NUREG/CR-3488
Vol. 1

Idaho Field Experiment 1981

Volume 1: Experimental Design and Measurement Systems

Prepared by G. E. Start, J. H. Cate, C. R. Dickson, J. F. Sagendorf, G. R. Ackermann

Air Resources Laboratories
National Oceanic and Atmospheric Administration

Prepared for
U.S. Nuclear Regulatory
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NUREG/CR-3488
Vol. 1
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Idaho Field Experiment 1981

NUREG/CR--3488-Vol.1

DE84 900725

Volume 1: Experimental Design and Measurement Systems

Manuscript Completed: August 1983
Date Published: October 1983

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NRC FIN B5690

ABSTRACT

The Idaho Field Experiment is reported in three volumes and supplemented by special contractor reports. Volume I describes the design and goals of the measurement program and the measurement systems utilized during the field program. The measurement systems layouts are described as well.

Volume II lists the data in tabular form or cites the special supplemental reports by other participating contractors. While the primary user file and the data archive are maintained on 9 track/1600 cpi magnetic tapes, listings of the individual values are provided for the user who either cannot utilize the tapes or wishes to preview the data. The accuracies and quality of these data are described.

Volume III contains descriptions of the nine intensive measurement days. General meteorological conditions are described, analyses of gaseous tracer data are shown, and overviews of test day cases are presented. Calculations using the ARLFRD MESODIF model are included and related to the gaseous tracer data. Finally, a summary and a list of recommendations are presented.

The 1981 Idaho Field Experiment was conducted in South East Idaho over the Upper Snake River Plain. Nine test-day case studies were measured between July 15 and 30, 1981. Eight-hour releases of SF_6 gaseous tracer were made from 46 m above ground. Tracer was sampled hourly, for 12 sequential hours, at about 100 locations within an area 24 km square. Also, a single total integrated sample, of about 30 hours duration, was collected at approximately 100 sites within an area 48 by 72 km (using 6 km spacings). Extensive tower profiles of meteorology at the release point were collected. RAWINSONDES, RABALS and PIBALS were collected at 3 to 5 sites. Horizontal, low-altitude winds were monitored using the INEL MESONET. SF_6 tracer plumes were marked with co-located oil fog releases and bi-hourly sequential launches of tetroon pairs. Aerial LIDAR observations of the oil fog plume and airborne samples of SF_6 were collected. High-altitude aerial photographs of daytime plumes were also collected.

Contents

		Page
Abstract		ii
List of Figures		iv - v
List of Tables		vi
Forward		vii
Acknowledgements		viii
I.	Introduction	1
II.	Idaho Study Setting	3
III.	Field Study Design	4
IV.	Organization and Participants	6
V.	Intensive Measurement Program	7
VI.	Other Concurrent Studies	10
VII.	Real-time Model Exercising	11
VIII.	Data Documentation and Archival	11
	References:	13

List of Figures

Figure	Caption	Page
Figure 1.	Relief map of the Upper Snake River Plain and the mountains of southeastern Idaho.	14
Figure 2.	Summer wind roses for CFA and TAN for measurements at 20 feet above ground (Yanskey et al., 1966).	15
Figure 3.	Summer PIBAL wind roses for surface (4935 feet MSL) and various heights above mean sea level (Yanskey et al., 1966).	16
Figure 4.	Early morning down-valley wind flow. Northeast is toward the top of the figure. + denotes the observation point. A full flag is 10 mph; a half flag is 5 mph. Airflow is indicated along the wind arrow toward the + symbol.	17
Figure 5.	Same as figure 4 except for late morning when the down-valley winds have mostly dissipated.	18
Figure 6.	Same as figure 4 except for afternoon when the up-valley winds have become established.	19
Figure 7.	Functional activities which comprise the organization for the field measurement program.	20
Figure 8.	Location of the measurement area in southeastern Idaho is within the largest rectangle. The source point is shown by ⊕. The area is 48 km wide by 72 km long.	21

List of Figures Continued

Figure	Caption	Page
Figure 9.	The outer grid for 30-hour time-integrated sampling is shown with the outline of the inner grid and the boundaries of the INEL. The release site is at the Grid III tower.	22
Figure 9-A.	Locations for 1-hour time-integrated air samplers on the fine or inner grid are shown by dots. 112 locations were used.	23
Figure 10.	Existing MESONET locations of towers for wind measurements are shown. Tall towers are at TAN, LOFT, GRID III, CFA, and EBR-II.	24
Figure 11.	Meteorological sensors are schematically shown as positioned on the Grid III tower.	25
Figure 12.	Locations for winds aloft and soundings are shown. Three sites for RABALS were used. RAWINSONDES were made near GRID III. A monostatic acoustic sounder was operated near the tracer source point. AIRSONDES and PIBALS were collected near Little Lost, Howe and Coyote Diversion Dam.	26
Figure 13.	The 2-day cycle of tracer releasing, sampling, observations, and analysis activities are shown. Each 2-day period has a repeat of the sequence of activities.	27
Figure 14.	Basic plan for coordinated vertical diffusion measurements using ALPHA-1 and SF_6 sampling aircraft.	28

List of Tables

Table	Caption	Page
Table 1.	Types of information collected.	5
Table 2.	Example use of field measurement data for stepwise diagnostic exercising of dispersion models.	6
Table 3.	Organization responsibilities for the field experiment.	7
Table 4.	Meteorological sensors and heights of measurements at Grid III.	10
Table 5.	Conventions of Units for Time, Date and Location.	12

FOREWORD

The Office of Nuclear Regulatory Research, U.S. Nuclear Regulatory Commission (NRC), supports a meteorological research program. The main objective of this program is to provide improved bases for licensing decisions and for the development and confirmation of regulations, standards, and guides. Within this context, estimates of atmospheric dispersive capacity are needed for emergency response planning and preparedness, and for site characterization.

A coordinated program of model evaluations, collections of data sets for model exercising, and assessments of computer capabilities was established by the U.S. NRC, Office of Nuclear Regulatory Research. Through this assessment program a basis for selection and design of computerized emergency response systems may be developed. Along with this knowledge, the suitabilities and accuracies to be expected from these estimates of atmospheric dispersive capabilities will be investigated. These studies are guided and critiqued by selected scientists and managers from NRC contractors within the atmospheric transport and diffusion research program. Members of this planning task group were the following.

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Research sponsored by U.S. Nuclear Regulatory Commission (NRC) Office of Nuclear Regulatory Research, Interagency Agreement No. RES-76-106. Sponsored in part by Fast Reactor Safety, DOE, Interagency Agreement No. DE-AI02,80ET327246.

ACKNOWLEDGEMENTS

The Office of Nuclear Regulatory Research, U. S. Nuclear Regulatory Commission, Washington, D. C. recognized the need for and advocated the collection of a comprehensive, high quality data set of gaseous tracer concentration data along with numerous concurrent meteorological measurements. Beginning in 1980, they sought the ability to exercise and evaluate atmospheric transport and diffusion models of interest to the NRC. The ability for making those assessments would have been greatly diminished without this data set.

This research was supported by the U. S. Nuclear Regulatory Commission, (NRC), Office of Nuclear Regulatory Research, and U. S. Dept. of Energy, Fast Reactor Safety. Analyses and data reporting were supported by the NRC. Technical direction has been provided by the staff of the Office of Nuclear Regulatory Research.

This experiment was a cooperative venture involving the complete staff of the Air Resources Laboratories' Field Research Division. It could not have been successful without the unstinting help of all of the staff. Special appreciation is expressed to the following individuals:

Mr. F. E. White set up the data acquisition for the many towers and sensors which were vital to the experiment.

Mr. R. E. Heard organized and maintained the over 200 air sampling devices necessary to conduct the experiment.

Mr. Michael A. Caldwell supervised the gas analysis laboratory and its associated experiments, calibrations, and operations.

Miss Christa A. Crapo edited, typed and compiled the manuscript. Miss Crapo also coordinated the production of figures and tables for the manuscript.

I. Introduction

An emergency preparedness capability is required for responding in the event of an atmospheric discharge of radioactive effluents from a nuclear power plant. This capability includes the preparation of guidance information, which is to be considered by the licensee who operates the nuclear power plant and appropriate emergency management authorities in local, state, and federal agencies (NRC/FEMA, 1980). The preparation of this guidance information can be grouped into the following three categories:

(1) the facility (computers and their system operating instructions) for preparation and display of information,
(2) the descriptive data and measurements utilized by the facility, and
(3) the theoretical and practical methodologies (physical models and computational algorithms) which reside in the facility and utilize the descriptive information.

The Idaho Field Experiment relates mostly to categories 2 and 3. The choice of models can dictate the type and cost of a facility as well as alter the necessary input data content. The models which may be included in category 3 inherently have levels of uncertainty attached to them (Hanna et al, 1978) which need to be objectively evaluated so that reasonable preparedness capabilities may be developed. A suitably comprehensive data base, to evaluate the various proposed models, does not now exist. This is particularly true for dispersion in the range of 10-80 km from the source. The Idaho experiment is designed specifically to provide a significant increase in the data available to evaluate possible models.

During planning for systems which might provide a means to estimate the atmospheric dispersion of radioactive material due to accidental releases by nuclear power plants, many alternatives have been proposed. Proposed atmospheric dispersion models range from straight-line Gaussian plume methods to three-dimensional micrometeorological models. In assessing which if any of these models are suitable, it is necessary to establish what performance characteristics are most critical. These measures of performance can then be used as evaluation criteria to discriminate between models. The most critical evaluation criteria may be divided into four categories (Lewellen et al, 1981):

(1) Accuracy
(2) Responsiveness
(3) Costs
(4) Growth potential

Unless the model attains some, as yet unspecified, level of accuracy it hinders rather than aids decision makers. On the other hand, if it is not able to make a timely response at an affordable cost, it is also useless. Responsiveness is measured by the ease of applicability and the time required between information input and receiving the desired output. Growth potential (model changes and adaptability) is desirable, but not essential.

The foremost accuracy requirement is reasonably representing the spatial and temporal distribution of surface level concentration. There are no generally accepted standards for evaluating the performance of atmospheric dispersion models. It is important to judge model performance based on the particular needs of the desired application. The spatial distribution appears to be more critical than the temporal distribution since health effects tend to depend on time integrated dosage; thus, effects with temporal uncertainties when integrated over time periods of a few hours, probably yield reasonable estimates if the spatial distribution is acceptably accurate.

In order to test how well a model describes the spatial distribution in any situation it is necessary to have a data set which adequately describes the spatial distribution for some conditions. The paucity of dispersion data which extended as far as 80 km (Sklarew and Joncich (1979), Londergan, et. al. (1980)) are generally inadequate to define a surface integrated dosage pattern. The sampling network for this experiment is designed to provide the necessary surface pattern out to 40 km.

A regional dispersion model is required to predict both a plume trajectory, which is related to the mean wind, and the rate of diffusion of the airborne effuent, which depends on the smaller scale turbulent mixing processes. Errors in the trajectory are probably responsible for the largest part of the differences in comparisons of modeled versus observed concentration patterns. But, dilution is also important in determining the utility of a prediction. A data set, with a diversity of meteorological data types and measurements at a number of locations, is desirable. This diversity permits the evaluation of which input information is most important for acceptable model performance. Again, adequate field data, which would permit such an evaluation, does not currently exist.

The specific intent of the Idaho Field Experiment is to obtain a suitable set of measured meteorological and concurrent atmospheric transport and diffusion data. This data set will provide the information for the diagnostic exercising and appraisal of the various modeling methodologies and will permit an evaluation of the types of and numbers of locations for collection of input information necessary for acceptable model performance.

The bulk of the information collected from the Idaho Field Experiment is reported in three volumes. The remaining information can be found in special, supplemental contractor reports. The first volume outlines the design and goals of the measurement program and the types of measurement systems utilized during the field program. The locations of the measurement systems are also described.

The second volume contains the data in tabular form or cites the special supplemental reports by other participating contractors. This volume describes the quality and accuracy of these data as well. The primary user file and the data archive are maintained on 9 track/1600 cpi magnetic tapes, but listings of the individual values are provided for the user who either cannot utilize the tapes or wishes to preview the data.

Volume III describes nine intensive measurement days. Some of the items discussed are the analyses of gaseous tracer data, the general meteorological conditions and the overview of test day cases. Also included are calculations using the ARLFRD MESODIF model. The calculations are related to the gaseous tracer. At the conclusion of this volume the test results are summarized and recommendations are made.

II. Idaho Setting

The climate of the Idaho test site is influenced by its altitude above sea level (about 5000 feet) as well as its topographic setting. The setting for the field experiment is a large rolling plain surrounded by mountains except to the southwest. Three large canyons break the mountain barrier on the western side. These topographic features are shown in Figure 1.

Since air masses entering the area lose most of their moisture while crossing the mountain barrier, the region has semi-desert characteristics. The orientation of the plain and its mountain range boundaries tend to channel the westerly winds into predominately southwesterly winds; the second most common wind is that from the northeast. In the absence of significant pressure gradients this cycle occurs almost daily; the northeasterly winds occur during the late night and early morning hours and shift to southwesterly directions by early afternoon. The late morning and evening transition periods result in complex flow patterns over the plain. Up- and down-canyon winds entering and leaving the valley result in local flow modifications; some of these local flows influence convective storm activity on the plain.

Wind roses for CFA and TAN are presented in Figure 2 for inversion and lapse conditions. The predominate southwest and northeast flows are evident at both sites. The average wind speed at 20 feet is approximately 8 mph.

Vertical wind structure is illustrated by the PIBAL wind roses shown in Figure 3. The summer PIBAL soundings were released around 8 am and typically represent conditions shortly after the surface based inversion has dissipated. An examination of Figure 3 shows the drainage flow has an average vertical extent of approximately 2000 ft above ground-level. As daytime heating continues, the drainage flow decreases and generally dissipates by late morning. Figures 4 to 6 show a typical diurnal sequence of winds. Figure 4 illustrates the night-time drainage flow; Figure 5 shows the morning transition, and Figure 6 depicts the afternoon up-valley flow. The arrows indicate wind direction, and the length of the barbs is proportional to the wind speed: a full flag represents 10 mph and a half flag shows 5 mph. The plus sign marks the wind observation point. Air motion flows from the flag to the plus sign.

The air is very dry during July (average relative humidity is 30%). Infrequent occurrence of clouds permits intense solar heating during the day and rapid radiational cooling at night. Therefore, large diurnal temperature variations occur in the lowest portion of the atmosphere. At CFA the July average maximum temperature is 87.3, the average minimum is 49.7, and the daily variation is 37.6 degrees F. Daily temperature changes of 50 degrees can occur. Approximately half of the days in July will have a maximum temperature over 90^{o}F. Some average daily July temperatures for other locations on the plain are: Aberdeen 70.2^{o}F, Dubois 69.4^{o}F, Fort Hall 70.6^{o}F, Idaho Falls 69.2^{o}F, Pocatello 72.4^{o}F, and TAN 68.7^{o}F (Rice, 1974) (Yanskey et al, 1966).

Temperature profile data for the CFA area show that, on the average, temperature inversions in the lowest 250' of the atmosphere are established 20 minutes before sunset each night and dissipate 84 minutes after sunrise. The average duration of these inversions is ten hours and forty two minutes. Johnson and Dickson (1962) analyzed eight years of records from CFA. For the summer months of June through August they found temperature lapse conditions occur approximately 56% of all hours; inversion conditions occur 40% of all hours and neutral conditions occur 4% of all hours. Only one night without an inversion condition is likely during July.

Solar radiation averages 2369 BTU/ft^2 on a horizontal surface during July; approximately 85% of the available sunshine is received. The sky will be clear or have only scattered clouds during more than half the days of the month.

Precipitation shows a great spacial variability for the month of July. No measuring site in the valley averages over .75 inches of rain. The precipitation usually occurs from showers or thunderstorms on two or three days during the month. Some comparative average July precipitation amounts (in inches) from around the plain are: Aberdeen .31, Blackfoot .40, CFA .34, Dubois .67, Fort Hall .42, Idaho Falls .46, Pocatello .51 (Rice, 1974, Yanskey et al, 1966). With warm high temperatures and low humidities, precipitation often evaporates before reaching the ground. For the fourteen year period of 1950-1963 only 15 cases with two sucessive days of precipitation have occurred (Yanskey,ibid). The average pressure for July is 849.7 millibars (Yanskey, ibid).

Most of the southern and western portions of the field study setting are lands covered with sage brush and bunch grasses. Lava rock is often exposed on the ground surface. The largest population centers are along the Snake River side of the valley, i.e. along the eastern edge of the plain. Farming is the major industry of the area. Extensive farm areas are irrigated over the northern and eastern sections of the plain, especially along the Snake River.

III. Field Study Design

A comprehensive and intensive 15 day field study program was conducted over the Idaho Snake River Plain. Detailed measurements of the meteorology, atmospheric transport, and diffusion were collected in an area surrounding the tracer release point within a 50 mile radius. The field study was accomplished during July 1981. The design of the field measurement program included a number of considerations. These considerations were:

(1) the types of information necessary,
(2) the assessments of various measurement platform capabilities, accuracies, and reliabilities,
(3) the determination of the suitability and acceptability of various measurement methodologies within the study site setting,
(4) the availability of those measurement systems during the conduct of the field program,
(5) the costs associated with each type of system, and
(6) the organization and direction of the measurement program.

Several fundamental types of information were collected. These information types are listed in Table 1. This information may be used for a stepwise diagnostic exercising of coupled transport and diffusion models. Five plausible scenarios for data usage are provided in Table 2. In scenario 1 the least amount of meteorological information is utilized to drive the models; most data are retained for model performance assessment. By scenario 5 all possible data are designated to drive the models; only observed tracer concentrations are used for model evaluation. An overall comparison of calculated versus observed concentrations may be determined. Additional diagnostic evaluations may be performed during various scenarios to identify weaknesses and strengths of the models in determining the spatial and temporal behaviors of the tracer concentrations.

Table 1. Types of information collected.

a. Tower profiles of wind and temperature, and their fluctuation statistics at or near the release point site.

b. Winds and temperatures aloft at several locations throughout the study area.

c. Depth of the turbulent mixed layer.

d. Trajectories of Lagrangian markers at plume height.

e. Observed diffusion of airborne markers to document "rate-of-diffusion".

f. Rates of controlled releases of inert, gaseous tracer.

g. Time-integrated concentrations of gaseous tracer at an array of ground-level receptor locations throughout the study area.

h. Pseudo real-time concentrations of gaseous tracer at selected times and locations (mostly aerial samples).

Table 2. Example use of field measurement data for stepwise diagnostic exercising of dispersion models.

SCENARIO	MODEL INPUT DATA	CHECK DATA
1	a. Source description b. Site meteorological tower measurements	a. Observed tracer concentration b. Observed rate-of-diffusion c. Observed trajectories.
2	c. Scenario 1 data plus vertical sounding at site	Same as above
3	d. Scenario 2 data plus array of soundings	Same as above
4	e. Scenario 3 data plus observed trajectories	a. Observed concentration b. Observed rate-of-diffusion
5	f. Scenario 4 plus rate-of-diffusion information	a. Observed concentration.

IV. Organization and Participants

The scope and complexity of the field measurement activities suggested that a relatively formal organizational structure be utilized. This organization was comprised of functional units depicted in Figure 7. Several organizations participated in the field measurement program, but the coordination and application of all systems were organized by Mr. C. Ray Dickson, program director. Most administrative assistance, quality control and assurance, data archiving, and communications, coordination between groups, and operations logistics were handled through special assistants who were on the director's project staff.

The responsibilities of participating organizations in the Idaho Field Experiment are shown in Table 3. Analysis denotes the conversion of measurements to calibrated engineering units from whatever intermediate form may have existed at the time of data collection. This report is meant to be a meaningful description of the engineering unit data, the method of measurement and calibration, and any description of the location and/or platform which is needed to understand and properly utilize the information. The data were archived onto magnetic tape media for use in model evaluations. Generally, those organizations which performed the raw data analyses, reported and submitted the data for archiving were also to be the organization to conduct the follow-on comprehensive scientific study of the data.

Table 3. Organization responsibilities for the field experiment.

ACTIVITY	DESIGN	CONDUCT	ANALYSIS	REPORT	ARCHIVE
Diffusion					
SF_6 release	ARL	ARL	ARL	ARL	ARL
SF_6 grid sampling	ARL	ARL	ARL	ARL	ARL
Aerial samping[1]	SRI (ARL)	PNL(SRI)	ARL	SRI(ARL)	ARL(SRI)
Oil fog release	ARL (SRI)	ARL	ARL	ARL	ARL
Oil fog LIDAR data	SRI (ARL)	SRI	SRI	SRI	SRI
Oil fog photography[1]	ATDL(ARL)	ATDL	ATDL	ATDL	ATDL
Meteorology					
Release site					
Tower Profiles	ARL (PNL)	PNL	ARL	ARL	ARL
RAWINSONDES	ARL (PNL)	PNL	PNL	PNL	PNL
Tetroons	ARL	ARL	ARL	ARL	ARL
Winds aloft	ARL (PNL)	PNL (ARL)	PNL (ARL)	ARL	ARL
Monostatic sounder	PNL (ARL)	PNL	PNL	PNL	PNL
SE. Idaho Mesonet	ARL	ARL	ARL	ARL	ARL

( ) denotes a shared role in the activity
ARL- Air Resources Laboratory, Field Research Division, Idaho Falls
SRI- SRI International, Menlo Park
PNL- Pacific Northwest Lab., Richland
ATDL- Atmospheric Turbulence and Diffusion Lab., Oak Ridge
1- Joint use data collected primarily for the parallel study of vertical diffusion.

V. Intensive Measurement Program

The Idaho Field Experiment was conducted over the Upper Snake River plain within the area shown in Figure 8. This study area was 48 km wide by 72 km long or 3456 square km. The release point was located near the center of the study area. Continuous, steady 8 hour releases of sulfurhexafluoride tracer (SF_6) were made every other day from the 46m level on the 61m Grid III tower. The field measurement program was an intensive, nearly-continuous process which began July 15 and lasted through July 30. Gaseous, inert tracer was released beginning on July 15.

Nearly 215 ground-level samplers were located within the area using 1 to 6 km spacing. The placement of samplers has been depicted in Figure 9 and 9-A. Two nested sampling grids were utilized. One grid, a sub-area of the full sampling area, was centered on the Grid III tower and was within an area 24 km square. Samplers within this sub-area were part of a grid with "fine-resolution". This array had a 1 km grid length. Within the initial

4 km distance outward from the Grid III tower, samplers were placed at 1 km spacing. For distances of 4 to 8 km the sampler spacing was 2 km and for 8 to 12 km the sampler spacing was 4 km. There were 112 samplers in this fine mesh and each collected 12 sequential 1-hour integrated whole air samples. Sampling began at the onset of tracer release and ended 12 hours later.

The second larger grid was 48 by 72 km in size and was also centered on the source point. The grid length for this sampling array was 6 km. About 100 of these 117 possible sampling locations were used; the remaining, unused sites were discarded due to their inaccessibility on high mountain slopes, very rugged lava fields, etc. The samplers at these sites collected long time total-integrated whole air samples and comprise the "outer grid".

The survey of sampler positions was a very lengthy process and involved many people. Some extremely remote locations within lava bed settings could not be utilized, such as the area in and around the Craters of the Moon National Monument (the southwest corner of the study area in Figure 8). The actual sampling positions were located by a radar tracked transponder moved to each site.

In addition to ground-level sampling, aerial sampling of pseudo-instantaneous concentrations was incorporated, using a syringe grab-sampling system in a Cessna 411 aircraft. This aircraft was furnished through PNL and ORNL. Tracer analysis was performed using the gas chromatography technology of ARLFRD. With the large number of ground-level and aerial samples, sample analyses, and the time needed for sampler servicing, approximately 40 personnel were required for gaseous tracer activities.

These SF_6 concentrations were the primary evaluation data to be calculated by the various dispersion models. The nearly instantaneous airborne concentrations and a limited number of one-hour ground-level integrated concentrations were collected for the vertical diffusion phase of the study. The aerial LIDAR samples were collected by SRI to compliment the SF_6 tracer data. More information about these samples and the vertical diffusion study will be presented in section VI.

A pair of Lagrangian markers (tetroons) were released every 2 hours and tracked throughout the study area to provide a direct indication of sequential trajectories. One tetroon was inflated to float at an altitude near the height of tracer release. The second tetroon floated at a greater height (300 to 500m above ground-level) and marked the airflow at that greater elevation in the planetary boundary layer (PBL). Tetroon tracking was conducted using a modified M-33 radar which was located on "Radar Hill", about 16 km southeast of the release point. The radar height was 5295 feet above mean sea level (the base of the Grid III tower is at 4910 feet MSL). The use of this diagnostic information may illustrate why the spatial and/or temporal behaviors of airborne material was or was not well described by a given dispersion model and observed winds. The degree of improvement in describing these behaviors may be examined by providing successively more of the supplementary meteorological data and recalculating the modeled trajectories and time integrated concentrations.

The proper identification of the effective atmospheric rate-of-diffusion was recognized as an important factor within the diagnostic exercising of atmospheric dispersion models. These rates could be estimated from the simple methodologies in common practice. There would be considerable uncertainty, however, with the use of the simple methods. It was highly desirable to remove these possible uncertainties and errors in specification of rates-of-diffusion during some aspects of model exercisings. To address this area of uncertainty releases of oil fog of 8 hour duration were made. LIDAR observations and high altitude photography of those plumes were performed to document the atmospheric rate-of-diffusion, the plume dimensions, and the effective stability category. The Alpha I airborne LIDAR system collected this data through numerous cross plume observations at several downwind distances. Additional details of the LIDAR observations and plume photography are to be reported by SRI and ATDL, respectively.

Profiles of wind and temperature aloft, wind and temperature from sensors mounted on towers throughout the study area, and special turbulence measurements at the release point were measured to provide a basis for reconstruction of the three-dimensional wind and temperature fields during the experiment.

Data from the existing MESONET of tower mounted wind and temperature sensors were archived; the tower locations within and adjoining the study area are shown in Figure 10. Meteorological profiles were specified in part by data collections at the five existing 200 to 250-foot meteorological towers at the INEL. Some profiles of temperature, wind speed, and direction were available from those towers. More specific descriptions of these measurement systems are provided in Volume II as a part of the data descriptions.

Sensors on the release tower were mounted at the several heights described in Table 4. Wind and temperature fluctuation statistics were available using special sensors mounted on the Grid III release tower. Each sensor designed for fluctuation information was sampled 2 times per second. Appropriate sensors for fluctuation measurements were obtained through a loan of sensors from another NOAA-ARL organization. The placement of sensors on the Grid III tower is depicted in Figure 11.

RAWINSONDE observations were taken every three hours near Grid III. PNL conducted half-hourly single theodolite PIBAL wind soundings at two locations; each three hours airsondes were conducted at these same sites during the initial 24 hours of each test case. Every half hour RABALS were made at the three radar sites shown in Figure 12. Estimates of the depth of the mixed layer may be based upon RAWINSONDE and acoustic sounder data. The monostatic acoustic sounder was operated by PNL near the Grid III tracer release point.

Radio communications were available for ground-level platforms and for operations coordination. ARL H-net radios were used. The existing radio repeater was located on East Butte to the southeast of the study area. An aircraft radio frequency was also used. Other communications included local telephone service and one or more FTS telephones.

Table 4. Meteorological sensors and heights of measurements at Grid III.

	Height (m)					
Measurement	2	4	10	32	48	61
Temperature	x	x	x	x	-	x
Wind Speed	x	-	x	x	x	x
Wind Direction	x	-	x	x	x	x
Dewpoint	-	-	x	-	-	-
Bivane Angles	-	-	x	-	x	-
u, v, w speeds	-	-	x	-	x	-
Temp. fluctuations	-	-	x	-	x	-

The two-day experimental cycle of activities is depicted in Figure 13. Gaseous tracer, SF_6, was released continuously during the first 8 hours along with oil fog. The tracer releases were scheduled to begin at various daily times to allow measurements at different times within the diurnal cycle. LIDAR plume observations and aerial bag sampling of SF_6 were performed during the tracer release. Two three-hour sampling periods were used by the aircraft systems within an 8 to 10 hour time window shortly after the beginning of tracer releasing. Aerial photography of the oil fog plume was conducted by the Idaho Air National Guard at times which usually corresponded with the LIDAR and aerial SF_6 samplings.

MESONET tower wind data were collected throughout the entire cycle. Meteorological profiles and turbulence data at the release tower were collected during most of the 24 hours following the initiation of tracer release. RABAL and PIBAL observations were made throughout the first 24 hours. Launches of tetroon pairs at 2-hour intervals were performed during the tracer release.

Gas laboratory analysis of SF_6 air samples, sample bag preparations, and sampler servicing were full time activities. Samplers were checked or serviced every day.

VI. Other Concurrent Studies

A joint study of vertical diffusion phenomena was interwoven with the Idaho Field Experiment. The vertical diffusion series was under the direction of SRI with participation by SRI, Battelle-PNL, and NOAA/ARL. The supporting meteorological information was the same data collected for the model evaluation data set.

The measurements, to be used specifically for vertical tracer diffusion determinations, included: 1) a part of the 1-hour time-integrated SF_6 concentration sampling at ground-level, 2) ALPHA-1 (Uthe, et al, 1980) airborne LIDAR mapping of vertical/crosswind sections of the oil fog plume, and 3) direct aerial sampling of SF_6 by a SRI syringe system in the Cessna 411 aircraft. This aircraft was in radio contact with the LIDAR aircraft.

It was vectored by SRI to fly the same ground track as the LIDAR aircraft to obtain coordinated plume tracer samples during the same periods as the ALPHA-1 observations. The paired observations of SF_6 and LIDAR data were to be compared by SRI to relate absolute backscatter intensities to absolute SF_6 concentrations. SRI provided a radio navigation system for assistance in positioning and vectoring the SF_6 sampling aircraft. The Cessna 411 had an on-board radio navigation system and a radar altimeter to document the sampling tracks. Sampled plume cross-sections were obtained at several downwind locations. The intended general procedure is shown in Figure 14. A single altitude was generally utilized by the SF_6 aircraft, instead of multiple heights as shown. The actual distances downwind were selected and adjusted by SRI during the period of the test.

Plume photography from a reconnaissance aircraft was arranged by the Atmospheric Turbulence and Diffusion Laboratory. High altitude photographic flights of opportunity by the Idaho ANG were utilized. The cooperation by the Idaho Air National Guard (Boise) was excellent.

VII. Real-time Model Exercising.

A number of organizations possess computerized emergency response capabilities for local support in the event of an airborne discharge of radioactive effluents. Although it was not the primary purpose of the experiment, an exercising of some of these capabilities was desired during a portion of the Idaho Field Experiment. The ARAC system was requested by NRC to provide a near real-time assessment of a part of one or two intervals within the intensive measurement period. It was also desirable to exercise the ARL capability. The ARL capability was utilized during the field experiment to the limited extent that was feasible without jeopardizing the conduct of the field program. A senior scientist from Aeronautical Research Associates of Princeton, Inc., was stationed in Idaho Falls to implement these calculations. However, the scope, extent, and results of those responses are not a part of this study.

VIII. Data Documentation and Archiving.

Data have been submitted to ARL, Idaho Falls, for inclusion in the information archive of the Idaho Field Experiment. Volume II reports these data. Archived information includes a narrative description of the data type, format, calibration method(s), and the measurement system (and platform) used, along with details of mounting, exposure, etc. as appropriate. The name and affiliation of the principal investigator or person to contact with questions may be obtained from the sponsors or from the Air Resources Laboratory, Field Research Division.

In general, blocked data on 9-track magnetic tapes are the primary archive. Specific formats were coordinated with ARL. Date, time, and location information were specified to be the conventions shown in Table 5.

Table 5. Conventions of Units for Time, Date, and Location.

DATA	NOTATION	
Time (24 hour clock, Mountain Daylight Time, with WWV reference)	HHMMSS	HH = Whole hours MM = Whole minutes SS = Whole seconds
Date	MMDDYY	MM = Month, 07 =July, DD = Day of month, YY = 81 for 1981
Location		
LAT.	XXX.XXXX	Decimal degrees to the
LONG.	YYY.YYYY	nearest 0.0001.

Note: 1 second equals 0.00028 degree latitude or 88 feet.

The data set resulting from this program is very large. With time-integrated tracer concentrations collected every hour during the 12 hours of each test day period, up to 108 separate fields of sampled concentrations are available for diagnostic comparisons. Similar sized sets of winds aloft, source area meteorological data, and Lagrangian trajectories were collected. Turbulence data from the site meteorological tower resulted in a large block of archived data. RAWINSONDES and real-time tracer concentrations were relatively smaller data files. LIDAR data sets for determining rate-of-diffusion and plume vertical diffusion were very large. Additional extensive processing was required for tower turbulence data, LIDAR determinations of diffusion, and aerial real-time tracer sampling. Ground-level SF_6 concentrations involved substantial data screening and sorting.

Quality assurance and system calibrations were required. ARL Idaho Falls was responsible for absolute calibrations of analysed SF_6 tracer concentrations and tracer release amounts. SRI was responsible for calibration and quality of data from the ALPHA-1 system. ARL initiated routine quality assurance maintainance and calibrations on the sensors of the MESONET. Meteorological sensors for profiles and turbulence measurements on the tracer release tower were calibrated before the intensive measurement program. A limited computerized screening of meteorological data was performed by ARL during the experiment to identify possible data abnormalities.

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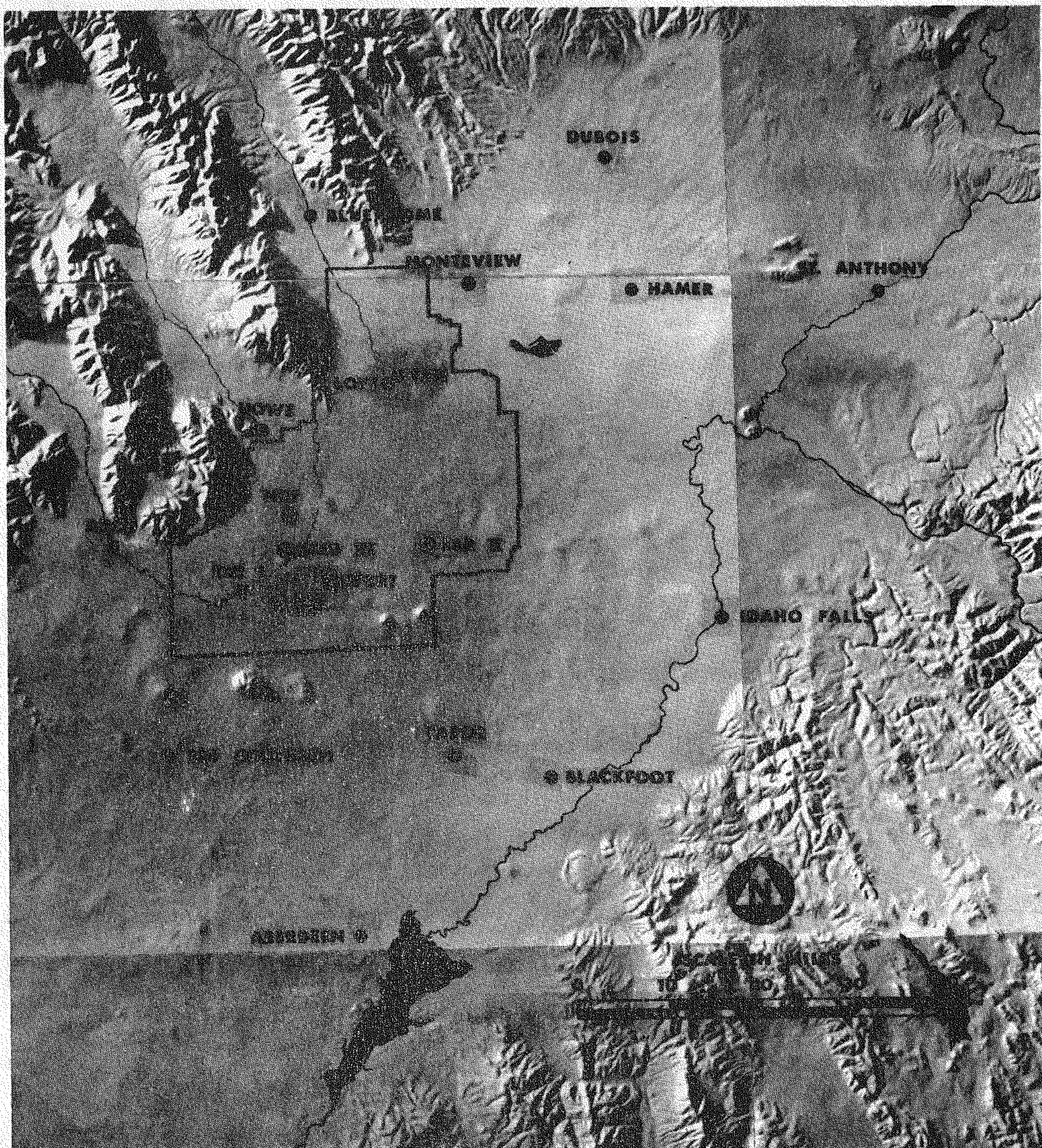


Fig. 1 Relief map of the Upper Snake River Plain and the mountains of southeastern Idaho.

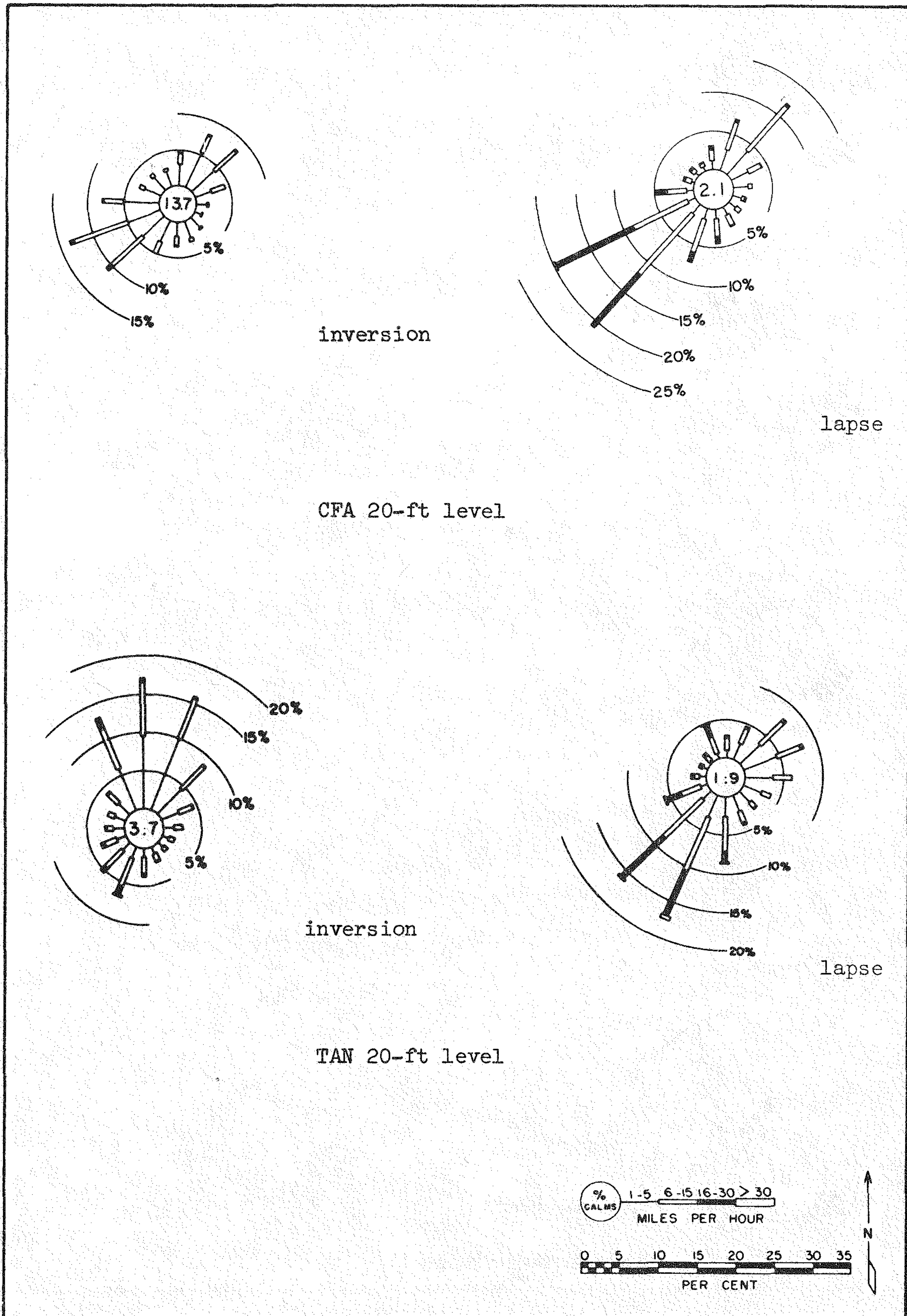


Fig. 2 Summer wind roses for CFA and TAN for measurements at 20 feet above ground (Yanskey et al., 1966).

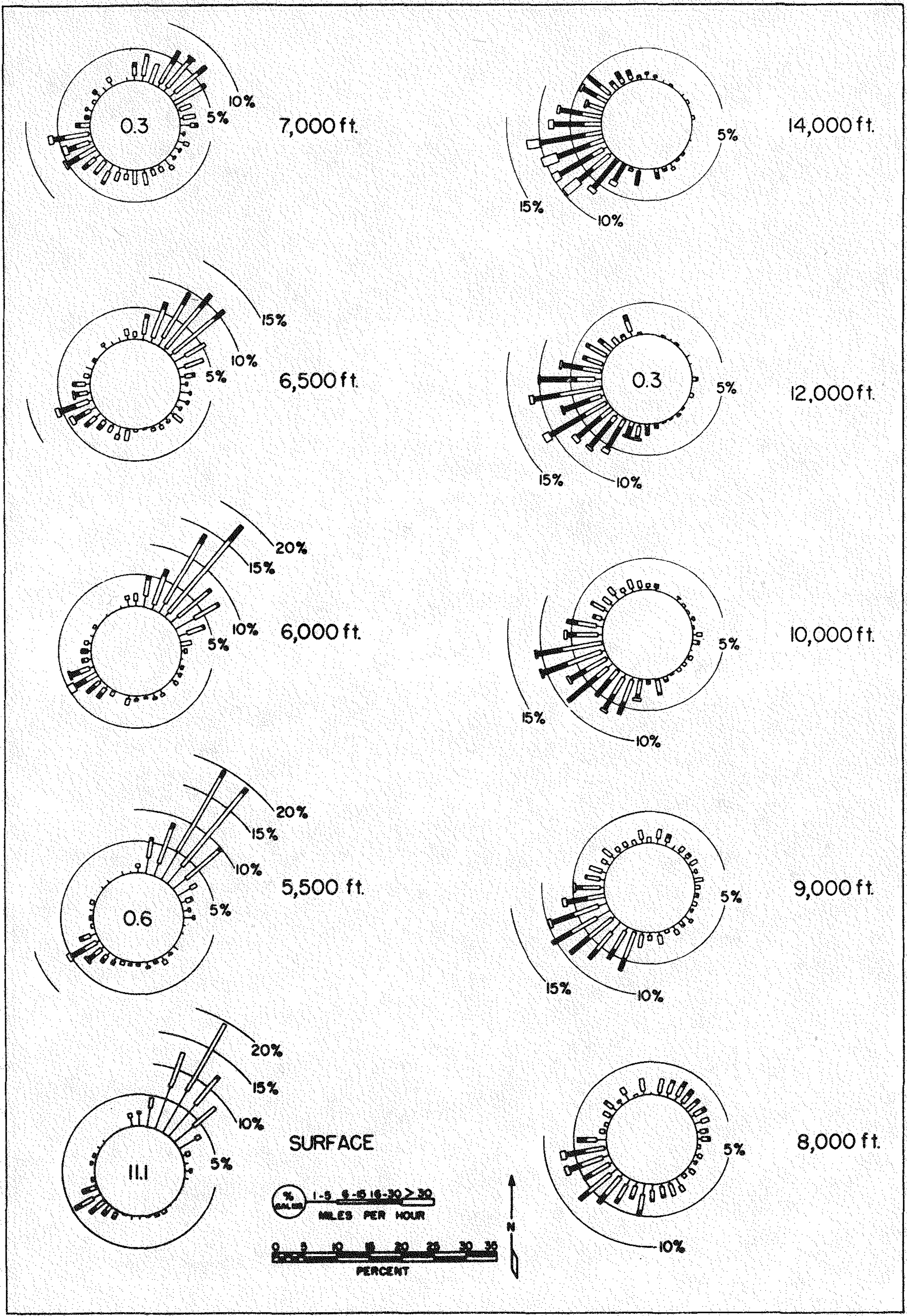


Fig. 3 Summer PIBAL wind roses for surface (4935 feet MSL) and various heights above mean sea level (Yanskey et al., 1966).

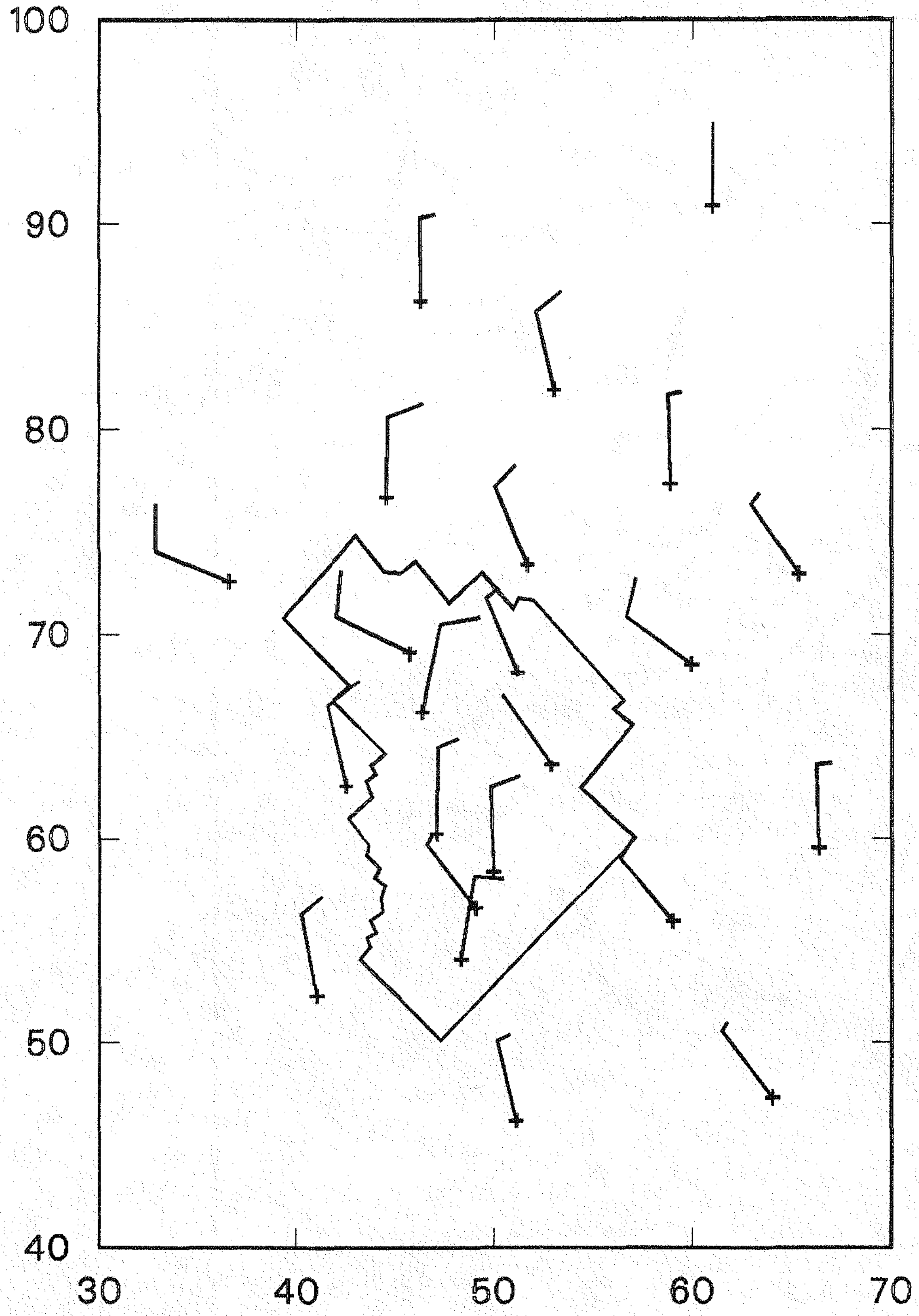


Fig. 4 Early morning down-valley wind flow. Northeast is toward the top of the figure. + denotes the observation point. A full flag is 10 mph; a half flag is 5 mph. Airflow is indicated along the wind arrow toward the + symbol.

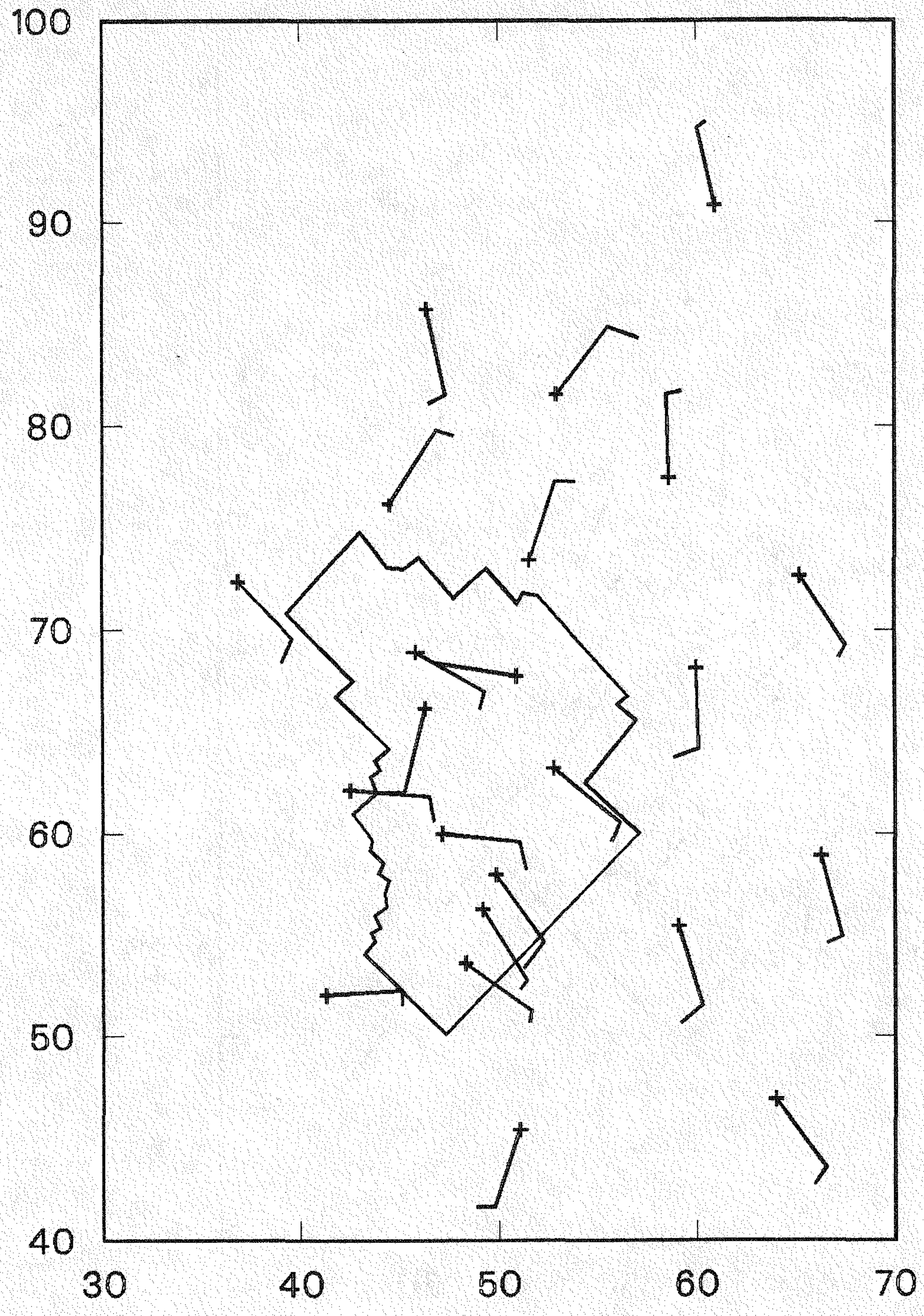


Fig. 5 Same as figure 4 except for late morning when the down-valley winds have mostly dissipated.

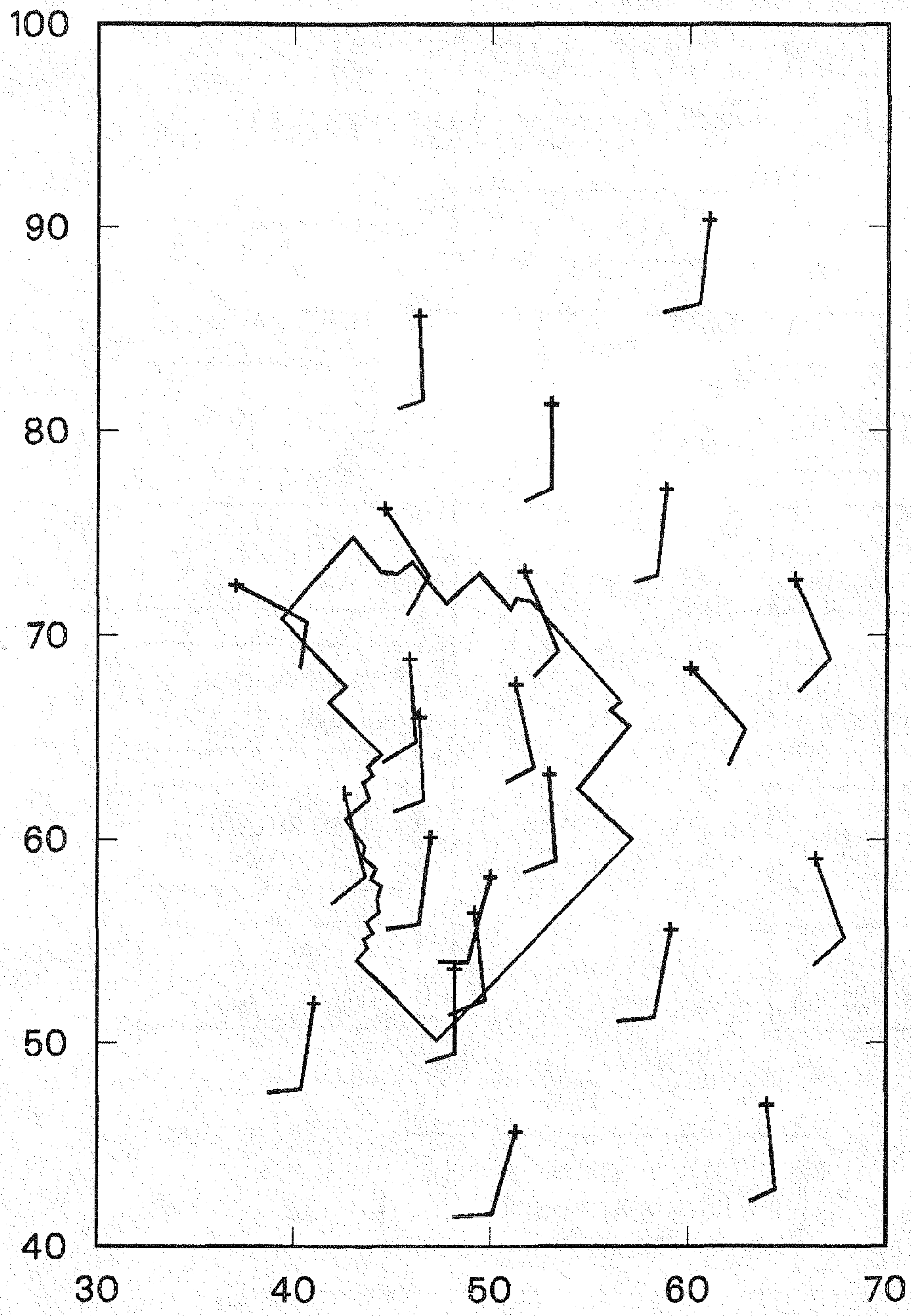


Fig. 6 Same as figure 4 except for afternoon when the up-valley winds have become established.

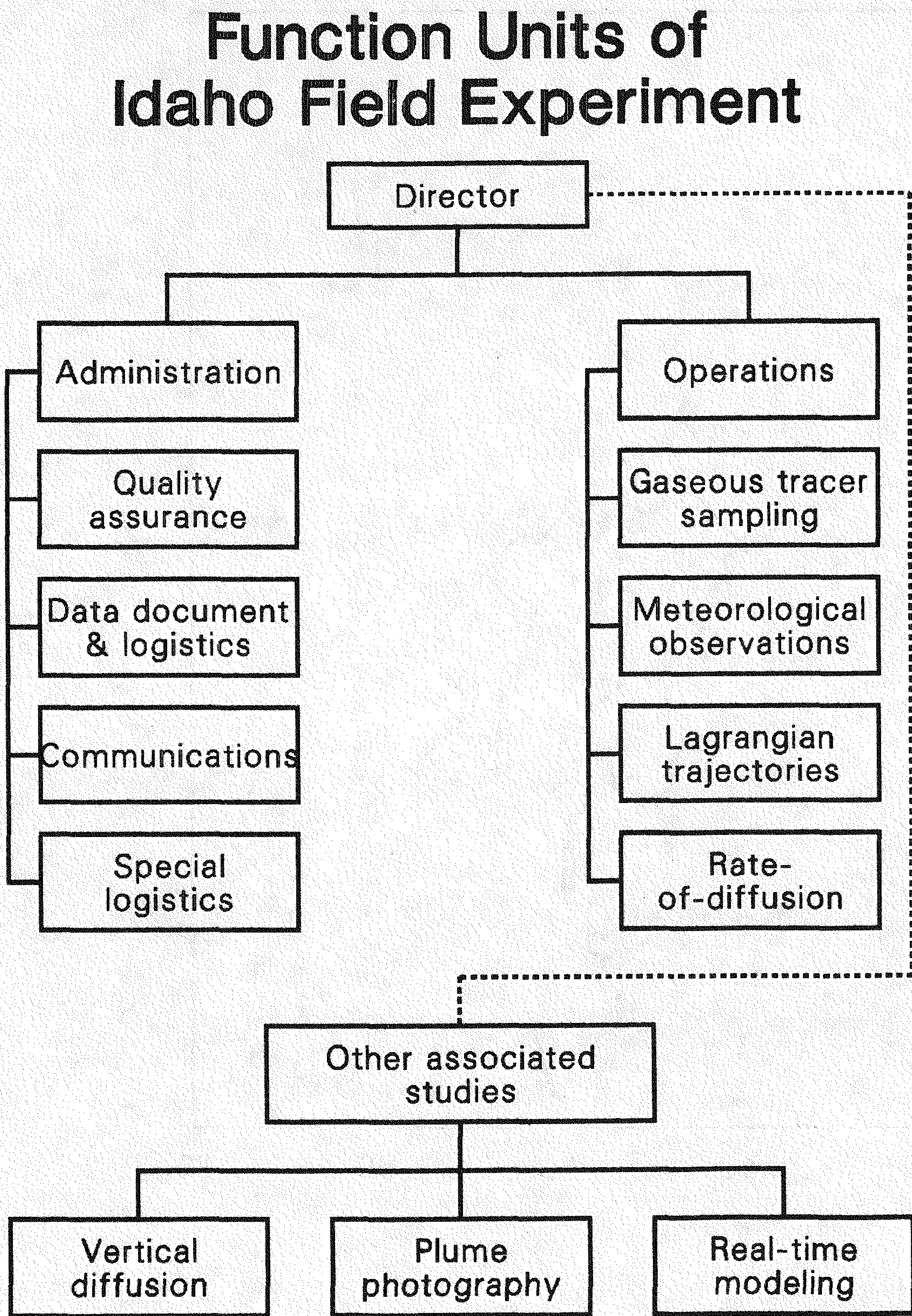


Fig. 7 Functional activities which comprise the organization for the field measurement program.

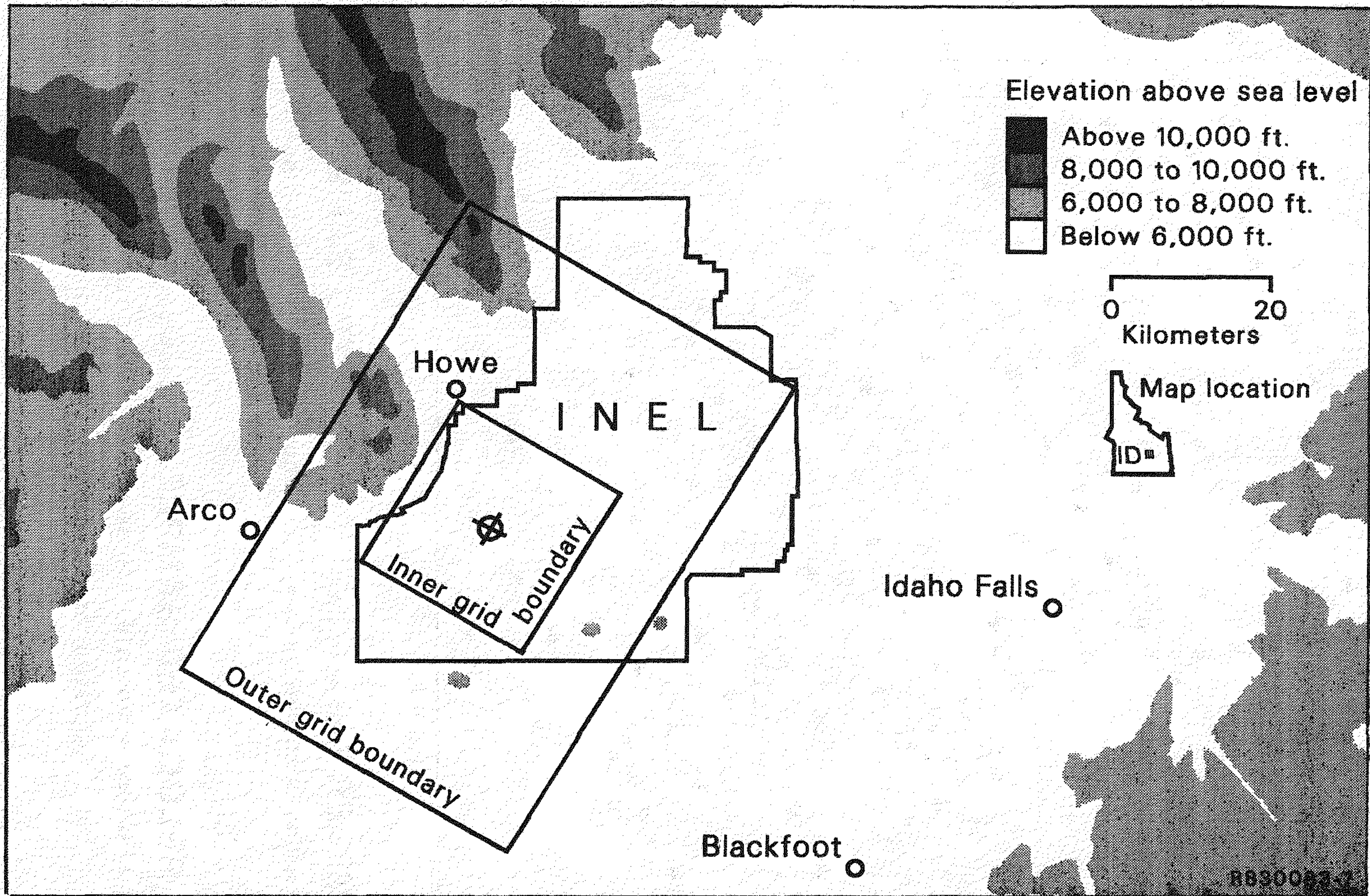
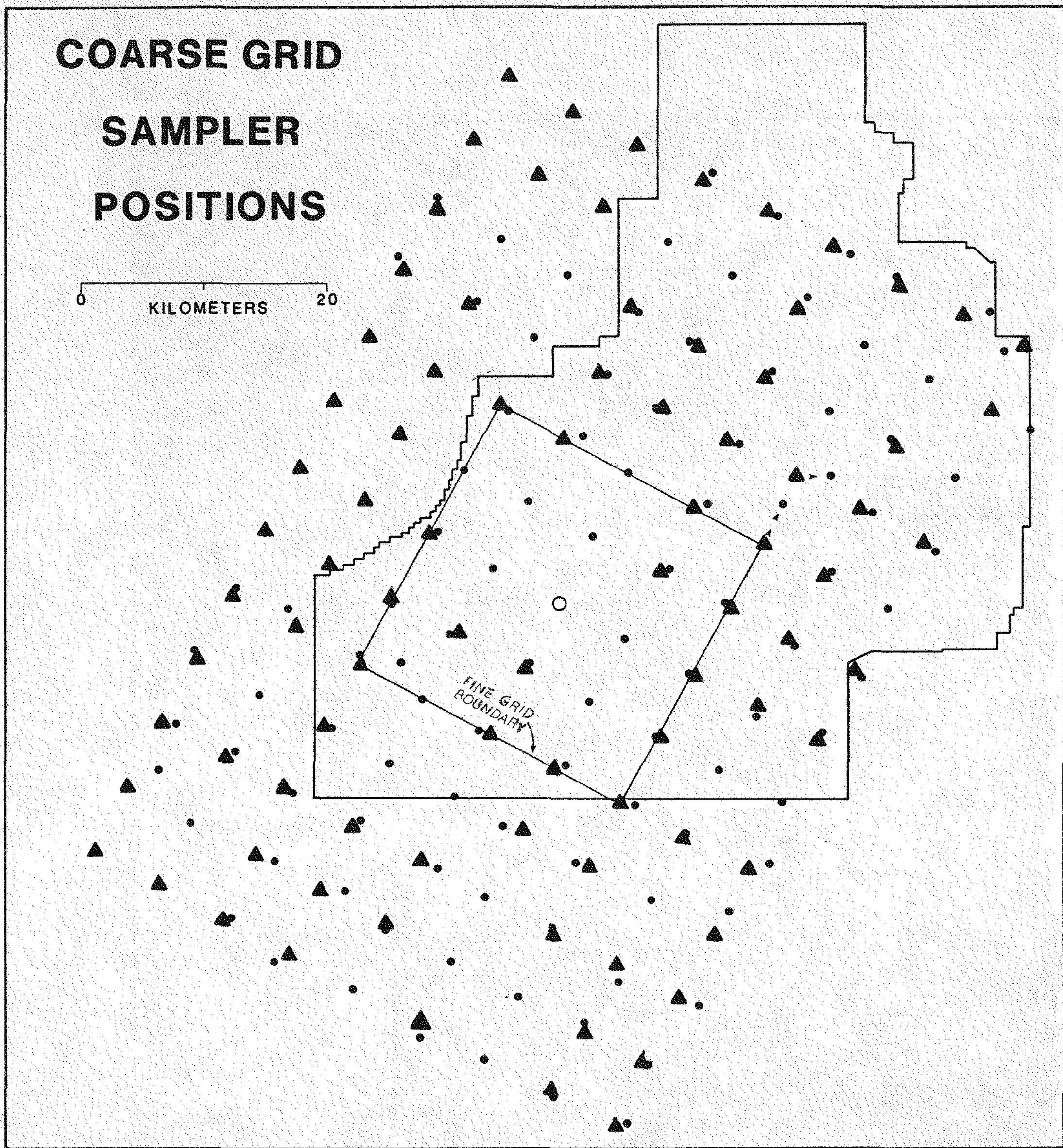


Fig. 8 Location of the measurement area in southeastern Idaho is within the largest rectangle. The source point is shown by ⊕. The area is 48 km wide by 72 km long.



A **SAMPLER** that is in its ideal position is shown by a •

A **DELETED SAMPLER** is shown by a ▲ without a nearby •

A **RELOCATED SAMPLER** is shown by either ▲–• or ▲• where ▲ indicates the sampler's ideal position and • indicates the sampler's final position.

Fig. 9 The outer grid for about 30 hour time-integrated sampling is shown with the outline of the inner grid and the boundaries of the INEL. The release site is at the Grid III tower.

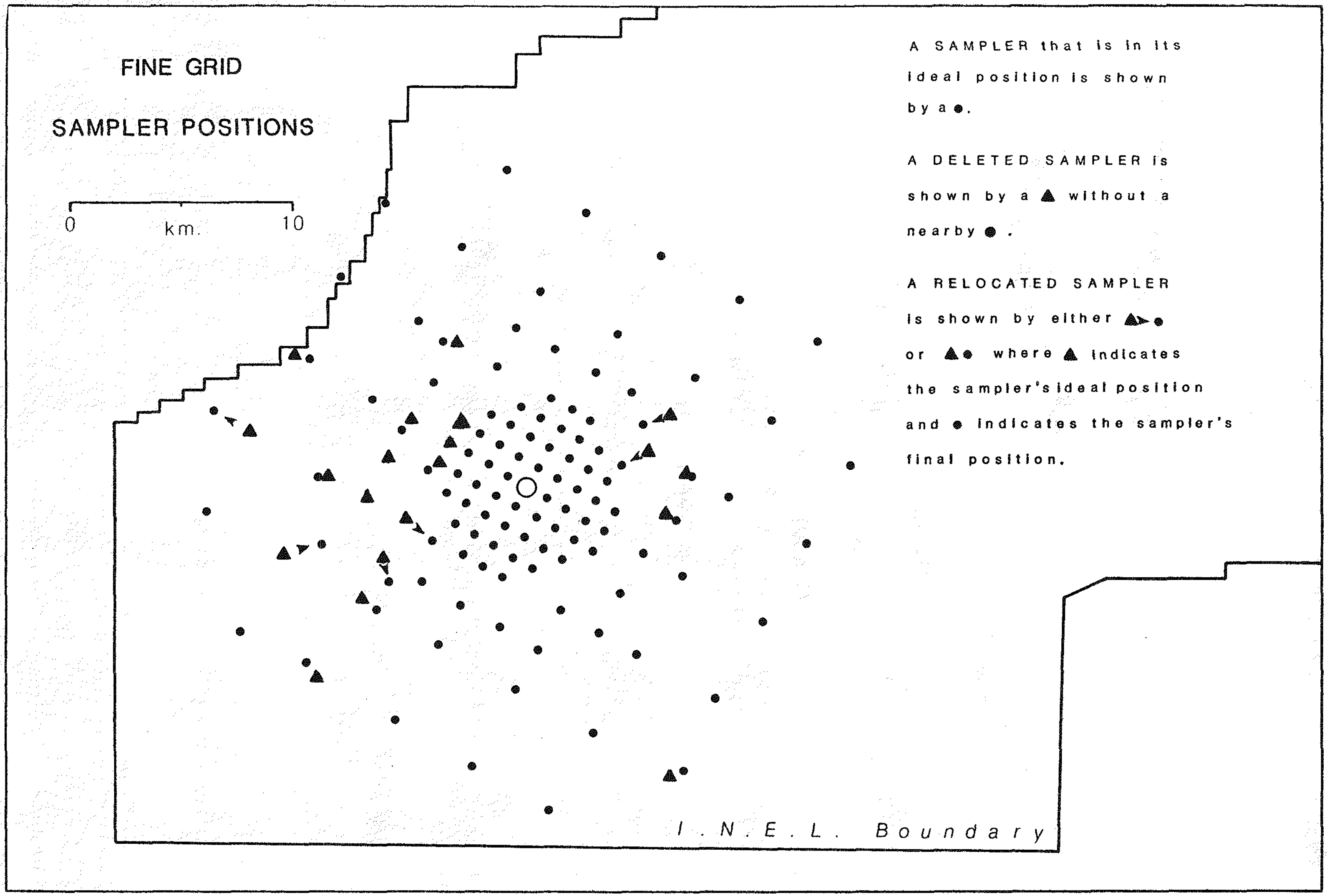


Fig. 9-A Locations for 1-hour time-integrated air samplers on the fine or inner grid are shown by dots. 112 locations will be used.

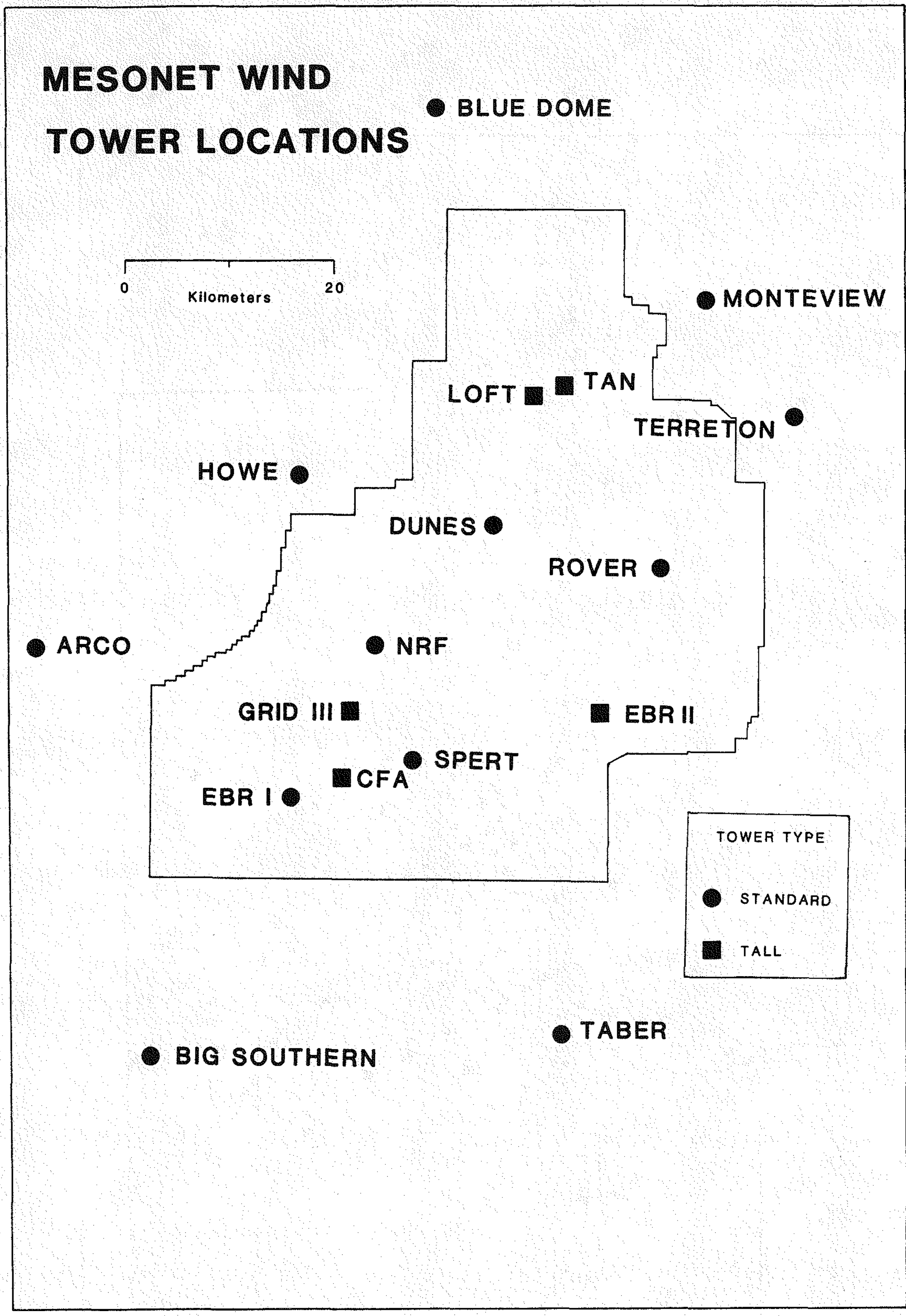


Fig. 10 Existing MESONET locations of towers for wind measurements are shown. Tall towers are at TAN, LOFT, GRID III, CFA, and EBR-II.

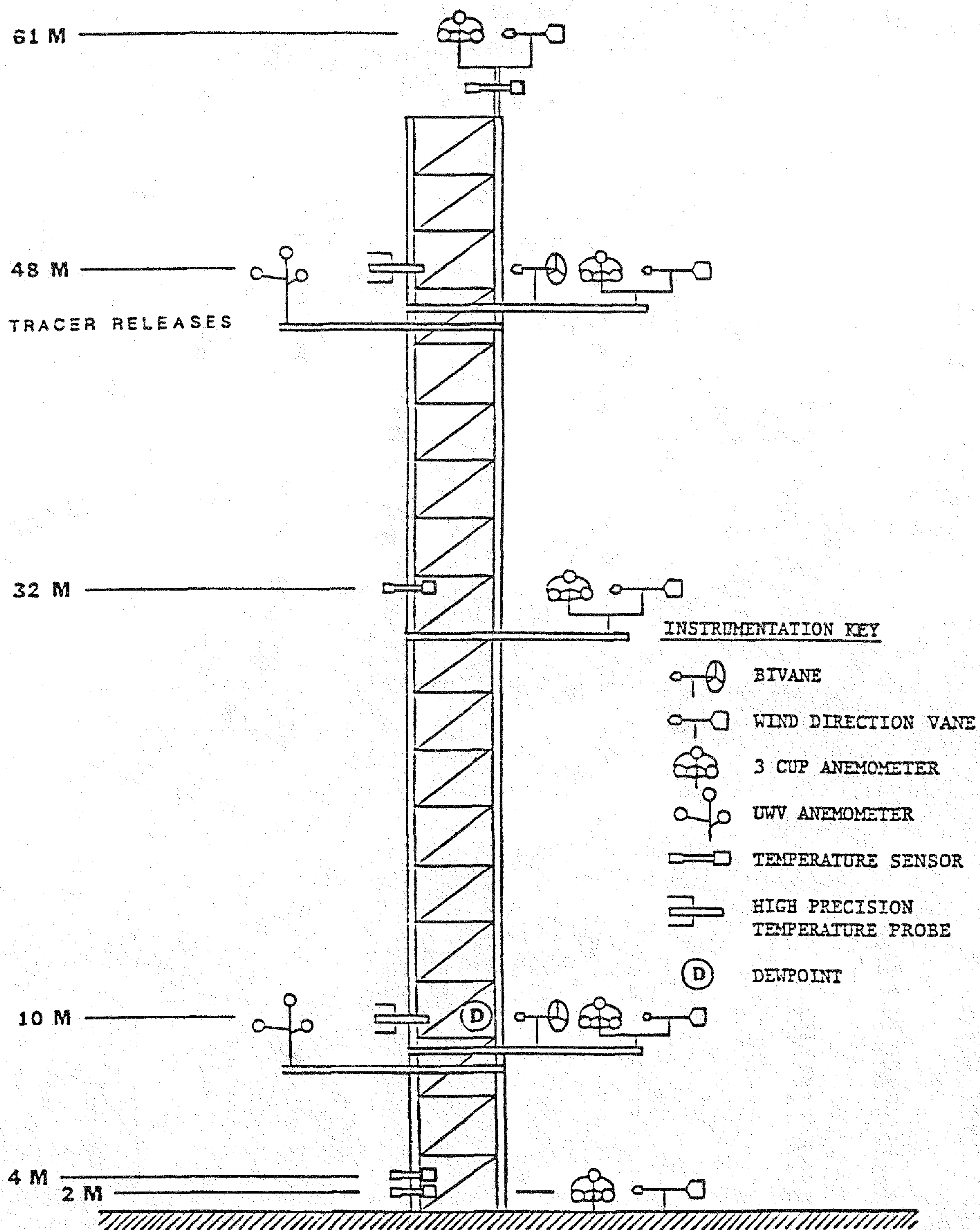


Fig. 11 Meteorological sensors are schematically shown as positioned on the Grid III tower.

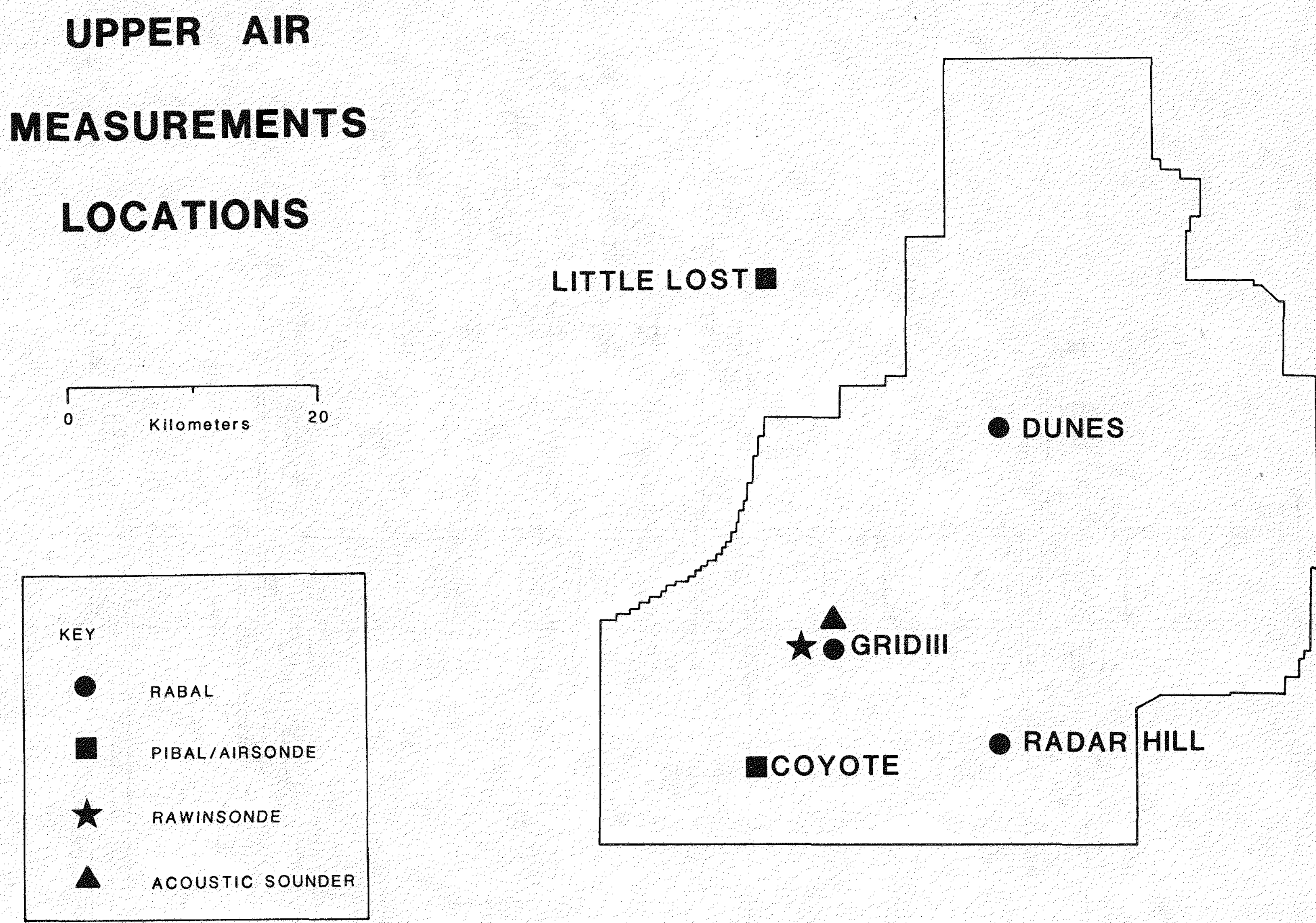


Fig. 12 Locations for winds aloft and soundings are shown. Three sites for RABALS were used. RAWINSONDES were made near GRID III. A monostatic acoustic sounder was operated by the tracer source point. AIRSONDES and PIBALS will be collected near Little Lost, Howe, and Coyote Diversion Dam.

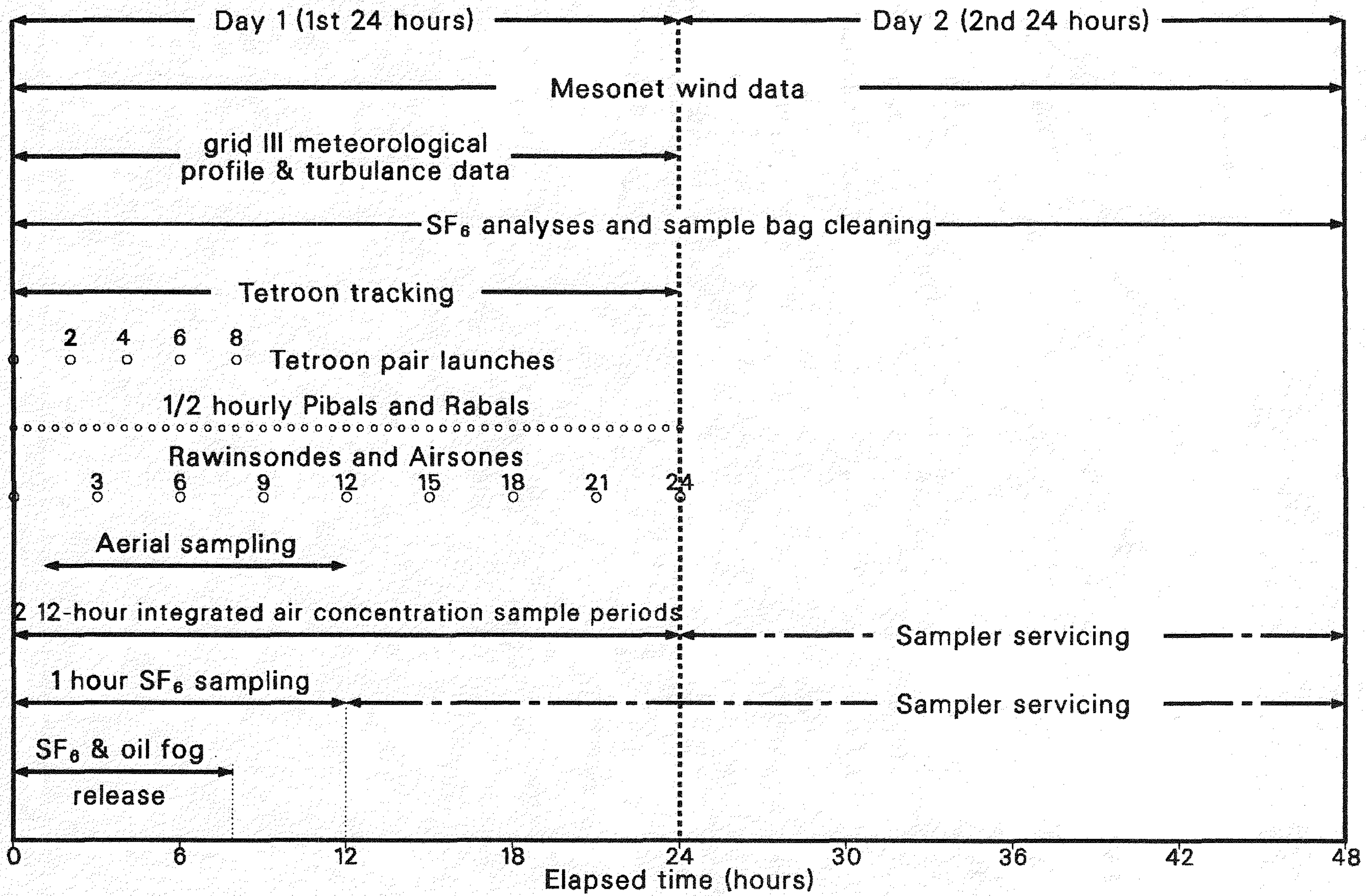


Fig. 13 The two-day cycle of tracer releasing, sampling, observations, and analysis activities are shown. Each two-day period has a repeat of the sequence of activities.

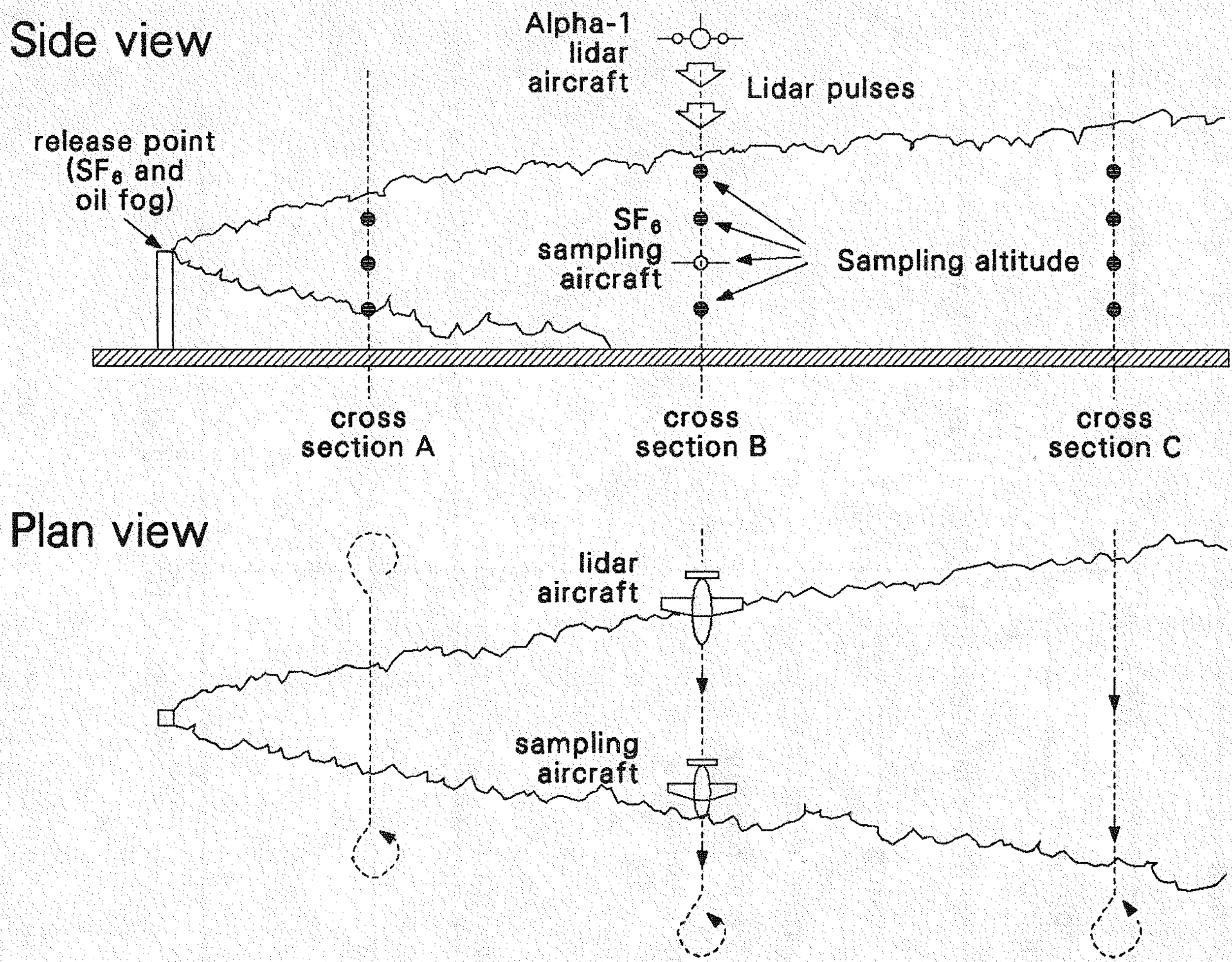


Fig. 14 Basic plan for coordinated vertical diffusion measurements using ALPHA-1 and SF_6 sampling aircraft (Johnson, 1981).