer. Plume background during all but one of the experiments was fairly clean and dry. On February 16, the PBL air became very hazy and foggy during the course of the experiment. However, except for a possible brief period of entrainment of a portion of the plume into the upper portion of the mixing layer on this day, the bulk of the plume transport was outside the very polluted mixing layer.

Typical winter conditions did not prevail during the entire CWPS period. During the first week (including the experiments of Feb. 12, 13, 14), the ambient conditions were colder than average for this time of year with snow on the ground. The second week (including Feb. 16 and 20), however, was unseasonably warm, with daytime ground level temperatures peaking above 15 C (59°).

Aircraft missions of the five days are summarized in the form of flight outlines and maps for the two in-situ aircraft, in Appendix A1. Table 3.2 summarizes the participation of all platforms for all days. All times in the CWPS data base are in Central Standard Time (CST).

Table 3.1 Summary of Plume Missions EMI, MRI and Lidar Aircraft.

<u>DATE</u>	<u>MISSION CONDITIONS</u>	<u>SAMPLING PERIOD</u>		
		<u>EMI</u>	<u>MRI</u>	<u>LIDAR</u>
2/12	Well-mixed, daytime plume Ground snow cover ($T_o = 12^\circ\text{F}$ @ 0900) Fairly clean background	0945-1430	1300-1845	1130-1345
2/13	Stable, daytime plume Ground snow cover ($T_o = 9^\circ\text{F}$ @ 0700) Fairly clean background	0745-1600	0900-1530	900-1515
2/14	Stable, daytime plume Melting snow ($T_o = 15^\circ\text{F}$ @ 745)	0745-1500	-	915-1530
2/16	Elevated, daytime plume Very warm day ($T_o > 60^\circ\text{F}$ in PM) Humid near ground Relatively hazy day	1300-1730	1200-1915	1245-1600
2/20	Expt. 1: Stable, night-time plume	-	0315-0715	245- 430
2/20	Expt. 2: Well-mixed, daytime plume Very warm day ($T_o > 60^\circ\text{F}$ in PM) Clean air mass	1030-1415	0900-1400	-

TABLE 3.2

Summary of the Participation of All Platforms on February 12, 1981.

Organization and Type of Data	HOUR OF DAY																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
EMI in-situ aircraft										X	X	X	X	X	X									
MRI in-situ aircraft													X	X	X	X	X	X	X					
EPA - LV lidar												X	X	X										
Rockwell T-sonde					X			X		X	X		X		X	X	X							
AV pibal													X		X	X	X							
AV mini-sonde													X	X	X	X	X							
NWS (Springfield)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NWS (St. Louis, Peoria, Springfield)	X			X			X			X			X			X			X			X		
Illinois State Water Survey Solar Radiation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Meteorological Tower	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Stack	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MRI impactor													X	X	X	X	X	X	X					
MRI hydrocarbon													X	X	X	X	X	X	X					
MRI XHF -													X	X	X	X	X	X	X					

TABLE 3.3

Summary of the Participation of All Platforms on February 13, 1981.

Organization and Type of Data	HOUR OF DAY																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
EMI in-situ aircraft								X	X	X	X	X		X	X	X								
MRI in-situ aircraft									X	X	X	X		X	X	X								
EPA - LV lidar										X			X	X	X	X								
Rockwell T-sonde						X	X		X	X	X	X		X	X	X								
AV pibal									X	X	X	X	X		X	X	X							
AV mini-sonde									X	X	X	X	X	X	X	X	X							
NWS (Springfield)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NWS (St. Louis, Peoria, Springfield)	X			X			X			X			X			X			X			X		
Illinois State Water Survey Solar Radiation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Meteorological Tower	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Stack	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MRI impactor									X	X	X	X		X	X	X								
MRI hydrocarbon									X	X	X	X		X	X	X								
MRI XHF									X	X	X	X		X	X	X								

TABLE 3.4

Summary of the Participation of All Platforms on February 14, 1981.

Organization and Type of Data	HOUR OF DAY																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
FMI in-situ aircraft							X	X	X	X	X	X		X	X	X								
MRI in-situ aircraft																								
EPA - LV lidar										X	X			X	X	X								
Rockwell T-sonde					X		X	X	X		X	X	X											
AV pibal													X	X										
AV mini-sonde													X	X										
NWS (Springfield)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NWS (St. Louis, Peoria, Springfield)	X			X			X			X			X			X		X			X			
Illinois State Water Survey Solar Radiation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Meteorological Tower	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Stack	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MRI impactor																								
MRI hydrocarbon																								
MRI XHF																								

TABLE 3.5

Summary of the Participation of All Platforms on February 16, 1981.

Organization and Type of Data	HOUR OF DAY																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
EMI in-situ aircraft														X	X	X	X	X						
MHI in-situ aircraft													X	X	X	X	X	X						
EPA - LV lidar													X	X	X	X								
Rockwell T-sonde								X	X	X	X	X			X	X	X							
AV pibal												X	X	X	X	X	X	X						
AV mini-sonde												X	X	X	X	X	X	X						
NWS (Springfield)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NWS (St. Louis, Peoria, Springfield)	X			X			X			X			X			X			X			X		
Illinois State Water Survey Solar Radiation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Meteorological Tower	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Stuck	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MHI impactor													X	X	X			X	X					
MHI hydrocarbon													X	X	X			X	X					
MHI XRP													X	X	X			X	X					

TABLE 3.6

Summary of the Participation of All Platforms on February 20, 1981.

Organization and Type of Data	HOUR OF DAY																							
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23
FMI in-situ aircraft												X	X	X	X	X								
MHI in-situ aircraft				X	X	X	X	X				X	X	X	X	X								
ETA - LV lidar			X	X	X																			
Rockwell T-sonde	X		X	X	X	X	X	X	X	X	X	X	X	X	X									
AV pitot			X	X	X	X	X	X		X	X	X	X	X	X									
AV mini-sonde			X	X	X	X	X	X		X	X	X	X	X	X									
NWS (Springfield)	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
NWS (St. Louis, Peoria, Springfield)	X			X			X			X			X			X			X			X		
Illinois State Water Survey Solar Radiation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Meteorological Tower	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Rockwell Stack	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
MRI Impactor				X	X	X	X	X				X	X	X	X	X								
MHI hydrocarbon				X	X	X	X	X				X	X	X	X	X								
MHI XRF				X	X	X	X	X				X	X	X	X	X								

4. CWPS DATA BASE

The data base of CWPS is summarized in Table 4.1. The Table gives, for each measurement platform, the measured parameters, temporal resolution of the data when regular, and the form(s) in which the data are available. In general, the data base exists in two forms—on magnetic tapes and in the form of reports and hard copy data volumes.

The magnetic tape data base is in two parts—the aircraft raw data base, and the final GDDB (General Distribution Data Base). The GDDB is the standardized final user form of the data base on magnetic tapes. It includes all the validated data collected in CWPS except the aircraft lidar data, and the EMI and MRI aircraft aerosol size distribution data. The lidar data on tapes are in raw form only, very voluminous, and not expected to be of interest to most users of CWPS data. The lidar hard copy data volume contains a complete and easily usable photographic presentation of the data. Corresponding to each lidar plume traverse, two photographs (one for I.R. return and one for Green return) give the entire picture of aerosol spatial distribution in grey scale contrast. The aircraft raw data base includes the raw data of the lidar aircraft as well as of the two chemical sampling aircraft.

In what follows, we describe the hard copy data base and the GDDB of CWPS.

-20-
TABLE 4.1

JOINT EPA-EPRI COLD WEATHER PLUME STUDY (CWPS 1981)

WU/EPA Special Studies Data Center
Washington University
St. Louis, MO

SUMMARY OF MEASUREMENTS

Sponsor	Organization	Platform	Data Description	Archive Form & Availability	
EPA	EMI	Aircraft (Cessna 404)	5 Sampling Missions		
			<u>Continuous Data:</u> (2 sec.)	Time, VOR/DME, (LAT/LONG), altitude, temp, dew point, SO ₂ , NO/NO _x , O ₃ , B _{scat} , ANC. Aerosol charge, SO ₄ ⁻ , H ₂ SO ₄ (continuous sulfate data believed to be of unacceptable quality)	Mag tapes Data Volume
			<u>Aerosol Size Distribution:</u>	EAA (Data not processed yet) OPC (Data not processed yet)	
			<u>Other Samples:</u>	Filter samples analyzed for SO ₄ ⁻ , NO ₃ ⁻ , NH ₄ ⁺ and NH ₃ , HNO ₃ Grab samples analyzed for detailed HC speciation	Tabulations in Data Volume Tabulations in Data Volume
			AV	Pibals Minisonde	Discrete vertical soundings during mission days altitude, wind speed/direction, temp
	SRI	Weather Forecast and Analysis Support	Meteorological Summary Report	Report	
	EPA-LV	Aircraft Lidar	<u>Continuous Data:</u>	Time, location, ground speed, ground temp, dual frequency lidar return (aerosol backscatter) at 20 ft. intervals (10000 ft to ground level) Flight maps, photographic data plots	Mag tapes Data Volume
			ILLINOIS (*) STATE WATER SURVEY (Champaign, IL)	Surface station	Total incident solar radiation
	(*) Collected independent of CWPS. ISWS broad-band radiation data received in stripchart form, and subsequently digitized at WU Data Center.				
	EPRI	MRI	Aircraft (Queen Air)	<u>Continuous Data:</u> (1 s.)	Time, location (Distance, heading from origin of each traverse), altitude, indicated air speed, temp, dew point, turbulence, UV & Broad-band Radiation, SO ₂ , NO, NO _x , HNO ₃ , O ₃ , B _{scat} , ANC, Aerosol Charge
<u>Aerosol Size Distribution:</u>				EAA, OPC, FSSP	Mag tapes
<u>Other Filter Samples:</u>				SO ₄ ⁻ , NO ₃ ⁻ (Ion Chromatography) Elemental (XRF & PIXIE) Composition Total Inorg. NO ₃ (EC-GC) NH ₃ (Colorimetry)	Mag tape
Bag Samples:				PAN, detailed HC speciation (GC)	Mag tape
<u>5-min average data</u>					
ROCKWELL INTERNATIONAL		Source Monitoring	SO ₂ , NO, O ₂ , Stack exit velocity & temp	Mag tapes	
		Met tower (10 m)	ΔT (2 m - 10 m)		
		Met tower (100 m)	Wind speed/direction (10, 30, 50, 100 m) ΔT (10 m - 50 m, 10 m - 100 m) Dew point (100 m) u, v, w winds (100 m)	Mag tape	
		Surface station	T _o , Radiation (Total, net, sky - data good 1 day only)		
		Surface station NWS Surface Obs. (Springfield)	<u>Hourly data</u> Atm. pressure, cloud cover, precip. Atm. pressure, T, dew point, wind speed/direction, ceiling height, cloud cover, precip.	Mag tape Mag tape	

4.1 Hard Copy Data Base of CWPS

Besides this report and its appendices, there are two other detailed reports related to CWPS. They are:

1. EMI (July 1984): Cold Weather Plume Study, Final Report to EPA (Contract No. 68-02-3411)
2. Battelle, Columbus Labs (May 1983): Nitrogen Oxide Transformations in Power Plant Plumes, Interim Report to EPRI (Research Project 1369-2)

The above reports describe the EPA and EPRI portions of the field program in detail. There are three other Data Volumes also:

1. EMI (Dec. 1983): Cold Weather Plume Study, Chem I Data Volume
2. AV (June 1983): Cold Weather Plume Study, Upper Air Measurements, Report No. DO81-025
3. EPA-Las Vegas (Jan. 1982): Airborne Downward Looking Lidar Measurements During the Cold Weather Plume Study, Data Volume. EPA-EMSL, Las Vegas, TS-AMD-81088

The following report prepared by SRI International provides a descriptive summary of pertinent weather information for each day of the study, based on meteorological data and guidance that were collected by SRI at the NWS Forecast Office in St. Peters, MO. This report also includes selected maps and plots depicting radar summaries, satellite photos, airmass trajectories and the upper air data of the Peoria and Salem, IL upper air weather stations.

4. SRI (June 1983): "Meteorological Summary Report, Cold Weather Plume Study, St. Louis, MO." W. Viezee, SRI Project 1446 Report.

Finally, there are the five daily data volumes related to this report of Washington University (Appendices A3, A4, A5, A6 and A7). These data volumes present, mostly in graphical and partly in tabular form, the continuous data of both chemical aircraft (EMI and MRI) as well as the meteorological data of Rockwell, AV and NWS. These are the only data volumes which contain plots of the MRI aircraft data. Copies of these unpublished data volumes can be provided by either the principal author or the EPA Project Officer.

4.2 GDDB of CWPS on Magnetic Tapes

Table 4.2 summarizes the daily data base of GDDB in matrix form.

The data files are all in STATE-20 or STATE-VS formats. Documentation for these data formats is included in Appendix A2.3. The only data files in STATE-VS are the AV upper air (pibal and minisonde) data files and the Rockwell T-sonde data files.

The GDDB of CWPS is written on two 2400 foot long, 1/2-inch wide, industry-compatible, 9-Track magnetic tapes. The data packing density is 1600 bpi. Blocking within each file is fixed, and block length is 1600 bytes.* The tapes have no labels or ANSI standard volume and file labels. Each file on a tape is separated by a single end-of-file (EOF) mark, and two EOF marks follow the last file on the tape. The data are encoded in ASCII.

Tape 1 contains a total of 35 files comprising the data of February 12, 13, and 14. Thirty-two of these files are data files and three are daily summary files. Tape 2 contains a total of 27 files, 13 for February 16 (1 summary file and 12 data files) and 14 for February 20 (1 summary file and 13 data files). The data files are grouped by day, and a leader file for each day with the name SUMMARY.mdd (mdd = 212, 213, 214, 216, and 220) simply contains a listing of the data files in that day's data base. Each entry in the summary files gives the file name, organization collecting data, type of data, and file format.

A listing of the daily summary files is included in Appendix 2.1. Collectively, this listing is also a list of all the 62 files on the two tapes. This listing of files is followed by a partial listing of the contents of each of the 12 data files of 13 February 1981 (Appendix A2.2). For each file, the partial listing gives the full contents of the header and the comments sections, and in-between, the contents of a few data records at the beginning and end of the data section.

The partial file content listings in the Appendix are followed by the documentation of the STATE-20 and STATE-VS file formats (Appendix A2.3).

* All data files have fixed 1600 byte blocks. The daily summary files (SUMMARY.mdd), however, have maximum block size of 1600 bytes.

TABLE 4.2

CATALOG OF FILES IN THE GDDB OF CWPS

<u>ORGANIZATION</u>	<u>DATA DESCRIPTION</u>	<u>FILENAME*</u>	<u>DATA COLLECTION DATE</u>				
			<u>12</u>	<u>13</u>	<u>14</u>	<u>16</u>	<u>20 (Feb.'81)</u>
EMI	Aircraft continuous data	EMIA81.mdd	X	X	X	X	X
MRI	Aircraft continuous data	MRIA81.mdd	X	X	-	X	X**
MRI	Aircraft integrated sample data	MRIINT.mdd	X	X	-	X	X
MRI	Aircraft elemental analysis (PIXE) data	MRIPIX.mdd	X	X	-	X	X
MRI	Aircraft elemental analysis (XRF) data	MRIXRF.mdd	X	X	-	X	X
ROCKWELL	Met tower and surface data at Kincaid	R81MET.mdd	X	X	X	X	X
ROCKWELL	NWS surface weather data at Springfield	R81NWS.mdd	X	X	X	X	X
ROCKWELL	Stack sampling data	R81STK.mdd	X	X	X	X	X
AV	Pibal data	AV81PI.mdd	X	X	X	X	X
AV	Airsonde data	AV81AS.mdd	X	X	X	X	X
ROCKWELL	T-sonde data	R81TS.mdd	X	X	X	X	X

* The extension .mdd in the filenames identifies the date of the data in month and day, e.g. 212, 213, 214, 216 and 220

** There are two MRI continuous data files for 2/20/81 (one for each mission)

APPENDIX A1

EMI, MRI AIRCRAFT FLIGHT OUTLINES AND MAPS

**This appendix contains credits for
References 37 and 39. These references
are BATTELLE, 1983 and EMI, 1983, respectively**

APPENDIX A1.1

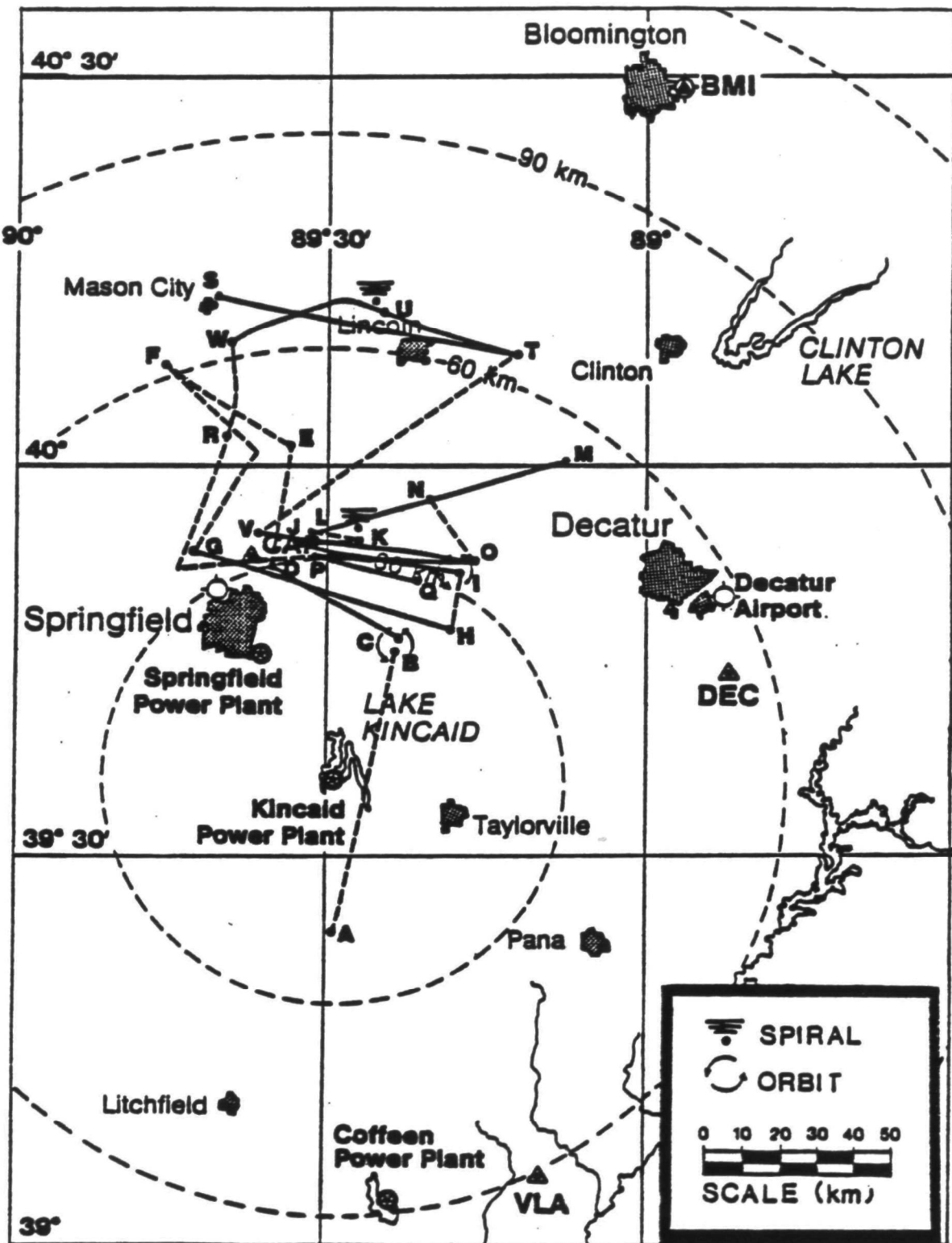
EMI AIRCRAFT FLIGHT OUTLINES AND MAPS

EMI Flight Outline for February 12, 1981.
(Taken from Reference 39, Table 5.1)

EVENT NO. TYPE	TIME	ROUTE	ALTITUDE (m MSL)	COMMENTS; CYCLONE FILTER NO.
1 F	0920-0945	KSUS-A		No magnetic data
2 F	0945-0954	A-B	622-470	SO ₂ plume seen (Coffeen?) CF#15
3 O	0954-0959	B-C	470	
4 T	0959-1003	C-D	470	
5 F	1003-1014	D-E-F	470	
6 F	1014-1026	F-G	470	
7 T	1026-1037	G-H	470	CF#18
8 F-O	1037-1043	H-I	470	
9 T	1043-1048	I-J	470	
10 F	1048-1054	J-K	470-318	
11 S	1054-1106	K	378-1540	
12 F	1106-1116	K-V-L	1540-683	Probably outside mixing layer
13 T	1116-1124	L-M	683	
14 F	1124-1134	M-N-O	549	
15 T	1134-1141	O-P	470	
16 T	1142-1146	P-Q	409	
17 T	1147-1152	Q-P	409	Bg CF#21
18 F	1152-1200	P-R	409-927	
19 F	1200-1231	R-X	897-592	

(Continued) EMI Flight Outline for February 12, 1981. (Taken from Reference 39, Table 5.1)

EVENT NO.	TYPE	TIME	ROUTE	ALTITUDE (m MSL)	COMMENTS; CYCLONE FILTER NO.
20	T	1231-1242	X-U-T	470	CF#23 Ozone instrument problem
21	T	1243-1254	T-S	561	
22	F	1254-1258	S-U	318	
23	S	1302-1307	U	318-927	
24	F	1307-1314	U-S	927-278	
25	T	1314-1325	S-T	409	
26	F	1325-1343	T-V	409-836	Ozone instrument problem
27	T	1343-1350	V-O	439	No valid data after 134700
28	T	1351-1359	O-V	592	CF#25 MRI flyby
29	T	1401-1409	V-O	683	
30	T	1410-1419	O-V	531	
31	F	1419- ?	V-KSPI		CF#24 No continuous data
32	F	1540- ?	KSPI-KSUS		



EMI Flight Map for February 12, 1981.
(Taken from Reference 39, Figure 5.1)

EMI Flight Outline for February 13, 1981,
morning flight. (Taken from Reference 39,
Table 5.2)

EVENT NO. TYPE	TIME	ROUTE	ALTITUDE (m MSL)	COMMENTS; CYCLONE FILTER NO.
1 F	0746-0755	A-B	905	CF#17
2 F	0755-0802	B-C	783	
3 T	0802-0805	C-D	631	
4 T	0805-0810	D-E	631	
5 T	0810-0815	E-F	631	
6 T	0815-0821	F-E	631	
7 F	0821-0827	E-G	631-417	
8 S	0827-0832	G	417-1060	No plume found CF#13
9 T	0835-0838	G-H	925	
10 T	0838-0842	H-G	844	
11 T	0843-0847	G-I	631	
12 T	0847-0852	I-J	631	
13 T	0852-0857	J-K	631	No plume found CF#16
14 F	0857-0911	K-L-M-N	631	
15 F	0911-0923	N-O-P	631	
16 T	0924-0928	P-Q	631	
17 Bg	0928-0940	Q-R-S	631	
18 T	0940-0948	S-T	631	
19 T	0948-0956	T-U	631	
20 F	0956-0959	U-V	631	SO ₂ 500ppb Data lost
21 T	0959-1008	V-W	631	
NO EVENT	1008-1013			

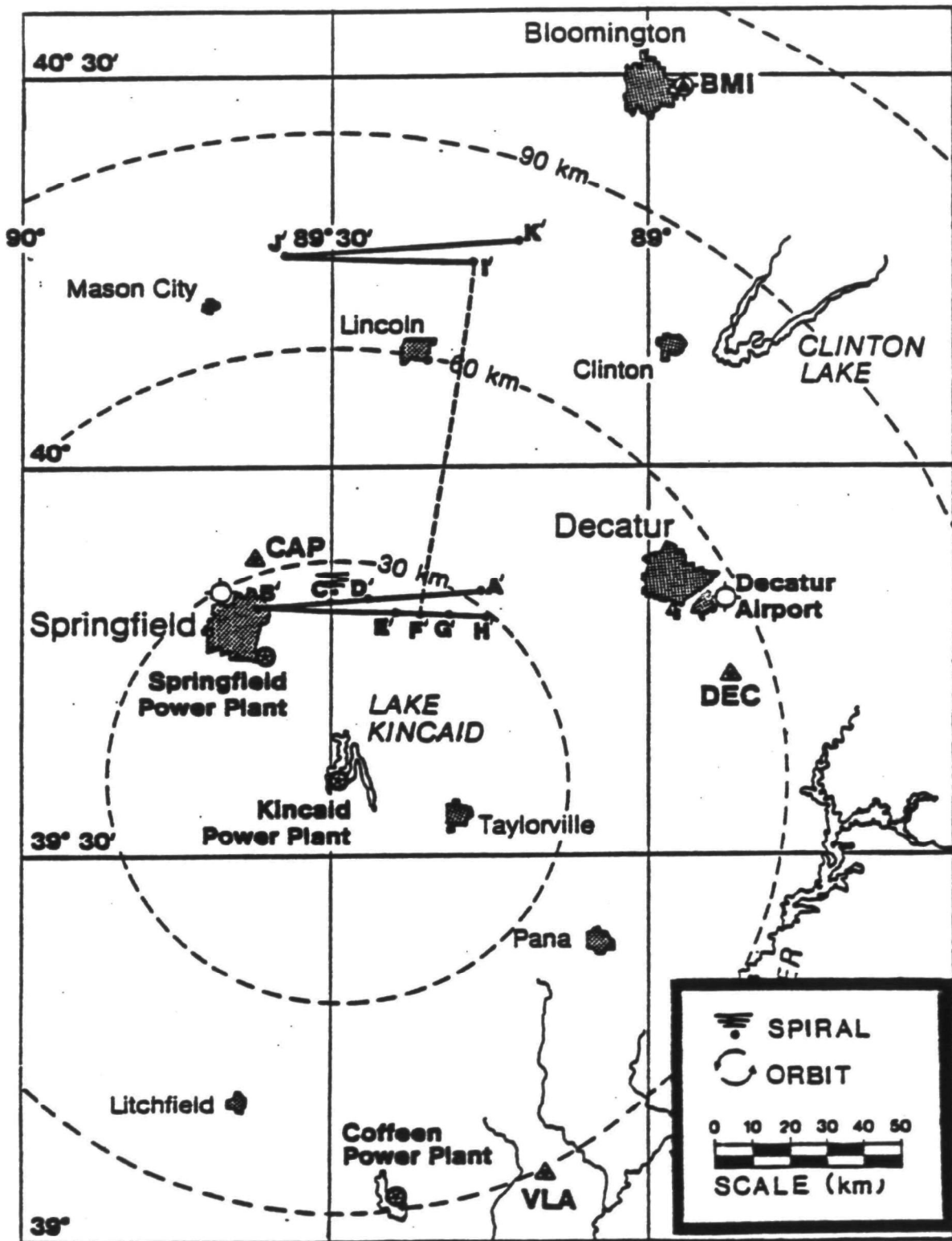
(Continued) EMI Flight Outline for February 13, 1981, morning flight. (Taken from Reference 39, Table 5.2)

EVENT NO. TYPE	TIME	ROUTE	ALTITUDE (m MSL)	COMMENTS; CYCLONE FILTER NO.
22 T	1013-1016	Q-X	539	CF#16
23 T	1016-1021	X-Y	539	
24 T	1022-1030	Y-Z	539	
25 F	1030-1036	Z-AA	509	
26 T	1036-1045	AA-Y	509	
27 T	1046-1056	Y-BB	539	
NO EVENT	1058-1102			SO ₂ 900ppb Data lost
28 F	1102-1108	CC-DD	539-600	No plume found
29 T	1108-1117	DD-BB	600	CF#30
30 T	1117-1122	BB-EE	600	
31 T	1122-1128	EE-Z	631	
32 T	1130-1135	Z-DD	661	
33 T	1137-1141	DD-Z	600	
34 T	1143-1148	Z-EE	539	
NO EVENT	1149-1154		479	Magnetic data lost Manual data show double plume: 700ppb, 100ppb SO ₂
35 T	1155-1159	BB-N	448	
36 S	1159-1201		448-844	

EMI Flight Map for February 13, 1981.
(Taken from Reference 39, Figure 5.2)

EMI Flight Outline for February 13, 1981,
afternoon flight. (Taken from Reference 39,
Table 5.3)

EVENT NO. TYPE	TIME	ROUTE	ALTITUDE (m MSL)	COMMENTS; CYCLONE FILTER NO.
NO EVENT	1318-1327	KSPI-A'		No data
37 T	1327-1336	A'-B'	528	}
38 T	1337-1340	B'-C'	437	
39 S	1340-1343	C'	437-741	
NO EVENT	1343-1346			
40 T	1346-1351	D'-B'	650	No data
41 T	1352-1357	B'-E'	589	No plume found
42 T	1357-1404	E'-B'	528	} CF#14
43 T	1406-1412	B'-F'	467	
44 T	1413-1419	F'-B'	437	
45 T	1420-1428	B'-G'	376	
46 T	1432-1439	G'-B'	406	}
47 T	1440-1446	B'-F'	467	
48 T	1447-1455	F'-B'	528	
49 T	1455-1503	B'-H'	528	
50 T	1504-1512	H'-B'	589	Tape change; missed plume. SO ₂ >1000ppb
NO EVENT	1513-1530	B'-F'-I'		CF#19
51 T	1530-1536	I'-J'	528	} CF#31; No USF
52 T	1538-1547	J'-K'	589	



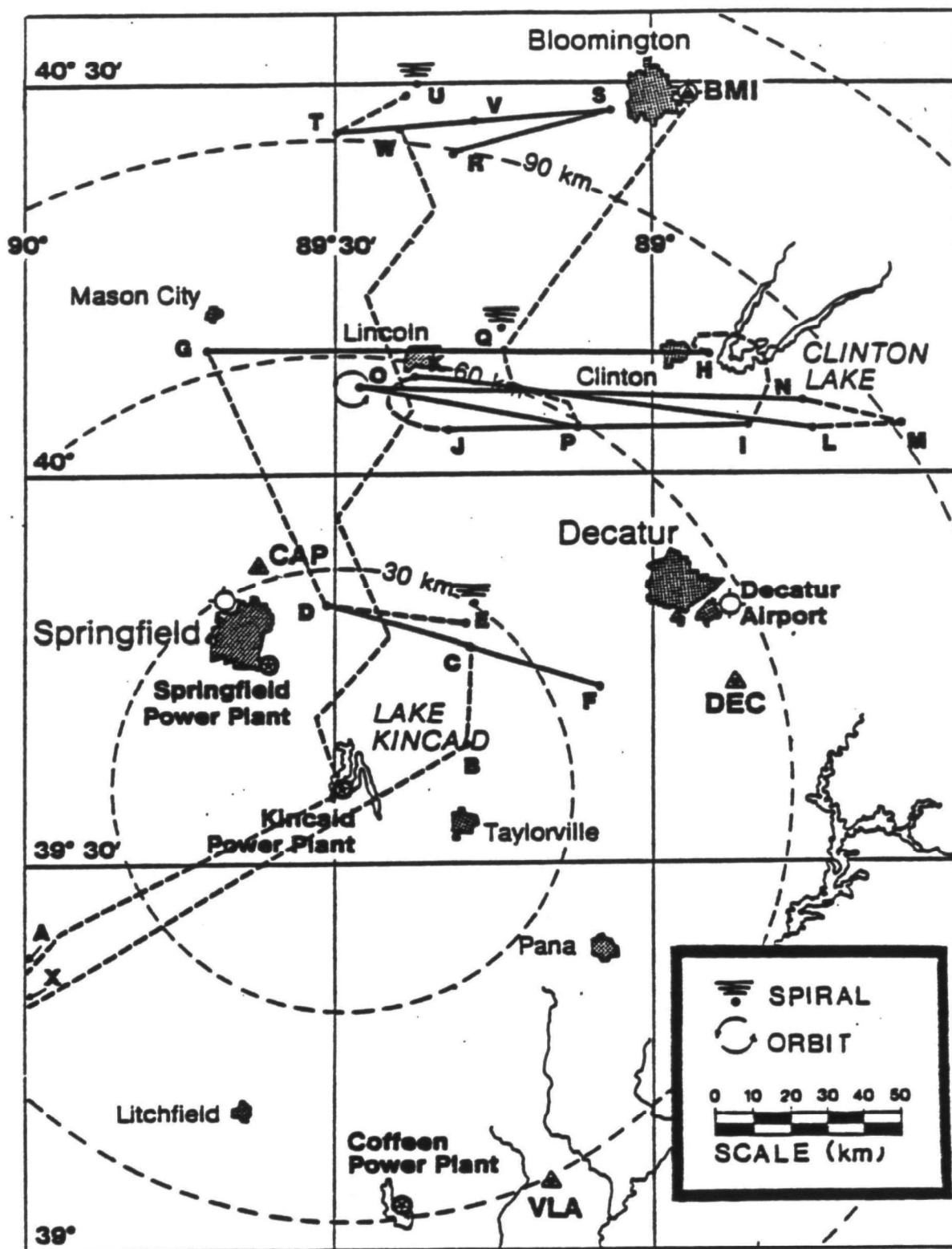
EMI Flight Map for February 13, 1981. afternoon flight. (Taken from Reference 39, Figure 5.3)

EMI Flight Outline for February 14, 1981.
(Taken from Reference 39, Table 5.4)

EVENT NO. TYPE	TIME	ROUTE	ALTITUDE (m MSL)	COMMENTS; CYCLONE FILTER NO.
1 Bg	0746-0811	A-B	908	} CF#39
2 F	0811-0814	B-C	908-542	
3 T	0814-0819	C-D	572	
4 F	0819-0824	D-E	572-390	
5 S	0826-0830	E	390-969	} No continuous data
NO EVENT	0830-0835		969-664	
6 T	0835-0845	D-F	664	
7 T	0848-0857	F-D	572	
8 T	0857-0907	D-F	496	} CF#34
9 T	0907-0918	F-D	511	
10 F	0918-0930	D-G	511	
11 T	0930-0947	G-H	542	
12 F	0948-0955	H-I	633	} Probably Springfield too
13 T	0955-1005	I-J	633	
14 F	1005-1010	J-K	633-450	
15 T	1010-1024	K-L	450	
16 F	1024-1032	L-M-N	633	} CF#38
17 T	1033-1048	N-O	633	
18 O	1048-1055	O	572	

(Continued) EMI Flight Outline for February 14,
1981. (Taken from Reference 39,
Table 5.4)

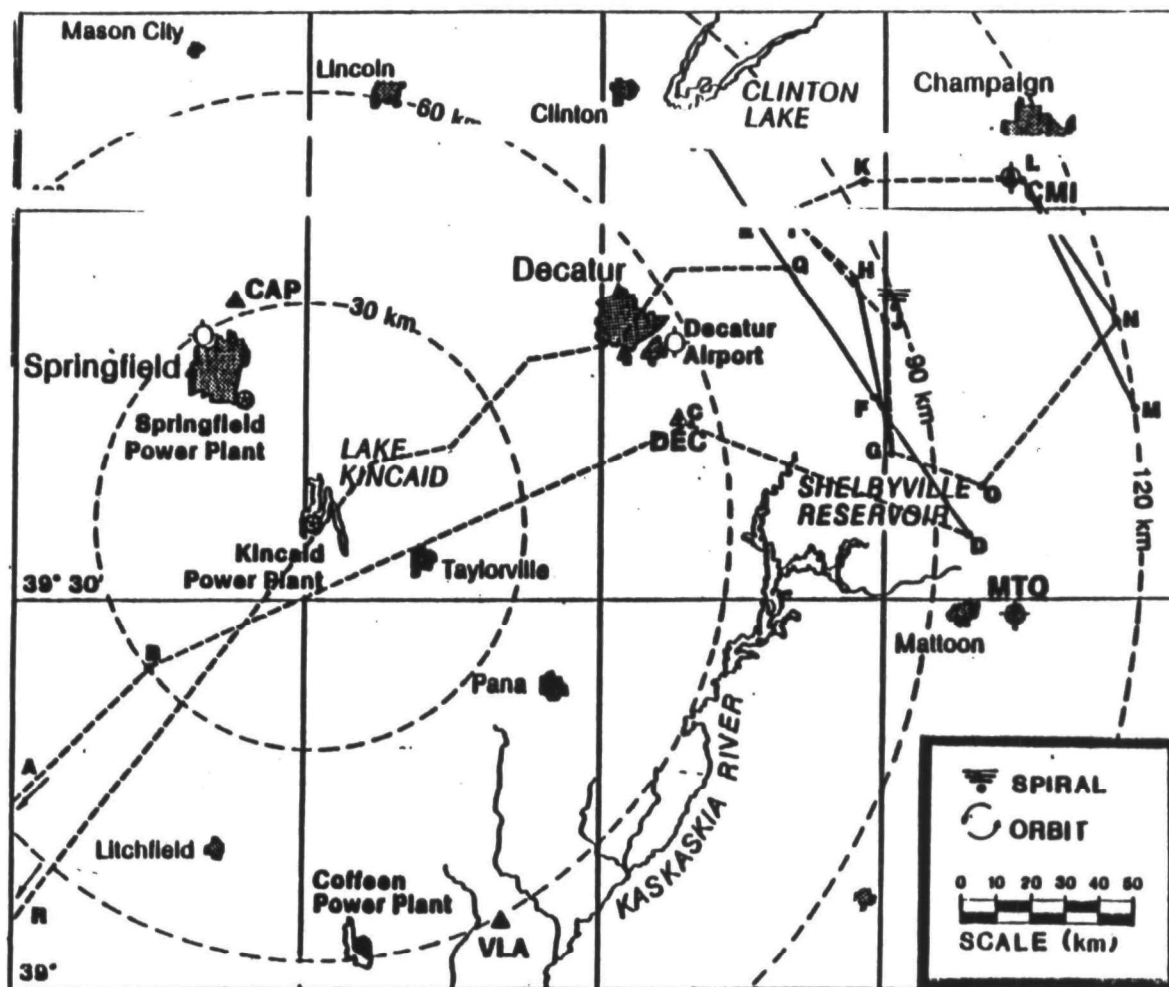
EVENT NO. TYPE		TIME	ROUTE	ALTITUDE (m MSL)	COMMENTS; CYCLONE FILTER NO.
19	T	1055-1104	O-P	572	} CF#35 Diagonal crossing of Coffeen(?)
20	F	1104-1109	P-Q	572-329	
21	S	1109-1112	Q	329-755	
22	F	1112-1124	Q-Blmngtn.	755-0	
Mission II					
23	T	1312-1318	R-S	606	} CF#37
24	T	1318-1328	S-T	606	
25	T	1329-1339	T-S	636	
26	T	1340-1350	S-T	667	
27	F	1351-1354	T-U	453-301	
28	S	1354-1359	U	301-941	
NO EVENT		1400-1403		941-697	
29	T	1403-1408	V-T	697	} CF#36
30	T	1408-1410	T-W	636	
31	Zig-zag	1410-1454	W-Kincaid	636-545	
32	F	1454-1528	Kincaid- KSUS	606	



EMI Flight Map for February 14, 1981. (Taken from Reference 39, Figure 5.4)

EMI Flight Outline for February 16, 1981.
(Taken from Reference 39, Table 5.5)

EVENT NO.	TYPE	TIME	ROUTE	ALTITUDE (m MSL)	COMMENTS; CYCLONE FILTER NO.
1	F	1310-1351	A-B-C-D	739	CF#44
2	T	1351-1407	D-E	739	
3	T	1407-1419	E-F	647	
4	T	1420-1429	F-E	678	
5	T	1431-1438	E-F	586	
6	T	1440-1447	G-H	678	Fly-by with MRI CF#46
7	F	1447-1457	H-I-J	678-342	
8	S	1458-1503	J	342-921	
9	F	1504-1512	J-G	921-769	
10	T	1512-1523	G-E	769	
11	Bg	1523-1536	E-K-L	744	CF#49 30 sec. gap
12	T	1538-1548	L-M	728	
13	T	1550-1559	M-L	708	
14	T	1559-1604	L-N	617	
15	T	1605-1611	N-L	556	
16	T	1611-1616	L-N	495	CF#51
17	F	1616-1628	N-O-G	495-678	
18	T	1628-1642	G-P	678	
19	T	1643-1649	P-Q	617	
20	Zig-zag	1649-1716	Q-Kincaid	678-586	
21	F	1716-1734	Kincaid-R	769	CF47



EMI Flight Map for February 16, 1981. (Taken from Reference 39, Figure 5.5)

EMI Flight Outline for February 20, 1981.
(Taken from Reference 39, Table 5.6)

EVENT NO. TYPE	TIME	ROUTE	ALTITUDE (m MSL)	COMMENTS; CYCLONE FILTER NO.
1 F	1035-1053	A-B-C	470-896	CF#58
2 Bg60	1055-1101	C	622	
3 F	1101-1118	C-D	622	
4 T	1120-1124	D-E	622	
5 T	1126-1130	E-F	683	
NO EVENT	1130-1135		683-226	CF#53
6 S	1135-1140	G	287-896	
7 T	1141-1144	G-E	683	
8 T	1146-1150	E-G	683	
9 T	1151-1154	G-E	531	
10 T	1154-1200	E-F	470	MRI fly-by
11 F	1200-1215	F-I-J-K	653	
12 T	1216-1229	K-L	592	
NO EVENT	1229-1223			1204-1209 No tape
13 T	1233-1246	M-N	592	
14 T	1248-1255	N-O	653	
15 T	1257-1312	O-P	546	Interpret with caution; see summary text. CF#52
16 T	1313-1328	P-O	470	
17 T	1330-1344	O-P	592	
18 F	1345-1415	P-Q-R-KSUS	927-165	Interpret with caution; see summary text CF#57

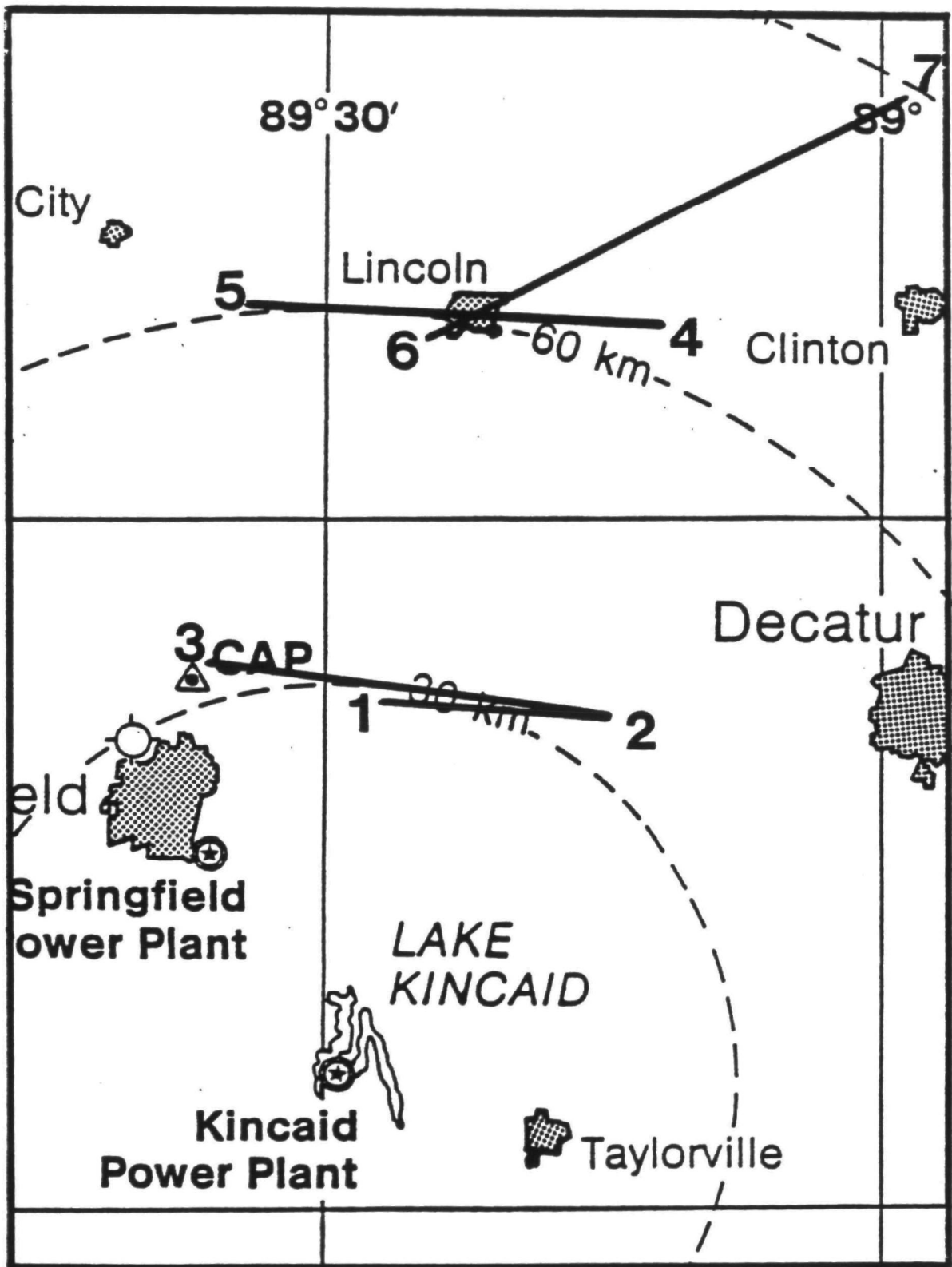
APPENDIX A1.2

MRI AIRCRAFT FLIGHT OUTLINES AND MAPS

MRI FLIGHT OUTLINE
COLD WEATHER PLUME STUDY
Plume Chemistry at 30 km and 60 km

12 February 1981
Tape Number: 212

Plume Chemistry at 30 km and 60 km																	Page Number: 222	
Pass No.	Sampling Times (MST)		Flight Type	End Points	Sampling Altitude m MSL		Traverse Length or Orbit Time	HC Bag	Impactor		teflon 47mm red H	teflon 25mm ylw T	quartz 47mm grn Q	nylon 47mm blu N	QA 47mm blk A	Comments		
	Start	End			Start	End			drum	filter 25 m								
1	1256	1356	Orbit	1	533		60.0 Min.	2B	A1	U3	H5	T5	Q4	N1	A22/A23	Plume orbit 30 km		
2	1356	1406	Traverse	1 - 2	533		19.2 Km.									Plume to background		
3	1410	1418	Traverse	2 - 3	518		32.8 Km.				"NO FILTERS"					Plume traverse 30 km EMI cross comparison		
4	1449	1502	Traverse	4 - 5	518		36.4 Km.									Plume traverse 60 km		
5	1506	1606	Orbit	6	518		60.0 Min.	2W	A2	U3	H6	T6	Q4	N2	A22/A23	Plume orbit 60 km		
6	1610	1615	Spiral	6	183- T62		N.A.				"NO FILTERS"					Plume spiral		
7	1616	1626	Traverse	6 - 7	518		40.0 Km.									Plume to background		
8	1725	1845	Orbit	2	518		60.0 Min.	1W	A3	U4	H7	T7	Q4	N3	A22/A23	Background some plume contamination		
<div>General weather: Clear, dry, cold; winds moderate southerly Preflight airport temp: -4°C Surface winds: 170° 12 m/s Plume: North, moderate stability, well defined, limited vertical mixing, mixing to ground began 1500-1600 Observer comments: Excellent sampling conditions, good chemistry day</div>																		
										U1-2	H8-4	T1-4	Q1-3		A12/A13	Motel blanks		
													Q5		A32/A33	Flight blanks		

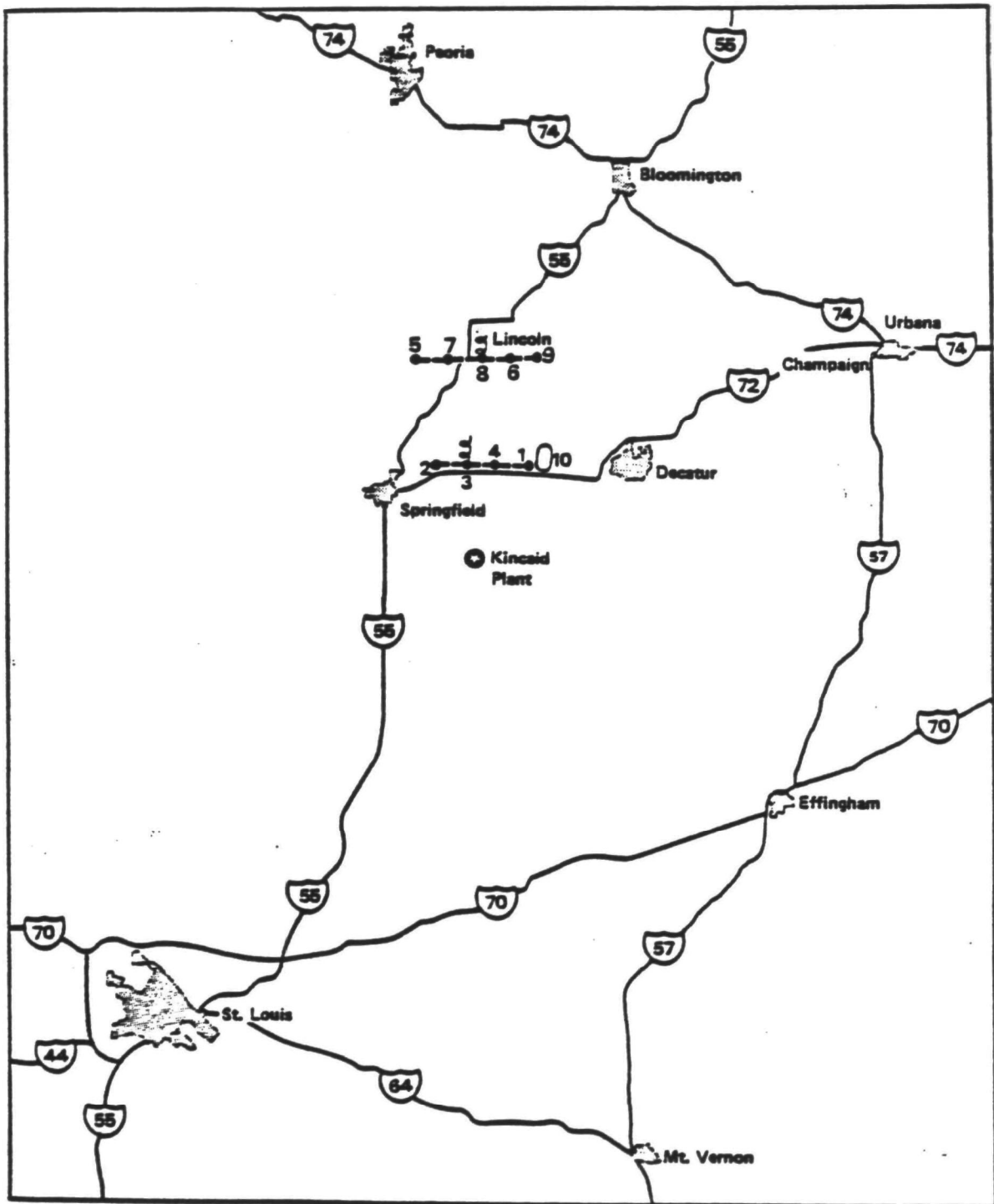


MRI Flight Map for February 12, 1981

MRI Flight Outline for February 13, 1981.
(Taken from Reference 37, Table 4.30)

Pass no.	Sampling Times (MST)		Flight Type	End Points	Sampling Altitude m MSL		Traversal Length or Orbit Time	Comments
	Start	End			Start	End		
1	852	901	Traverse	2 - 1	533		26.0 Km.	Plume traverse 28 km SO ₂ overrange
2	904	912	Traverse	1 - 2	488		26.0 Km.	"
3	913	921	Traverse	2 - 1	457		26.0 Km.	"
4	922	930	Traverse	1 - 2	427		26.0 Km.	Traverse below plume
5	932	940	Traverse	2 - 1	549		26.0 Km.	Traverse above plume
6	944	952	Traverse	1 - 2	518		26.0 Km.	Plume traverse 28 km SO ₂ overrange
7	953	958	Traverse	2 - 4	488		15.6 Km.	Plume traverse 28 km NO _x , SO ₂ , O ₃ overrange
8	1011	1016	Spiral	3	305 - 762		N.A.	Plume spiral 28 km
9	1030	1035	Traverse	4 - 2	579		15.6 Km.	Plume traverse 28 km
10	1036	1043	Traverse	2 - 4	549		15.6 Km.	"
11	1049	1054	Traverse	2 - 4	518		15.6 Km.	Plume traverse 28 km SO ₂ , O ₃ overrange
12	1056	1100	Traverse	4 - 2	488		15.6 Km.	"
13	1102	1106	Traverse	2 - 4	457		15.6 Km.	"
14	1108	1113	Traverse	4 - 2	427		15.6 Km.	Plume traverse 28 km SO ₂ overrange
15	1114	1118	Traverse	2 - 4	396		15.6 Km.	Plume traverse 28 km
16	1120	1124	Traverse	4 - 2	366		15.6 Km.	"
17	1126	1129	Spiral	3	762 - 274		N.A.	Plume spiral 28 km
18	1308	1317	Traverse	5 - 6	472		30.8 Km.	Plume traverse 57 km SO ₂ overrange
19	1318	1324	Traverse	6 - 7	549		17.8 Km.	"
20	1325	1330	Traverse	7 - 6	488		17.8 Km.	Plume traverse 57 km
21	1331	1341	Traverse	6 - 5	427		30.8 Km.	Plume traverse 57 km SO ₂ , O ₃ overrange
22	1342	1350	Traverse	5 - 6	396		30.8 Km.	Plume traverse 57 km
23	1357	1400	Spiral	8	183 - 762		N.A.	Plume spiral 57 km SO ₂ overrange
24	1406	1417	Traverse	5 - 9	457		35.5 Km.	Plume traverse 57 km SO ₂ , O ₃ overrange
25	1431	1531	Orbit	10	457		60.0 Min.	Background orbit with plume interference

General weather: Clear, dry winds southerly-light AM, moderate PM
Pre-flight airport temperature: 9°C
Surface winds: 130° 3 m/s
Plume: North, vertically stable throughout day, light early morning
winds caused some plume meandering earlier in day
Observer comments:

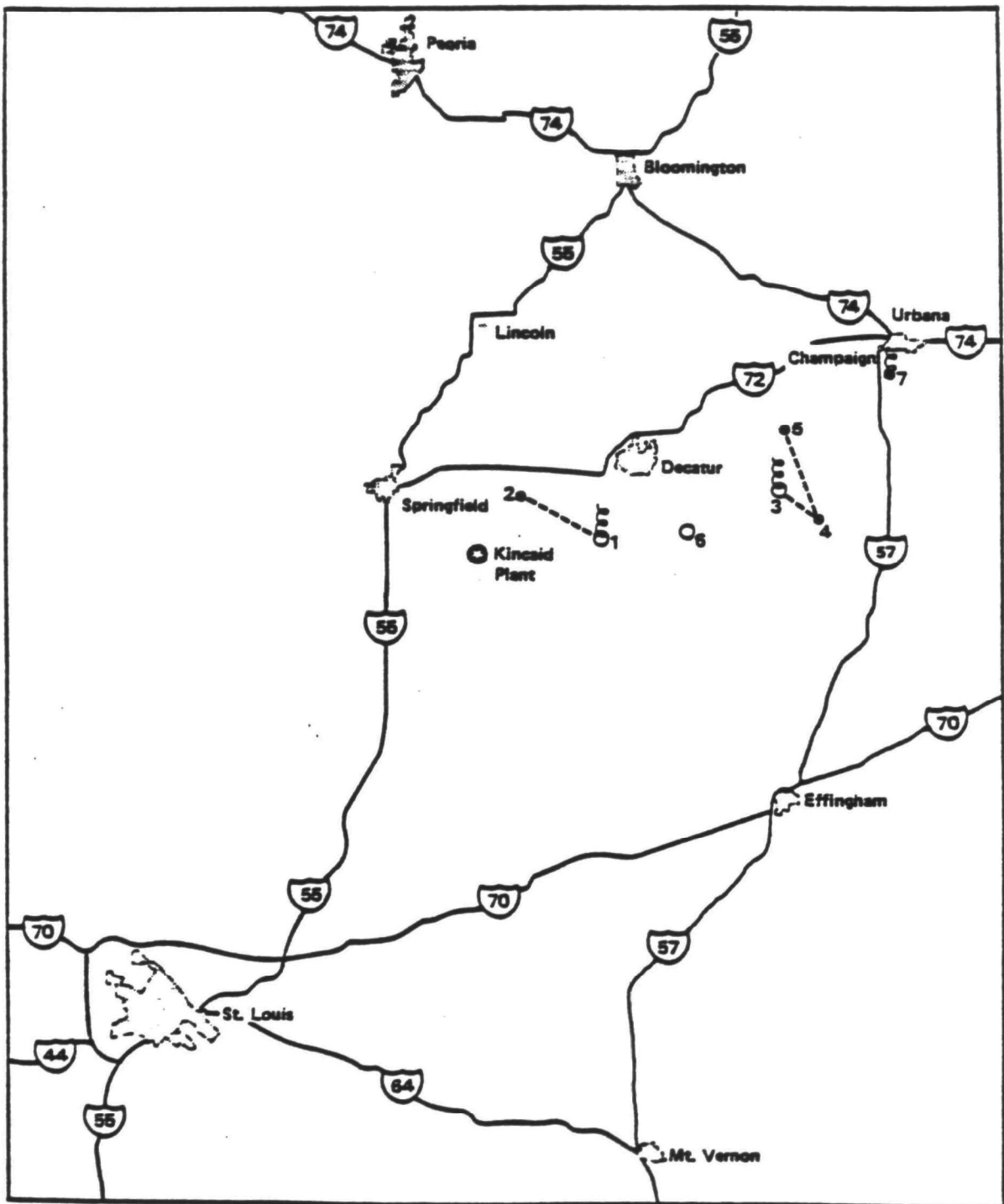


MRI Flight Map for February 13, 1981.
(Taken from Reference 37, Table 4.6)

MRI Flight Outline for February 16, 1981. (Taken from Reference 37,
Table 4.13)

Pass No.	Sampling Times (MST)		Flight Type	End Points	Sampling Altitude m MSL		Traverse Length or Orbit Time	Comments
	Start	End			Start	End		
1	1200	1300	Orbit	1	488		60.0 Min.	Plume orbit 36 km some sampling in clouds
2	1300	1307	Traverse	1 - 2	640		22.4 Km.	Plume to background
3	1328	1428	Orbit	3	610		60.0 Min.	Plume orbit 81 km
4	1428	1433	Traverse	3 - 4	610		18.0 Km.	Plume to background
5	1441	1447	Traverse	4 - 5	671		22.4 Km.	Plume traverse 88 km EMI cross comparison
6	1452	1457	Spiral	3	198 - 914		N.A.	Plume spiral 81 km
7	1503	1507	Zero Spiral		914 - 244		N.A.	Zero spiral Champaign airport
8	1719	1819	Orbit	6	762		60.0 Min.	Background orbit exceptionally hazy

General weather: Overcast, warm, humid; fog and low level clouds
in sampling area, some sampling done in clouds; winds moderate WSW;
background very hazy, visibility low
Preflight airport temperature: 15°C
Surface winds: 240° 14 m/s
Plume: FNE, stable, well defined, no vertical mixing
Observer comments: Should be an interesting plume chemistry day

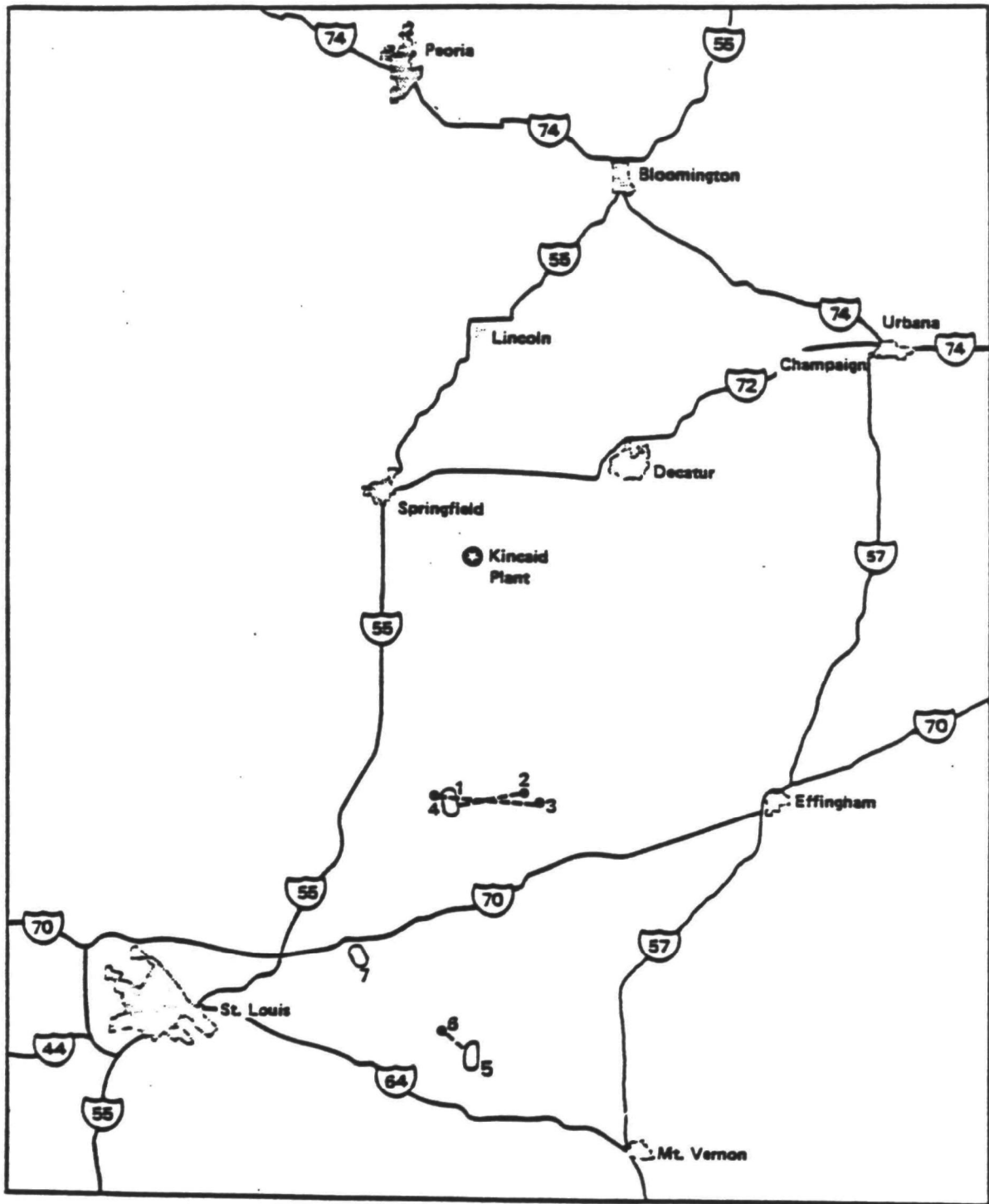


MRI Flight Map for February 16, 1981.
(Taken from Reference 37, Figure 4.2)

MRI Flight Outline for February 20, 1981, first flight. (Taken from
Reference 37, Table 4.19)

Pass No.	Sampling Times (MST)		Flight Type	End Points	Sampling Altitude in MSL		Traverse Length or Orbit Time	Comments
	Start	End			Start	End		
1	320	420	Orbit	1	518		60.0 Min.	Plume orbit 58 km SO ₂ overrange
2	421	426	Traverse	1 - 2	518		17.0 Km.	Plume to background
3	445	453	Traverse	3 - 4	518		28.2 Km.	Plume traverse 58 km
4	515	615	Orbit	5	518		60.0 Min.	Plume orbit 120 km
5	615	619	Traverse	5 - 6	518		11.2 Km.	Plume to background
6	619	716	Orbit	7	518		56.9 Min.	Background orbit with plume interference

General weather: Clear, dry, strong northwest wind
 Preflight airport temperature: 7°C
 Surface winds: 320° 16 m/
 Plume: Southeast, stable, very narrow, no mixing
 Observer comments: Plume 400 ft thick from top to bottom,
 very difficult to stay in the plume



MRI Flight Map for February 20, 1981, first flight. (Taken from Reference 37, Figure 4.3)

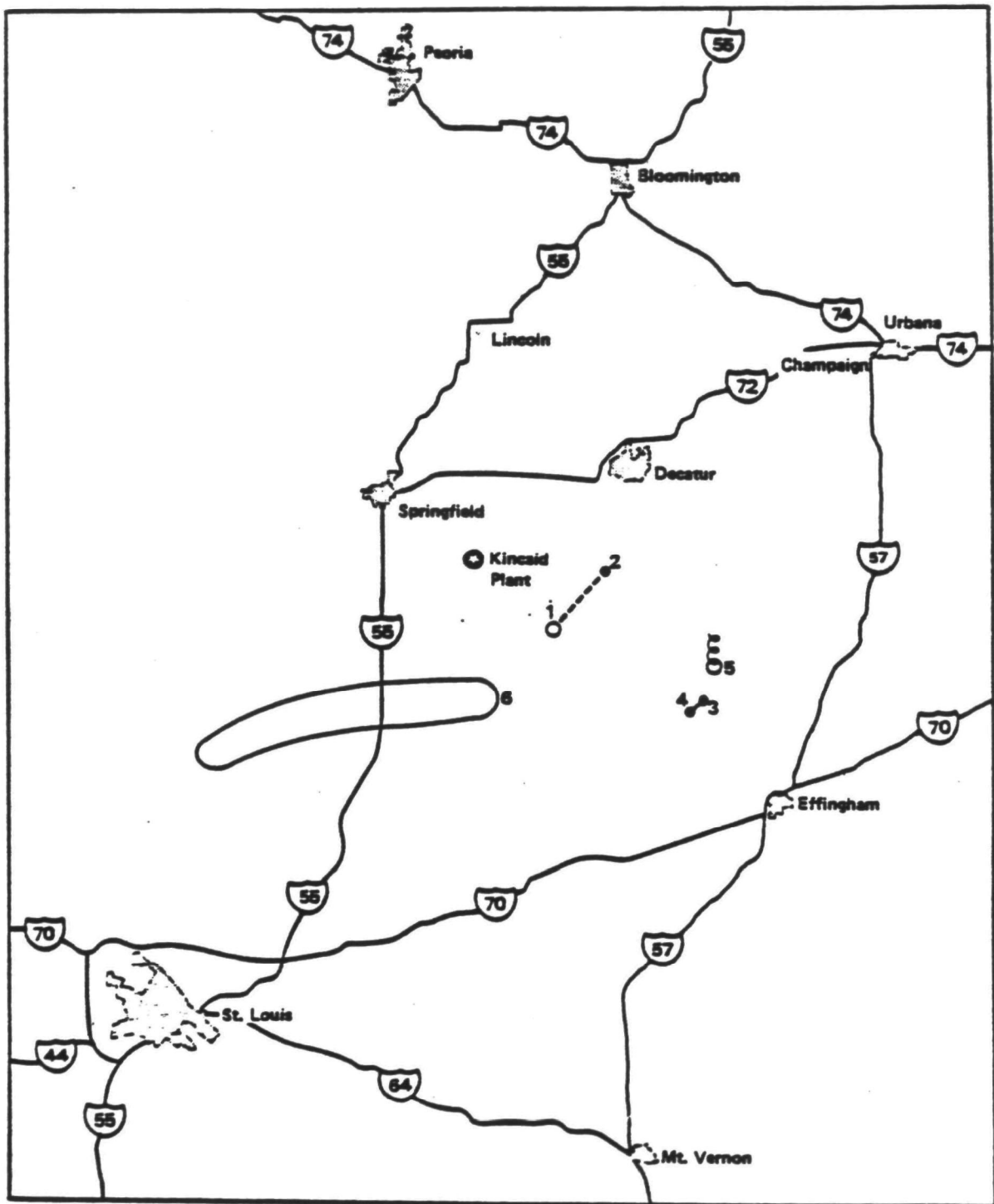
MRI Flight Outline for February 20, 1981, second flight. (Taken from Reference 37, Table 4.24)

Pass No.	Sampling Times (MST)		Flight Type	End Points	Sampling Altitude m MSL		Traverse Length or Orbit Time	Comments
	Start	End			Start	End		
1	1014	1114	Orbit	1	488		60.1 min.	Plume orbit 32 km SO ₂ overrange
2	1114	1121	Traverse	1 - 2	488		22.1 km	Plume to background 32 km
3	1148	1150	Traverse	3 - 4	671		7.5 km.	Plume traverse 76 km
4	1153	1253	Orbit	5	610		60.0 min.	Plume orbit 76 km
5	1300	1304	Spiral	5	1067	- 183	N.A.	Plume spiral
6	1309	1409	Orbit	6	610		60.0 min.	Background orbit

General weather: Clear, dry, warmer than earlier flight: light to moderate winds west northwest.

Plume: Southeast, wind direction changing during sampling, stable, no vertical mixing, some meandering.

Observer comments: Best EMI cross comparison in program, plume easier to stay with than earlier in the day.



MRI Flight Map for February 20, 1981, second flight. (Taken from Reference 37, Figure 4.4)

APPENDIX A2

GDDDB FILES, THEIR CONTENTS AND FORMATS

APPENDIX A2.1

Listing of Files in GDDB-CWPS

GDDDB-CWPS: FILES ON TAPE 1

<u>SUMMARY.212</u>		<u>LIST OF FILES FOR 2/12/81</u>	
EMIA81.212	EMI	EMI AIRCRAFT CONTINUOUS DATA	STATE-20
MRIA81.212	MRI	MRI AIRCRAFT CONTINUOUS DATA	STATE-20
M31INT.212	MRI	AIRCRAFT INTEGRATED SAMPLE DATA	STATE-20
M31PIX.212	MRI	PIXE ELEMENTAL ANALYSIS DATA	STATE-20
M31XRF.212	MRI	XRF ELEMENTAL ANALYSIS DATA	STATE-20
AV81AS.212	AV	AIRSONDE DATA	STATE-VS
AV81PI.212	AV	PIBAL DATA	STATE-VS
R31VS.212	ROCKWELL	SUPPLEMENTAL TSOND DATA	STATE-VS
R31MET.212	ROCKWELL	MET DATA AT KINKAID	STATE-20
R31NWS.212	ROCKWELL	NWS SURFACE STATION DATA	STATE-20
R31STK.212	ROCKWELL	STACK SAMPLING DATA	STATE-20
ISWS81.RAD	ISWS	TOTAL SOLAR RADIATION DATA	STATE-20

<u>SUMMARY.213</u>		<u>LIST OF FILES FOR 2/13/81</u>	
EMIA81.213	EMI	EMI AIRCRAFT CONTINUOUS DATA	STATE-20
MRIA81.213	MRI	MRI AIRCRAFT CONTINUOUS DATA	STATE-20
M31INT.213	MRI	AIRCRAFT INTEGRATED SAMPLE DATA	STATE-20
M31PIX.213	MRI	PIXE ELEMENTAL ANALYSIS DATA	STATE-20
M31XRF.213	MRI	XRF ELEMENTAL ANALYSIS DATA	STATE-20
AV81AS.213	AV	AIRSONDE DATA	STATE-VS
AV81PI.213	AV	PIBAL DATA	STATE-VS
R31VS.213	ROCKWELL	SUPPLEMENTAL TSOND DATA	STATE-VS
R31MET.213	ROCKWELL	MET DATA AT KINKAID	STATE-20
R31NWS.213	ROCKWELL	NWS SURFACE STATION DATA	STATE-20
R31STK.213	ROCKWELL	STACK SAMPLING DATA	STATE-20
ISWS81.RAD	ISWS	TOTAL SOLAR RADIATION DATA	STATE-20

<u>SUMMARY.214</u>		<u>LIST OF FILES FOR 2/14/81</u>	
EMIA81.214	EMI	EMI AIRCRAFT CONTINUOUS DATA	STATE-20
AV81AS.214	AV	AIRSONDE DATA	STATE-VS
AV81PI.214	AV	PIBAL DATA	STATE-VS
R31VS.214	ROCKWELL	SUPPLEMENTAL TSOND DATA	STATE-VS
R31MET.214	ROCKWELL	MET DATA AT KINKAID	STATE-20
R31NWS.214	ROCKWELL	NWS SURFACE STATION DATA	STATE-20
R31STK.214	ROCKWELL	STACK SAMPLING DATA	STATE-20
ISWS81.RAD	ISWS	TOTAL SOLAR RADIATION DATA	STATE-20

GDDDB-CWPS: FILES ON TAPE 2

<u>SUMMARY.216</u>		<u>LIST OF FILES FOR 2/16/81</u>	
EMIA81.216	EMI	EMI AIRCRAFT CONTINUOUS DATA	STATE-20
MRIA81.216	MRI	MRI AIRCRAFT CONTINUOUS DATA	STATE-20
M31INT.216	MRI	AIRCRAFT INTEGRATED SAMPLE DATA	STATE-20
M31PIX.216	MRI	PIXE ELEMENTAL ANALYSIS DATA	STATE-20
M31XRF.216	MRI	XRF ELEMENTAL ANALYSIS DATA	STATE-20
AV81AS.216	AV	AIRSONDE DATA	STATE-VS
AV81PI.216	AV	PIBAL DATA	STATE-VS
R31VS.216	ROCKWELL	SUPPLEMENTAL TSOND DATA	STATE-VS
R31MET.216	ROCKWELL	MET DATA AT KINKAID	STATE-20
R31NWS.216	ROCKWELL	NWS SURFACE STATION DATA	STATE-20
R31STK.216	ROCKWELL	STACK SAMPLING DATA	STATE-20
ISWS81.RAD	ISWS	TOTAL SOLAR RADIATION DATA	STATE-20

<u>SUMMARY.220</u>		<u>LIST OF FILES FOR 2/20/81</u>	
EMIA81.220	EMI	EMI AIRCRAFT CONTINUOUS DATA	STATE-20
MRIA81.220	MRI	MRI AIRCRAFT CONTINUOUS DATA	STATE-20
MRIA81B.220	MRI	MRI AIRCRAFT CONTINUOUS DATA	STATE-20
M31INT.220	MRI	AIRCRAFT INTEGRATED SAMPLE DATA	STATE-20
M31PIX.220	MRI	PIXE ELEMENTAL ANALYSIS DATA	STATE-20
M31XRF.220	MRI	XRF ELEMENTAL ANALYSIS DATA	STATE-20
AV81AS.220	AV	AIRSONDE DATA	STATE-VS
AV81PI.220	AV	PIBAL DATA	STATE-VS
R31VS.220	ROCKWELL	SUPPLEMENTAL TSOND DATA	STATE-VS
R31MET.220	ROCKWELL	MET DATA AT KINKAID	STATE-20
R31NWS.220	ROCKWELL	NWS SURFACE STATION DATA	STATE-20
R31STK.220	ROCKWELL	STACK SAMPLING DATA	STATE-20
ISWS81.RAD	ISWS	TOTAL SOLAR RADIATION DATA	STATE-20

APPENDIX A2.2

Partial Listing of Contents of Data Files of 2/13/81

18 RECORDS AT BEGINNING OF FILE

```

20 3 22 EMIA81.213 02/13/81 2. SECONDS
COLD WEATHER PLUME STUDY 1981 EMI EMI AIRCRAFT CONTINUOUS DATA
(8F10.2,/,8F10.2,/,1F10.2,1F10.0,2F10.2,2F10.3,20X)
DATE TIME CST ALTITUDE @SO2 VOR VORFQ DME TEMP
TDP SO2 NO NOX OZONE BSCAT ANC CHARGE
PRESSURE EVENT @NOX @O3 LATITUDE LONGITUD
YYMMDD HHMMSS M MSL PPB DEGREES HZ KM DEGREE C
DEGREE C PPB PPB PPB PPB 10-4M-1 KN/CC SEE (5)
MILLIBAR CODE PPB PPB DD.D N DD.D W

10857
81.02 240000.00 3000.00 1000.00 360.00 118.00 250.00 25.00
25.00 2000.00 1000.00 1000.00 100.00 10.00 100.00 12000.00
1100.00 10. 1000.00 200.00 40.500 91.000
0.00 0.00 0.00 0.00 0.00 108.00 0.00 -25.00
-25.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00
500.00 0. 0.00 0.00 38.000 87.000
810213.00 74632.00 904.95 100.00 51.00 117.40 95.19 0.80
-10000.00 -2.04 14.24 19.64 -9959.69 0.21 3.54 4.00

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35 RECORDS AT END OF FILE

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982.20 0. 500.00 200.00 40.303 88.999
810213.00 154916.00 467.14 500.00 123.00 115.20 545.04 -1.45
-10002.09 40.98 -0.89 16.63 23.74 0.45 20.09 51.63
982.20 0. 500.00 200.00 40.302 88.998
810213.00 154918.00 467.14 500.00 116.00 115.20 79.27 -1.40
-10002.52 40.16 1.12 18.07 38.75 0.47 20.05 51.00
982.20 0. 500.00 200.00 40.301 88.997

```

COMMENTS:

- 1) @SO2,@NOX,@O3, AND @ANC CONTAIN VALUES OF SO2, NO/NOX,O3, AND ANC INSTRUMENT RANGE SETTINGS. THE RANGE INFORMATION HAS BEEN INCORPORATED INTO THE DATA VALUES OF THE APPROPRIATE POLLUTANT CHANNELS.
- 2) VOR/DME DATA LOGGING WAS BASED ON CONTINUOUS CYCLING (APPROXIMATELY EVERY FIVE SECONDS) BETWEEN TWO GROUND VORTAC STATIONS. THE VORTAC FREQUENCIES ARE RECORDED IN THE VORFQ CHANNEL.
- 3) LONG/LAT DATA ARE INFERRED BASED ON THE VOR/DME DATA.
- 4) ANC = AITKEN NUCLEI COUNT. KN/CC = 1000 NUCLEI PER CUBIC CENTIMETER.
- 5) CHARGE = UNCALIBRATED VOLTAGE SIGNAL OF THE WASHINGTON UNIVERSITY AEROSOL CHARGER.
- 6) THE EMI AIRCRAFT ALSO MADE CONTINUOUS MEASUREMENT OF THE PARTICULATE SULFUR AND THE H2SO4 COMPONENT OF IT. IT IS CURRENTLY BELIEVED THAT THE DATA OF THESE PARAMETERS ARE NOT USABLE, AND ARE NOT INCLUDED HERE. ATTEMPTS WILL CONTINUE TO BE MADE TO VERIFY THIS. IF GOOD DATA IS REALIZED, IT WILL BE MADE AVAILABLE LATER.
- 7) THE EMI AIRCRAFT ALSO MADE SOME AEROSOL SIZE DISTRIBUTION MEASUREMENTS BASED ON AN OPTICAL PARTICLE COUNTER AND AN ELECTRICAL AEROSOL ANALYZER. THESE DATA HAVE NOT YET BEEN PROCESSED, AND THE RAW DATA ARE NOT INCLUDED HERE. RESULTS OF THE INFERRED AEROSOL SIZE DISTRIBUTIONS WILL BE MADE AVAILABLE IN HARD COPY FORM IN THE NEAR FUTURE.

25 RECORDS AT BEGINNING OF FILE

28 4 38 MRIA81.213 2/13/81 18. SECONDS
 COLD WEATHER PLUME STUDY 1981 MRI MRI AIRCRAFT CONTINUOUS DATA
 (8F18.2,/,6F18.1,F18.3,F18.8,/,8F18.3,/,6F18.2)
 TIME CST ALTITUDE PRESSURE IAS TURB TEMP TDP CNC
 CHARGER LOGBSPGR O3 NT NOX SO2 DISTANCE BAG FLAG
 ALPHAB-G ALPHAG-R BSPGREEN BSP BLUE NO NEPTHEMP UVRAD
 TOTRAD EAA CURR EVENT RH-CALC LATITUDE LONGITUD
 HHMMSS M MSL MB M/SEC R UNIT DEG C DEG C 1888CM-3
 PPB PPB PPB PPB V
 18-4/M 18-4/M 18-4/M 18-4/M
 W/M2 NAMP CODE PERCENT DEGREES DEGREES DEG K W/M2

13264								
240000.00	3000.00	1010.00	71.00	7.00	14.00	7.60	111.00	
385.0	416.0	500.0	1500.0	1500.0	1511.0	80.000	5.	
5.780	5.780	14.450	18.890	9.594	1518.000	300.000	37.740	
1624.00	4930.00	5.00	100.00	41.00	90.00			
0.00	0.00	0.00	0.00	0.00	-10.10	-27.70	0.00	
-38.0	0.0	-4.0	-2.0	0.0	-11.0	0.000	0.	
-1.670	-1.860	0.000	0.000	0.000	-7.000	0.000	-0.410	
0.00	-642.00	0.00	0.00	38.00	88.00			
85229.00	523.00	971.00	52.00	0.30	0.00	-13.10	2.00	
-15.0	238.0	39.0	11.0	6.0	6.0	0.050	0.	
1.680	1.700	0.240	0.330	0.162	6.000	277.000	15.110	
467.00	-999.00	2.00	37.01	0.00	0.00			
85230.00	523.00	971.00	52.00	0.30	0.00	-13.10	2.00	

38 RECORDS AT END OF FILE

35.0	253.0	35.0	16.0	19.0	-1.0	59.980	0.
1.540	1.870	0.339	0.454	0.220	8.000	276.000	15.180
412.00	3.00	-999.00	35.83	0.00	0.00		
153115.00	468.00	968.00	56.00	0.40	-0.90	-999.00	13.00
34.0	252.0	35.0	17.0	19.0	-1.0	60.000	0.
1.570	1.790	0.331	0.446	0.219	9.000	276.000	15.040
402.00	3.00	-999.00	-100000.00	0.00	0.00		
153115.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	0.00	0.00	0.00	0.00	0.00	0.000	0.
0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
0.00	0.00	0.00	100.00	0.00	0.00		

COLD WEATHER PLUME STUDY, KINCAID GENERATING STATION, MRI AIRBORNE SAMPLING
 DATA, COLLECTED FROM 02/12/81 THRU 01/20/81.

- 1) LOCATION DATA ARE BASED ON INTERPOLATED LONGITUDE AND LATITUDE VALUES BETWEEN EVENT END POINT VALUES. END POINT VALUES ARE INFERRED FROM AIRCRAFT NAVIGATIONAL DATA.
- 2) R UNIT = CM^(2/3)/SEC
- 3) NT REPRESENTS AL GASEOUS NITROGEN OXIDES, INCLUDING HN03.
 NOX = NT-HN03
- 4) RH-CALC REPRESENTS CALCULATED RELATIVE HUMIDITY BASED ON TEMPERATURE (T) AND DEW-POINT (TDP) DATA ACCORDING TO FORMULA:

$$RH-CALC = ((231.8 + 1.8(TDP - 0.1T)) / (231.8 + 1.62T)) ** 8$$
- 5) TIME IS CENTRAL STANDARD TIME (CST).
- 6) VALUE OF +/- 999 FOR ANY CHANNEL INDICATES NO VALID DATA.

25 RECORDS AT BEGINNING OF FILE

25 4 26 M81INT.213 2/13/80 0. IREGULAR
 CWPS 1981 MRI AIRCRAFT INTEGRATED SAMPLE DATA
 (2F10.0,6F10.3,/,8F10.3,/,8F10.3,/,2F10.3,60X)
 TSTART TEND NO3P SO4P NH4P SP TNO3IO TNO3P
 PAN ETHANE ETHYLENE ACETYLEN PROPANE PROPENE I-BUTANE N-BUTANE
 I-PENTAN N-PENTAN 2-METHP 3-METHP N-HEXANE BENZENE TOLUENE ETHYLBZ
 M+P-XYL O-XYLENE
 HHMMSS HHMMSS UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3
 PPBC PPBC PPBC PPBC PPBC PPBC PPBC PPBC
 PPBC PPBC PPBC PPBC PPBC PPBC PPBC PPBC
 4
 236000. 236000. 0.830 7.520 1.210 1.870 2.840 2.790
 0.100 8.000 11.700 6.200 7.400 0.600 2.000 5.000
 3.900 2.100 1.700 1.700 1.200 3.300 6.600 1.100
 3.500 1.700
 0. 0. -0.180 2.830 0.860 1.230 0.920 0.670
 0.100 6.900 9.800 5.200 6.600 0.100 1.400 4.600
 3.500 1.700 0.600 1.100 0.600 2.600 4.200 0.700
 2.200 1.100
 85200. 102000. 0.480 2.830 0.930 1.230 1.160 0.980
 0.100 8.000 11.700 6.200 7.400 0.100 2.000 5.000
 3.900 2.100 1.700 1.700 0.600 3.300 4.200 0.700
 2.200 1.100
 103000. 113000. 0.830 3.500 0.860 1.410 0.920 0.860

30 RECORDS AT END OF FILE

-995.000 -995.000
 131000. 142000. 0.770 7.520 1.210 1.870 1.310 0.670
 0.100 6.900 9.800 5.200 6.600 0.600 1.400 4.600
 3.500 1.700 0.600 1.100 1.200 2.600 6.600 1.100
 3.500 1.700
 143000. 153000. -0.180 4.540 0.890 1.870 2.840 2.790
 -995.000 -995.000 -995.000 -995.000 -995.000 -995.000 -995.000 -995.000
 -995.000 -995.000 -995.000 -995.000 -995.000 -995.000 -995.000 -995.000
 -995.000 -995.000

TSTART,TEND = START/END TIMES (CST) OF INTEGRATED SAMPLE
 THE AEROSOL CONCENTRATION DATA (CHANNELS 3-8) ARE BASED ON ANALYSES OF
 INTEGRATED FILTER SAMPLES.

THE PAN AND HYDROCARBON DATA (CHANNELS 9-26) ARE BASED ON ANALYSES OF
 INTEGRATED BAG SAMPLES.

THE FOLLOWING ARE DEFINITIONS OF PARAMETERS WHOSE NAMES MAY NOT BE
 SELF-EXPLANATORY:

NO3P = PARTICULATE NITRATE < 2.5 MICRONS
 SO4P = PARTICULATE SULFATE < 2.5 MICRONS
 NH4P = PARTICULATE AMMONIUM < 2.5 MICRONS
 SP = PARTICULATE SULFUR < 2.5 MICRONS
 TNO3IO = TOTAL INORGANIC NITRATE
 TNO3P = TOTAL PARTICULATE NITRATE
 ACETYLEN = ACETYLENE
 I-PENTAN = I-PENTANE
 N-PENTAN = N-PENTANE
 2-METHP = 2-METHYLPENTANE
 3-METHP = 3-METHYLPENTANE
 ETHYLBZ = ETHYLBENZENE
 M+P-XYL = M+P-XYLENE

35 RECORDS AT BEGINNING OF FILE

28 9 67 M81PIX.213 2/13/81
CWPS 1981 MRI
(3F10.2)

8. IREGULAR PIXE ELEMENTAL ANALYSIS DATA

[illegible]

236.000.00	236.000.00	85.00	92.50	27.70	7.20	0.00	621.00
00.20	23.40	1.40	0.00	1900.00	317.00	96.60	23.00
195.00	-12.60	-7.10	-15.00	-13.70	-30.20	217.00	48.20
33.10	219.00	1240.00	87.30	17.70	0.00	0.00	0.00
262.00	54.00	14.90	5.10	58.90	570.00	78.50	20.90
5.20	0.00	62.80	12.00	3.30	1.50	0.00	6.10
-0.70	3.10	0.60	29.00	1220.00	194.00	48.40	14.50
6.20	3.40	0.80	0.00	0.00	0.00	11.50	10.40
4.50	3.20	0.00					
0.00	0.00	68.10	-6.80	35.60	-4.30	0.00	182.00
94.80	27.10	-4.60	0.00	500.00	360.00	61.40	-0.60
-35.40	-12.60	-7.10	-15.00	-13.70	-30.20	23.50	16.50
17.30	19.60	1650.00	25.60	61.50	0.00	0.00	0.00

18 RECORDS AT END OF FILE

4.50	3.20	0.00					
143000.00	153000.00	68.10	92.50	35.60	-4.30	0.00	182.00
94.80	27.10	-4.60	0.00	500.00	360.00	61.40	-0.60
195.00	-12.60	-7.10	-15.00	-13.70	-30.20	23.50	16.50
17.30	19.60	1650.00	25.60	61.50	0.00	0.00	0.00
43.90	69.90	8.80	-1.90	58.90	118.00	84.80	15.00
1.40	0.00	12.50	7.20	2.20	-0.10	0.00	3.60
-0.70	3.10	-0.20	29.00	93.70	95.30	20.20	3.90
34.60	0.00	0.00	0.00	0.00	0.00	23.00	35.60
26.60	9.20	0.00					

THE DATA IN THIS FILE ARE BASED ON IMPACTOR SAMPLES COLLECTED IN THE MRI AIRCRAFT.

ELEMENTAL IMPACTOR DATA OF THE FOUR STAGES
REPRESENT 50% CUTS AT 4,2,1,0.5 MICRONS.

SAMPLE COLLECTION WAS ON 2 MICRON TEFLON AFTER FILTER, AND ANALYSIS WAS BY PIXE.

20 RECORDS AT BEGINNING OF FILE

20 5 34 M81XRF.213 2/13/81 0. IREGULAR
 CWPS 1981 MRI XRF ELEMENTAL ANALYSIS
 (2F10.0,6F10.3,/,8F10.3,/,8F10.3,/,8F10.3,/,2F10.3,60X)
 TSTART TEND AL SI P S CL K
 CA TI V CR MN FE NI CU
 ZN GA AS SE BR RB SR Y
 ZR PD AG CD IN SN SB BA
 PG PB
 HHMMSS HHMMSS UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3
 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3
 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3
 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3 UG/M3
 UG/M3 UG/M3
 3
 236000. 236000. 0.237 0.212 0.073 1.870 -0.005 0.057
 0.024 0.007 0.002 0.001 0.001 0.065 0.002 -0.001
 0.015 0.002 0.007 0.004 0.003 0.003 0.001 0.000
 0.013 0.000 0.002 0.019 0.001 0.012 -0.007 0.022
 0.000 0.011
 0. 0. 0.144 0.200 0.048 1.240 -0.009 0.033

15 RECORDS AT END OF FILE

0.013 0.006 0.002 0.019 -0.003 0.010 -0.011 -0.043
 0.000 0.007
 103000. 113000. 0.157 0.206 0.070 1.410 -0.009 0.057
 0.021 0.007 0.002 0.000 0.000 0.065 0.002 -0.002
 0.012 0.002 0.007 0.003 0.003 0.000 -0.001 0.000
 -0.008 0.008 -0.003 0.011 -0.004 0.012 -0.010 0.022
 0.000 0.004
 131000. 153000. 0.237 0.212 0.073 1.870 -0.005 0.033
 0.021 0.006 0.002 0.000 0.001 0.041 0.001 -0.001
 0.013 0.001 0.001 0.004 0.002 0.003 0.001 0.000
 0.002 0.003 -0.001 0.011 0.001 -0.011 -0.007 -0.020
 0.000 0.011

ELEMENTAL COMPOSITION DATA ARE BASED ON SAMPLE
 COLLECTION ON 2 MICRON TEFLON 25MM FILTERS IN THE MRI AIRCRAFT.
 THE SAMPLES WERE ANALYZED BY X-RAY FLOURESCENCE.

TOTAL OF 42 RECORDS IN FILE M81XRF.213

38 RECORDS AT BEGINNING OF FILE

FORMAT: STATE-VS

PHYSICAL RECORD: 80 BYTES LOGICAL RECORD: 80 BYTES

PROJECT: COLD WEATHER PLUME STUDY -- AIRSONDE MEASUREMENTS

ORGANIZATION: AEROVIRONMENT

TYPE OF DATA: COLD WEATHER PLUME STUDY -- AIRSONDE DATA

FILENAME: AV81AS.213 DATE OF DATA COLLECTION: 2/13/81

DELTA T: VALUE = 0 UNITS CODE = 0

NO. OF PARAMETERS PER RECORD: 7

DATA RECORD FORMAT: (2(F8.0,X),3(F9.1,X),2(F8.0,X),14X)

PARAMETER NAMES

DATE	TIME	ALT.	TEMP	RH	LONG.	LAT.
------	------	------	------	----	-------	------

PARAMETER UNITS

MMDDYY	HHMMSS	METER	DEG. C	%	DDMMSS	DDMMSS
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DATA MINIMA

21281.	121500.	0.0	-20.0	0.0	0.	0.
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DATA MAXIMA

22081.	140000.	2500.0	50.0	100.0	180.	90.
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PLOT MINIMA

21281.	121500.	0.0	-15.0	0.0	88.	39.
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PLOT MAXIMA

22081.	140000.	2500.0	15.0	100.0	90.	41.
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NO. OF SUBFILES: 9

&&END OF MAIN HEADER

SUBFILE 1

LOCATION OF OBSERVATION (NAME, LAT, LONG, ELEV)

NAME: MOUNT PULASKI, ILL

INITIAL POSITION: 0.4001000E+06N 0.8916400E+06W 0.1810000E+03 M MSL

FINAL POSITION: 0.4001000E+06N 0.8916400E+06W 0.1810000E+03 M MSL

TIME OF OBSERVATION

DATE: 2/13/81

TIME: 83800

NO. OF SUBFILE DATA RECORDS: 26

21381.	83800.	190.0	-999001.0	-999001.0	890950.	400036.
21381.	83824.	213.1	-10.0	-999001.0	890950.	400036.
21381.	83848.	279.8	-9.8	-999001.0	890950.	400036.
21381.	83912.	334.5	-7.0	-999001.0	890950.	400036.
21381.	83936.	390.8	-6.0	-999001.0	890950.	400036.
21381.	84000.	447.7	-4.8	-999001.0	890950.	400036.

10 RECORDS AT END OF FILE

21381.	164348.	420.0	-4.1	34.1	890950.	400036.
21381.	164415.	482.0	-2.5	9.8	890950.	400036.
21381.	164442.	548.9	-1.6	7.7	890950.	400036.
21381.	164509.	614.0	-1.1	5.1	890950.	400036.
21381.	164536.	676.5	-0.8	2.0	890950.	400036.
21381.	164045.	1145.2	-1.1	3.2	890950.	400036.

OTHER INFORMATION RELEVANT TO SUBFILE 9

@@END OF SUBFILE 9

&&

FILE CREATION DATE: 24-FEB-84 CREATING PROGRAM: AVVS

TOTAL OF 311 RECORDS IN FILE AV81AS.213

38 RECORDS AT BEGINNING OF FILE

FORMAT: STATE-VS
 PHYSICAL RECORD: 80 BYTES LOGICAL RECORD: 80 BYTES
 PROJECT: COLD WEATHER PLUME STUDY -- PIBAL MEASUREMENTS
 ORGANIZATION: AEROVIRONMENT
 TYPE OF DATA: COLD WEATHER PLUME STUDY -- PIBAL DATA
 FILENAME: AV81PI.213 DATE OF DATA COLLECTION: 2/13/81
 DELTA T: VALUE = 0 UNITS CODE = 0
 NO. OF PARAMETERS PER RECORD: 7
 DATA RECORD FORMAT: (2(F8.0,X),F9.1,X,F8.0,X,F9.1,X,2(F8.0,X),15X)
 PARAMETER NAMES
 DATE TIME ALT. WD WS LONG. LAT.
 PARAMETER UNITS
 MDDYY HHMMSS METER DEG. M/S DDDMMSS DDDMMSS
 DATA MINIMA
 21281. 121500. 0.0 0. 0.0 0. 0.
 DATA MAXIMA
 22081. 140000. 2500.0 360. 50.0 180. 90.
 PLOT MINIMA
 21281. 121500. 0.0 0. 0.0 88. 39.
 PLOT MAXIMA
 22081. 140000. 2500.0 360. 25.0 90. 41.
 NO. OF SUBFILES: 8
 &&END OF MAIN HEADER
 SUBFILE 1
 LOCATION OF OBSERVATION (NAME, LAT, LONG, ELEV)
 NAME: MOUNT PULASKI, ILL
 INITIAL POSITION: 0.4001000E+06N 0.8916400E+06W 0.1810000E+03 M MSL
 FINAL POSITION: 0.4001000E+06N 0.8916400E+06W 0.1810000E+03 M MSL
 TIME OF OBSERVATION
 DATE: 2/13/81
 TIME: 83830
 NO. OF SUBFILE DATA RECORDS: 15

21381.	83830.	268.0	193.	8.6	890950.	400036.
21381.	83900.	344.0	205.	6.6	890950.	400036.
21381.	83930.	415.0	213.	4.8	890950.	400036.
21381.	84000.	484.0	191.	4.9	890950.	400036.
21381.	84030.	552.0	191.	6.3	890950.	400036.
21381.	84100.	620.0	198.	6.9	890950.	400036.

 10 RECORDS AT END OF FILE

21381.	164630.	834.0	229.	13.2	890950.	400036.
21381.	164700.	906.0	229.	13.2	890950.	400036.
21381.	164730.	979.0	227.	13.4	890950.	400036.
21381.	164800.	1051.0	229.	12.6	890950.	400036.
21381.	164830.	1124.0	229.	11.8	890950.	400036.
21381.	164900.	1197.0	226.	11.6	890950.	400036.

 OTHER INFORMATION RELEVANT TO SUBFILE 8
 @END OF SUBFILE 8
 &&
 FILE CREATION DATE: 24-FEB-84 CREATING PROGRAM: AVVS

TOTAL OF 282 RECORDS IN FILE AV81PI.213

33 RECORDS AT BEGINNING OF FILE

FORMAT: STATE-VS
PHYSICAL RECORD: 80 BYTES LOGICAL RECORD: 80 BYTES
PROJECT: COLD WEATHER PLUME STUDY T-SONDE DATA FEB 1981
ORGANIZATION: ROCKWELL INTERNATIONAL
TYPE OF DATA: SUPPLEMENTAL TSOND DATA FEB81
FILENAME: R81VS.213 DATE OF DATA COLLECTION: 02/13/81
DELTA T: VALUE = 0 UNITS CODE = 0
NO. OF PARAMETERS PER RECORD: 4
DATA RECORD FORMAT: (4E10.4)
PARAMETER NAMES
TSOND HT TSOND WD TSOND WS TSOND TMP
PARAMETER UNITS
M DEGREES M/S K
DATA MINIMA
0.0000E+000.1610E+030.2700E+010.2607E+03
DATA MAXIMA
0.1630E+040.2730E+030.1540E+020.2754E+03
PLOT MINIMA
0.0000E+000.2000E+020.1000E+010.2500E+03
PLOT MAXIMA
0.2000E+040.4000E+030.3000E+020.2900E+03
NO. OF SUBFILES: 9
&&END OF MAIN HEADER
SUBFILE 1
LOCATION OF OBSERVATION (NAME, LAT, LONG, ELEV)
NAME: KINCAID ILLINOIS PLANT
INITIAL POSITION: 0.3935300E+06N 0.8929300E+06W 0.2000000E+03 M MSL
FINAL POSITION: 0.3935300E+06N 0.8929300E+06W 0.2000000E+03 M MSL
TIME OF OBSERVATION
DATE: 02/13/81
TIME: 50000
NO. OF SUBFILE DATA RECORDS: 13
0.5000E+00-.9950E+03-.9950E+030.2607E+03

15 RECORDS AT END OF FILE

0.1370E+040.2220E+030.8700E+010.2730E+03
0.1460E+040.2200E+030.9400E+010.2732E+03
0.1541E+040.2220E+030.7900E+010.2731E+03
OTHER INFORMATION RELEVANT TO SUBFILE 9
@@END OF SUBFILE 9
&&
FILE CREATION DATE: 23-FEB-84 CREATING PROGRAM: ROCKVS
COLD WEATHER PLUME STUDY, KINCAID ILLINOIS PLANT, T-SONDE DATA FOR CENTRAL SITE,
COLLECTED ON 02/13/81. DATA FOR 9 SEPARATE LAUNCHINGS ON THIS DATE ARE IN
SEPARATE SUBFILES. THE TIMES FOR EACH LAUNCHING ARE AS FOLLOWS-
0500 0645 0804 0916 1019 1117 1343 1446 1552 CST
ORIGINAL DATA TAPE FOR THIS INTENSIVE STUDY PERIOD PREPARED BY ALAN JONCICH OF
ROCKWELL INTERNATIONAL, PHONE 805-498-6771. STATE FORMATTED TAPE PREPARED AT
WASHINGTON UNIVERSITY SPECIAL STUDIES DATA CENTER.
THE VALUE -995 IS USED TO DENOTE INVALIDATED DATA.

TOTAL OF 313 RECORDS IN FILE R81VS.213

22 RECORDS AT BEGINNING OF FILE

28 5 38 R81MET.213 02/13/81 5. MINUTES
 CWPS 1981 ROCKWELL MET DATA AT KINKAID
 (1F10.0,7F10.3,/,8F10.3,/,8F10.3,/,8F10.3,/,6F10.3,20X)
 TIME CST WS 10M WS 30M WS 50M WS 100M TEMP010M TEMP050M TEMP100M
 DT10-50M DT10-100 TDP P NI RAD NET RAD DIF RAD PRECIP
 RMGST T10MTOW DTZ-10M WD 10M WD 30M WD 50M WD 100M SGWD010M
 SGWD030M SGWD050M SGWD100M V GILL W GILL WS GILL WD GILL UV GILL
 UW GILL VW GILL SGU GILL SGV GILL SGW GILL RH K K
 HIIMSS M/S M/S M/S M/S K WATTS/M2 WATTS/M2 K
 K K K MILLIBAR DEGREES DEGREES DEGREES DEGREES
 DEGREES DEGREES DEGREES M/S M/S M/S DEGREES M2/S2
 M2/S2 M2/S2 M/S M/S M/S PERCENT

236.000	5.857	10.900	-999.000	13.370	349.100	360.500	363.700
14.670	1.459	264.400	2037.000	-999.000	151.000	149.400	0.000
273.900	271.600	4.970	206.800	198.900	-999.000	217.600	6.073
4.958	0.000	3.225	10.850	-0.640	10.900	179.600	-999.000
-999.000	-999.000	-999.000	-999.000	-999.000	0.363		
0.	1.343	4.061	-999.000	4.951	349.000	357.800	363.600
8.776	14.580	259.300	1017.000	-999.000	-96.960	1.340	0.000
259.600	257.800	-0.691	1.340	145.300	-999.000	151.500	2.748

18 RECORDS AT END OF FILE

263.200	262.400	1.668	144.800	151.000	-999.000	167.400	-999.000
1.087	0.000	0.351	10.610	-1.147	10.680	-999.000	-999.000
-999.000	-999.000	-999.000	-999.000	-999.000	-999.000		
235500.	2.054	6.406	-999.000	11.430	-999.000	-999.000	-999.000
-999.000	-999.000	263.300	1018.000	-999.000	-38.260	3.508	0.000
262.000	262.300	1.628	147.600	153.700	-999.000	169.600	-999.000
2.116	0.000	0.731	10.850	-1.004	10.900	-999.000	-999.000
-999.000	-999.000	-999.000	-999.000	-999.000	-999.000		

COLD WEATHER PLUME STUDY, KINCAID ILLINOIS PLANT,
 METEOROLOGICAL DATA FOR CENTRAL SITE, COLLECTED FROM
 02/09/81 THRU 02/22/81. ORIGINAL DATA TAPE FOR
 THIS INTENSIVE STUDY PERIOD PREPARED BY ALAN
 JONCICH OF ROCKWELL INTERNATIONAL, PHONE
 805-498-6771. STATE FORMATTED TAPE PREPARED AT WU/EPA SPECIAL
 STUDIES DATA CENTER. THESE MET DATA WERE COLLECTED FROM TWO
 MET TOWERS (10M AND 100M) AND AT A SURFACE SITE.
 FOR DETAILS, REFER TO CWPS REPORTS OF WU (GILLANI ET AL, 1985) AND
 OF BATTELLE COLUMBUS (1983).

TOTAL OF 1474 RECORDS IN FILE R81MET.213

12 RECORDS AT BEGINNING OF FILE

28 2 9 R81NWS.213 02/13/81 1. HOURS
 CWPS 1981 ROCKWELL NWS SURFACE STATION DATA
 (F8.0,8F9.2)
 TIME CST NWS PRES NWS TEMP NWS DP NWS WD NWS WS NWS CH NWS CC
 NWS PREC
 HHMMSS MILLIBAR K K DEGREES M/S M TENTHS
 MM

24

236000.	1044.00	273.70	26.87	190.00	7.72	33000.00	1.00	0.00
0.	1040.00	262.60	259.30	160.00	3.09	33000.00	0.00	0.00
0.	1042.00	263.70	260.40	180.00	6.69	33000.00	0.00	0.00
100000.	1043.00	263.10	259.30	180.00	5.66	33000.00	0.00	0.00

17 RECORDS AT END OF FILE

180000.	1041.00	270.90	266.50	160.00	4.11	33000.00	1.00	0.00
190000.	1041.00	270.90	267.60	170.00	3.09	33000.00	1.00	0.00
200000.	1041.00	269.80	267.60	170.00	3.60	33000.00	0.00	0.00
210000.	1040.00	269.30	267.00	160.00	4.11	33000.00	0.00	0.00
220000.	1040.00	268.70	264.80	160.00	5.14	33000.00	0.00	0.00
230000.	1040.00	268.70	265.90	170.00	3.09	33000.00	0.00	0.00

COLD WEATHER PLUME STUDY, KINCAID ILLINOIS PLANT,
 NATIONAL WEATHER SERVICE DATA FOR SPRINGFIELD, IL, COLLECTED FROM
 02/09/81 THRU 02/22/81. ORIGINAL DATA TAPE FOR
 THIS INTENSIVE STUDY PERIOD PREPARED BY ALAN
 JONCICH OF ROCKWELL INTERNATIONAL, PHONE
 805-498-6771. STATE FORMATTED TAPE PREPARED BY
 WU/EPA SPECIAL STUDIES CENTER.

DP = DEW POINT TEMPERATURE
 WD/WS = WIND DIRECTION AND SPEED
 CH/CC = CLOUD BASE HEIGHT AND CLOUD COVER

TOTAL OF 45 RECORDS IN FILE R81NWS.213

12 RECORDS AT BEGINNING OF FILE

20 1 6 R81STK.213 02/13/81 5. MINUTES
 CWPS 1901 ROCKWELL STACK SAMPLING DATA
 (6F10.2,20X)
 TIME STCK SO2 STCK NO STCK O2 STCK VEL STCK TMP
 HHMMSS PPM PPM PPM M/S K
 238
 236000.00 1836.00 593.00 119.00 22.00 388.00
 0.00 1518.00 436.00 103.00 18.00 379.00
 0.00 1637.00 477.00 114.00 19.00 379.00
 500.00 1611.00 473.00 114.00 19.00 379.00
 1000.00 1617.00 471.00 113.00 19.00 380.00
 1500.00 1658.00 495.00 110.00 18.00 380.00

15 RECORDS AT END OF FILE

232500.00 1643.00 533.00 112.00 21.00 384.00
 233000.00 1666.00 549.00 111.00 21.00 384.00
 233500.00 1704.00 565.00 109.00 20.00 385.00
 234000.00 1704.00 569.00 110.00 20.00 386.00
 234500.00 1669.00 549.00 111.00 21.00 386.00
 235000.00 1666.00 543.00 111.00 21.00 386.00
 235500.00 1652.00 535.00 112.00 21.00 386.00
 COLD WEATHER PLUME STUDY, KINCAID ILLINOIS PLANT,
 STACK DATA FOR CENTRAL SITE, COLLECTED FROM
 02/09/81 THRU 02/22/81. ORIGINAL DATA TAPE FOR
 THIS INTENSIVE STUDY PERIOD PREPARED BY ALAN
 JONCICH OF ROCKWELL INTERNATIONAL, PHONE
 305-498-6771. STATE FORMATTED TAPE PREPARED BY
 WU/EPA SPECIAL STUDIES DATA CENTER AT WASHINGTON UNIVERSITY,
 2/12/85.

TOTAL OF 304 RECORDS IN FILE R81STK.213

15 RECORDS AT BEGINNING OF FILE

20 1 4 ISWS81.RAD 1. MINUTES
 CWPS 1981 ISWS TOTAL SOLAR RADIATION DATA
 (4F10.2,40X)
 DATE TIME SOL ISWS EVENT
 YYMMDD HHMMSS W/M2 CODE
 117
 810222.00 240000.00 1000.00 5.00
 810212.00 0.00 0.00 0.00
 810212.00 0.00 0.00 2.00
 810212.00 10000.00 0.00 2.00
 810212.00 20000.00 0.00 2.00
 810212.00 30000.00 0.00 2.00
 810212.00 40000.00 0.00 2.00
 810212.00 50000.00 0.00 2.00
 810212.00 60000.00 0.00 2.00

10 RECORDS AT END OF FILE

810220.00 160000.00 306.60 2.00
 810220.00 170000.00 175.20 2.00
 810220.00 180000.00 29.20 2.00
 810220.00 190000.00 0.00 2.00
 810220.00 200000.00 0.00 2.00
 810220.00 210000.00 0.00 2.00
 810220.00 220000.00 0.00 2.00
 810220.00 230000.00 0.00 2.00
 DATA WAS OBTAINED FROM ILLINOIS STATE WATER SURVEY, CHAMPAIGN.
 DATA WAS DIGITIZED FROM STRIP CHART PLOTS.

TOTAL OF 127 RECORDS IN FILE ISWS81.RAD

APPENDIX A2.3

Documentation of STATE-20 and STATE-VS File Formats

STATE-20 DOCUMENTATION

The STATE-20 data file format has been designed for data of a time-series form, i.e. sequential data records, each consisting of a time and corresponding values of a certain number of measured variables. Most data in the STATE data base, (comprising the GDDBs of MISTT, TPS, PEPE/NEROS, and CWPS) are of this form. Hence, STATE-20 is the most predominant data file format in these GDDBs.

File Format

The entire file is written in fixed 80-character card images (logical records). Each file has the following overall structure:

HEADER SECTION
DATA SECTION
COMMENTS SECTION
EOF (End of File mark)

The *comments section* consists of an arbitrary number of logical records with literal information of an elucidatory nature -- who, what, when, where, why, how, problems, quality assessment, exceptions, definitions, etc. It includes, in particular, definitions of data variables whose names are not self-explanatory. The comments section starts immediately following the data section. No separation markers or records exist. The start of the data section and its length, however, are predefined. The end of the comments is followed by an end-of-file (EOF) marker.

The *data section* contains the actual data of the measured variables, grouped into individual repeated observations. Each observation consists of one set of values of the measured variables (including date and time of the observation). Observations are sequential and chronological, and they all have the same format since the same variables are repeated in each observation. This observation format is a predefined syntactically correct FORTRAN format incorporating several 80-character records in one observation.

The *header section* contains important information which self-documents the file format and contents. It defines the number of variables (NVAR) and the number of 80-character logical records (NREC) in each observation; it identifies the data variables by their assigned names, and gives the specific FORTRAN format of each observation of data; and it gives the averaging time of the observation (i.e. the inter-observation time interval for continuous data) and the overall size of the data section, i.e. the total number of observations (NOBS) in the data section.

The detailed record-by-record documentation of the file is as follows:

Header Records (Logical H1, H2, ...)

H1: Content	-	NVERSION, NREC, NVAR, FILENAME, DATEC, DELTAT, UNITDT						
Column(s)	-	1-2	5-6	7-10	13-22	25-32	35-39	41-48
Format	-	I2	I2	I2	10A1*	8A1	F5.0	8A1*

(* = left justified)

Definitions -

NVERSION = 20 = current version of this STATE format

NREC = number of 80-character logical records per observation

NVAR = number of variables in one observation

FILENAME = FFFFFFFF.XXX

FFFFFFF = any upto-6-character alphanumeric filename, starting in column 13. Usually, this name has the form OOOOyy, where OOOO is an identifier of organization/platform collecting data, and yy denotes year of data collection.
Examples: MRI75, WU76, NASA80, UVDIAL

.XXX = any upto-3-character alphanumeric filename extension. For dated missions, we recommend XXX to provide the date in the form mdd, where m=month (1-9 = Jan-Sept; A,B,C = Oct,Nov,Dec), and dd=day of month (1-31)

DATEC = Date of data collection, preferably in the format mm/dd/yy.

DELTAT = Time interval between successive observations, if fixed (0 for irregular intervals).

UNITDT = Unit of DELTAT (e.g. HOURS, MIN, SEC, etc.)

H2: Content - PROJECT, ORGANIZATION COLLECTING DATA, DATA DESCRIPTION

Format - (30A1, 10A1, 40A1)

H3: Data encoding format in parentheses. The format is assumed to be syntactically correct FORTRAN format with NVAR fields in F or E format (no I-format); use of X for spacing and / for line feed may be used in the format statement. Example for an observation with NVAR = 17 and NREC = 2:
(9F8.2, 8X, /, 5F7.1, 3E13.6, 6X)

H(4a, 4b, etc...as needed):
Names of the NVAR data variables, 8 per line, in (8(8A1, 2X)) format.

H(5a, 5b, etc...as needed):
Units of the NVAR variables, 8 per line, in (8(8A1, 2X)) format.

H6: Number of total data observations (NOBS) in file in I10 format.

--- End of Header Section ---

Data Records (Logical D1, D2, ...)

The total number of logical records in this section is NREC*(NOBS+2). The first 2*NREC records contain the physical upper and lower bounds of all data variables. The remaining NREC*NOBS records contain the actual data of the NOBS observations. The data section thus has the following record-by-record form:

D(1 to NREC):
Physical upper bounds of data variable values in specified FORTRAN format for any data observation

D(NREC+1 to 2*NREC):
Physical lower bounds of data variable values in observation format

D(2*NREC + 1 to NREC*[NOBS+2]):
The actual observed data in observation format.

--- End of Data Section ---

Comment Records (Logical C1, C2, ...)

C1 to Last logical record of file:

Arbitrary number of logical records with literal comments containing any useful information concerning the program, the data variables, data quality assessment, references to related reports, people to contact for help, or any other useful message for posterity.

EOF

--- End of File ---

STATE-VS DOCUMENTATION

The STATE-VS format has been designed as a complement to the currently existing STATE-20 format. STATE-20 is appropriate for time-series type data, while STATE-VS is appropriate for vertical soundings type data, e.g. pibal, radiosonde, sodar, etc.

File Format

Each file normally contains the data of all vertical soundings of a given platform (or station) for a given day. The filename has the form nnnnnn.mdd, nnnnnn= any I.D. of file (e.g. organization, type of data, etc.), and
mdd = month, day (e.g. 724=July 24)
= date of data collection
(A=October, B=November, C=December)

The overall file format is as follows:

FILE HEADER RECORDS	
&&	
SUBFILE 1 (for first sounding)	{ subfile header records subfile data records subfile comment records
@@	
SUBFILE 2 (second sounding)	{ subfile header records subfile data records subfile comment records
@@	
⋮ SUBFILE n ⋮	
@@	
&&	
FILE COMMENT RECORDS	
EOF	

The main file header defines such specific items common to all soundings in the file as Project, Organization Collecting Data, Type of Data, Filename, Reported Data Parameters, their Units, Range, etc., Data Record Format and Size, etc. If the data are of vertical soundings, the first parameter should be the height level (altitude).

The main file comments provide any additional information common to the total data set which is judged useful, but which cannot be included in the main file header.

Each subfile contains the information pertinent to a single sounding. Subfiles must be arranged in chronological order. The subfile header specifically defines the time and location of the sounding and the number of records (height levels for a vertical sounding) in the subfile. Each data record provides a height level and the corresponding data of the measured parameters (e.g. wind speed, wind direction). The subfile is concluded by any comment records specific to this sounding.

Logical record size is fixed at 80 characters.

(a) Main File Header

The main file header defines specific minimum file information in a specific format. In the following header format description, underlined character strings are to be fixed, as indicated, and the rest of the information is variable.

Record 1: FORMAT: STATE-VS

Record 2: PHYSICAL RECORD: 80 BYTES, LOGICAL RECORD: 80 BYTES

Record 3: PROJECT: (T10,71A1)

Record 4: ORGANIZATION: (T15,66A1)

Record 5: TYPE OF DATA: (T15,66A1)

Record 6: FILENAME: (T11,nnnnnn.mdd) DATE OF DATA COLLECTION: MM/DD/YY

Record 7: DELTA T: VALUE = (T20,I3) UNITS CODE = (T39,I2)

This record provides information about time interval between soundings.

UNITS CODE = 0	indicates	interval is irregular
= 1	indicates	interval is in seconds
= 2	indicates	interval is in minutes
= 3	indicates	interval is in hours

(e.g. 3-hourly soundings defined by value = 3, code = 3).

Record 8: NO. OF PARAMETERS PER RECORD: (T30,I4)

Record 9: DATA RECORD FORMAT: (Data encoding format in parenthesis)
Open parenthesis to be placed in column 21. The encoding format is assumed to contain a syntactically correct FORTRAN format specification utilizing only F, E and X format codes (no I-format please!) and "read record" slashes, suitable for decoding the data. Example: (F6.0, 2E12.4, 2F5.0, 40X)

Record 10: PARAMETER NAMES

Record 11: Logical record 11 should contain the parameter names in the format: n(8A1, 2X), n=number of parameters

Record 12: PARAMETER UNITS

Record 13: Logical record 13 should contain the parameter units in the format: n(8A1,2X), n=number of parameters.

Record 14: DATA MINIMA

Record 15: The actual or possible minimum values of the parameters in data record format

Record 16: DATA MAXIMA

The actual or possible maximum values of the parameters in data record format

Record 17: PLOT MINIMA

Record 18: Suggested lower bound values of the parameters to be used for general plotting purposes

Record 19: PLOT MAXIMA

Record 20: Suggested upper bound values of the parameters to be used for general plotting purposes.

N.B. Data min/max range should include range of valid data values, including outlier (but valid) values.

Plot min/max range would normally include normal data values (and possibly not include valid outliers).

Record 21: NO. OF SUBFILES: (T19,I3)

Record 22: && (end of Main File Header)

(b) Subfile Header

Record 1: SUBFILE (T8,I3) Sequential subfile number

Record 2: LOCATION OF OBSERVATION

Record 3: NAME: (T26,55A1) Literal name of location, if any.

Record 4: INITIAL POSITION: (T26,E14.7,2X,E14.7,2X,E14.7)
LAT LONG ELEV(m MSL)

Record 5: FINAL POSITION: (T26,E14.7,2X,E14.7,2X,E14.7)
LAT LONG ELEV

For stationary platforms (e.g. PIBAL during a single sounding), initial and final positions will be same. For a moving platform, such as an aircraft lidar making a remote vertical profile sounding, the subfile may contain an average profile measured between aircraft initial and final positions during averaging time.

Record 6: TIME OF OBSERVATION

Record 7: DATE: (T26, MM/DD/YY)

Record 8: TIME: (T26, HHMMSS)

Record 9: NO. OF SUBFILE DATA RECORDS: (T30,I10)

Record 10: Start of data records (in specified data record format)

:
:
N data records
:
:

Record 10 Start of comment records (80A1 format)
+ N:

@@ (End of subfile)