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Sandia National Laboratories ASCOT (Atmospheric Studies in Complex Terrain)

Field Experiment – September 1980

Dr. 626
MASTER

Robert O. Woods

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SANDIA NATIONAL LABORATORIES ASCOT
(Atmospheric Studies in Complex Terrain)
FIELD EXPERIMENT - September 1980

R. O. Woods
Division 4774
Sandia National Laboratories
Albuquerque, NM 87185

ABSTRACT

During the period September 8 through September 25, 1980, Sandia National Laboratories, Division 4774, participated in a series of experiments held in The Geysers area of California. These experiments, aimed at providing data on nighttime drainage flow in complex terrain, were intended to provide a reliable basis for mathematical flow modeling. Tracers were released at several points on a valley rim and sampled by a large number of stations at ground level. Sandia's contribution was to make it possible to derive vertical tracer profiles. This was done by taking air samples from a captive balloon at chosen altitudes between the surface and 450 meters above ground.

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SANDIA NATIONAL LABORATORIES ASCOT
(Atmospheric Studies in Complex Terrain)
FIELD EXPERIMENT - September 1980

Introduction

The objective of the ASCOT series of experiments was to characterize the nighttime drainage flow in a valley. This was done by adding to an existing data base. The Geysers area of California, 100 km west of Sacramento, was chosen because its micrometeorology had been studied in connection with a number of geothermal power stations located there. The state of flow modeling will be advanced by providing extensive and reliable data of a sort that do not now exist.

Sandia National Laboratories, Division 4774, undertook a major operation in connection with ASCOT 1980. This included fielding a staff of seven, supported by a portable trailer laboratory. Additional equipment included a tethered balloon with a payload capacity of 36 kg, a powered winch that had been built to Sandia specifications, and a helium transport trailer. During a period of nearly a month in the field, experiments were performed on five nights. Dates were established by occurrence of favorable meteorological conditions.

Scope

The following material is cast in the format specified by the editors of the overall ASCOT 1980 data report. At this writing the volume is in preparation and will, when finished, contain complete outputs from all participating laboratories.

Narrative

Sandia's experiment provided vertical distribution data regarding tracer concentrations. These were obtained by pumping air samples into approximately 60 litre bags at controlled altitudes and times. In addition to bag sampling, a Sandia-developed syringe sampler that was capable of loading ten samples per flight was used to obtain point data. This supplemented other sampling, which was intentionally integrated over altitude and/or time.

The experiment was carried by a 100 m³ Raven aerodynamically shaped balloon with a payload capacity of roughly 36 kg (Figure 7). Bag and syringe samplers were housed in an airframe (Figures 8 and 9) that also carried telemetry, command and control equipment, and real-time sensors of such variables as altitude, balloon envelope pressure, and magnetic heading (i.e., wind direction). Surface meteorological parameters were recorded by a station located in a trailer. The balloon was reeled up and down at a nominal speed of 0.5 m/s by a gasoline powered winch (Figure 10). Experiments were controlled from the ground by a radio link; real-time data were telemetered to the mobile laboratory trailer (Figure 11) which also served as a base of operations. Experiments took place between the surface and an altitude of 450 m above the "Diamond-D" (West) site after each ASCOT tracer release.

Following each sampling run, filled bags and syringes were taken to the "Caltrans" site for distribution to laboratories that were to perform analyses for SF₆, heavy methane,

and perfluorinated hydrocarbons. Results will be published in the ASCOT 1980 data volume. Some data, relating to SF_6 concentrations in the syringe samples, are published here.

After consultation with P. Gudiksen (the field project director) and other experimenters, three different modes of sampling were employed:

- Morning of September 12, 1980

The initial plan was to cover altitudes between the surface and 450 m in three equal bands. Each of six sample bags was to contain air that had been pumped into it during 150 m of ascent or descent. Sampling was performed on both upleg and downleg. Since the altitude range over which each sample was taken was established by the reel-up/down speed of 0.5 m/s and because a running time for each pump of 200 s had been "hardwired" into the system, the coverage was in fact by 100 m layers. These were spaced so as to bracket the 450 m altitude range. Two sets of six bags were obtained. The experiment is documented in Table I.

- Morning of September 16, 1980

At Gudiksen's request, the experiment plan was revised to provide samples integrated over both altitude and time. The flight timer was reset to provide pump running times of 100 s. Each bag was flown three times at half-hour intervals and sampled over different altitude ranges covering a 150 m band. Bag sampling was done on

the upleg of each flight and syringe samples were taken during downlegs at an altitude of 91 m and at the surface. Flight data are given in Table II.

• Mornings of September 19, 20, and 25

The final mode of sample gathering was agreed upon at an experimenters' meeting of September 17. The pump running time was reset to five minutes, which in conjunction with the nominal rate of climb and descent of 0.5 m/s caused samples to be taken over three successive bands to an altitude of 450 m. Samples were taken on both upleg and downleg, yielding six bags per flight. Syringe samples were taken on the downleg during selected flights. Times and altitudes at which samples were gathered are shown in Tables III, IV, and V.

Tracer concentrations occurring in bag samples have been measured by other laboratories and will appear in a joint publication describing the entire ASCOT 1980 operation. Tables II through V present SF₆ concentrations in syringe samples. These were furnished by the Environmental Systems and Service Company and by the Environmental Sciences Division of Lawrence Livermore National Laboratory. Accuracy of these data is estimated at $\pm 10\%$.

TABLE I
 ASCOT Bag Samples
 Night of September 11-12, 1980
 Sandia National Laboratories

Bag Ident. Number	Altitude Range (m above ground level)	Time Started* (H:M PST)
1/1	0-100	23:03
1/2	152-252	23:10
1/3	305-405	23:16
1/4	457-356	23:24
1/5	305-204	23:32
1/6	152-52	23:37
3/1	0-100	01:17
3/2	152-252	01:27
3/3	305-405	01:33
3/4	457-356	01:38
3/5	305-204	01:44
3/6	152-52	01:50

*Samples were taken during a 200 second pumping cycle.

TABLE II
ASCOOT Vertical Sampling
Night of September 15-16, 1980
Sandia National Laboratories

Bag Ident. Number	Sampling Number	Altitude Range (m above ground level)	Time Started* (H:M PST)	Syringe Ident. Number	Altitude (m above ground level)	Time (H:M PST)	SF ₆ Concentration† (Parts per trillion)
2/1	1	0-51	23:00	2/1	91	23:23	6
	2	46-96	23:33	2/2	00	23:25	4
	3	91-142	00:04	2/3	91	23:54	1952
2/2	1	152-203	23:05	2/4	00	23:57	480
	2	198-249	23:39	2/5	00	00:25	496
	3	244-294	00:09	3/6	91	00:56	552
2/3	1	305-355	23:13	3/7	00	00:58	72
	2	350-398	23:44	3/8	91	01:19	80
	3	396-447	00:17	3/9	00	01:22	344
3/1	1	0-51	00:41	3/10	00	01:46	236
	2	46-96	01:03	4/1	91	02:50	6
	3	91-142	01:28	4/2	00	02:52	44
3/2	1	152-203	00:45	4/3	91	03:11	24
	2	198-249	01:07	4/4	00	03:13	28
	3	244-294	01:33	4/5	00	03:37	12
3/3	1	305-355	00:49	5/6	91	04:24	32
	2	350-398	01:12	5/7	00	04:26	14
	3	396-447	01:37	5/8	91	04:44	5
4/1	1	0-51	02:21	5/9	00	04:45	6
	2	46-96	02:56	5/10	00	05:06	2
	3	91-142	03:22				
4/2	1	152-203	02:39				
	2	198-249	03:00				
	3	244-294	03:25				
4/3	1	305-355	02:43				
	2	350-398	03:03				
	3	396-447	03:28				
5/1	1	0-51	04:11				
	2	46-96	04:29				
	3	91-142	04:50				
5/2	1	152-203	04:15				
	2	198-249	04:32				
	3	244-294	04:53				
5/3	1	305-355	04:18				
	2	350-398	04:36				
	3	396-447	04:57				

* Samples were taken during a 300 second pumping cycle.

† Divide by 164.6 for $\mu\text{g}/\text{m}^3$

TABLE III
ASCOT Vertical Sampling
Night of September 18-19, 1980
Sandia National Laboratories

Bag Ident. Number	Altitude Range (m above ground level)	Time Started* (H:M PST)	Syringe Ident. Number	Altitude (m above ground level)	Time (H:M PST)	SF ₆ Concentration† (Parts per trillion)
7/1	0-152	00:07	1	411	23:34	4
7/2	152-305	00:13	2	365	23:35	80
7/3	305-457	00:18	3	320	23:36	39
7/4	457-305	00:24	4	274	23:38	80
7/5	305-152	00:31	5	229	23:39	44
7/6	152-0	00:36	6	183	23:40	87
			7	137	23:42	123
8/1	0-152	00:55	8	91	23:46	144
8/2	152-305	01:00	9	46	23:47	93
8/3	305-457	01:06	10	0	23:49	115
8/4	457-305	01:11				
8/5	305-152	01:18				
8/6	152-0	01:23				
9/1	0-152	02:01				
9/2	152-305	02:06				
9/3	305-457	02:12				
9/4	457-305	02:17				
9/5	305-152	02:23				
9/6	152-0	01:28				
10/1	0-152	03:03				
10/2	152-305	03:09				
10/3	305-457	03:14				
10/4	457-305	03:19				
10/5	305-152	03:25				
10/6	152-0	03:31				
11/1	0-152	04:01				
11/2	152-305	04:07				
11/3	305-457	04:13				
11/4	457-305	04:18				
11/5	305-152	04:24				
11/6	152-0	04:30				

* Samples were taken during a 300 second pumping cycle.

† Divide by 164.6 for $\mu\text{g}/\text{m}^3$

TABLE IV
ASCOT Vertical Sampling
Night of September 19-20, 1980
Sandia National Laboratories

Bag Ident. Number	Altitude Range (m above ground level)	Time Started* (H:M PST)	Syringe Ident. Number	Altitude (m above ground level)	Time (H:M PST)	SF ₆ Concentration† (Parts per trillion)
12/1	0-152	23:05	14/1	411	01:49	2
12/2	152-305	23:11	14/2	366	01:51	4
12/3	305-457	23:16	14/3	320	01:52	8
12/4	457-305	23:22	14/4	274	01:54	18
12/5	305-152	23:28	14/5	229	01:55	21
12/6	152-0	23:33	14/6	183	01:57	35
			14/7	137	01:59	23
13/1	0-152	00:15	14/8	91	02:00	5
13/2	152-305	00:21	14/9	46	02:02	69
13/3	305-457	00:26	14/10	0	02:03	108
13/4	457-305	00:31				
13/5	305-152	00:37	15/1	411	03:05	-
13/6	152-0	00:42	15/2	366	03:06	-
			15/3	320	03:08	-
14/1	0-152	01:31	15/4	274	03:10	-
14/2	152-305	01:36	15/5	229	03:11	1
14/3	305-457	01:42	15/6	183	03:12	7
14/4	457-305	01:47	15/7	137	03:15	2
14/5	305-152	01:53	15/8	91	03:16	10
14/6	152-0	01:57	15/9	46	03:18	7
			15/10	0	03:19	29
15/1	0-152	02:47				
15/2	152-305	02:52				
15/3	305-457	02:58				
15/4	457-305	03:03				
15/5	305-152	03:09				
15/6	152-0	03:14				
16/1	0-152	04:02				
16/2	152-305	04:08				
16/3	305-457	04:13				
16/4	457-305	04:19				
16/5	305-152	04:25				
16/6	152-0	04:31				

* Samples were taken during a 300 second pumping cycle.

† Divide by 164.6 for $\mu\text{g}/\text{m}^3$

TABLE V
ASCOT Vertical Sampling
Night of September 24-25, 1980
Sandia National Laboratories

Bag Ident. Number	Altitude Range (m above ground level)	Time Started* (H:M PST)	Syringe Ident. Number	Altitude (m above ground level)	Time (H:M PST)	SF ₆ Concentration† (Parts per trillion)
17/1	0-152	20:36	18/1	396	22:19	331
17/2	152-305	20:41	18/2	366	22:20	298
17/3	305-457	20:46	18/3	320	22:22	176
17/4	457-305	20:52	18/4	274	22:24	198
17/5	305-152	20:58	18/5	229	22:25	176
17/6	152-0	21:04	18/6	183	22:27	136
			18/7	137	22:29	148
18/1	0-152	22:01	18/8	91	22:30	83
18/2	152-305	22:06	18/9	46	22:31	77
18/3	305-457	22:11	18/10	0	22:33	551
18/4	457-305	22:17				
18/5	305-152	22:23	20/1	411	01:18	13
18/6	152-0	22:28	20/2	366	01:20	13
			20/3	320	01:22	12
19/1	0-152	23:31	20/4	274	01:23	33
19/2	152-305	23:36	20/5	229	01:25	25
19/3	305-457	23:41	20/6	183	01:26	28
19/4	457-305	23:46	20/7	137	01:28	12
19/5	305-152	23:52	20/8	91	01:30	6
19/6	152-0	23:58	20/9	46	01:31	20
			20/10	0	01:33	22
20/1	0-152	01:00				
20/2	152-305	01:05				
20/3	305-457	01:11				
20/4	457-305	01:16				
20/5	305-152	01:22				
20/6	152-0	01:28				
21/1	0-152	02:30				
21/2	152-305	02:36				
21/3	305-457	02:41				
21/4	457-305	02:46				
21/5	305-152	02:51				
21/6	152-0	02:56				

* Samples were taken during a 300 second pumping cycle.

† Divide by 164.6 for $\mu\text{g}/\text{m}^3$

FIGURE 1
 SF_6 CONCENTRATION IN
SYRINGE SAMPLES
NIGHT OF SEPTEMBER 15-16, 1980

FIGURE 2
 SF_6 CONCENTRATION IN
SYRINGE SAMPLES

NIGHT OF SEPTEMBER 18-19, 1980
23:34 TO 23:49 (PST)

FIGURE 3
 SF_6 CONCENTRATION IN
SYRINGE SAMPLES
NIGHT OF SEPTEMBER 19-20, 1980
01:49 TO 02:03 (PST)

FIGURE 4
SF₆ CONCENTRATION IN
SYRINGE SAMPLES
NIGHT OF SEPTEMBER 19-20, 1980
03:04 TO 03:19 (PST)

FIGURE 5
SF₆ CONCENTRATION IN
SYRINGE SAMPLES

NIGHT OF SEPTEMBER 24-25, 1980
22:19 TO 22:32 (PST)

FIGURE 6
SF₆ CONCENTRATION IN
SYRINGE SAMPLES

NIGHT OF SEPTEMBER 24-25, 1980
01:18 TO 01:32 (PST)

Figure 7. Sandia 100 m³ aerodynamically shaped balloon and winch.

Figure 8. Radio controlled balloon sampling payload.

 

Figure 9. Radio controlled sampling payload and balloon.

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Dr. Russell Dietz
Environmental Chemistry Division
Bldg. 426
Brookhaven National Laboratory
Upton, NY 11973

Paul H. Gudiksen (2)
Lawrence Livermore National Laboratory
University of California
P. O. Box 808
Livermore, CA 94550

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Office of Health & Environmental Research
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