AD-A055 264 MASSACHUSETTS INST OF TECH LEXINGTON LINCOLN LAB F/G 17/8
GEODSS EXPERIMENTAL TEST SYSTEM PARTICIPATION IN PROJECT EXCEDE--ETC(U)
MAR 78 D E BEATTY F19628-78-C-0002
UNCLASSIFIED ETS-33 ESD-TR-78-33 NL

END
DATE FILMED
7-78
DDC

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

LINCOLN LABORATORY

GEODSS EXPERIMENTAL TEST SYSTEM PARTICIPATION IN PROJECT EXCEDE

D. E. BEATTY

Group 94

PROJECT REPORT ETS-33

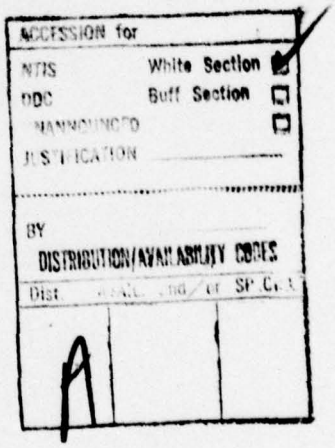
8 MARCH 1978

LEXINGTON MASSACHUSETTS

ABSTRACT

The GEODSS Exterimental Test System participated in Project EXCEDE in cooperation with and in response to a request by the Optical Physics Division of the Air Force Geophysics Laboratory (AFGL), OPR. The experiment involved tracking "the optical emissions induced in the atmosphere by an energetic electron source".[1]

Since the flight path of the electron aurora fell within the operational limits of the GEODSS system, the tracking mission was undertaken. Tracking was successful. Using both the 14" and the 31" telescopes, rate and position information was recorded on both digital magnetic tape and video tape. This data, along with several Polaroid photos (all of which will be used by the AFGL for data analysis) illustrate the atmospheric effects caused by the electron beam.



Contents

I. INTRODUCTION

This report on Project EXCEDE presents telescopic and positional observation of the atmospheric luminescence produced by high energy electrons from a rocketborne electron accelerator. The investigation of electron luminescence was part of a program sponsored by the Optical Physics Division of the Air Force Geophysics Laboratory (AFGL) OPR. The telescopic and positional data were taken at the GEODSS facilities operated by Lincoln Laboratory for the USAF at Stallion Range Center in White Sands Missile Range.

Part II of this report provides historical background for the project and also relevant background concerning the ability of the GEODSS facility to meet the project's need. Both predicted and actual sight-times and positions are discussed, and photographs along with a table of events are presented to substantiate the report.

Part III is a "how-to" section and specifies the step by step procedure which made for successful tracking and video recording of the aurora.

II. PROJECT EXCEDE

This project report is the result of observations of a low altitude research payload associated with the EXCEDE project. The observations were made from the GEODSS site in New Mexico employing both the 31" and 14" electro-optical sensors on day 347 (UT) of 1977.

Project EXCEDE was conducted under the direction of Robert R. O'Neil of the Optical Physics Division of the AFGL, OPR. The EXCEDE project was designed to investigate some of the chemical luminescence properties of the atmosphere. (For further information, see reference 1) Mr. O'Neil requested mission support by the GEODSS system to assist in observing the atmospheric luminescence that was expected to accompany the EXCEDE payload during its flight.

The EXCEDE payload was launched from the primary launch site on White Sands Missile Range (WSMR) aboard an Aerobee liquid fueled rocket. This primary launch site is located at the southern end of WSMR. The elevation and azimuth of the vehicle at launch were approximately 86° elevation and 044° azimuth. The low angular velocities produced by the northerly direction of the flight (almost directly at the GEODSS sensors) was one of the prime reasons that the deep space tracking sensors of the GEODSS system could be utilized to support the EXCEDE mission.

It should be noted here that the GEODSS system was developed to track mainly deep space object; i.e., objects with orbits greater than 5000 km from the earth and angular velocites of less than 2000 arc-sec/sec.

The flight path of the EXCEDE payload fell within the operational limits

of the GEODSS system, and therefore, the tracking mission was undertaken.

Because of the speed of the EXCEDE payload, manual tracking was utilized by the GEODSS operators. The apparent azimuth and elevation of the turn-on of the luminescence experiment were computed by Mr. O'Neil, utilizing our site coordinates along with 7 other positions along the payload's flight path. These locations and times are presented in Table 1a. The actual azimuth and elevation of the payload as observed during the flight at the calculated times are presented in Table 1b.

The primary reason for the differences between the predicted and actual azimuth and elevation was a shorter than expected burn from the aerobee booster.

The total time of the track from first sighting to termination of track was 3 min, 18 sec.

The range of the target at apogee to the GEODSS sensors has been computed to be ≈ 160 km. The altitude of the payload at apogee was ≈ 106 km.

The turn-on azimuth and elevation were entered into the GEODSS "B" system computer and were maintained automatically by the computer until T + 60 sec (T is launch time) at which time the telescope was brought under manual control. The first sighting of the payload, utilizing the full 7^{o} field of view (FOV) of the 14" sensor occurred at T + 108 sec. The payload was then moved into the 1^{o} FOV of the 31" sensor and was tracked manually for the duration of the mission in the 1^{o} FOV of the 31" sensor.

Figures 1a and 1b show Polaroid photographs of what was typically observed during the chemical luminescence portion of the EXCEDE mission as seen through the 31" sensor. Figures 2a and 2b illustrate the pulsed nature of the

TABLE 1a

PREDICTED LOCATIONS OF EXCEDE

	Time (Launch time +)	Azimuth Degree	Elevation Degree
Turn-on	109 sec	167°	34°
	125 sec	167°	38°
	148 sec	166°	41°
	180 sec	166°	44°
	Predicted Apogee:		
	212 sec	165°	45°
	235 sec	165°	44°
	251 sec	165°	41°
	265 sec	164	39°

TABLE 1b

OBSERVED LOCATIONS

	Time (Launch time +)	Azimuth Degree	Elevation Degree
Turn-on	110 sec	166.8°	33.9°
	125 sec	166.7°	34.2°
	150 sec	165.6°	37.9°
	180 sec	164.8°	40.6°
	Actual Apogee:		
	205 sec	163.8°	41.0°
	235 sec	162.8°	38.8°
	250 sec	162.1°	36.5°
	265 sec	161.4°	32.7°

experiment as seen in the 1^{o} FOV of the 31" sensor, and Figures 3a and b show the observations as seen through the 14' sensor with the 3^{o} field of view.

Appendix 1 is a listing of the positional and rate information at 5 second intervals as recorded during the tracking mission.

During this mission, computer-generated sensor rate and position information were recorded on digital magnetic tape, while a computer print-out narrated the data as it occurred. Visual information from both the 14" and 31" sensors was recorded on video tape during the entire EXCEDE activity. Both videos were annotated with GMT (UT) time code, which may be especially useful in analyzing the display when post-flight data reduction is undertaken.

All of the material which was recorded during this mission has been turned over to Mr. O'Neil of the AFGL. This material includes both the 31" and 14" sensor video tapes, the computer magnetic tape of positional information and the print-out as well.

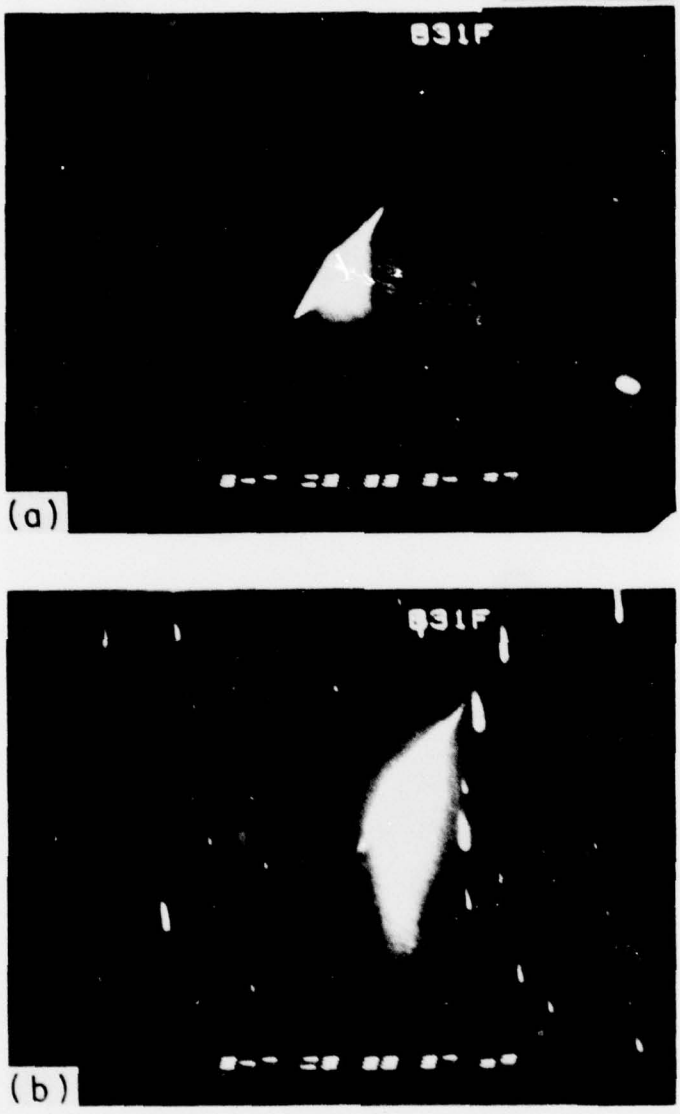


Fig. 1: Photographs of the EXCEDE payload as seen through the 31" sensor during the EXCEDE mission.

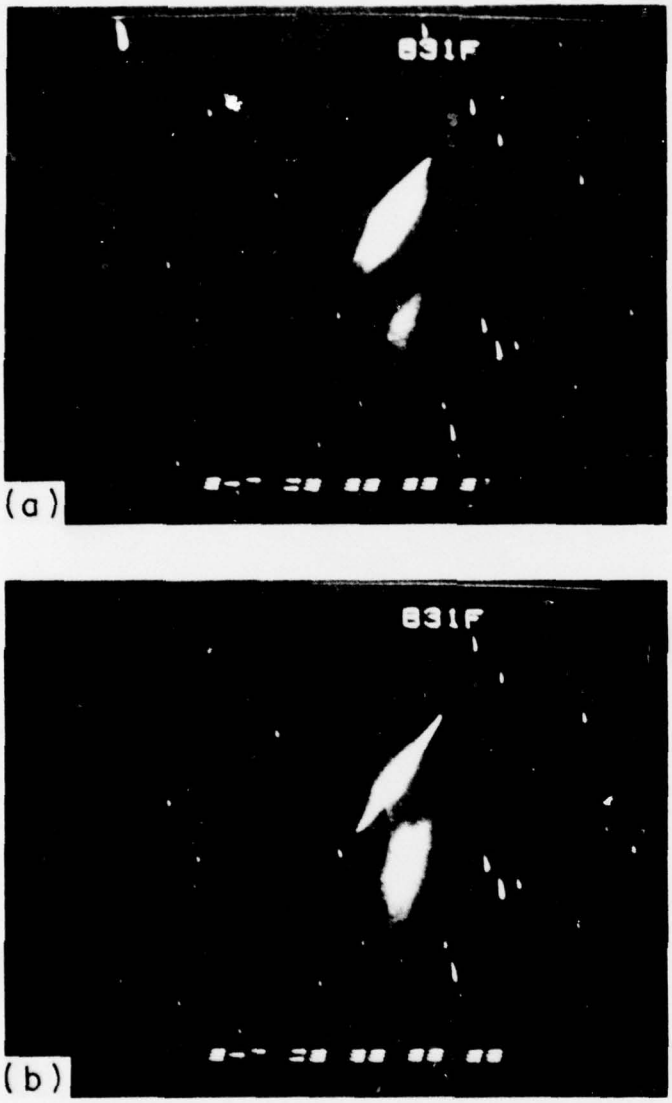


Fig. 2: Photographs of the EXCEDE payload as seen through the 31" sensor during the EXCEDE mission. These photographs illustrate the pulsed portion of the experiment.

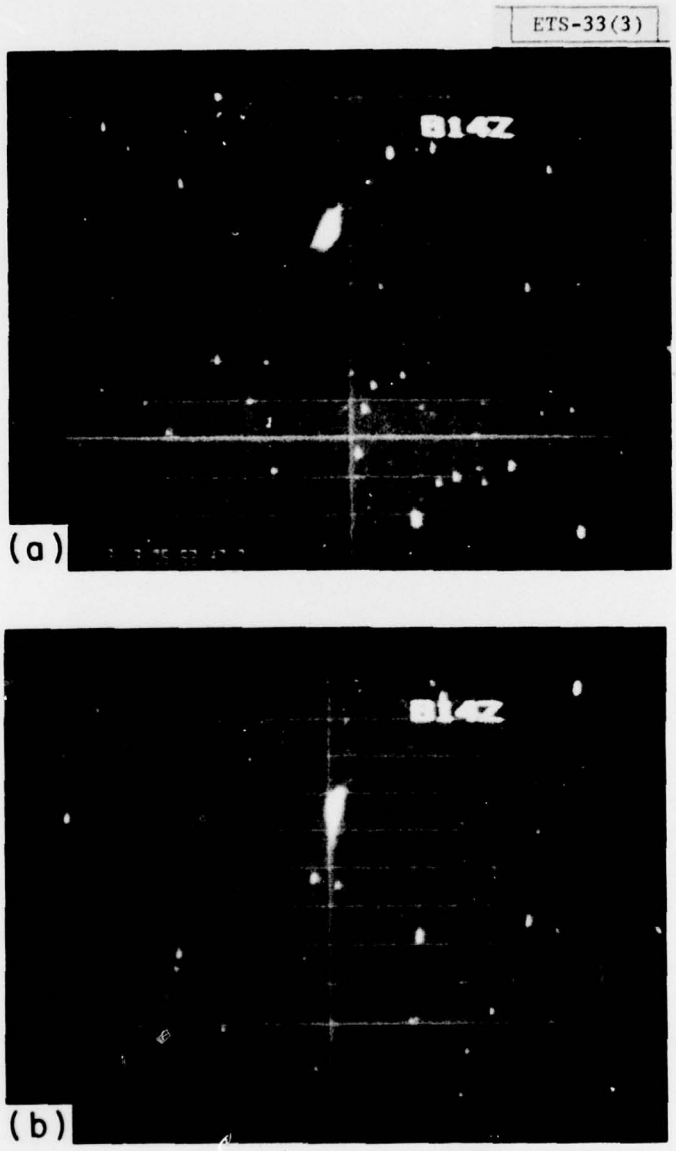


Fig. 3: Photographs of the EXCEDE payload as seen through the 14" sensor. These scenes are typical observations during the EXCEDE mission.

III. OPERATIONAL DESCRIPTION OF SUPPORT

The procedure listed below was followed during GEODSS support of the EXCEDE project. It should be useful as a guideline in planning similar operations in the future.

All times are listed as $\pm$ launch time. T - time is before launch; T + time is after launch.

T - 30 min	Obtain local extinction and bright sky measurements and record.
T - 20	Load all video tape recorders with fresh tapes. Load computer with a fresh magnetic tape.
T - 10	Drive telescope to the initial starting coordinates and calibrate telescope on a star in that location.
T - 5	Drive telescope to the initial starting azimuth/elevation and slew the telescope to track that location automatically.
T - 1	Turn on video tape recorder(s). Turn on the computer's magnetic tape recording.
T = Ø Launch Time	Turn on the 1 sec interval hard-copy record of the position and rate information. Turn on the 15° override.
T + 60 sec	Take manual control of the sensor in maintaining the starting azimuth/elevation. Have a second operator enter the azimuth/elevation of payload. Predicted location is 20 sec after predicted "first sighting".

NOTE: This is done to provide a second chance to pick up the payload

should it not be visible at the time of the predicted first sighting.

Tracking is best accomplished using the 14" sensor in the 7^{o} FOV as a spotting sensor and the 31" sensor with its 1^{o} FOV as the tracking sensor. Once tracking has commenced using the 31" sensor, the 14" sensor may be changed to its 3^{o} FOV for additional perspective.

During reentry, the second operator should read the elevation to the prime operator. This will allow the prime operator to stop the sensor when it reaches an elevation of approximately 14^{o}.

When the telescope is stopped, turn off all computer and video tape recording equipment.

APPENDIX

POSITIONAL AND RATE INFORMATION OF EXCEDE TRACKING MISSION AS BASED ON 5 SECOND INTERVALS

TIME (UT)	LAUNCH T + time	RA POSITION hr	min	sec	DECLINATION in Degrees deg	min	RA RATE Arc/Sec Sec	DEC RATE Arc/Sec Sec	AZIMUTH	ELEVATION
347-05 50 00	0	04	56	40	-21	5.7	14.9	0.0	167.0	34.0
51 40	100	04	59	18	-21	7.5	2.0	-3.0	166.7	33.9
51 45	05	04	59	18	-21	7.7	2.0	-3.0	166.7	33.9
51 50	110	04	59	19	-21	7.9	1.9	-3.0	166.8	33.9
51 55	115	04	59	19	-21	3.3	3.0	215.0	166.8	34.0
52 00	120	04	59	30	-21	6.0	72.0	110.0	166.8	33.9
52 05	125	04	59	30	-20	51.5	1.0	286.0	166.7	34.2
52 10	130	05	01	04	-20	13.7	116.1	302.0	166.1	34.7
52 15	135	05	01	22	-19	14.3	2.0	543.0	165.8	35.7
52 20	140	05	01	23	-18	26.5	2.0	503.0	165.6	36.4
52 25	145	05	01	03	-17	43.3	-68.0	533.0	165.6	37.2
52 30	150	05	00	30	-17	2.6	-2.0	425.0	165.6	37.9
52 35	155	05	00	31	-16	28.0	2.0	319.0	165.4	38.5
52 40	160	05	00	31	-15	46.3	2.0	575.0	165.3	39.1
52 45	165	05	00	32	-15	21.1	3.0	271.0	165.2	39.5
52 50	170	05	00	32	-14	59.9	2.0	210.0	165.1	39.9
52 55	175	05	00	37	-14	37.5	62.0	176.0	165.0	40.3
53 00	180	05	00	50	-14	16.0	7.0	195.0	164.8	40.6
53 05	185	05	00	19	-14	1.2	78.0	172.0	164.6	40.8
53 10	190	05	01	59	-13	51.6	120.0	94.0	164.4	40.9
53 15	195	05	02	36	-13	44.5	81.1	77.0	164.2	41.0
53 20	200	05	03	09	-13	42.5	112.0	0.0	164.1	41.0
53 25	205	05	03	54	-13	42.5	209.1	-1.0	163.8	41.0
53 30	210	05	04	40	-13	45.9	96.9	-175.0	163.6	40.9
53 35	215	05	05	20	-13	55.6	151.0	-75.0	163.5	40.7
53 40	220	05	06	33	-14	9.8	151.0	-252.0	163.2	40.4
53 45	225	05	07	17	-14	32.8	214.0	-312.0	163.1	40.0
53 50	230	05	08	27	-14	59.6	257.1	-406.0	162.9	39.5
53 55	235	05	09	52	-15	34.8	296.9	-444.0	162.8	38.8
54 00	240	05	11	15	-16	05.4	340.9	-514.0	162.6	38.2
54 05	245	05	12	45	-16	51.2	237.9	-515.0	162.4	37.4
54 10	250	05	14	52	-17	44.1	404.0	-623.0	162.1	36.5
54 15	255	05	16	49	-18	44.9	352.1	-725.0	161.9	35.4
54 20	260	05	19	21	-19	54.9	472.0	-951.0	161.6	34.1
54 25	265	05	21	56	-21	14.9	460.0	-971.0	161.4	32.7
54 30	270	05	24	51	-22	40.1	521.0	-985.0	161.1	31.1
54 35	275	05	28	17	-24	31.7	646.0	-1435.0	160.9	29.1
54 40	280	05	32	20	-26	26.2	911.9	-1581.0	160.6	27.0
54 45	285	05	37	30	-28	49.1	875.8	-1672.0	160.3	24.4
54 50	290	05	42	49	-31	17.6	1070.0	-1829.0	159.9	21.7
54 55	295	05	49	11	-34	07.0	1222.0	-2127.0	159.7	18.6
55 60	300	05	56	52	-37	17.6	1531.0	-2446.0	159.4	15.1
55 65	305	06	02	10	-39	28.2	0.0	0.0	159.2	12.68

Maximum Sensor Rates: RA = 1550.9 arc/sec sec,
DEC = -2493 arc/sec sec,

Apogee Occurred At T + 208 sec (347-05-53-28 UT),

Elevation = 40.98 Deg., Azimuth = 163.7143

ACKNOWLEDGEMENT

I would especially like to thank SSgt Mike Weber for his valuable assistance as second operator during the EXCEDE mission.

REFERENCE

1. R. R. O'Neil, E. T. P. Lee, A. T. Stair, and J. C. Ulwich (1976) EXCEDE II AFGL-TR-76-0308, Environmental Research Papers, No. 586.

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER ESD-TR-78-33	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE *(and Subtitle)* GEODSS Experimental Test System Participation in Project EXCEDE		5. TYPE OF REPORT & PERIOD COVERED Project Report 6. PERFORMING ORG. REPORT NUMBER Project Report ETS-33
7. AUTHOR(s) David E. Beatty		8. CONTRACT OR GRANT NUMBER(s) F19628-78-C-0002
9. PERFORMING ORGANIZATION NAME AND ADDRESS Lincoln Laboratory, M.I.T. P.O. Box 73 Lexington, MA 02173		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS Program Element No. 63428F Project No. 2128
11. CONTROLLING OFFICE NAME AND ADDRESS Air Force Systems Command, USAF Andrews AFB Washington, DC 20331		12. REPORT DATE 8 March 1978 13. NUMBER OF PAGES 20
14. MONITORING AGENCY NAME & ADDRESS *(if different from Controlling Office)* Electronic Systems Division Hanscom AFB Bedford, MA 01731		15. SECURITY CLASS. *(of this report)* Unclassified 15a. DECLASSIFICATION DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT *(of this Report)*

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT *(of the abstract entered in Block 20, if different from Report)*

18. SUPPLEMENTARY NOTES

None

19. KEY WORDS *(Continue on reverse side if necessary and identify by block number)*

GEODSS	optical emissions	atmospheric effects
ETS	energetic electron source	EXCEDE

20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*

The GEODSS Experimental Test System participated in Project EXCEDE, in cooperation with and in response to a request by the Optical Physics Division of the Air Force Geophysics Laboratory (AFGL), OPR. The experiment involved tracking the optical emissions induced in the atmosphere by an energetic electron source.

Since the flight path of the electron aurora fell within the operational limits of the GEODSS system, the tracking mission was undertaken. Tracking was successful. Using both the 14" and the 31" telescopes, rate and position information were recorded on both digital magnetic tape and video tape. This data, along with several Polaroid photos (all of which will be used by the AFGL for data analysis) illustrate the atmospheric effects caused by the electron beam.

DD FORM 1 JAN 73 1473 EDITION OF 1 NOV 65 IS OBSOLETE

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE *(When Data Entered)*