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Upper Atmosphere Chemical Release and Smoke Trail Triangulation 1978-1981

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Upper atmosphere release photography

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This report covers the four field trips taken and the triangulation photographic coverage provided.

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INTRODUCTION

For many years the School of Aerospace Engineering at Georgia Tech has provided field support to the Aeronomy Division of the Air Force Geophysics Laboratory. In the early 1960's, camera and timing equipment was developed specifically for high resolution photography from three sites of upper atmosphere chemical releases in the lower thermosphere to enable triangulation of the chemical release position with time, and the calculation of the winds responsible for the observed dispersion. More recently, this equipment has been used to photograph smoke trails released in the stratosphere.

During this final grant period (1978-1981), four field trips were undertaken - one to Wallops Island, Va. in May of 1978; one to Ft. Churchill, Canada in September 1978; and one to Lima, Peru in October 1979, for the purpose of studying stratospheric winds and windshears. One trip was made to Fairbanks, Alaska in February 1981 for the purpose of studying the quantitative relationship between the electron density profile and the optical emissions for the continuous aurora.

As part of this service contract, the films from the cameras at each site were processed by the Photo Lab at Georgia Tech to the desired characteristics requested by the sponsor, and forwarded to AFGL for subsequent analysis.

OBJECTIVES

The objective of the first three field trips was to determine experimentally the magnitude and direction of stratospheric winds and shears, and to mark persistent layers of turbulence as a function of geographic latitude. The experiment conducted at Wallops Island, Virginia provided data corresponding to mid-latitudes.

The trips to Ft. Churchill, Canada and Lima, Peru provided similar data corresponding to Arctic and Tropical Latitudes respectively.

The objective of the trip to Fairbanks, Alaska in February, 1981 was to launch a cooperative AFGL Space Physics and Aeronomy Division rocket, satellite, aircraft and ground-based experiment which would gather the data necessary to test the concepts of making quantitative electron density assessments from optical measurements.

The experiences with the Auroral Data Program and with recent studies demonstrate that the circumpolar auroral E-layer is the site of the major energy input into the polar ionosphere and is well-behaved in space and time. If success is achieved in this investigation, the techniques can be applied to other regions of the globe in an effort to achieve three-dimensional ionospheric assessments from optical measurements.

GEORGIA TECH REQUIREMENT

For each of the field trips Georgia Tech operated two or more triangulation cameras. These cameras were equipped with 7-inch f/2.5 lenses. Typical expected camera orientations are shown in the following tables using the Wallops Island trip as example with rocket launch azimuths of 130 and 160 degrees. The precise azimuth to be used for each rocket was known a day or two before the launch. When two cameras shared a mount, they would be aligned in azimuth, but their fields of view would be separated vertically. This was necessary in order to assure that the entire trail was photographed at late times.

Launch Azimuth 130 degrees.

	Wachapreague		Pocomoke City	
	Azimuth	Elevation	Azimuth	Elevation
Camera A - Rig 1	40°	44°	159°	45°
Camera B - Rig 1	40°	36°	159°	39°
Camera C - Rig 2	40°	40°	159°	42°

Georgia Tech personnel were responsible for determining that all cameras were properly oriented. In addition, they would verify that shutters, cameras, time code generators and lights were operating normally. The use of 7-inch lenses with a 35° field of view permitted orienting the cameras in such a way that the evolution of the trails could be recorded without moving the cameras.

The film used was 12.7 cm KODAK 2402. The resulting negatives were to have a Gamma in the range 1.2 to 1.5 as determined from measurements of step wedge images exposed through a Wratten 29 filter.

The film was processed in a Kodak Versomat system using D-19 developer and at an average temperature of 86° F. and at a speed of 5.2 ft./min. At times the film needed to be forced and higher temperatures and slower processor speed were necessary.

A star calibration was made for all cameras the night before the rocket launch, and another one within one hour before scheduled launch. Star calibrations were to be taken with the Wratten filters off, and with time code generators operating. At least four frames were exposed. Exposure times of 15, 30, 60 and 120 seconds were used.

Upon completion of the field trip, the film was returned to Ga. Tech where it was processed. After processing, the film was sent to AFGL for analysis.

CONCLUSIONS AND RECOMMENDATIONS

This final report terminates a research program in the study of chemical releases from rockets which began in January 1959.

Ga. Tech has worked continuously with AFGL during these 22 years. The work has been scientifically rewarding and personally enjoyable. Many Ga. Tech students have received their start in the study of Upper Atmosphere Physics and Dynamics from work on the many contracts.

It is our understanding that no further work of this nature is currently being planned. Hence, there are no recommendations for future work.

The triangulation camera equipment is owned by Howard D. Edwards and should a need arise for its use in the future, it would undoubtedly be available.