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Volcanic-plume data from
Mount St. Helens during 1980-88

by

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INTRODUCTION

Airborne monitoring of Mount St. Helens for sulfur dioxide emissions was initiated in May 1980 using a correlation spectrometer, or COSPEC (Casadevall et al., 1981). The COSPEC, originally designed for industrial pollution studies, measures incident ultraviolet radiation from skylight for absorption by sulfur dioxide (Hamilton et al., 1978; Milan and Hoff, 1978). This vertically-directed instrument is flown in a fixed-wing aircraft underneath and at right angles to the volcanic plume. It produces a profile on a chart recorder that is a continuous series of line integrals of concentration (concentration \times distance along a line through the plume) that can be correlated with an internal standard of known concentration-pathlength for calibration. The width of the plume can be easily calculated using the length of the chart-recorder profile, the chart-recorder speed, and the true aircraft speed.

DISCUSSION

From May 1980 to September 1988, more than 1000 fixed-wing aircraft flights were made with the COSPEC as part of a U.S. Geological Survey gas-studies program to characterize and measure gaseous emissions from Mount St. Helens (Casadevall et al., 1981). On the majority of these flights, sulfur dioxide was successfully detected by the COSPEC, resulting in a data base containing important information about the structure and dynamics of the chemical plume from Mount St. Helens as well as the rate of emission of sulfur dioxide from the volcano. In addition, during many of the gas-measurement flights during 1980 and 1981, an infrared spectrometer was used to make emission-rate measurements of carbon dioxide (Harris et al., 1981). Unlike the COSPEC, an infrared spectrometer requires penetration and direct sampling of the plume at several different altitudes for CO₂ measurements. Consequently, it is possible not only to determine the width of the plume but also its thickness.

The data listing at the end of this report presents the available plume data from Mount St. Helens collected by the USGS from May 1980 through the end of the measurements in September 1988. Wind direction, wind speed, and distance from the volcano were recorded by the instrument operators during the gas-measurement flights. Sulfur dioxide plume widths were calculated from the COSPEC data as described above. Carbon dioxide plume widths and plume thicknesses were calculated from the infrared data. A report by McGee (in press) summarizes these data and discusses factors that may influence the structure, dynamics, and composition of the plume from Mount St. Helens.

ACKNOWLEDGMENTS

Tom Casadevall started the USGS airborne gas measurement program at Mount St. Helens. The data presented here represent the efforts of many individuals who contributed to the success of program by participating in the gas measurement flights during 1980-88.

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PLUME DATA FROM MOUNT ST. HELENS, 1980-88

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
05/31/80	318	10		5.5		
06/03/80	155	7	17.6	14.1		
06/06/80	199	3	19.2	40.5		
06/09/80	210	16	24.0	23.2		
06/11/80	188	21	12.8	17.5		
06/14/80	329	10	8.0	11.4		
06/18/80	200	4	8.0	19.2		
06/22/80	220	15	12.8	11.6		
07/05/80	210	7	4.8	14.8		
07/06/80	245	6	4.8	18.5	9.0	1150
07/08/80	170	17	4.8	12.5	9.5	1350
07/09/80	120	13	4.0	11.6	4.0	900
07/13/80	340	8	8.0		8.8	1400
07/16/80	260	12	8.0	4.6	5.0	1050
07/18/80	320	11	8.0	9.6	6.9	700
07/22/80		20		5.0	4.0	550
07/23/80	300	7	16.0	9.9	12.8	850
07/25/80	330	11	16.0	13.6	11.0	850
07/28/80				12.7		
07/29/80	320	7	16.0	11.0	8.4	700
07/30/80	230	15	16.0	7.6	6.4	500
08/03/80	340	18	16.0	9.6	11.8	650
08/04/80	300	12	16.0	9.8	9.0	550
08/05/80	300	5	16.0	22.9		
08/06/80	340	6	20.8	13.6	9.1	600
08/07/80	90	10	8.0	21.3	9.5	600
08/08/80	350	6	4.0	10.9	4.9	1700
08/09/80	60	10	8.0	20.6	15.6	500
08/10/80	200	5	6.4	12.8	7.5	950
08/11/80	250	7	9.6	8.9	6.5	950
08/12/80	360	4	16.0	14.3	12.3	600
08/13/80	30	10	16.0	16.9	11.9	900
08/14/80	310	9	7.0	8.2	6.8	850
08/15/80	300	15		6.7	8.6	600
08/16/80	320	16	16.0	8.4	7.8	750

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
08/17/80	290	23		8.8	8.2	600
08/18/80	160	21		6.5	6.1	
08/19/80	330	13	8.0			500
08/20/80	330	17		9.8	7.4	950
08/21/80	120	7		19.4	12.9	1150
08/22/80	360	8	6.4	17.0	14.4	900
08/23/80	190	11		13.5	9.4	650
08/24/80	310	23	8.0	9.8	9.3	500
08/25/80	150	6	3.2	2.7	10.6	550
08/26/80	210	26	8.0	7.0	5.8	900
08/29/80	150	3	8.0	22.6	10.7	750
09/03/80	270	12	12.8	8.4		
09/05/80	200	13	8.0	5.0	4.7	900
09/06/80	150	25	6.4	7.7	13.0	950
09/08/80	210	20	8.0	13.2	10.4	500
09/10/80	120	2	9.6	15.3	9.4	950
09/15/80	210	2	3.2	18.8	7.9	750
09/17/80	280	9	4.8	5.6	5.2	850
09/22/80	100	15	11.2	10.7		
09/23/80	320	17	12.8	9.0	8.7	500
09/24/80	330	20	14.4	14.2	9.0	750
09/25/80	190	9	11.2	25.5	9.8	400
09/26/80	190	11		11.3	9.4	700
09/27/80	230	22	4.8	7.9	10.2	1200
09/29/80	190	35	8.0	8.1		
09/30/80	260	12	19.2	11.6	6.7	900
10/01/80	190	12	9.6	11.7	7.9	900
10/03/80	190	15	8.0	5.5	5.1	1050
10/06/80	220	15		6.5		
10/07/80	220	22	12.8	6.3	6.8	950
10/08/80	170	14	12.8	7.9	5.3	900
10/09/80	250	14	8.0	11.2	9.0	950
10/10/80	160	20	32.0	15.9		
10/15/80	20	14	9.6	8.9	9.4	650
10/16/80	30	16	8.0		5.7	600
10/17/80	290	10	8.0		5.6	650
10/18/80	230	10	16.0	12.0	10.4	550
10/19/80	220	17		11.0	7.8	750
10/21/80	310	39		8.4		
10/22/80		8	4.8	16.1	8.2	1000
10/27/80	310	6	6.4	12.7		
10/28/80	260	17	8.0	10.3	8.2	600
10/29/80	250	21	14.4	6.1	6.6	850
10/30/80	190	20	6.4	6.8	4.9	300

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SD ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
11/04/80	210	20		5.1	4.9	800
11/05/80	230	30		3.5	4.3	400
11/10/80		3	2.0	16.4	10.6	700
11/11/80	140	10		5.8	4.8	750
11/12/80	330	5		7.9	6.5	700
11/13/80	210	12	4.8	5.6	8.4	850
11/15/80	30	15		5.8	5.8	650
11/20/80		25	5.5			
11/24/80	280	10		10.7	11.1	750
11/26/80	220	20	9.6	6.3	4.6	850
11/28/80	200	20	10.5	3.8	3.6	650
12/01/80		26			3.3	950
12/06/80	30	20		7.8	5.0	1100
12/07/80	90	27		6.3	5.8	950
12/08/80	310	25		7.4	6.7	700
12/12/80	250	15		5.3	4.4	950
12/13/80	225	15		8.0		
12/15/80	270	22		6.1	5.6	1400
12/16/80	240	12		7.6	6.6	1100
12/18/80	260	7		6.0	5.6	750
12/19/80	190	23		8.7	6.8	850
01/01/81	300	15				
01/02/81	180	8		8.1		
01/04/81	287	16		4.4		
01/07/81	230	5		5.6		
01/08/81	210	30		3.2		
01/09/81	220	15				500
01/11/81	215	19	6.4	5.7	4.5	850
01/12/81	210	15		5.6	4.0	575
01/13/81	170	3		5.7		
01/14/81	210	20		3.4		
01/16/81	190	5	8.0	6.5		
01/19/81	210	20		4.0		
01/20/81	200	25		3.6		
01/25/81	240	12		5.4	4.5	900
01/31/81	320	12		5.4	6.0	750
02/02/81	300	10		4.7		
02/03/81	110	8	3.2	6.3	4.0	550
02/04/81	190	5		3.8		
02/05/81	70	5		12.9		
02/06/81	20	17		6.9	2.3	600
02/07/81	360	16				600
02/21/81	260	20	6.4	5.7		
02/25/81	220	5	8.0	11.5	6.6	550

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
02/26/81	200	5		10.0		
03/02/81	290	10	6.4			850
03/05/81	340	15	8.0	4.2		
03/06/81	270	5	6.4	9.5		
03/09/81	160	11	7.0	10.3		
03/10/81	170	9	8.0	7.2	3.9	650
03/11/81	160	5	6.4	7.9	6.3	550
03/12/81	200	10	6.4	4.3		
03/13/81	150	11	4.8	5.1	5.0	700
03/17/81	210	11	5.6	4.0	4.0	550
03/27/81	320	23		5.6		
03/28/81	260	17	9.6	4.3		
04/01/81	270	10	6.4			450
04/13/81	180	10	6.4			1050
04/14/81	170	15	6.4	3.8	3.2	500
04/15/81	210	25	6.4			
04/16/81	280	10	6.4	6.7	4.0	500
04/18/81	200	15	3.2	5.4		
04/23/81	220	23		9.0		
04/29/81	260	15	6.4	5.6		
04/30/81	140	20	5.6	6.5		
05/01/81	220	25	6.4	5.6		
05/04/81	230	20	6.4	6.7		
05/08/81	230	8	4.8	8.1	4.1	550
05/09/81	280	15	6.4	6.7	3.5	350
05/11/81	310	17	6.4	5.4		
05/12/81	60	7	4.8	8.1	5.1	400
05/13/81	240	5	4.8	5.6	2.8	350
05/16/81	310	7	4.0	7.6		
05/22/81	240	5	8.0	10.1	5.4	450
05/23/81	190	12	6.4	7.6	4.8	600
05/26/81	240	10	4.8	4.9	5.0	450
05/27/81	270	15	5.6	4.3	3.4	550
05/28/81	310	10	6.4	4.5	4.4	500
05/29/81	170	20		4.7		
06/01/81	160	15	4.8	4.9	6.0	900
06/02/81	300	15		4.7		
06/05/81	220	20	5.6	6.0	4.0	450
06/06/81	260	20	5.6	4.7		
06/11/81	190	15	4.8	6.4		
06/14/81	350	7	4.8	6.9		
06/15/81	230	15	4.8	7.6		
06/17/81	250	20	7.0	9.6		
06/20/81	250	30	6.4	9.4		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
06/25/81	280	8	4.0	5.1	5.7	400
06/26/81	260	17	6.4	5.6	5.1	550
06/27/81	310	20	6.4	4.3	5.6	450
06/29/81	260	10	6.4	6.0		
07/01/81	350	15		4.1		
07/03/81	240	10		9.0	2.9	730
07/04/81	230	15	3.2	4.7		
07/10/81	250	7	8.0	11.8		
07/11/81	240	5	4.0	13.0		
07/14/81	290	5	4.0	6.7	5.8	400
07/15/81	220	7		8.1		650
07/16/81	170	10	4.8	4.9		900
07/17/81	170	12	4.8	3.6	2.5	450
07/18/81	310	23		5.6		640
07/20/81	320	20	4.8	6.0		760
07/21/81	290	18	8.0	6.7		900
07/22/81	320	10	7.0	12.8		910
07/23/81	300	18	3.2	6.5	7.0	400
07/24/81	230	12	3.2	6.0		550
07/25/81	360	10		6.5		
07/27/81	120	3	1.6	12.3		
07/28/81	240	21	4.8	4.9		
07/30/81	260	5	4.0	8.5		
07/31/81	260	8		6.3	6.7	500
08/01/81	360	3	5.0	11.6		
08/03/81	90	10	13.0	6.9		
08/05/81	320	10	4.0	5.4		550
08/06/81	330	10		5.8		
08/07/81	260	7		10.5		
08/08/81	30	7	5.0	5.6		
08/10/81	135	10	6.0	7.2		
08/12/81	240	5	1.6	4.7		
08/13/81	120	10	6.0	3.8		
08/14/81	100	5		3.8	4.5	400
08/15/81	230	6		6.1		
08/17/81	180	10	3.2	4.0		366
08/18/81	150	5	3.2	4.5		
08/19/81	120	13		3.8		
08/20/81	270	8		5.4		
08/21/81	250	11		5.1		
08/22/81	140	7	3.2	7.6		820
08/24/81	360	22	8.0	6.9		500
08/26/81	190	6	3.2	4.0		820
08/27/81	240	10	4.0	6.7		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
08/28/81	360	8	4.0	4.5	2.5	400
08/31/81	235	14	4.0	5.6		370
09/02/81	180	11	3.2	6.7		300
09/03/81	210	7	8.0	9.4		
09/04/81	300	20	4.0	5.1		600
09/05/81	330	10	4.0	5.1		
09/06/81	120	20	4.8	7.4		
09/07/81	360	10	4.8	6.3		
09/08/81	180	15	3.2	4.5		
09/09/81	230	20	3.2	5.6		
09/10/81	10	10	4.0	5.8		
09/11/81	300	8	3.2	4.7		
09/12/81	260	8	3.2	6.3		
09/15/81	170	10	4.8	6.7		
09/16/81	110	11	4.8	7.4		
09/17/81	160	20	6.4	5.6		
09/18/81	220	17		4.5		300
09/24/81	250	11	12.8	9.4		
09/25/81	260	10	7.2	8.1		
09/29/81	270	13	7.2	11.0		
09/30/81	295	16	4.8	7.4		
10/09/81	70	16	6.4	5.1		
10/10/81	270	7	3.2	5.4		
10/11/81	350	11		6.0		
10/12/81	50	12	1.6	4.5		
10/13/81	20	11	3.2	4.5		
10/14/81	40	13	3.2	4.3		
10/15/81	20	14	3.2	4.9		
10/17/81	320	8	3.2	6.9		
10/19/81	290	25	3.2	4.7		
10/20/81	300	11	3.2	4.3		
10/21/81	360	18	8.0	6.3		
10/22/81	10	10	4.8	6.5		
10/23/81	360	15	9.6	7.2		
10/24/81	340	25	3.2	5.1		
10/31/81	220	28	6.4	3.1		
11/01/81	220	15	6.4	4.7		
11/02/81	180	23	3.2	3.1		
11/04/81	360	20	4.8	5.6		
11/06/81	220	16	3.2	5.4		
11/07/81	220	19	8.0	9.4		
11/08/81	190	12	4.8	4.9		
11/09/81	190	10	6.4	5.8		
11/10/81	170	25	6.4	2.9		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
11/16/81	120	14	4.8	6.5		
11/24/81	300	9	3.2	6.7		
11/25/81	210	17	11.2	7.6		
11/27/81	50	8	3.2	3.6		
12/01/81	270	38	12.8	5.8		
12/11/81	270	9	3.2	3.6		
12/12/81	220	15	4.8	5.4		
12/16/81	160	18	8.0	7.8		
01/06/82	300	20	3.0	10.3		
01/07/82	240	15	3.0	5.0		
01/10/82	280	20	2.0	1.9		
01/13/82	320	37	4.8	5.2		
01/18/82	260	14		5.4		
01/24/81	270	30	4.0	5.5		
01/31/82	310	25	4.8	4.6		
02/04/82	10	19	3.2	3.5		
02/05/82	50	13	3.2	4.9		
02/06/82	270	5	3.2	6.6		
02/07/82	20	8	3.2	6.7		
02/08/82	40	5	3.2	5.6		
02/09/82	40	12	3.2	4.9		
02/10/82	220	12	4.0	6.3		
02/21/82	260	12	3.2	4.7		
02/24/82	200	14	3.2	4.4		
02/25/82	190	22		2.6		
03/04/82	320	20		5.0		
03/05/82	290	5	4.8	8.7		
03/06/82	300	13		5.8		
03/07/82	320	10		6.1		
03/15/82	70	11	6.4	8.5		
03/16/82	140	10	3.2	7.4		
03/17/82	120	10		6.3		
03/18/82	330	9	3.2	6.9		
03/19/82	240	12	3.2	10.4		
03/20/82	40	7	2.0	4.8		
03/21/82	40	8	1.0	4.8		
03/22/82	40	13	1.0	3.3		
03/23/82	330	21	3.2	4.4		
03/24/82	330	6		3.3		
03/28/82	230	10		7.8		
03/29/82	210	8	4.0	6.2		
04/05/82	150	20	4.0	6.2		
04/06/82	160	8	4.8	4.8		
04/08/82	90	4	2.2	5.8		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
04/09/82	340	5	3.2	8.4		
04/16/82	200	15	6.0	4.6		
04/19/82	200	14	3.2	6.7		
04/22/82	200	11	3.2	5.1		
04/24/82	300	10		6.0		
04/25/82	310	7	5.6	9.3		
04/26/82	340	5	3.2	8.9		
04/27/82	240	7	3.2	6.7		
04/29/82	260	9	3.2	6.2		
04/30/82	210	13	3.2	4.7		
05/01/82	240	5	1.6	5.6		
05/04/82	320	20		6.3		
05/05/82	330	22	1.6	4.3		
05/06/82	290	30		5.4		
05/11/82	340	10		4.0		
05/12/82	290	20	2.5	9.2		
05/13/82	260	10	1.6	4.7		
05/14/82	230	12		5.6		
05/15/82	260	9	1.0	6.0		
05/16/82	200	13		3.1		
05/18/82	310	18		8.3		
05/19/82	320	9	1.6	11.2		
05/20/82	230	6		4.7		
05/21/82	260	5		4.0		
05/23/82	350	15		4.0		
05/24/82	30	14		4.7		
05/25/82	260	15		3.8		
05/26/82	300	26		5.1		
05/28/82	10	11	2.0	5.6		
05/29/82	40	18		4.0		
05/30/82	70	10		3.6		
06/02/82	200	10	1.0	9.4		
06/03/82	210	7		9.0		
06/07/82	340	20	1.6	6.3		
06/08/82	350	7		4.0		
06/09/82	300	7		6.9		
06/10/82	270	10		7.8		
06/11/82	300	7		4.9		
06/14/82	340	9		6.9		
06/15/82	240	8		8.1		
06/16/82	340	15		6.9		
06/17/82	60	25		4.7		
06/19/82	210	7	1.6	11.9		
06/20/82	220	5	1.6	3.8		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
06/21/82	330	22	1.6	4.0		
06/22/82	310	8		4.7		
06/23/82	330	14		5.6		
06/24/82	170	15		2.9		
06/25/82	190	5		4.5		
06/27/82	180	10		6.0		
06/28/82	150	21	1.6	3.4		
06/29/82	30	11	1.0	4.3		
06/30/82	310	13	3.0	7.4		
07/01/82	270	10	1.0	4.3		
07/04/82	280	20	1.0	4.7		
07/05/82	270	15	1.0	5.6		
07/06/82	180	6	1.0	3.1		
07/08/82	220	3	1.0	11.0		
07/09/82	220	15		6.5		
07/10/82	180	10	1.6	6.3		
07/11/82	180	22		5.6		
07/12/82	270	5	1.0	2.7		
07/13/82	220	10	1.0	6.3		
07/14/82	270	20		5.6		
07/16/82	20	25	2.0	3.7		
07/17/82	270	5	1.0	3.6		
07/18/82	280	16	1.0	4.9		
07/19/82	300	21	2.0	5.7		
07/20/82	230	25	1.0	4.7		
07/21/82	240	20	1.6	3.6		
07/22/82	360	5	2.0	5.6		
07/23/82	360	4	2.0	8.5		
07/25/82	180	10		3.8		
07/28/82	145	6	1.0	3.6		
07/29/82	130	18	2.0	4.5		
07/30/82	140	25	1.0	2.9		
07/31/82	250	12	2.0	5.2		
08/03/82	260	6	1.0	5.8		
08/04/82	230	10	3.0	4.9		
08/05/82	190	12	1.0	3.1		
08/06/82	180	17	1.6	2.7		
08/08/82	180	5	1.6	3.8		
08/09/82	180	10	1.6	8.1		
08/14/82	180	5	1.6	5.1		
08/15/82	180	10	1.6	3.4		
08/16/82	180	10	2.0	3.1		
08/17/82	200	15	1.0	3.1		
08/18/82	180	21	1.0	3.4		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
08/19/82	170	10	1.0	4.5		
08/21/82	220	22	1.0	3.8		
08/22/82	360	10	1.0	4.0		
08/23/82	360	15	1.0	3.8		
08/24/82	170	13	1.0	4.3		
08/25/82	210	5	1.0	5.2		
08/26/82	240	8	1.0	6.0		
08/27/82	220	20	1.6	4.0		
08/28/82	220	10	1.0	4.6		
08/31/82	280	5	1.0	4.7		
09/01/82	360	3	1.0	7.1		
09/02/82	180	15	1.0	2.7		
09/03/82	170	10	1.0	4.9		
09/07/82	300	4	1.0	8.8		
09/08/82	270	22	2.0	4.2		
09/17/82	150	10	1.0	3.4		
09/18/82	120	17	1.6	4.6		
09/21/82	30	5	1.0	4.2		
09/22/82	80	9	1.0	7.5		
09/23/82	120	20	1.0	4.3		
09/27/82	330	20	2.0	5.0		
09/29/82	20	18	1.0	5.6		
09/30/82	30	26	1.0	3.0		
10/01/82	300	21	1.0	3.8		
10/05/82	340	20	1.0	3.9		
10/09/82	60	11	1.0	6.0		
10/12/82	70	6	2.0	6.7		
10/15/82	190	8	1.0	3.8		
10/29/82	90	10	1.0	2.5		
11/01/82	320	22	1.0	2.7		
11/09/82	100	12	1.0	3.3		
11/21/82	230	7	1.0	2.7		
12/09/82	220	7	1.0	2.7		
12/24/82	200	10	1.0	2.7		
12/27/82	30	18	1.0	2.0		
12/31/82	160	15	1.0	1.8		
01/13/83	240	18	1.0	2.9		
01/15/83	130	10	1.0	6.0		
01/19/83	210	20	1.0	3.4		
01/20/83	315	5	1.0	4.0		
01/21/83	150	19	1.0	5.1		
01/30/83	160	10	1.0	2.7		
01/31/83	220	6	1.0	6.9		
02/01/83	180	8	1.0	3.6		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
02/04/83	220	5	1.0	10.9		
02/05/83	160	13	1.0	4.3		
02/07/83	260	7	1.0	7.2		
02/15/83	190	25	1.0	3.7		
02/21/83	150	17	1.0	4.5		
02/23/83	200	30	2.0	2.7		
02/28/83	190	18	1.0	3.3		
03/02/83	170	17	1.0	2.7		
03/03/83	190	8	1.0	3.8		
03/10/83	190	10	1.0	7.4		
03/11/83	200	10	1.0	5.8		
03/15/83	90	7	1.0	5.6		
03/17/83	70	8	1.0	3.5		
03/22/83	150	27	1.0	5.6		
03/24/83	150	13	1.0	4.9		
03/31/83	220	15	1.0	5.8		
04/04/83	90	15	1.0	4.5		
04/06/83	330	5	2.5	8.3		
04/11/83	310	10	1.0	3.2		
03/12/83	30	15	1.0	3.9		
04/14/83	160	9	1.0	4.7		
04/15/83	100	10	1.0	5.8		
04/18/83	90	5	1.0	8.3		
04/19/83	180	10	1.0	2.7		
04/21/83	270	10	1.0	2.9		
04/23/83	170	28	1.0			
04/25/83	260	12	3.0	9.2		
04/26/83	180	8	1.0	4.0		
04/27/83	110	7	1.0	5.2		
04/28/83	160	15	1.0	2.9		
04/30/83	320	7	1.0	6.5		
05/04/83	210	11	1.0	4.3		
05/11/83	50	5	1.0	6.0		
05/12/83	120	6	1.0	5.8		
05/13/83	150	5	1.0	4.0		
05/17/83	300	15	1.0	3.2		
05/19/83	340	23	1.0	5.4		
05/20/83	340	15	1.0	4.5		
05/21/83	330	13	1.0	5.8		
05/23/83	330	10	1.0	3.9		
05/24/83	220	7	1.0	5.1		
05/27/83	170	15	1.0	2.9		
06/03/83	330	18	1.0	2.2		
06/06/83	20	10	1.0	6.3		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
06/08/83	220	8	1.0	3.4		
06/13/83	200	8	1.0	4.2		
06/16/83	250	5	1.0	4.0		
06/20/83	330	5	1.0	11.6		
06/21/83	320	7	1.0	9.6		
06/22/83	160	15	1.0	4.0		
06/25/83	180	15	1.0	3.4		
06/27/83	330	6	1.0	8.4		
06/28/83	180	5	1.0	10.7		
07/04/83	160	14	1.0	3.6		
07/05/83	225	15	1.0	4.4		
07/06/83	210	17	1.0	4.9		
07/10/83	310	12	1.0	5.3		
07/11/83	240	22	1.0			
07/15/83	340	10	1.0	7.2		
07/17/83	70	12	1.0	4.0		
07/21/83	180	10	1.0	4.5		
07/22/83	310	16	1.0	3.1		
07/23/83	180	7	1.0	3.6		
07/28/83	240	13	1.0	4.9		
07/29/83	110	5	1.0	5.6		
08/01/83	210	12	1.0	4.3		
08/02/83	250	20	1.0	3.4		
08/04/83	150	20	1.0	2.9		
08/05/83	180	20	1.0	2.9		
08/08/83	180	18	1.0	3.2		
08/09/83	140	11	1.0	3.6		
08/12/83	330	5	1.0	5.1		
08/13/83	250	8	1.0	6.1		
08/15/83	250	11	1.0	4.2		
08/17/83	250	10	1.0	4.3		
08/18/83	300	4	1.0	12.3		
08/21/83	360	10	1.0	6.0		
08/22/83	120	8	1.0	3.1		
08/24/83	170	8	1.0	2.9		
08/25/83	135	13	1.0	3.1		
08/27/83	210	15	1.0	3.6		
09/03/83	320	15	1.0	8.3		
09/05/83	330	17	1.0	6.0		
09/07/83	360	11	1.0	6.9		
09/09/83	260	8	1.0	5.1		
09/13/83	270	11	1.0	3.1		
09/14/83	360	16	1.0	6.9		
09/15/83	260	16	1.0	2.9		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
09/17/83	310	18	1.0	3.1		
09/19/83	25	24	1.0	2.7		
09/22/83	260	17	1.0	4.0		
09/23/83	320	21	1.0	3.6		
09/26/83	230	22	1.0	3.6		
09/29/83	160	15	1.0	3.9		
10/01/83	285	19	1.0	5.4		
10/04/83	210	15	1.0	5.8		
10/05/83	270	10	1.0	3.8		
10/06/83	280	20	1.0	4.0		
10/07/83	70	6	1.0	4.3		
10/08/83	230	30	1.0	6.7		
10/09/83	250	15	1.0			
10/10/83	300	12	1.0	5.2		
10/11/83	320	8	1.0	5.1		
10/12/83	170	11	1.0	4.5		
10/13/83	300	17	1.0	2.9		
10/15/83	90	2	1.0	4.3		
10/16/83	240	7	1.0	2.7		
10/18/83	180	14	1.0	2.9		
10/19/83	20	14	1.0	4.0		
10/20/83	190	16	1.0	3.8		
10/23/83	290	14	1.0	3.5		
10/24/83	230	20	1.0	5.1		
10/25/83	170	15	1.0	3.2		
10/26/83	220	27	1.0	4.7		
10/27/83	240	10	1.0	3.6		
10/31/83	190	20	1.0	3.1		
11/05/83	180	30	2.0	3.8		
11/08/83	330	10	1.0	3.6		
11/21/83	340	15	1.0	5.6		
11/28/83	350	24	2.0	3.4		
11/29/83	140	15	1.0	3.4		
12/01/83		5	1.0	3.6		
12/11/83	300	8	1.0	4.0		
12/13/83	275	7	1.0	4.3		
12/17/83	320	10	1.0	6.7		
12/21/83	120	15	1.0	3.6		
12/22/83	310	10	1.0	3.8		
12/28/83	190	15	1.0	3.9		
12/31/83	240	8	1.0	5.1		
01/05/84	240	17	1.0	3.8		
01/09/84	140	14	1.0	2.6		
01/12/84	15	16	1.0	2.9		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
01/13/84	40	15	2.0	2.2		
01/14/84		24	1.0			
01/16/84	350	30	1.0	2.7		
01/17/84	10	22	1.0	2.5		
01/18/84	260	11	1.0	5.4		
01/19/84	100	8	1.0	5.8		
01/20/84	240	14	1.0	4.9		
01/26/84	300	21	1.0			
01/29/84	340	12	1.0	3.6		
01/30/84	100	7	1.0	6.3		
01/31/84	250	5	1.0	3.8		
02/01/84	340	29	1.0	3.6		
02/02/84	300	22	1.0	3.3		
02/03/84	90	11	1.0	3.3		
02/05/84	210	10	1.0	4.3		
02/06/84	300	15	1.0	5.1		
02/07/84	190	28	1.0	4.0		
02/14/84	230	11	1.0	5.1		
02/15/84	230	9	1.0	5.6		
02/16/84	330	10	1.0	4.5		
02/26/84	190	27	1.0	3.6		
02/27/84	210	35	1.0			
03/03/84	330	30	1.0	4.0		
03/06/84	290	5	1.0	3.8		
03/15/84	180	18	1.0	6.0		
03/22/84	230	12	1.0	3.8		
03/27/84	330	6	1.0	5.3		
03/29/84	50	14	1.0	4.9		
03/30/84	70	13	1.0	6.0		
04/02/84	140	4	1.0	7.1		
04/13/84	220	35	1.0			
04/14/84	190	30	1.0			
04/16/84	210	20	1.0	5.1		
04/20/84	270	15	1.0	3.4		
04/26/84	330	15	1.0	3.2		
05/04/84	240	15	1.0	5.8		
05/07/84	150	15	1.0	1.8		
05/14/84	230	15	1.0	3.1		
05/27/84	315	6	1.0	7.8		
05/28/84	10	5	1.0	6.5		
06/01/84	300	10	1.0	3.1		
06/06/84	230	7	1.0	2.5		
06/12/84	95	4	1.0	3.6		
06/14/84	30	7	1.0	5.0		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
06/18/84	300	9	1.0	3.6		
06/19/84	300	9	1.0	4.9		
06/22/84	120	6	1.0	9.2		
06/23/84	350	15	1.0	3.1		
07/01/84	270	22	1.0	3.4		
07/06/84	290	16	1.0	4.3		
07/13/84	285	18	1.0	3.8		
07/20/84	240	15	1.0	1.8		
07/27/84	190	12	1.0	1.6		
08/03/84	10	6	1.0	4.5		
08/10/84	220	6	1.0	2.2		
08/17/84	220	33	1.0	2.0		
08/24/84	260	5	1.0	4.7		
08/30/84	200	8	1.0	2.2		
09/04/84	195	25	1.0	2.1		
09/08/84	250	25	1.0	11.1		
09/10/84	260	15	2.0	6.8		
09/12/84	250	13	1.0	3.8		
09/13/84	20	10	1.0	3.4		
09/15/84	210	20	1.0	3.6		
09/18/84	220	11	1.0	2.9		
09/23/84	360	15	2.0	5.8		
09/26/84	270	11	1.0	4.9		
09/28/84	140	8	1.0	5.8		
10/02/84	50	6	1.0	4.0		
10/08/84	210	30	1.0	4.0		
10/15/84	310	10	1.0	3.8		
10/22/84	350	12	1.0	3.4		
10/31/84	220	15	1.0	3.6		
11/14/84	270	10	1.0	3.6		
11/21/84	10	7	1.0	3.6		
11/26/84	150	15	1.0	1.1		
12/03/84	110	10	1.0			
12/05/84	200	11	1.0	1.6		
01/02/85	120	7	1.0	5.4		
01/07/85	35	15	1.0	2.2		
01/22/85	90	5	1.0	8.8		
01/25/85	70	11	1.0	2.8		
02/04/85	330	20	1.0			
02/17/85	310	8	1.0	6.9		
02/18/85	230	8	1.0	5.6		
02/26/85	40	12	1.0	4.4		
03/02/85	20	20	1.0	3.6		
03/07/85	160	20	1.0	5.0		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
03/09/85	190	12	1.0	3.7		
03/11/85	260	17	1.0	3.8		
03/13/85	180	6	1.0	5.1		
03/28/85	330	13	1.0			
03/29/85	230	12	1.0	3.6		
04/02/85	280	22	1.0			
04/05/85	320	21	1.0			
04/09/85	140	9	1.0	2.0		
04/12/85	210	10	1.0	4.9		
04/14/85	230	10	1.0			
04/25/85	230	4	1.0	4.3		
04/29/85			1.0			
05/01/85	210	26	1.0			
05/07/85	180	7	1.0	3.8		
05/09/85	210	11	1.0			
05/13/85	230	18	1.0	4.0		
05/16/85	90	17	1.0	4.7		
05/17/85	210	6	1.0	1.9		
05/21/85	240	5	1.0	2.7		
05/23/85	145	14	1.0	3.6		
05/26/85	170	5	1.0	2.0		
05/30/85	160	8	1.0	3.6		
06/02/85	95	8	1.0	5.1		
06/03/85	160	14	1.0	3.1		
06/08/85	330	10	1.0	5.0		
06/10/85	320	6	1.0	6.9		
06/12/85	260	20	1.0	3.6		
06/18/85	160	7	1.0	3.7		
06/21/85	310	20	1.0	3.9		
06/26/85	130	12	1.0	3.1		
06/28/85	210	20	1.0	2.3		
07/02/85	160	10	1.0	2.5		
07/05/85	160	15	1.0	3.5		
07/08/85	150	15	1.0	2.1		
07/11/85	260	6	1.0	3.0		
07/15/85	320	9	1.0	4.7		
07/22/85	290	9	1.0	4.4		
07/23/85	305	18	1.0	3.8		
07/24/85	320	18	1.0	3.5		
07/25/85	285	8	1.0	5.0		
07/26/85	285	8	1.0	2.8		
07/31/85	140	10	1.0			
08/03/85	200	5	1.0	2.9		
08/12/85	320	16	1.0	3.7		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
08/13/85	15	13	1.0	3.1		
08/16/85	70	7	1.0			
08/26/85	220	6	1.0	3.5		
08/29/85	170	25	1.0	2.6		
09/03/85	345	22	1.0	7.2		
09/18/85	340	10	1.0	5.8		
09/20/85	345	7	1.0	4.5		
09/24/85	350	23	1.0			
09/26/85	330	21	1.0			
10/01/85	270	18	1.0	3.7		
10/03/85	330	19	1.0	3.6		
10/07/85	120	5	1.0	4.7		
10/08/85	20	12	1.0	2.5		
10/15/85	220	23	1.0	3.1		
10/18/85	220	24	1.0			
10/25/85	280	25	1.0	3.0		
10/28/85	290	14	1.0	3.8		
11/12/85	115	8	1.0	2.5		
11/18/85	295	20	1.0	4.1		
11/22/85	280	5	1.0	3.1		
12/10/85	50	29	1.0			
12/11/85	20	20	1.0			
12/18/85	280	16	1.0	3.8		
12/27/85	300	13	1.0			
01/06/86	290	20	1.0	5.0		
01/24/86	140	10	1.0	3.6		
02/08/86	20	20	1.0			
02/10/86	65	12	1.0	5.5		
02/18/86	250	37	1.0			
02/26/86	240	5	1.0			
03/16/86	290	8	1.0	3.6		
03/19/86	300	6	1.0	5.1		
03/31/86	240	8	1.0	4.5		
04/07/86	160	3	1.0	3.8		
04/18/86	300	24	1.0	3.8		
04/21/86	260	16	1.0			
04/23/86	300	17	1.0			
04/30/86	180	14	1.0			
05/08/86	340	16	1.0	9.4		
05/14/86	300	11	1.0	1.8		
05/16/86	300	10	1.0	3.2		
05/19/86	170	12	1.0	3.5		
05/28/86	170	20	1.0	1.4		
06/09/86	15	14	1.0	2.4		

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
06/19/86	205	10	1.0	1.3		
06/25/86	280	13	1.0	2.1		
07/07/86	200	10	1.0	1.8		
07/18/86	150	16	1.0	2.6		
07/25/86	300	15	1.0	2.4		
07/28/86	270	24	1.0	2.2		
08/04/86	300	10	1.0			
08/07/86	120	5	1.0			
08/13/86	140	5	1.0	7.7		
08/19/86	270	5	1.0	5.1		
08/27/86	140	15	1.0			
08/28/86	160	10	1.0			
09/03/86	310	13	1.0	3.4		
09/11/86	360	5	1.0	4.2		
09/12/86	180	8	1.0			
09/22/86	350	5	1.0	2.6		
10/06/86	90	10	1.0	3.9		
10/08/86	145	8	1.0	3.4		
10/14/86	120	5	1.0	3.4		
10/16/86	150	13	1.0	1.8		
10/18/86	120	5	1.0	4.3		
10/20/86	170	10	1.0	3.2		
10/21/86	130	15	1.0	6.4		
10/22/86	120	7	1.0	5.1		
10/23/86	140	17	1.0	4.3		
10/24/86	150	16	1.0	3.1		
11/03/86	320	17	1.0	3.0		
11/13/86	250	18	1.0			
11/25/86	220	20	1.0			
12/02/86	290	5	1.0	4.2		
12/09/86	30	18	1.0	7.1		
12/11/86	70	12	1.0			
12/15/86	140	7	1.0			
12/16/86	90	5	1.0	2.6		
12/30/86	320	10	1.0	1.9		
01/06/87	50	7	1.0			
01/08/87	150	8	1.0	3.9		
01/15/87	30	10	1.0	3.9		
01/20/87	340	22	1.0			
01/21/87	160	5	1.0	4.0		
02/07/87	190	7	1.0			
02/10/87	220	22	1.0			
02/20/87	330	9	1.0			
02/25/87	30	28	1.0			

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
03/22/87	200	8	1.0			
03/24/87	40	7	1.0	3.1		
03/25/87	250	17	1.0			
03/27/87	350	25	1.0			
03/30/87	210	11	1.0			
04/01/87	140	20	1.0			
04/13/87	210	17	1.0			
04/20/87	250	8	1.0	4.3		
04/23/87	220	20	1.0			
04/27/87	190	13	1.0	3.2		
04/28/87	190	10	1.0	5.5		
05/04/87	210	24	1.0			
05/05/87	119	12	1.0			
05/07/87	170	12	1.0			
05/08/87	230	7	1.0			
05/11/87	240	23	1.0			
05/13/87	250	23	1.0			
05/22/85			1.0			
06/02/87	350	21	1.0			
06/09/87	230	14	1.0			
06/11/87	210	19	1.0			
06/23/87	270	10	1.0			
06/29/87	110	8	1.0			
07/06/87	270	7	1.0			
07/14/87	260	7	1.0			
07/27/87	200	31	1.0			
07/29/87	200	30	1.0			
08/05/87	300	16	1.0			
08/06/87	330	9	1.0			
08/10/87	275	18	1.0			
08/15/87	300	12	1.0			
08/18/87	350	8	1.0	6.7		
08/20/87	290	11	1.0			
08/22/87	150	10	1.0	2.6		
08/24/87	350	7	1.0			
08/26/87	200	5	1.0			
08/28/87	270	12	1.0			
08/31/87	160	8	1.0	3.9		
09/04/87	40	12	1.0			
09/08/87	210	5	1.0	2.8		
09/10/87	60	7	1.0			
09/11/87	50	10	1.0			
09/16/87	330	14	1.0			
09/17/87	110	7	1.0			

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
09/18/87	230	10	1.0	3.7		
09/21/87	130	5	1.0	1.7		
09/24/87	190	14	1.0			
09/28/87	220	10	1.0	4.6		
09/30/87	230	10	1.0			
10/14/87	280	7	1.0			
10/19/87	60	10	1.0			
10/20/87	100	5	1.0	3.3		
10/22/87	230	8	1.0	3.7		
10/26/87	205	7	1.0	4.4		
10/28/87	350	15	1.0	2.8		
11/02/87	330	7	1.0			
11/04/87	150	7	1.0	3.5		
11/17/87	250	12	1.0	2.8		
11/18/87	230	20	1.0			
12/15/87	270	6	1.0			
12/17/87	20	14	1.0			
01/04/88	165	10	1.0	3.3		
01/12/88	230	22	1.0			
01/19/88	280	17	1.0			
01/21/88	310	26	1.0			
02/01/88	40	16	1.0			
02/02/88	330	28	1.0			
02/04/88	250	18	1.0			
02/19/88	350	24	1.0			
02/22/88	40	10	1.0			
02/24/88	220	7	1.0			
03/08/88	330	10	1.0	2.8		
03/11/88	240	5	1.0	5.2		
03/15/88	50	25	1.0			
03/17/88	100	10	1.0	3.6		
03/31/88	20	7	1.0			
04/01/88	260	15	1.0			
04/11/88	220	7	1.0			
04/13/88	180	12	1.0			
04/18/88	210	5	1.0	4.7		
04/25/88	160	7	1.0			
05/10/88	180	20	1.0			
05/11/88	180	17	1.0			
05/24/88	280	6	1.0	6.7		
05/26/88	240	21	1.0			
06/13/88	90	8	1.0			
07/08/88	200	5	1.0	0.7		
07/18/88	350	9	1.0			

DATE	WIND DIRECTION (degrees)	WIND SPEED (knots)	DISTANCE FROM VENT (km)	PLUME WIDTH SO ₂ (km)	PLUME WIDTH CO ₂ (km)	PLUME THICKNESS (m)
07/20/88	240	15	1.0			
07/27/88	270	17	1.0			
08/02/88	40	10	1.0			
08/04/88	240	20	1.0			
08/09/88	250	21	1.0			
08/10/88	260	15	1.0			
08/15/88	270	8	1.0			
08/17/88	200	20	1.0			
08/24/88	180	22	1.0			
08/29/88			1.0			
08/31/88	210	7	1.0	5.8		
09/06/88	260	11	1.0			