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Cloud Fraction, Layer, and Direction of Movement Results From Sky Cameras During the FIRE IFO Coffeyville, Kansas, Experiment For the Period November 12 Through December 9, 1991

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Cloud Fraction, Layer, and Direction of Movement Results From Sky Cameras During the FIRE IFO Coffeyville, Kansas Experiment For the Period November 12 Through December 9, 1991

by

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SUMMARY

Tables and figures are presented which show local site observations of cloud fractions, the number of cloud layers, direction of movement, and precipitation data collected during the FIRE (First ISCCP Regional Experiment) Phase II Cirrus Intensive Field Observations (IFO) conducted in Coffeyville, Kansas during November and December, 1991. Selected data are also presented at the times of the TIROS Operational Vertical Sounder (TOVS) satellite overpass.

INTRODUCTION

Several major scientific projects have used surface-based observations of clouds to compare directly with those being observed from satellites. Characterizing the physical properties of clouds is extremely useful in obtaining a more accurate analysis of the effect of clouds and their movements on weather and climate. It is the purpose of this paper to report data collected during the FIRE Phase II IFO experiment and to provide a brief history of such a surface-based system and the technical information required for recording local cloud parameters. The observations were taken from images recorded by both the 180° FOV All-Sky and the 5° FOV Overhead cloud camera systems. Information of this type is useful in analyzing other types of cloud and meteorological data.

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MEASUREMENT SYSTEM

PREVIOUS METHOD - In 1989 a video-based system was developed to record cloud movements and their properties (Purgold and Whitlock, 1990). The system was developed around off-the-shelf, state-of-the-art video equipment. Early development tests used a camera and fish-eye lens aimed directly skyward. Preliminary experiments showed this configuration to be somewhat limited, as the camera's view could be severely distorted by small rain droplets, dew, or other contaminants falling on the lens. This upward-looking optical approach also required frequent cleaning of the lens to minimize these unwanted effects. Subsequently, a different design was adopted which featured an inverted camera mounted on a tripod, which looked downward on a dome shaped reflector as shown in figure 1. This arrangement, called the All-Sky camera, allowed the recording of cloud movements even under poor conditions such as in moderate rain. The configuration virtually eliminated all of the problems previously associated with the fish-eye lens setup. The tripod and camera were visible within the field-of-view (FOV), however, this was not a problem in meeting the original objective of measuring cloud movement, type, and layering characteristics.

PRESENT DESIGN - In the present All-Sky cloud monitoring system, the video cassette recorder and 180° plastic dome remained unchanged. The camera support tripod was replaced by a single support arm as shown in figure 2 to clean up the All-Sky image. Although the camera and single support arm are still visible in the FOV, this is a necessary tradeoff for the advantages offered by the inverted-camera approach. A second cloud recording system was added to complement the All-Sky cloud imaging system. The design for this system was driven by the need to monitor overhead cloud movements more precisely. The Overhead cloud camera system consists of a single down-looking camera and an acrylic mirror similar to the All-Sky system. The Overhead camera and its support arm are not visible within the narrow 35° FOV due to the offset design as shown in figure 3. This configuration provides a more detailed view of this smaller area of interest directly above the site as shown by comparing figures 4 and 5.

ELECTRONIC COMPONENTS - The All-sky and Overhead cloud imaging systems each employ a charge-coupled device (CCD) video camera with a 28-mm auto-iris lens. The All-Sky system uses a hemispherical dome mirror, while the Overhead system employs a slightly convex mirror. The electronic hardware consists of a time-lapse video cassette recorder, camera power supply, and video monitor for each of the cloud imaging systems. The electronic equipment is normally located in an indoor environment within 500 feet of the camera/dome setup. The camera/dome is located outside and should avoid any physical structures which may block the horizon-view of the All-Sky camera. Long term recording of video images of cloud movements is accomplished through the use of a Panasonic AG-6050 time-lapse recorder as shown in figure 6. This recorder uses standard VHS video cassettes, but records in its own unique time-lapse format. Images recorded in the time-lapse format are easily copied to any standard VHS video cassette recorder for later viewing. The AG-6050 uses a standard 2-hour VHS cassette which allows recording capacities from 2 to 480 hours in eight steps. The 480-hour range allows one image to be recorded every 4 seconds and has proven to be the most effective time format for recording cloud movements. The AG-6050 has special provisions for programming its turn-on and turn-off time, allowing cloud data to be recorded for up to 30 days by programming the recorder to sleep during non-daylight hours. The solid state CCD video camera shown in figure 7 was selected for its small size and automatic gain control features. Equally important is the auto-iris lens which automatically compensates for the wide range of light levels encountered during a normal 12 to 14 hour recording period. The combination of auto-iris lens and the automatic gain control enables the camera to adjust instantly to a wide range of light levels from early dawn or overcast conditions to direct sunlight.

DATA DESCRIPTION

Both All-Sky and Overhead cloud imaging systems were deployed in support of the FIRE Phase II IFO experiment conducted in Coffeyville, Kansas, from November 12 through December 9, 1991. The systems were positioned at the Coffeyville Municipal Airport Site A. The imaging systems were installed on an elevated platform to allow an unobstructed view of the hemisphere to within 10° of the horizon. The elevated position prevented local site activity and obstructions from interfering with the camera's view and provided a small measure of physical security for the systems. Surface heaters were affixed to the underside of the acrylic mirrors to aid in the removal of condensation such as frost or snow which could be expected during winter conditions. The surface temperature of each mirror surface was maintained between 10°C and 20°C by controlling the heater voltage with a simple variable AC power supply. The mirrors were cleaned by hand once a week as a prudent operational procedure.

Table 1 chronicles Site A observations, cloud fractions, the number of cloud layers, direction of movement, and precipitation at the times of the TIROS Operational Vertical Sounder (TOVS) satellite overpass. The observations were taken from images recorded by both the 180° FOV All-Sky and the 35° FOV Overhead cloud camera systems. Note the cloud fraction differences listed in table 1 on 11/17/91. The All-Sky image indicates 5/10 cloud fraction over the hemisphere, while the Overhead image indicates a clear-sky condition overhead. Variable conditions of this type show the need to monitor both the all-sky cloud cover and the conditions directly above the instrument site. Figure 8 shows digitally derived cloud fraction values from the Overhead camera for TOVS overpass times.

Table 2 chronicles hourly observations taken during daylight hours by the All-Sky camera. As noted previously, these values are representative of the local hemisphere rather than the area directly above the Coffeyville experiment site. Overhead camera observations taken during daylight hours are shown in figure 9.

REFERENCE

Purgold, G. C., and Whitlock, C. H.: A System for Recording Physical Properties of Clouds. (Presented at the FIRE Science Team Meeting, Monterey, California, July 10-14, 1989.) NASA CP-3079, 1990, pp 467-471.

Table 1. CLOUD OBSERVATIONS AT AFTERNOON TOVS OVERPASS TIMES.

		ALL-SKY CAMERA				OVERHEAD CAMERA
DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT	CLOUD CONDITIONS DIRECTLY ABOVE SITE
11/13/91	2015	9/10	1	W	NO	OVERCAST
11/14/91	2004	10/10	2	LOWEST-S UPPER-SW	NO	OVERCAST
11/16/91	2120	10/10	1	S	YES	OVERCAST
11/17/91	2109	5/10	1	S	NO	CLEAR
11/18/91	2057	CLEAR	0		NO	CLEAR
11/19/91	2045	9/10	3	LOWEST - NNW MIDDLE - SW UPPER - S	NO	OVERCAST
11/20/91	2033	CLEAR	0		NO	CLEAR
11/21/91	2021	CLEAR	0		NO	CLEAR
11/22/91	2009	9/10	1	SW	NO	OVERCAST
11/25/91	2125	1/10	1	STATIONARY	NO	CLEAR
11/26/91	2103	10/10	1	SW	NO	OVERCAST
11/27/91	2051	10/10	1	S	NO	OVERCAST

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 1. CLOUD OBSERVATIONS AT AFTERNOON TOVS OVERPASS TIMES.

		ALL-SKY CAMERA				OVERHEAD CAMERA
DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT	CLOUD CONDITIONS DIRECTLY ABOVE SITE
11/28/91	2039	8/10	2	LOWEST - SW UPPER - W	NO	4/10
11/29/91	2027	10/10	1	SW	YES	OVERCAST
11/30/91	2015	10/10	2	UPPER - SW LOWEST- N	NO	OVERCAST
12/01/91	2004	* FREEZING RAIN EVENT / DOME OBSCURRED			UNKNOWN	OVERCAST
12/03/91	2121	CLEAR	0		NO	CLEAR
12/04/91	2109	CLEAR	0		NO	CLEAR
12/05/91	2057	9/10	1	W	NO	OVERCAST
12/06/91	2045	2/10	1	SW	NO	1/10
12/07/91	2033	1/10	1	S	NO	1/10
12/08/91	2021	1/10	1	SW	NO	CLEAR

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/12/91	1300	10/10	1	W	NO
	1400	10/10	1	W	NO
	1500	10/10	1	WSW	NO
	1600	10/10	1	S	NO
	1700	9/10	1	S	NO
	1800	5/10	1	SSW	NO
	1900	N/A	N/A	N/A	N/A
	2000	N/A	N/A	N/A	N/A
	2100	N/A	N/A	N/A	N/A
	2200	N/A	N/A	N/A	N/A
	2300	N/A	N/A	N/A	N/A
11/13/91	1300	5/10	1	W	NO
	1400	5/10	1	W	NO
	1500	5/10	1	W	NO
	1600	5/10	1	W	NO
	1700	5/10	1	W	NO
	1800	3/10	1	W	NO
	1900	7/10	1	W	NO
	2000	9/10	1	W	NO
	2100	9/10	2	LOWEST - S UPPER - SW	NO
	2200	9/10	2	LOWEST - S UPPER - SW	NO
	2300	9/10	2	LOWEST - S UPPER - SW	NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/14/91	1300	10/10	2	S	START-13:20
	1400	10/10	2	S	YES
	1500	10/10	2	S	YES
	1600	10/10	2	LOWEST - S UPPER - SW	END-16:18
	1700	9/10	2	LOWEST - S UPPER - SW	NO
	1800	9/10	2	LOWEST - S UPPER - SW	NO
	1900	10/10	2	LOWEST - S UPPER - SW	START-19:30,END-19:50
	2000	10/10	2	LOWEST - S UPPER - SW	START-20:21
	2100	10/10	1	SSW	YES
	2200	10/10	1	SSW	YES
	2300	10/10	1	SSW	END-AFTER DARK
11/15/91	1300	N/A	N/A	N/A	N/A
	1400	N/A	N/A	N/A	N/A
	1500	N/A	N/A	N/A	N/A
	1600	N/A	N/A	N/A	N/A
	1700	N/A	N/A	N/A	N/A
	1800	10/10	1	N	NO
	1900	10/10	1	N	NO
	2000	10/10	1	N	NO
	2100	10/10	1	N	NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/15/91	2200	10/10	1	N	NO
	2300	10/10	1	N	NO
11/16/91	1300	10/10	2	LOWEST - E	START-BEFORE DAWN
				UPPER - SSE	YES
	1400	10/10	2	LOWEST - E	END-14:00
				UPPER - S	
	1500	9/10	2	LOWEST - E	NO
				UPPER - S	
	1600	10/10	2	LOWEST - E	START-16:50,END-17:00
				UPPER - S	
	1700	9/10	2	LOWEST - E	START-17:38
				UPPER - S	
	1800	10/10	1	ENE	END-18:00
	1900	10/10	1	ENE	NO
	2000	10/10	1	S	START-20:27
	2100	10/10	1	S	YES
	2200	10/10	1	S	YES
	2300	10/10	1	S	END-AFTER DARK
11/17/91	1300	10/10	2	LOWEST - S	NO
				UPPER - SW	
	1400	8/10	2	LOWEST - S	NO
				UPPER - SW	
	1500	8/10	2	LOWEST - S	NO
				UPPER - SW	
	1600	8/10	2	LOWEST - S	NO
				UPPER - SW	

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/17/91	1700	8/10	2	LOWEST - S UPPER - SW	NO
	1800	7/10	1	SSW	NO
	1900	7/10	1	S	NO
	2000	6/10	1	S	NO
	2100	5/10	1	S	NO
	2200	3/10	1	S	NO
	2300	CLEAR	0		NO
11/18/91	1300	CLEAR	0		NO
	1400	CLEAR	0		NO
	1500	CLEAR	0		NO
	1600	CLEAR	0		NO
	1700	CLEAR	0		NO
	1800	1/10	1	S	NO
	1900	CLEAR	0		NO
	2000	CLEAR	0		NO
	2100	CLEAR	0		NO
	2200	CLEAR	0		NO
	2300	CLEAR	0		NO
11/19/91	1300	9/10	2	LOWEST - SSW	NO
	1400	10/10	2	LOWEST - SSW	START-14:14
	1500	10/10	1	SSW	END-15:40
	1600	9/10	2	LOWEST - SSW	START-16:30
	1700	10/10	2	LOWEST - SSW	YES
	1800	10/10	1	SSW	YES
	1900	10/10	2	LOWEST - SW	YES

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/19/91	2000	10/10	2	LOWEST - SW	END-19:20
	2100	9/10	3	LOWEST - NNW MIDDLE - SW UPPER - S	NO
	2200	10/10	2	LOWEST - SW	NO
	2300	10/10	2	LOWEST - SW	NO
11/20/91	1300	7/10	1	NE	NO
	1400	7/10	1	NE	NO
	1500	7/10	1	NE	NO
	1600	5/10	1	N	NO
	1700	1/10	1	NNE	NO
	1800	1/10	1	W	NO
	1900	CLEAR	0		NO
	2000	CLEAR	0		NO
	2100	CLEAR	0		NO
	2200	CLEAR	0		NO
	2300	CLEAR	0		NO
11/21/91	1300	CLEAR	0		NO
	1400	CLEAR	0		NO
	1500	CLEAR	0		NO
	1600	CLEAR	0		NO
	1700	CLEAR	0		NO
	1800	CLEAR	0		NO
	1900	CLEAR	0		NO
	2000	CLEAR	0		NO
	2100	CLEAR	0		NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/21/91	2200	3/10	1	W	NO
	2300	3/10	1	W	NO
11/22/91	1300	9/10	1	W	NO
	1400	9/10	1	SW	NO
	1500	10/10	1	SW	NO
	1600	10/10	1	SSW	NO
	1700	10/10	1	SSW	NO
	1800	10/10	1	S	NO
	1900	9/10	1	SW	START-19:20,END-19:40
	2000	9/10	1	SW	START-20:47
	2100	9/10	1	SW	END-21:00
	2200	9/10	1	WSW	NO
	2300	10/10	1	SW	NO
11/23/91	1300	1/10	1	NW	NO
	1400	1/10	1	NW	NO
	1500	CLEAR	0		NO
	1600	CLEAR	0		NO
	1700	CLEAR	0		NO
	1800	5/10	1	NW	NO
	1900	6/10	1	NW	NO
	2000	7/10	1	NW	NO
	2100	7/10	1	NW	NO
	2200	7/10	1	NW	NO
	2300	7/10	1	NW	NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/24/91	1300	CLEAR	0		NO
	1400	CLEAR	0		NO
	1500	CLEAR	0		NO
	1600	CLEAR	0		NO
	1700	CLEAR	0		NO
	1800	CLEAR	0		NO
	1900	CLEAR	0		NO
	2000	1/10	1	NW	NO
	2100	CLEAR	0		NO
	2200	3/10	1	NW	NO
	2300	3/10	1	NW	NO
11/25/91	1300	9/10	1	NW	NO
	1400	9/10	1	NW	NO
	1500	9/10	1	NW	NO
	1600	10/10	1	NNW	NO
	1700	9/10	1	NW	NO
	1800	9/10	1	WNW	NO
	1900	2/10	1	WNW	NO
	2000	1/10	1	WNW	NO
	2100	1/10	1	STATIONARY	NO
	2200	2/10	1	W	NO
	2300	2/10	1	W	NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/26/91	1300	CLEAR	0		NO
	1400	CLEAR	0		NO
	1500	CLEAR	0		NO
	1600	2/10	1	W	NO
	1700	3/10	1	W	NO
	1800	9/10	1	W	NO
	1900	8/10	1	W	NO
	2000	10/10	2	LOWEST - SW	NO
	2100	10/10	2	LOWEST - SW	NO
	2200	10/10	2	LOWEST - SW	NO
	2300	4/10	2	LOWEST - SW	NO
11/27/91	1300	3/10	1	SW	NO
	1400	3/10	1	SW	NO
	1500	10/10	1	S	NO
	1600	10/10	1	S	NO
	1700	10/10	1	S	NO
	1800	10/10	1	S	NO
	1900	10/10	1	S	NO
	2000	10/10	1	S	NO
	2100	10/10	1	S	NO
	2200	10/10	1	S	NO
	2300	10/10	1	S	NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/28/91	1300	9/10	2	LOWEST - S UPPER - W	NO
	1400	9/10	2	LOWEST - S UPPER - W	NO
	1500	10/10	2	LOWEST - S UPPER - W	NO
	1600	9/10	2	LOWEST - S UPPER - W	NO
	1700	9/10	2	LOWEST - SW UPPER - W	NO
	1800	9/10	2	LOWEST - SW UPPER - W	NO
	1900	8/10	2	LOWEST - SW UPPER - W	NO
	2000	8/10	2	LOWEST - SW UPPER - W	NO
	2100	8/10	2	LOWEST - SW UPPER - W	NO
	2200	8/10	2	LOWEST - SW UPPER - W	NO
	2300	8/10	2	LOWEST - SW UPPER - W	NO
11/29/91	1300	10/10	1	S	NO
	1400	10/10	1	S	NO
	1500	10/10	1	S	NO
	1600	10/10	1	S	NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
11/29/91	1700	10/10	1	S	START-17:50
	1800	10/10	1	S	YES
	1900	10/10	1	S	YES
	2000	10/10	1	SW	YES
	2100	10/10	1	SW	END-21:18
	2200	4/10	1	SW	NO
	2300	CLEAR	0		NO
11/30/91	1300	8/10	2		NO
	1400	8/10	2		NO
	1500	8/10	2	LOWEST - N UPPER - W	NO
	1600	8/10	2	LOWEST - N UPPER - SW	NO
	1700	8/10	2	LOWEST - N UPPER - SW	NO
	1800	10/10	2	LOWEST - N UPPER - SW	NO
	1900	10/10	1	S	NO
	2000	10/10	1	S	NO
	2100	10/10	1	S	NO
	2200	10/10	1	S	NO
	2300	10/10	1	S	NO
12/01/91	1300	8/10	2	LOWEST-ENE UPPER-ESE	NO
	1400	8/10	2	LOWEST-ENE UPPER-ESE	NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
12/01/91	1500	9/10	1	W	NO
	1600	10/10	1	W	START-16:37
	1700	10/10	1	W	YES
	1800	* FREEZING RAIN EVENT / DOME OBSCURRED			YES
	1900	* FREEZING RAIN EVENT / DOME OBSCURRED			END-19:20
	2000	* FREEZING RAIN EVENT / DOME OBSCURRED			UNKNOWN
	2100	* FREEZING RAIN EVENT / DOME OBSCURRED			UNKNOWN
	2200	* FREEZING RAIN EVENT / DOME OBSCURRED			UNKNOWN
	2300	* FREEZING RAIN EVENT / DOME OBSCURRED			UNKNOWN
12/02/91	1300	10/10	1	SW	START-12:30
	1400	10/10	1	SW	END-14:00
	1500	10/10	1	SW	NO
	1600	10/10	1	NW	NO
	1700	10/10	1	NW	NO
	1800	10/10	1	NW	NO
	1900	10/10	1	NW	NO
	2000	10/10	1	NW	NO
	2100	10/10	1	NW	NO
	2200	10/10	1	NNW	NO
	2300	10/10	1	NNW	NO
12/03/91	1300	5/10	1	W	NO
	1400	6/10	1	W	START-14:07
	1500	6/10	1	W	END-15:30
	1600	CLEAR	0		NO
	1700	CLEAR	0		NO
	1800	CLEAR	0		NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
12/03/91	1900	CLEAR	0		NO
	2000	CLEAR	0		NO
	2100	CLEAR	0		NO
	2200	CLEAR	0		NO
	2300	CLEAR	0		NO
12/04/91	1300	1/10	1	N	NO
	1400	1/10	1	N	NO
	1500	1/10	1	N	NO
	1600	CLEAR	0		NO
	1700	CLEAR	0		NO
	1800	CLEAR	0		NO
	1900	CLEAR	0		NO
	2000	CLEAR	0		NO
	2100	CLEAR	0		NO
	2200	CLEAR	0		NO
	2300	CLEAR	0		NO
12/05/91	1300	CLEAR			NO
	1400	1/10	1	W	NO
	1500	CLEAR			NO
	1600	5/10	1	W	NO
	1700	5/10	1	W	NO
	1800	5/10	1	W	NO
	1900	5/10	1	W	NO
	2000	6/10	1	W	NO
	2100	9/10	1	W	NO
	2200	4/10	1	W	NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
12/05/91	2300	4/10	1	W	NO
12/06/91	1300	4/10	1	W	NO
	1400	8/10	1	W	NO
	1500	10/10	1	W	NO
	1600	4/10	1	W	NO
	1700	4/10	1	W	NO
	1800	3/10	1	W	NO
	1900	3/10	1	W	NO
	2000	3/10	1	W	NO
	2100	2/10	1	SW	NO
	2200	2/10	1	SW	NO
	2300	CLEAR	0		NO
12/07/91	1300	8/10	1	SSW	NO
	1400	8/10	1	SSW	NO
	1500	9/10	1	SSW	NO
	1600	8/10	1	SSW	NO
	1700	7/10	1	S	NO
	1800	3/10	1	S	NO
	1900	2/10	1	S	NO
	2000	2/10	1	S	NO
	2100	1/10	1	S	NO
	2200	1/10	1	S	NO
	2300	1/10	1	W	NO

*Human Observation Estimates From Viewing All-Sky Video Images.

Table 2. ALL-SKY CAMERA HOURLY OBSERVATIONS (Continued)

DATE	TIME (GMT)	APPROXIMATE* CLOUD FRACTION	MINIMUM NUMBER OF CLOUD LAYERS	DIRECTION OF MOVEMENT (FROM)	PRECIPITATION EVENT
12/08/91	1300	CLEAR	0		NO
	1400	1/10	1	SW	NO
	1500	1/10	1	SW	NO
	1600	CLEAR	0		NO
	1700	CLEAR	0		NO
	1800	CLEAR	0		NO
	1900	1/10	1	SW	NO
	2000	1/10	1	SW	NO
	2100	1/10	1	SW	NO
	2200	1/10	1	SW	NO
	2300	1/10	1	SW	NO
12/09/91	1300	6/10	1	SW	NO
	1400	6/10	1	SW	NO
	1500	4/10	1	SW	NO
	1600	CLEAR	0		NO
	1700	CLEAR	0		NO
	1800	CLEAR	0		NO

*Human Observation Estimates From Viewing All-Sky Video Images.

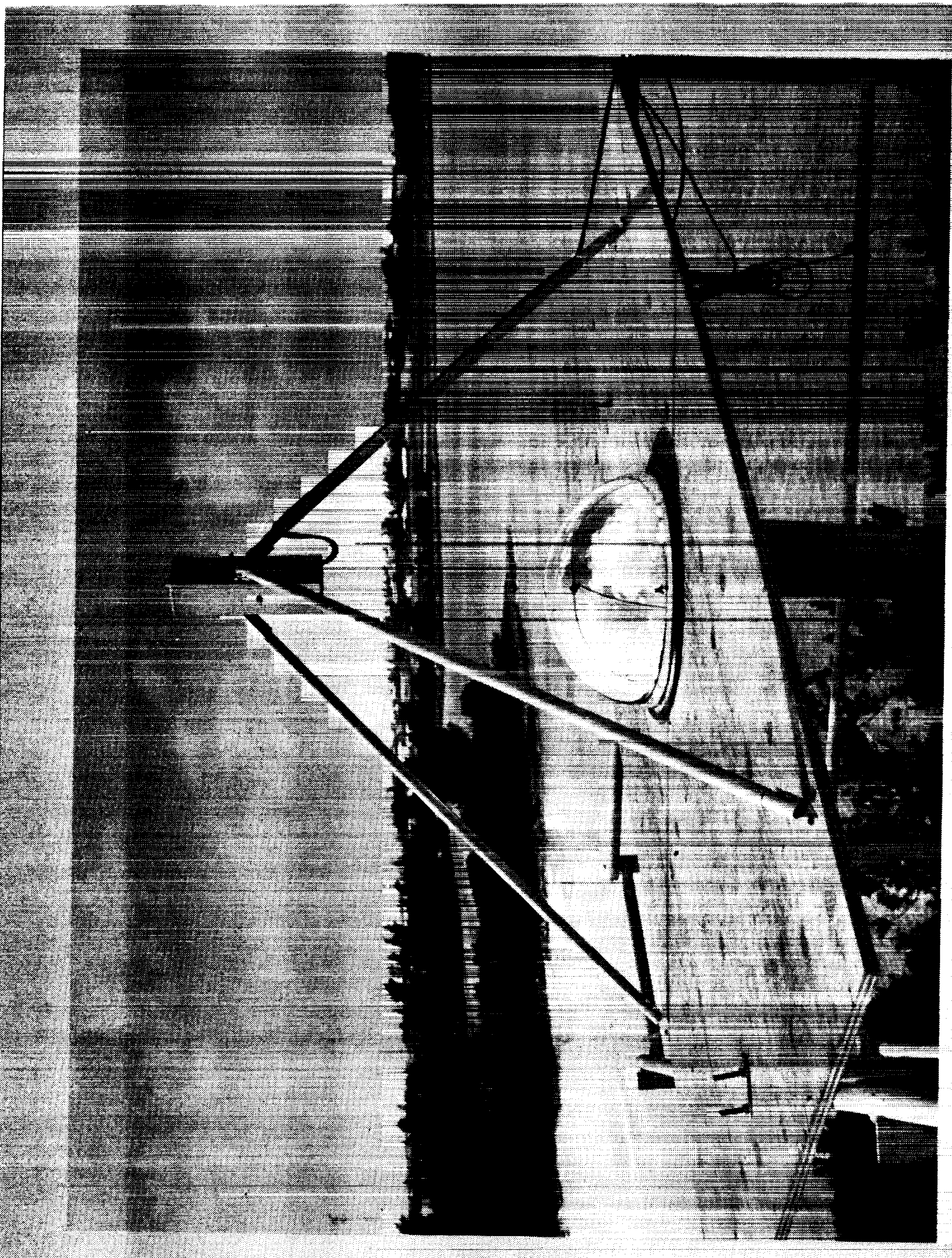

Figure 1. All-Sky Camera System using a tripod supported inverted camera and acrylic dome reflector.

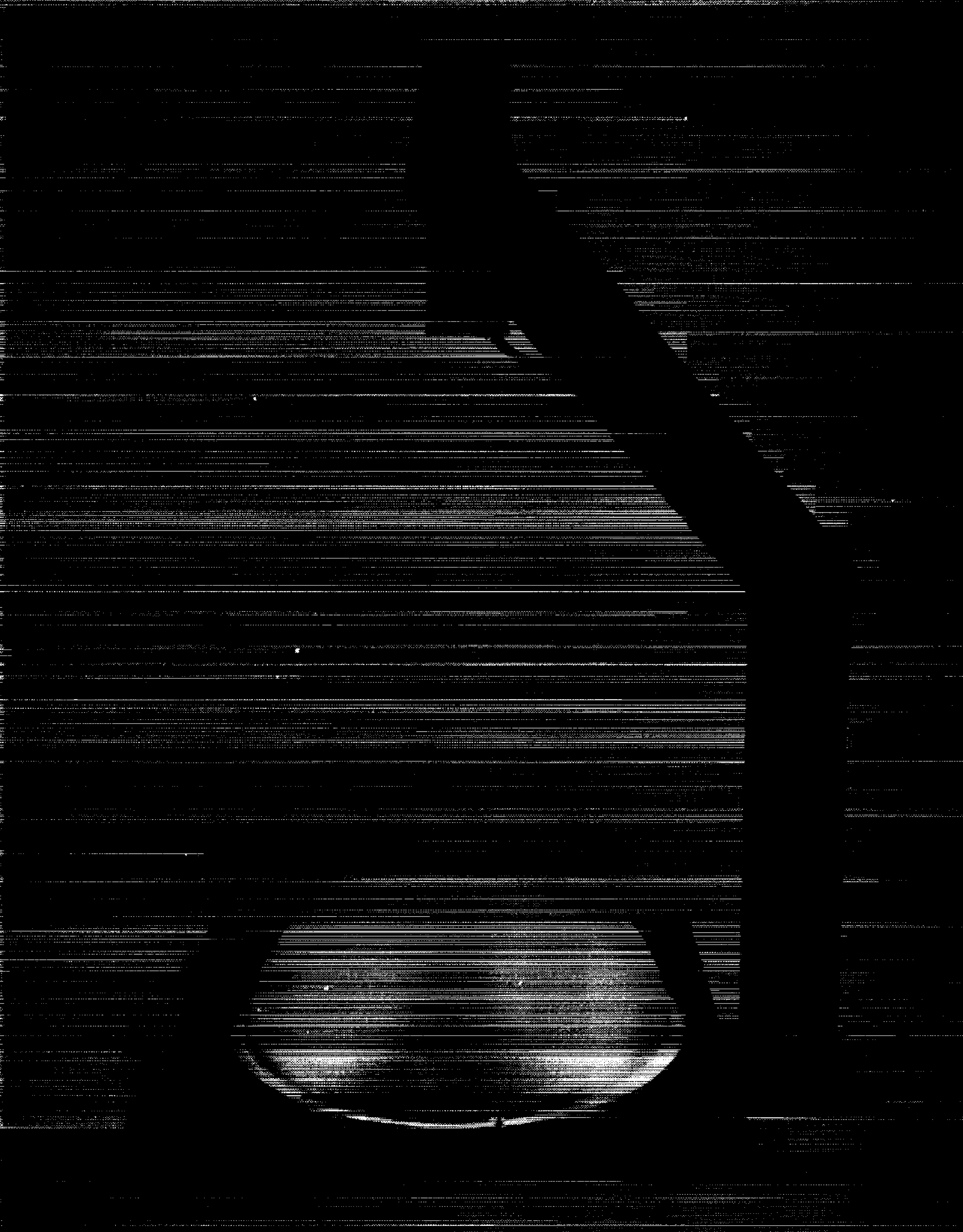

Figure 2. Improved All-Sky Camera System using a single camera support arm and heated mirrored-dome reflector.

Figure 3. Overhead Camera System showing the off-set camera design and the heated acrylic reflector.

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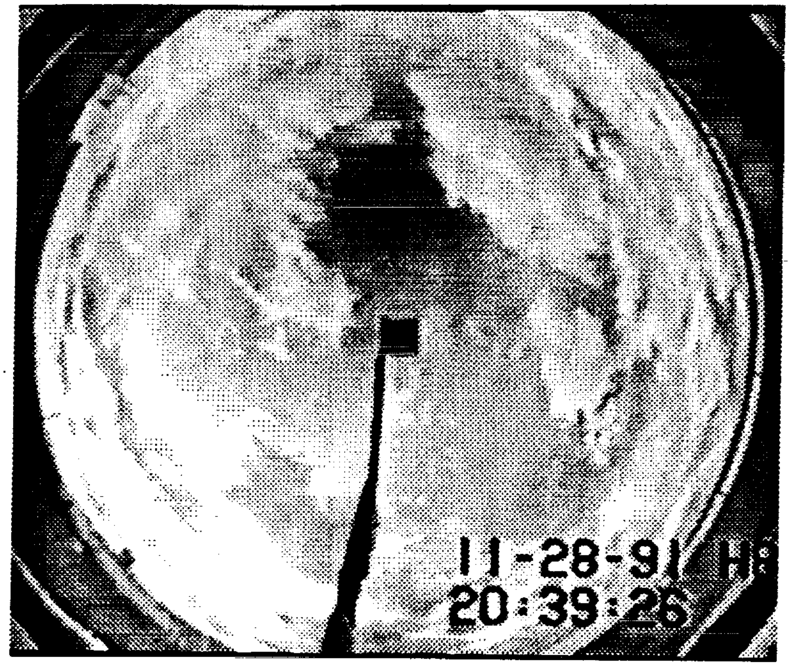


Figure 4. Typical All-Sky Camera image over Coffeyville Airport Site A synchronized with the Overhead Camera image shown in figure 5.

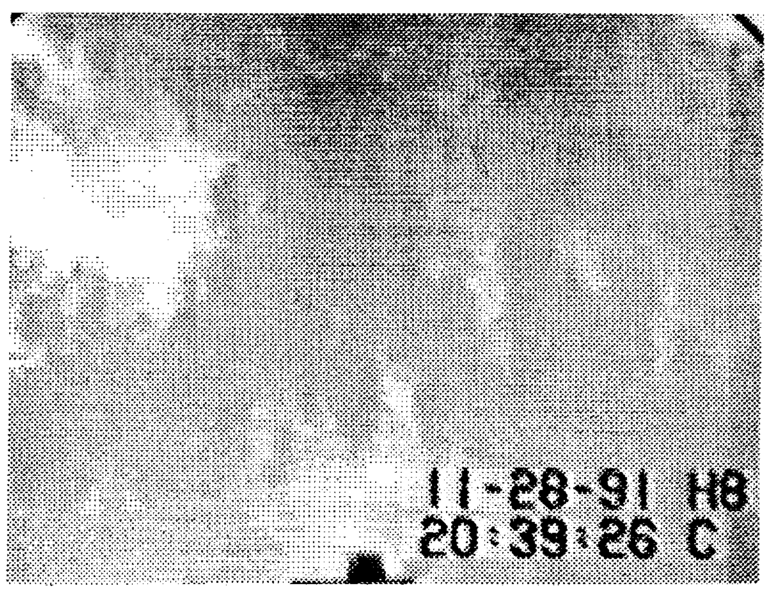


Figure 5. Typical Overhead Camera image over Coffeyville Airport Site A synchronized with the All-Sky Camera image shown in figure 4.

Figure 6. Panasonic Time Lapse Video Recorder Model AG-6050, used to record cloud images from the cloud camera systems.

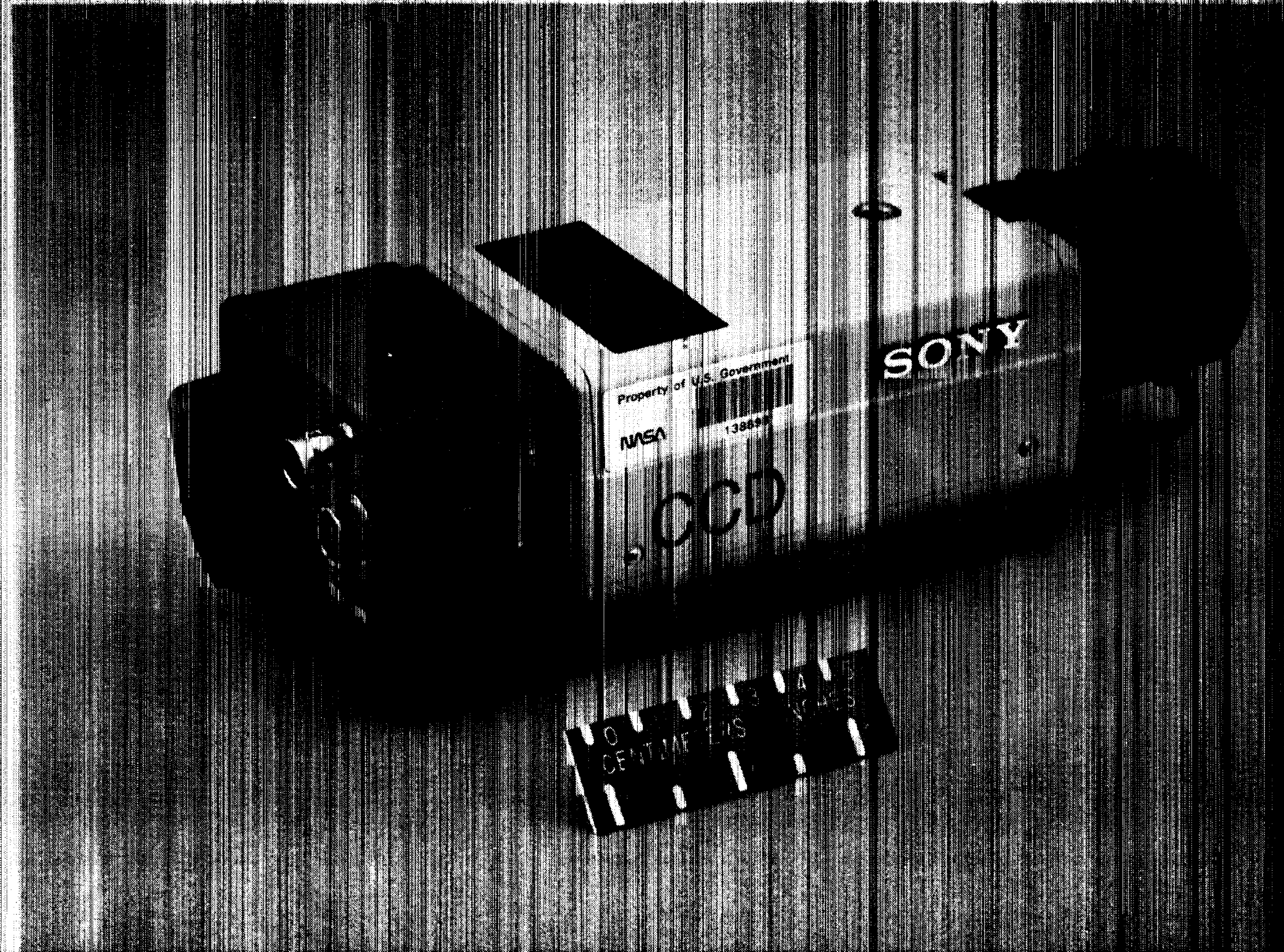


Figure 7. Sony Solid State Video Camera Model DXC-101 with Auto-Iris Lens, used to obtain cloud images over a wide range of light conditions.

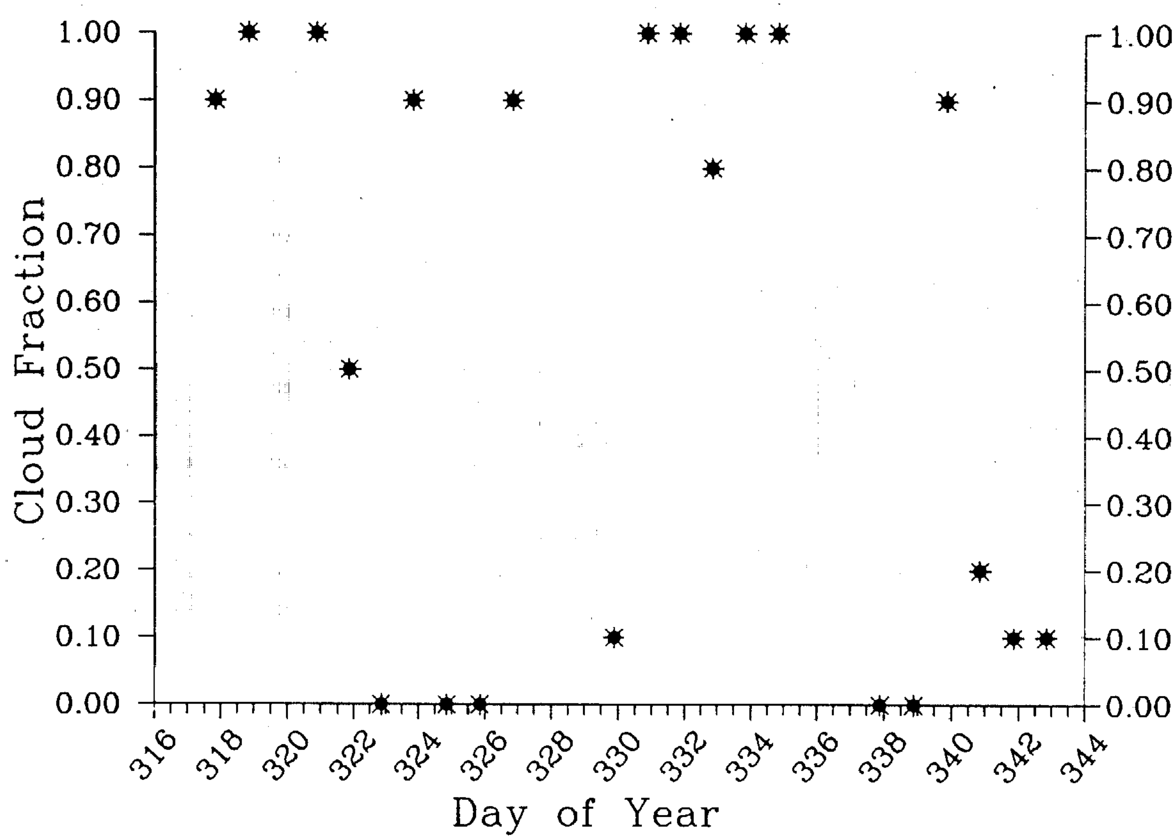


Figure 8. Cloud Fraction at NOAA-11 Overpass.
NASA LaRC / SRB Overhead View Sky Imager System
FIRE Phase II IFO Experiment Coffeyville, Kansas
November – December 1991.

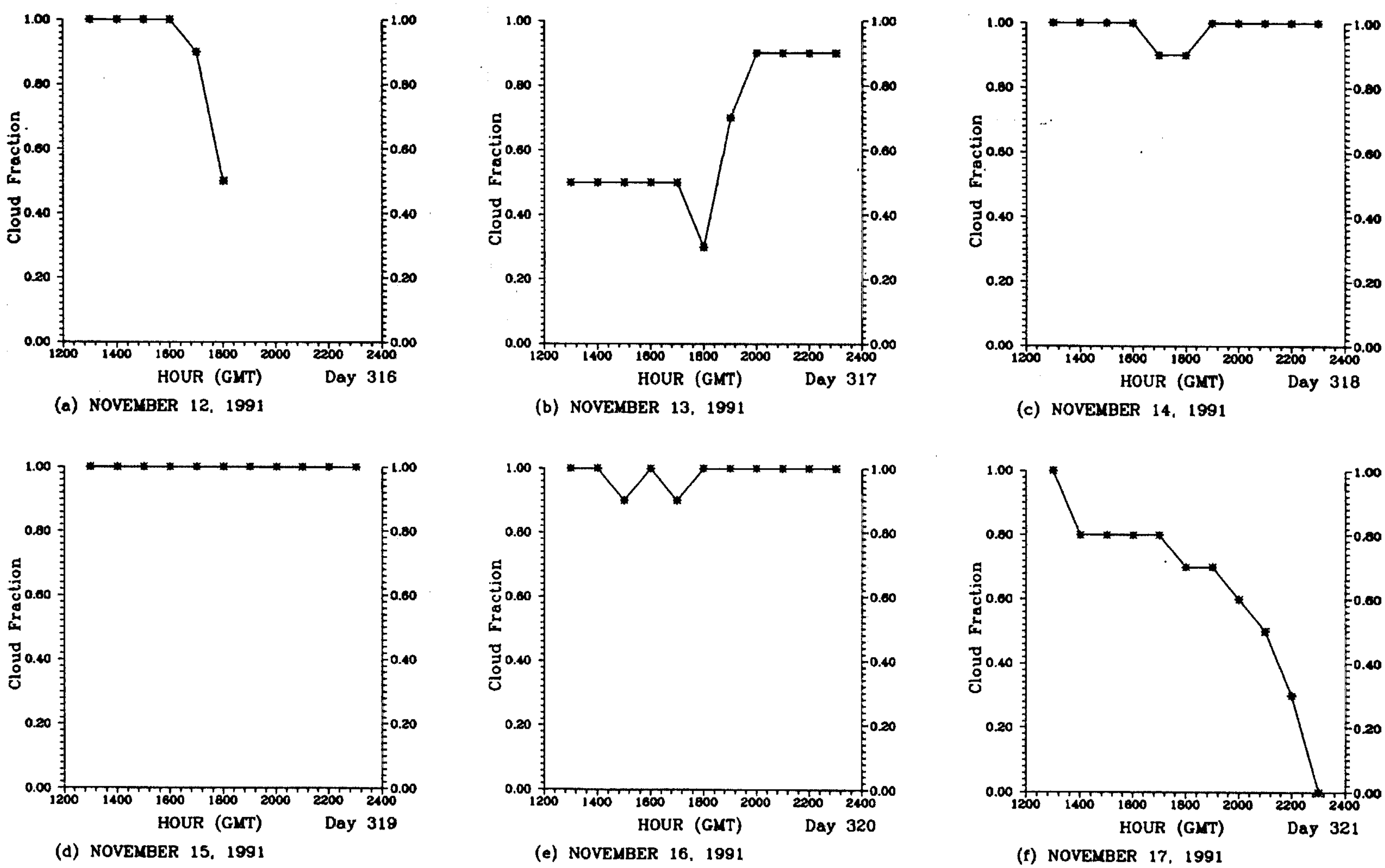


Figure 9. Daily cloud fraction for FIRE Phase II IFO experiment Coffeyville, Kansas November – December 1991.

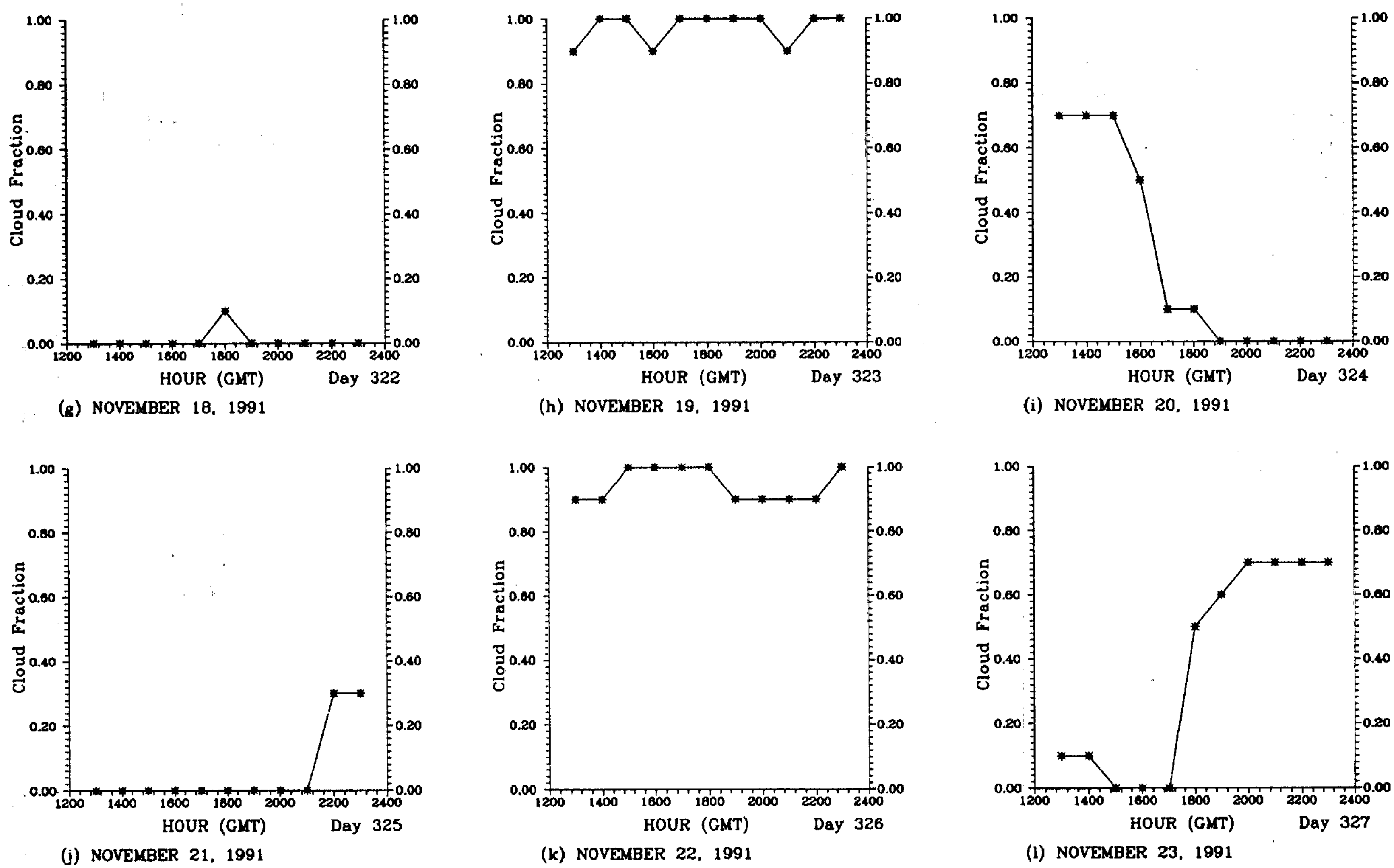


Figure 9. Continued.

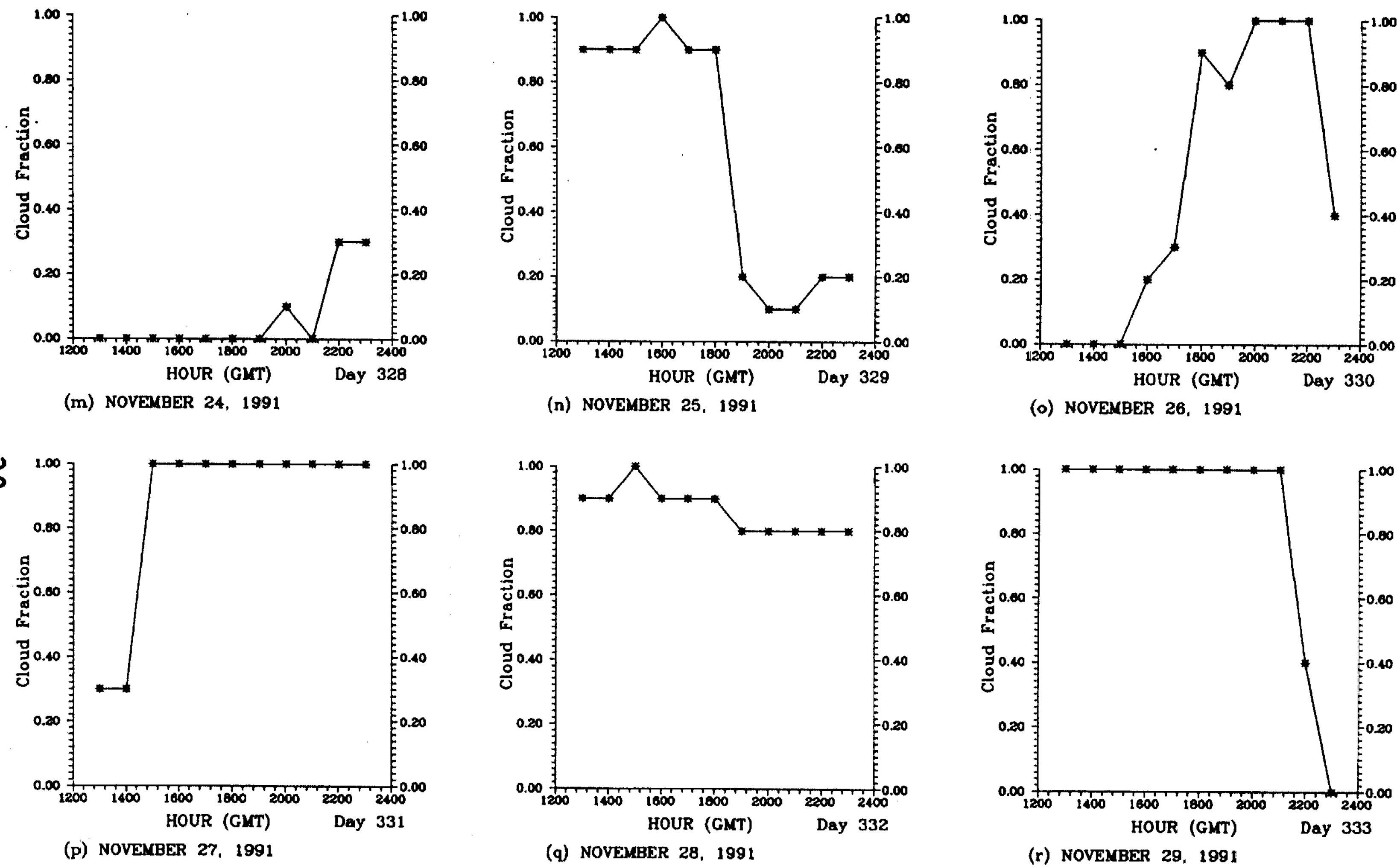
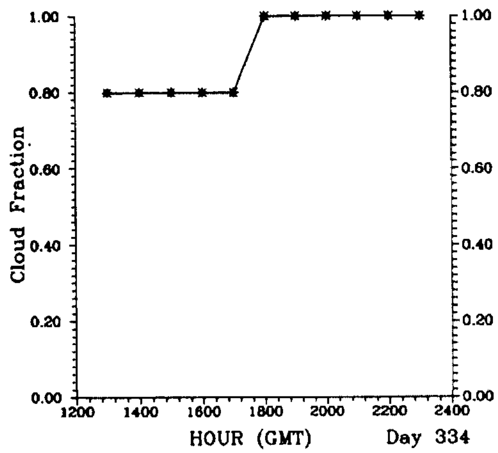
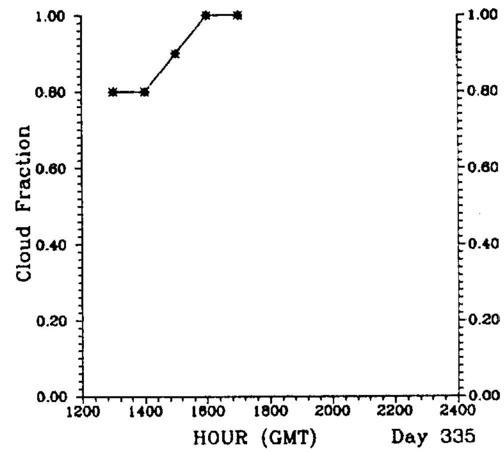


Figure 9. Continued.



(s) NOVEMBER 30, 1991



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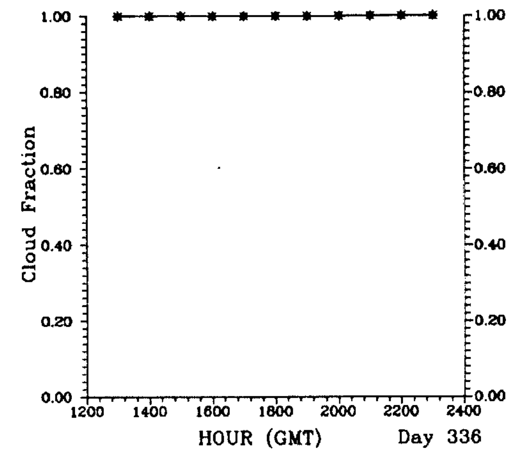

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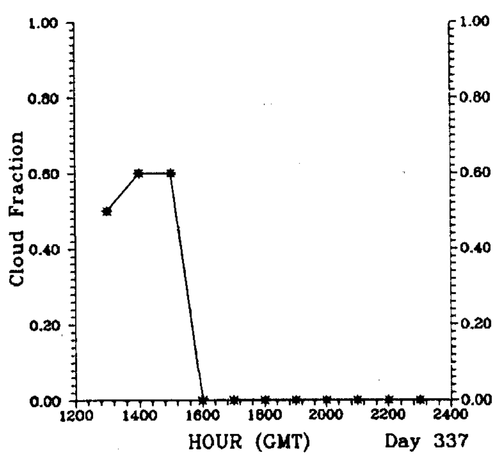

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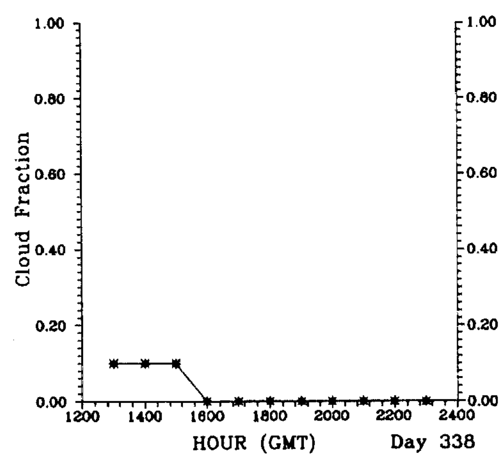

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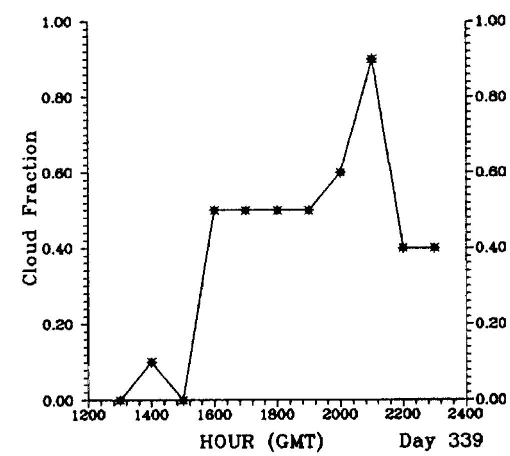

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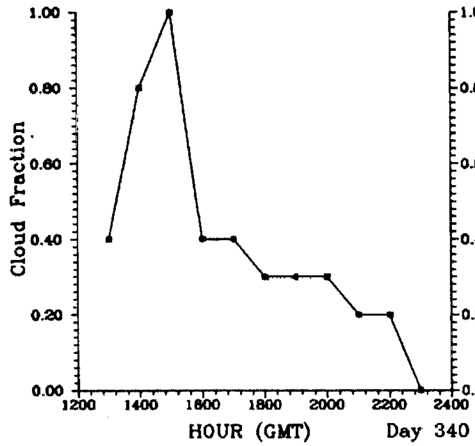
Figure 9. Continued.



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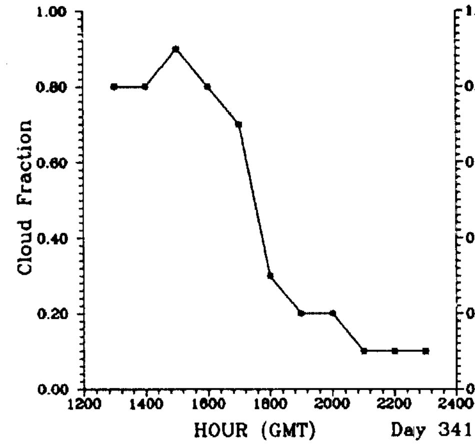

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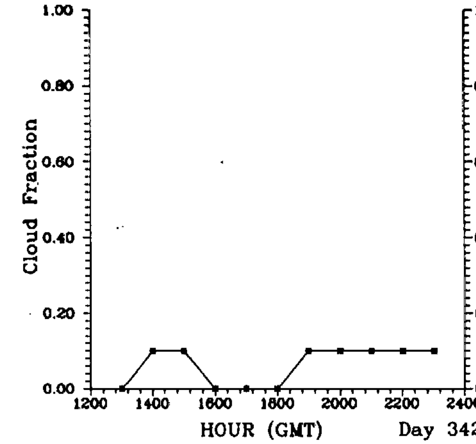

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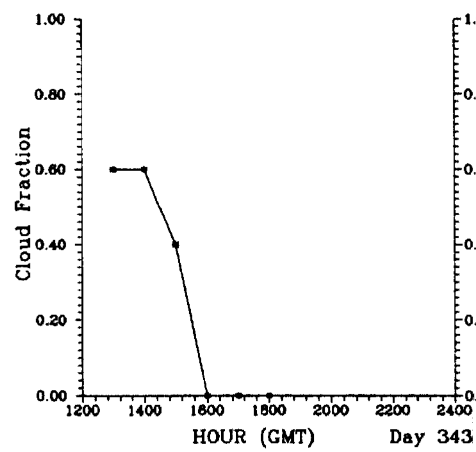

(ab) DECEMBER 9, 1991

Figure 9. Concluded.

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13. ABSTRACT *(Maximum 200 words)*

Tables and figures are presented which show local site observations of cloud fractions, the number of cloud layers, direction of movement, and precipitation data collected during the FIRE (First ISCCP Regional Experiment) Phase II Cirrus Intensive Field Observations (IFO), conducted in Coffeyville, Kansas during November and December, 1991. Selected data are also presented at the times of the TIROS Operational Vertical Sounder (TOVS) satellite overpass.

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