

**MISSION SUPPORT FOR THE COMMUNICATION/
NAVIGATION OUTAGE FORECAST SYSTEM**

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22 December 2004

Scientific Report No. 1

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REPORT DOCUMENTATION PAGE

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1. REPORT DATE (DD-MM-YYYY) 22 Dec 2004		2. REPORT TYPE Interim, Scientific Report No. 1		3. DATES COVERED (From - To) Sep 2003 - Sep 2004	
4. TITLE AND SUBTITLE Mission Support for the Communication/Navigation Outage Forecast System				5a. CONTRACT NUMBER F19628-03-C-0067	
				5b. GRANT NUMBER	
				5c. PROGRAM ELEMENT NUMBER 69120C	
				5d. PROJECT NUMBER 1010	
				5e. TASK NUMBER CN	
				5f. WORK UNIT NUMBER A1	
6. AUTHOR(S) D.L. Hysell				8. PERFORMING ORGANIZATION REPORT NUMBER	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Cornell University Department of Earth and Atmospheric Sciences Ithaca, NY 14853				10. SPONSOR/MONITOR'S ACRONYM(S)	
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) Air Force Research Laboratory 29 Randolph Road Hanscom AFB, MA 01731-3010				11. SPONSOR/MONITOR'S REPORT NUMBER(S) AFRL-VS-HA-TR-2005-1013	
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES					
14. ABSTRACT This is a project to provide mission support for the Communication/Navigation Outage Forecast System (C/NOFS) under BAA VS-03-01 during its first four years of operation. Cornell is required to support the mission with ground-based radar observations of background ionospheric parameters and of equatorial spread F events from the Jicamarca Radio Observatory near Lima, Peru. In the pre-launch period for C/NOFS, Cornell and Jicamarca contributed to the project by measuring plasma density, drift, temperature, and composition profiles during eight campaign periods. The data were processed and made available to AFRL for model validation and also for DMSP CalVal operations. Cornell also developed an extensive collection of codes for processing incoherent scatter data from the Altair radar, which will also provide support for the C/NOFS mission. Finally, Cornell undertook a new theoretical formulation of the ionospheric stability problem which stresses the role of shear instabilities in preconditioning the postsunset ionosphere. This work led to the production of two manuscripts (published or in press) and to a number of presentations.					
15. SUBJECT TERMS Ionospheric stability, ionospheric irregularities, scintillations, spread F, incoherent scatter					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT SAR	18. NUMBER OF PAGES 12	19a. NAME OF RESPONSIBLE PERSON Lt. K. Gruenstein
a. REPORT Unclassified	b. ABSTRACT Unclassified	c. THIS PAGE Unclassified			19b. TELEPHONE NUMBER (Include area code) (781) 377-3107

20050705 026

Contents

1	INTRODUCTION	3
2	METHODS AND PROCEDURES	3

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List of Figures

1.1	Summary Plot of Ionospheric Parameters Measured with the Jicamarca Incoherent Scatter Radar. The figure shows plasma density, electron temperature, ion temperature, and light ion fraction.	5
1.2	<i>F</i> Region Electron Density Profiles Obtained from Scans of the Altair UHF Incoherent Scatter Radar During a Spread <i>F</i> Event. Colors denote electron density on a log scale.	6

1 INTRODUCTION

This is a project to provide mission support for the Communication/Navigation Outage Forecast System (C/NOFS) under BAA VS-03-01 during its first four years of operation. Cornell will support the mission with ground-based radar observations of background ionospheric parameters and of equatorial spread F (ESF) events from the Jicamarca Radio Observatory near Lima, Peru. Jicamarca is capable of measuring ionospheric electric field and conductivity profiles from the valley region well into the topside ionosphere. Jicamarca can also make very detailed observations of ionospheric irregularities associated with ESF. Three main tasks will be supported under this project: (1) in-flight calibration of the electric field/drift meter sensors on board the spacecraft, (2) provision of Jicamarca radar support for experimental campaigns, both before the launch and during the satellite operations, and (3) analysis and interpretation of the data obtained during these campaigns in light of the C/NOFS mission goals.

2 METHODS AND PROCEDURES

In the pre-launch period for C/NOFS, Cornell and Jicamarca contributed to the project by providing calibration and validation support for the DMSP satellites in cooperation with Paul Straus at The Aerospace Corporation and Jonathan Makela at the Naval Research Laboratory, now at the University of Illinois. The data thus acquired were processed and made available to the C/NOFS science team for their model validation studies. An exhaustive schedule for observations in 2004 was followed. CalVal campaigns were supported at Jicamarca in the periods from February 17–19, March 9–11, March 16–18, April 19–21, May 10–13, June 21–23, August 23–25, and September 13–16. Data from these campaigns have recently been reprocessed and are available for extraction from the Madrigal database at the URL <http://landau.geo.cornell.edu>. A summary plot for the September data is shown in Fig. 1.1 as an example. The incoherent scatter mode used for these observations is one of several that will be available during C/NOFS campaigns, and we are using DMSP CalVal operations as an opportunity to test and upgrade the mode and streamline scheduling, data processing, and delivery. A Ph. D. student, Fabiano Rodrigues, is being supported at Cornell partly through the BAA award to assist with this work.

We are also working with AFRL's Don Hunton to obtain radar data from the Altair UHF/VHF radar on Kwajalein Atoll for additional support of the C/NOFS mission. Over 50 DVDs of data were obtained from Altair during NASA's recent EQUIS II campaign, and numerous processing codes have been developed to view and evaluate the data. An example of the data obtained is shown in Fig. 1.2. A number of new and more incisive radar modes for monitoring the background ionosphere over Kwajalein as well as the emergence of ionospheric irregularities are being developed for both the UHF and VHF systems that will utilize the high bandwidth capabilities of the radar. As more data are processed, they will be made available to the C/NOFS science team.

The capabilities of the Jicamarca radar, along with samples of our data products, were

presented to the C/NOFS science team at the January EWG meeting in Los Angeles, the May EWG meeting at Hanscom, and the June CEDAR meeting in Santa Fe, where Jicamarca scheduling, calibration and validation issues, and larger issues pertaining to ionospheric stability and scintillation forecasts were also discussed. We have also been working on a new theoretical formulation of the equatorial ionospheric stability problem, and this work has led to several publications and presentations. It will be discussed further during the upcoming C/NOFS workshop in Estes Park, Colorado.

One paper has been published under this award: Hysell, D. L., and E. Kudeki, Collisional Shear instability in the equatorial F region ionosphere, *J. Geophys. Res.*, 109, 10.1029//2004JA0106362004, 2004. Another is being submitted presently: Hysell, D. L., and J. L. Chau, Possible preconditioning of the equatorial ionosphere by shear flow leading to spread F , *Space Weather*, 2004, submitted. A poster on this work was presented at the Fall AGU in San Francisco.

The C/NOFS data workshop, co-chaired by Hysell, will take place in January in Estes Park, Colorado. Hysell will continue to work with a graduate and an undergraduate student in the development and streamlining of Jicamarca data modes suitable for supporting the C/NOFS mission. Hysell will also work toward the implementation of data acquisition and processing codes for Altair suitable for C/NOFS mission support. We anticipate that a new schedule for Jicamarca and Altair operations will be in place soon after the launch of the satellite, currently scheduled for July, 2005.

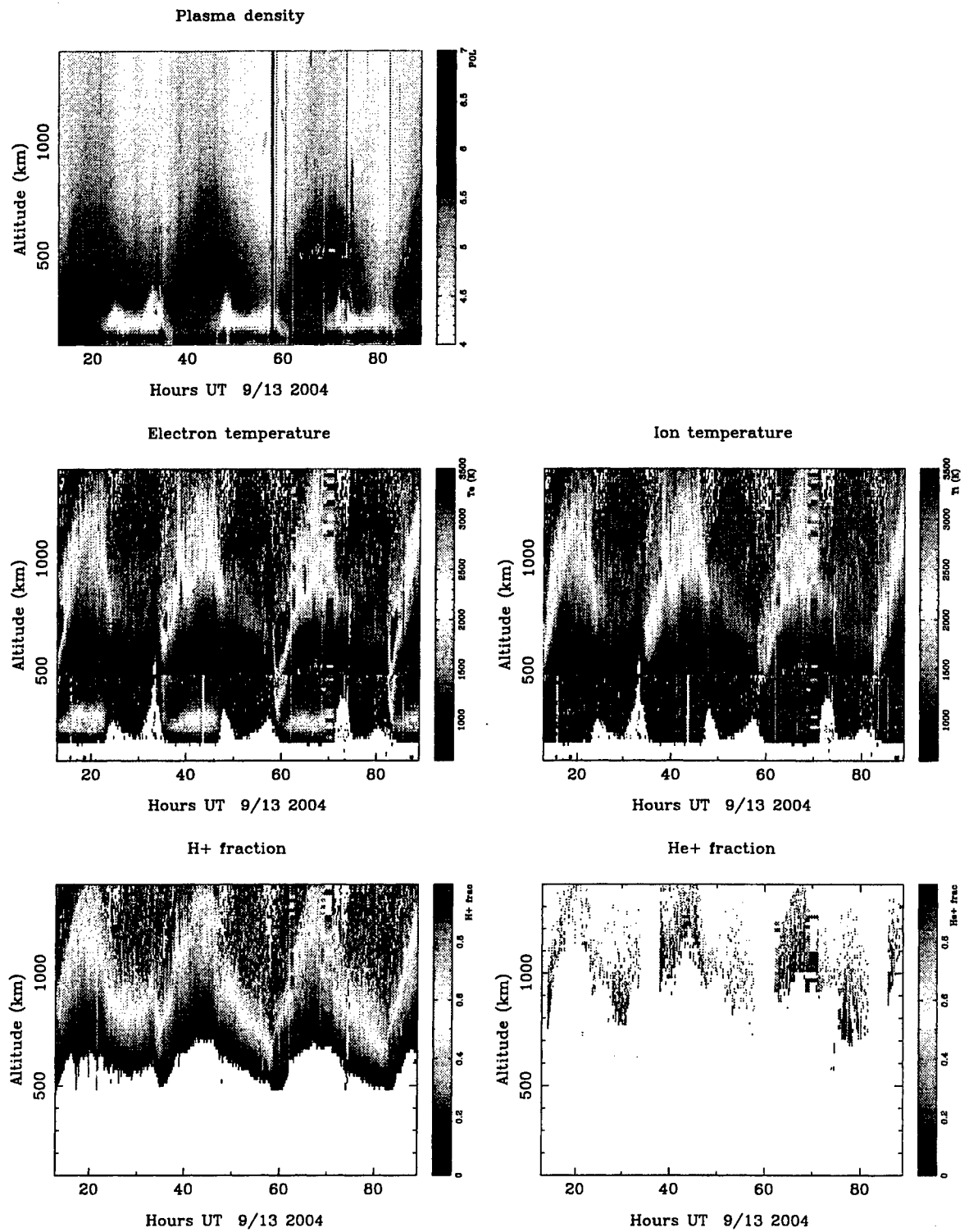


Figure 1.1: Summary Plot of Ionospheric Parameters Measured with the Jicamarca Incoherent Scatter Radar. The figure shows plasma density, electron temperature, ion temperature, and light ion fraction.

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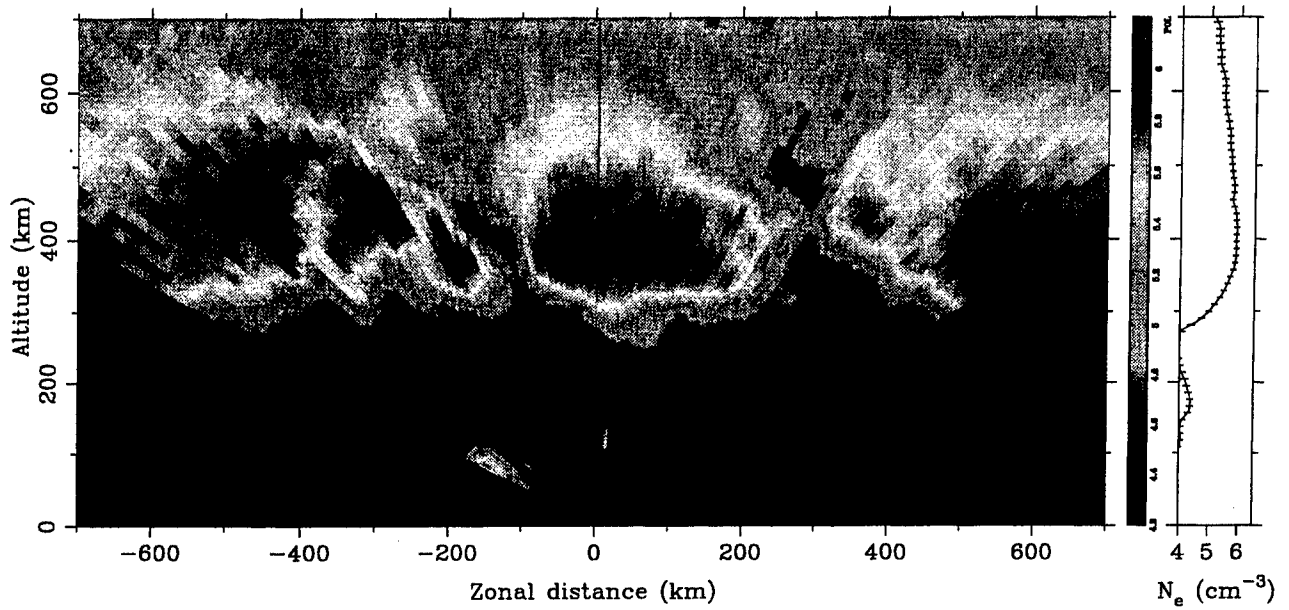


Figure 1.2: *F* Region Electron Density Profiles Obtained from Scans of the Altair UHF Incoherent Scatter Radar During a Spread *F* Event. Colors denote electron density on a log scale.