October 11, 2002
02-JGS-0359

NASA Goddard Space Flight Center
Code 210.G
Greenbelt Rd.
Greenbelt, MD 20771

Attn: Ms. Cheryl Lee

Subject: Final Report

Reference: NAG5-8264 (RTSC No. 3453)

Dear Ms. Lee:

In accordance with Grant Provision 1260.22, Technical Publications and Reports, incorporated in the referenced order, Raytheon Technical Services Company ("RTSC") is pleased to enclose a copy of the Final Report and negative patent/copyright certification.

Should additional information be required, please contact the undersigned at (301) 794-5276.

Sincerely,

RAYTHEON TECHNICAL SERVICES COMPANY

Julie G. Smith
Principal Contract Administrator

Enclosures

cc: Joseph Bredekamp/SR
300 E Street, SW
Washington, DC 20546
(hard copy plus electronic copy)

NASA Center for Aerospace Information (CASI)
Attn: Document Processing Section
7121 Standard Drive
Hanover, MD 21076

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DATE: 10/03/2002

BY: 

NAME: JANET MASTERS

TITLE: CONTRACT CLOSEOUT ADMINISTRATOR

CONTRACTOR: RAYTHEON TECHNICAL SERVICES COMPANY

GRANT NO.: NAG5-8264

PROJECT NO.: 3453

IONOSPHERIC ELECTRON / ION DENSITIES AND TEMPERATURES ON CD-ROM AND WWW

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FINAL REPORT

August 31, 2002

NASA Applied Information Systems Research

Grant #NAG5-8264 (Raytheon #3453)

CONTENTS

Summary

As part of this project a large volume of ionospheric satellite insitu data from the sixties, seventies and early eighties were made accessible online in ASCII format for public use. This includes 14 data sets from the **BE-B, Alouette 2, DME-A, AE-B, ISIS-1, ISIS-2, OGO-6, DE-2, AEROS-A, AE-C, AE-D, AE-E,** and **Hinotori** satellites.

The original data existed in various machine-specific, highly compressed, binary encoding on 7-, or 9-track magnetic tapes. The data were decoded and converted to a common **ASCII** data format, solar and magnetic indices were added, and some quality control measures were taken.

The original intent of producing CD-ROMs with these data was overtaken by the rapid development of the Internet. Most users now prefer to obtain the data directly online and greatly value WWW-interfaces to browse, plot and subset the data. Accordingly the data were made available online on the **anonymous ftp site of NASA's National Space Science Data Center (NSSDC)** at ftp://nssdcftp.gsfc.nasa.gov/spacecraft_data/ and on NSSDC's **ATMOWeb** (http://nssdc.gsfc.nasa.gov/atmoweb/), a WWW-interface for plotting, subsetting, and downloading the data.

Several new features were implemented into **ATMOWeb** as part of this project including a filtering and scatter plot capability. The availability of this new database and WWW system was announced through several electronic mailer (AGU, CEDAR, IRI, etc) and through talks and posters during scientific meetings.

Major Accomplishments

New Data put on NSSDC's Anonymous ftp Site

9 data sets were processed (decoded, checked, converted to ASCII etc.) for online availability (BE-B, Alouette 2, DME-A, AE-B, ISIS-1,ISIS-2 (2), OGO-6, and AEROS-A) and were made available on NSSDC's anonymous ftp site at nssdcftp.gsfc.nasa.gov (**ftp://nssdcftp.gsfc.nasa.gov/spacecraft data/**).

New Data prepared NSSDC's ATMOWeb interfacee

14 data sets (the 9 data sets mentioned above plus data sets from AE-C, -E, -D, Hinotori and DE-2) were promoted to online availability on ATMOWeb interface for browsing, plotting, sub-setting and downloading (**http://nssdc.gsfc.nasa.gov/atmoweb/**).

New ATMOWeb Features Developed

The ATMOweb interface was greatly enhanced and now allows scatter plots of user-selected x, y parameters in addition to the previously available time-series plots. A filtering option was also added that allows users to constrain any one of the data set parameters, e.g. location or time and plot data for specific conditions.

Talks at Scientific Meetings

The project was described in talks given at the International Reference Ionosphere (IRI) Workshop in Sao Jose dos Campos, Brazil (June 2001), at the Asian-Pacific Radio Science Conference in Tokyo, Japan (August 2001), and at the Applied Information Systems Research Program (AISRP) Principal Investigators' Annual Meeting in Baltimore, Maryland (October 2001). The abstracts are listed in APPENDIX B.

Publications

The data were announced in the following articles in newsletters and science journals:

D. Bilitza and N. Papitashvili, SNOE and Older Ionospheric Data Set Available at NSSDC Online, National Space Science Data Center, *NSSDC NEWS*, Volume 17, Number 4, pp 1, December 2001

D. Bilitza and N. Papitashvili, SNOE and Older Ionospheric Data Set Available at NSSDC Online, International Reference Ionosphere, *IRI NEWS*, Volume 8, Number 4, pp 9-11, December 2001.

D. Bilitza, Ionospheric Data from 1965 to 1983 Now Network-accessible at NSSD, American Geophysical Union, SPA Section Newsletter, Volume IX, Issue 28, 8 March 2002.

D. Bilitza, ITM data newly e-accessible, new functionality for OGO, National Space Science Data Center, *NSSDC News*, http://nssdc.gsfc.nasa.gov/nssdc_news/, March 2002.

D. Bilitza, N. Papitashvili, J. Grebowsky, and W. Schar, Ionospheric Data for Two Solar cycles Available Online, pp 23-28, in: *Proceedings of the IRI Task Force Activity 2001*, S. Radicella (ed.), The Abdus Salam International Centre for Theoretical Physics, Report IC/IR/2002/23, Trieste, Italy, 2002.

D. Bilitza, B. Reinisch, R. Benson, J. Grebowsky, N. Papitashvili, X. Huang, W. Schar, and K. Hills, Online Data Base of Satellite Sounder and insitu measurement covering two solar cycles, submitted to *Advances in Space Research*, 2002.

Project Overview

The data sets considered by this project are listed in Table 1. This includes electron density and temperature data from Lamgmuir Probe (LP) instruments, electron and ion temperatures and densities from Retarding Potential Analyzer (RPA) instruments, and ion densities from Ion Mass Spectrometer (IMS) instrument. The time resolution of the measurements is typically seconds to minutes. An 'A' in the second column of Table 1 indicates that the data processing was successfully completed and the ASCII data are available on ATMOWeb. In the cases of the Ariel 3, 4, and ESRO 4 data sets, the format descriptions were very limited or not existing and we were not able to decipher the data format and structure. Table 1 lists the time periods covered by the different data sets and information about the orbits and data volume.

TABLE 1. Project Data Sets

Satellite		*Instrument*	*Time Period/ ddmmyy*	*Height Range/ km*	*Inclin./ degree*	*Volume/ MByte*
BE-B	A	LP	10/10/64 - 26/08/67	900 - 1100	80	4.3
Alouette-2	A	LP	21/02/66 - 12/05/67	500 - 3000	80	3.9
DME-A	A	LP, (IMS)	29/10/65 - 20/08/68	500 - 3000	80	6.4
AE-B	A	IMS	09/06/66 - 17/01/67	280 - 2700	65	4.6
Ariel-3		LP, RPA	5/67 - 10/67	500 - 600	80	?
ISIS-1	A	LP	30/01/69 - 01/06/71	550 - 3500	88	14
OGO-6	A	IMS	12/06/69 - 31/12/70	400 - 1000	82	260
ISIS-2	A	LP, IMS	4/21/71 - 3/31/73	1400	88	180
Ariel-4		LP	12/71 - 12/73	500 - 600	83	?
ESRO-4		LPs	11/72 - 4/74	250 - 1200	91	?
AEROS-A	A	RPA	03/01/73 - 03/08/73	250 - 850	97	48
AE-C (UA)	A	LP, RPA, IMS, more	16/12/73 - 11/12/78	150 – 350	68	296
AEROS-B		RPA, IP	7/74 - 9/75	250 – 850	97	?
AE-D (UA)	A	LP, RPA, IMS, more	06/10/75 - 29/01/76	150– 3000	90	52
AE-E (UA)	A	LP, RPA, IMS, more	01/12/75 - 06/06/81	150 - 450	20	170
ISS-b		RPA, IMS	8/78 - 3/80	950 - 1200	69	?
Hinotori	A	RPA	23/02/81 - 19/06/82	550 - 600	31	137
DE-2 (UA)	A	LP, RPA, MORE	06/08/81 - 15/02/83	300 - 1000	90	244

LP=Langmuir Probe, RPA=Retarding Potential Analyzer, IMS=Ion Mass Spectrometer
A = available on ATMOWeb

A graph of the year-altitude coverage of these data sets is shown in Figure 1. Stretching from 1966 to 1983 our combined database covers close to two solar cycles. Such a database will be a unique asset for studies of the variation and variability of ionospheric parameters. It will be an important element in the quest for a better understanding of ionospheric plasma processes and for improved predictions of ionospheric Space Weather. Current models are still very limited in their predictive capabilities especially at equatorial and auroral latitudes. Better descriptions of the seasonal, solar cycle, and magnetic stormtime variation patterns are expected with the usage of our multi-satellite database.

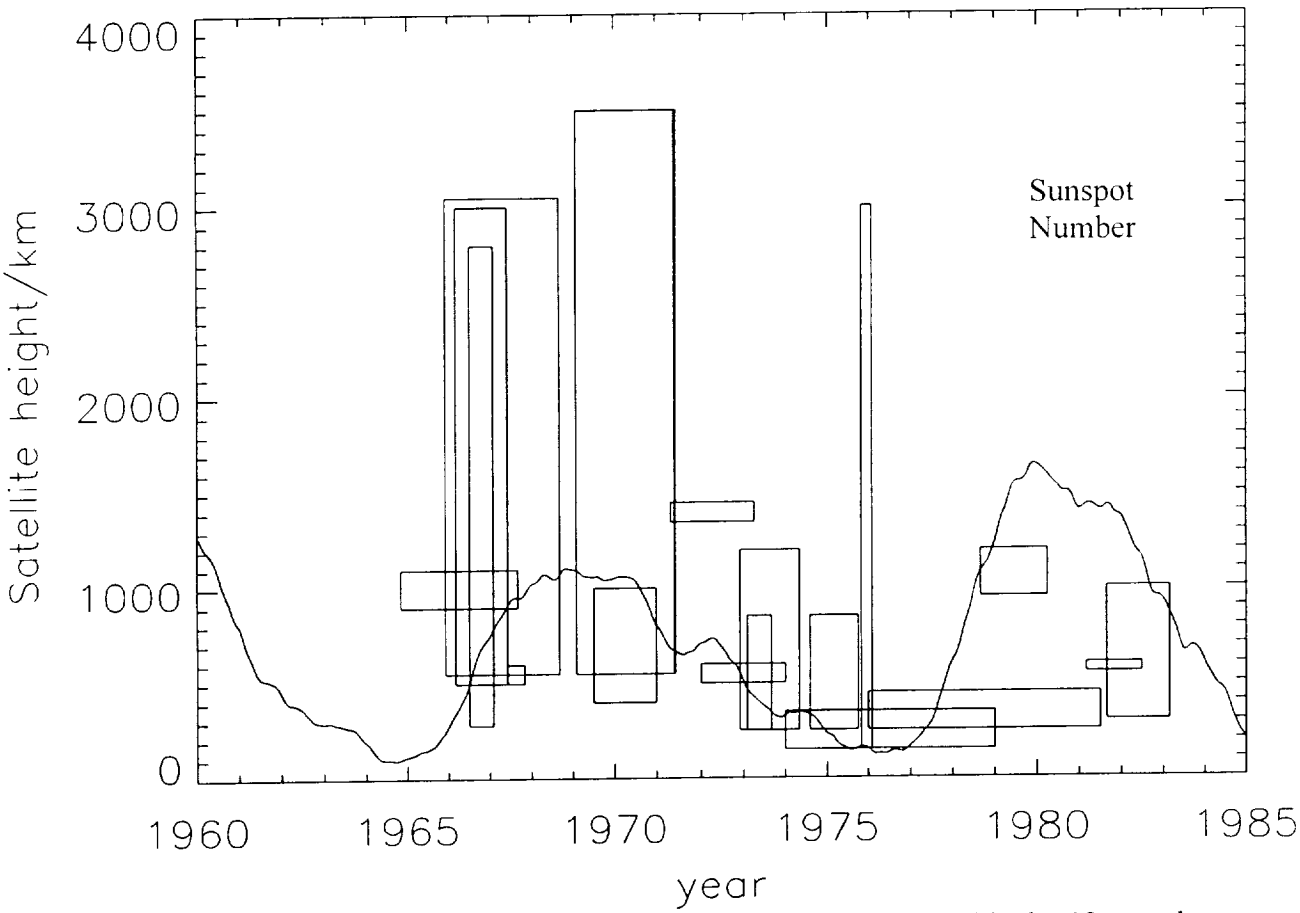


Fig. 1. Time-altitude coverage of the different data sets. Also included is the 12-month running mean of sunspot number indicating the almost two solar cycles covered by the combined database.

This project was endorsed by many colleagues and by the International Reference Ionosphere (IRI) team. IRI is the international standard for the ionosphere based on all available ground and space data. The IRI ionospheric modeling effort will benefit greatly from the easy access to these ionospheric data. Many of the electron data and almost all of the ion data have not yet been exploited for IRI modeling.

Data Sets

The data were converted to ASCII and magnetic and solar indices were added. The magnetic dip and the McIlwain L-shell value were computed using the International Geomagnetic Reference Field (IGRF) and added to the data set parameters. Fill values were added for all out-of-range values. Data set specific details follow below.

Ariel 1: This data were originally on a 7-track 556-bpi BCD magnetic tape written on an IBM 7094 computer. The orbit inclination was 54 degrees and the altitude range was 400-1200 km. Langmuir probe data are available from April 26 to July 10, 1962.
STATUS: Able to read tape, but problems with understanding parameters/format.

BE-B (Explorer 22): This data set provides the electron density and temperature measured by the Langmuir Probe (PI: L.H. Brace). The instrument operated for 22 seconds every 3 minutes. Data were acquired when the satellite passed one of 10 ground stations (STADAN). This is one of the data sets that had not yet been archived at NSSDC.
STATUS: Completed (ATMOweb)

Alouette 2: This data set provides the electron density measured by the Langmuir Probe (PI: L.H. Brace). Electron temperature data are only available for very few and short time periods (less than 5%). Data were recorded when the spacecraft was in line of sight of telemetry stations (primary data coverage is near the 80 deg W meridian plus areas near Hawaii, Singapore, Australia, the UK, India, Norway, and Central Africa). Initially data were recorded about 8 h per day.
STATUS: Completed (ATMOweb)

DME-A (Explorer 31): This data set provides the electron density and temperature measured by the Langmuir Probe (PI: L.H. Brace). A partial power failure in May 1966 reduced data acquisition time to about half. The documentation also notes "some difficulties with obtaining attitude information that was necessary for the reduction of the experiment observations." This is one of the data sets that had not yet been archived at NSSDC. In addition NSSDC holds ion density data from the Magnetic Ion Mass Spectrometer (PI: J.H. Hoffman) on magnetic tape in IBM 360/BDC binary format.
STATUS: Completed (ATMOweb)

AE-B (Explorer 32): This data set provides the ion densities (O^+, H^+, He^+, N^+) measured by the Ion Mass Spectrometer (PI: H.C. Brinton). The data were acquired in real time by 13 ground stations and over remote areas by use of a spacecraft tape recorder. During measurement cycle (about 3.5 minutes) all 4 ion densities were measured followed by a second measurement of the heavy ions. In addition to converting the data to ASCII and adding IGRF coordinate information and solar and magnetic indices, we also simplified the record structure and combined several flags in a single word.
STATUS: Completed (ATMOweb).

Ariel 3, 4: NSSDC archives include electron temperature data from the Langmuir Probe (PI: J. Sayers) and electron density data from the Capacitance Probe (PI: J. Sayers) of this U.K. satellite on magnetic tape in IBM7094/BCD binary format.
STATUS: Able to read tape, but problems with understanding parameters/format.

ISIS-1: This data set provides the electron density and temperature measured by the Langmuir Probe (PI: L.H. Brace). A tape recorder with 1-h capacity extended the data coverage beyond the reach of the telemetry stations. The data records provide

alternatively electron density and electron temperature. The time resolution is typically 30 seconds from density to temperature record and 3.5 minutes from temperature to density record. NSSDC also holds electron density and temperature data on magnetic tape from the Spherical Electrostatic Analyzer (PI: R.C. Sagalyn).
STATUS: Completed (ATMOweb)

OGO-6: This data set provides the ion densities (O^+, N_2^+, NO^+, O_2^+, H^+, He^+, N^+) measured by the Ion Mass Spectrometer (PI: H.A. Taylor, Jr.). A measurement cycle of the six ion densities takes about 40 seconds. In addition to converting the data to ASCII, adding IGRF coordinate information and solar and magnetic indices, we also used the PI-provided mass-specific correction factors to compute the final densities. NSSDC archives also include a data set of ion densities, temperature and photoelectron fluxes from the Planar Ion and Electron Trap (PI: W.B. Hanson) on magnetic tape in IBM360 binary format.
STATUS: Completed (ATMOweb with new capabilities)

ISIS-2: Two ISIS-2 data sets were processed for inclusion in our data base: (1) the ion densities (O^+, N_2^+, NO^+, O_2^+, H^+, He^+, N^+) measured by the Ion Mass Spectrometer (PI: J.H. Hoffman) and the electron densities and temperatures measured by the Cylindrical Electrostatic Probe (PI: L.H. Brace). Additionally there are ion density and temperature data from the Retarding Potential Analyzer (PI: E.J. Maier) available on magnetic tape from NSSDC.
STATUS: Nearly completed (ATMOweb).

AEROS-A: This data set provides electron density, electron and ion temperatures, ion composition and photoelectron fluxes from the Retarding Potential Analyzer (PI: K. Spenner) as calibrated with the electron densities of the Impedance Probe (PI: E. Neske). Decoding and understanding of this data set required a considerable amount of time because of the highly compressed UNIVAC 1100 binary format and the six different modes used by the RPA. Communications with the AEROS Project Scientist, K. Rawer, helped a great deal in resolving problems with this data set.
STATUS: Completed (ATMOweb)

ISS-b: This data set provides ion densities (O^+, H^+, He^+) measured by the Ion Mass Spectrometer (PI: I. Iwamoto) on this Japanese satellite. The data are now being prepared for inclusion in our database.
STATUS: In progress.

Hinotori: This data set provides 10-second averages of electron density and temperatures as measured by the Plasma Probes (PI: K. Oyama). The data had been included on the nssdcftp site as part of this project and were now promoted to accessibility from the ATMOWeb browse/plot interface.
STATUS: Complete (ATMOWeb)

DE-2: The 16-second merged mission data (UA) include electron, ion and neutral densities, temperatures and velocities from the many instruments that flew on this

satellite. The data had been converted to ASCII and included on the nssdcftp site as part of this project and were now promoted to accessibility from the ATMOWeb browse/plot interface.
STATUS: Complete (ATMOWeb)

ATMOWeb Interface for Browsing and Plotting the Data

The ATMOWeb is a WWW-based retrieval and browsing interface to online data. It was developed using C/C++ and PERL. The graphical capabilities are based on IDL running on the NSSDC WWW-server, and (for some spacecraft) on Java applets, which are built into the WWW Home Page and dynamically created by the C-based script. The Java applets run on the user's local machine but read the data from the remote server (NSSDC). This limits the CPU demand on the central server. ATMOWeb accesses the atmospheric-ionospheric data stored in NSSDC's anonymous ftp archive at nssdcftp.gsfc.nasa.gov. ATMOWeb provides data listing and plotting options. This allows the user to display and then to download (using the WWW browser's capabilities) a subset of the data by specifying the time interval and any combination of parameters for each of the spacecraft.

Two new important capabilities were implemented as part of this project: (1) The ability to generate scatter plots of any two data set parameters, (2) the ability to constrain with minimum and maximum values any one of the data set parameters. This will allow users to generate plots for their specific study objectives. These new capabilities are currently only implemented for the OGO-6 data. Figure 2 shows the new entry WWW page for OGO-6 including the filtering option at the right end of each parameter row and a link to the scatter plot page (line in italics that ends with 'here').

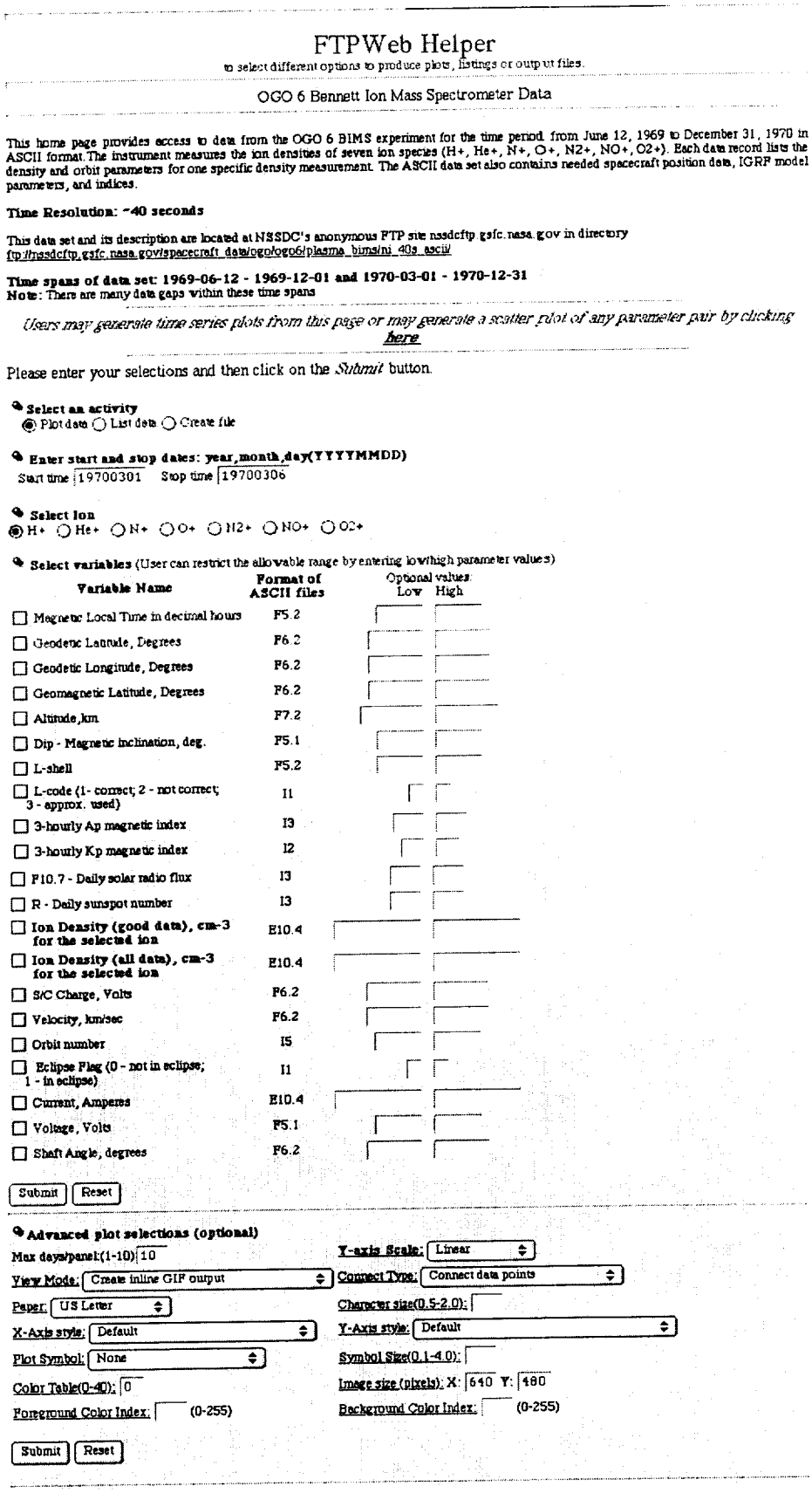
Figure 3 shows a series of time series panels generated with the standard interface displaying OGO-6 orbit parameters and ion densities measured on March 5, 1970. From top to bottom consecutive panels show the Magnetic Local Time (MLT), the geomagnetic latitude, the satellite altitude, the H^+ density, He^+ density, N^+ density, and O^+ density. For all of these plots the altitude low and high value (at the right of the altitude parameter field) was set to 900km and 1100 km, respectively, to eliminate a large part of the altitude related variation. The figures indicate a general decrease of light ion densities (H^+, He^+) along the orbit, and an increase in O^+ and N^+ densities. A detailed interpretation of this trend as well as of specific features (maxima) is difficult because of the difficulty to separate the influence of MLT, geomagnetic latitude and altitude in these plots. The new scatter plot functionality lets the user investigate these aspects in more detail (sse below). Time series plots are however an excellent browsing tool. In Figure 3 we see a quite regular behavior at the beginning of the day a distinct drop in density around 9 AM and a return to regular behavior towards the end of the day. It will be interesting to find out what caused this drop in ion densities.

Another series of time plots is shown in Figure 4 again for March 5, 1970 but now for the altitude window 300-500 km. IT displays from top to bottom the Magnetic Local Time

(MLT), the geomagnetic latitude, the satellite altitude, the O^+ density, N_2^+ density, NO^+ density, and O_2^+ density. The variation patterns of the molecular ions (N_2^+, NO^+, O_2^+) are very similar to each other and depend strongly on solar zenith angle (MLT). The latitudinal and altitudinal variations also play a role. The latitudinal pattern of the molecular ions is different from that of O^+, which shows a strong peak at the magnetic equator.

The WWW-interface for generating scatter plots from the OGO-6 data set is reproduced in Figure 5. Examples of dip latitude versus altitude coverage plots for the whole mission are shown in Figures 6 and 7. Indicating that the best height range for studying latitudinal variations during daytime is 300 to 500 km and 1000 to 1200 during nighttime. For studying the altitudinal variation of ion densities during noontime or midnight only the high latitudes show a good enough altitudinal coverage. In Figures 8-14 we present a few examples of scatter plots generated from the OGO-6 ion density data. the latitudinal variation of ion density is plot for the MLT range 11-13 and for the altitude range 300-500km for H^+, He^+, N^+, O^+, N_2^+, NO^+, and O_2^+, respectively. The density plots display very interesting features that will be the starting point for further studies. The noontime N^+ and O^+ densities at 300-500 km in Figure 10 show as expected a peak at the magnetic equator. At 1000-1200 km during nighttime H^+ and He^+ show a remarkable double peak at low latitudes (Figure 11) that may reflect a similar structure seen in electron density data (equator anomaly).

The density height profiles in Figures 12 – 14 illustrate the typical decrease of O^+ and N^+ with altitude and the increase of H^+.



FTPWeb Helper

to select different options to produce plots, listings or output files.

OGO 6 Bennett Ion Mass Spectrometer Data

This home page provides access to data from the OGO 6 BIMS experiment for the time period from June 12, 1969 to December 31, 1970 in ASCII format. The instrument measures the ion densities of seven ion species (H+, He+, N+, O+, N2+, NO+, O2+). Each data record lists the density and orbit parameters for one specific density measurement. The ASCII data set also contains needed spacecraft position data, IGRF model parameters, and indices.

Time Resolution: ~40 seconds

This data set and its description are located at NSSDC's anonymous FTP site nssdcftp.gsfc.nasa.gov in directory ftp://nssdcftp.gsfc.nasa.gov/spacecraft_data/ogo/ogo6/plasma_bims/ni_40s_ascii/

Time spans of data set: 1969-06-12 - 1969-12-01 and 1970-03-01 - 1970-12-31
Note: There are many data gaps within these time spans

Users may generate time series plots from this page or may generate a scatter plot of any parameter pair by clicking here

Please enter your selections and then click on the *Submit* button.

Select an activity
(•) Plot data ( ) List data ( ) Create file

Enter start and stop dates: year,month,day(YYYYMMDD)
Start time [19700301] Stop time [19700306]

Select Ion
(•) H+ ( ) He+ ( ) N+ ( ) O+ ( ) N2+ ( ) NO+ ( ) O2+

Select variables (User can restrict the allowable range by entering low/high parameter values)

Variable Name	Format of ASCII files	Optional values: Low	High
[ ] Magnetic Local Time in decimal hours	F5.2		
[ ] Geodetic Latitude, Degrees	F6.2		
[ ] Geodetic Longitude, Degrees	F6.2		
[ ] Geomagnetic Latitude, Degrees	F6.2		
[ ] Altitude,km	F7.2		
[ ] Dip - Magnetic inclination, deg.	F5.1		
[ ] L-shell	F5.2		
[ ] L-code (1- correct; 2 - not correct; 3 - approx. used)	I1		
[ ] 3-hourly Ap magnetic index	I3		
[ ] 3-hourly Kp magnetic index	I2		
[ ] F10.7 - Daily solar radio flux	I3		
[ ] R - Daily sunspot number	I3		
[ ] **Ion Density (good data), cm-3 for the selected ion**	E10.4		
[ ] **Ion Density (all data), cm-3 for the selected ion**	E10.4		
[ ] S/C Charge, Volts	F6.2		
[ ] Velocity, km/sec	F6.2		
[ ] Orbit number	I5		
[ ] Eclipse Flag (0 - not in eclipse; 1 - in eclipse)	I1		
[ ] Current, Amperes	E10.4		
[ ] Voltage, Volts	F5.1		
[ ] Shaft Angle, degrees	F6.2		

[Submit] [Reset]

Advanced plot selections (optional)

Max days/panel(1-10): [10]
Y-axis Scale: [Linear]
View Mode: [Create inline GIF output]
Connect Type: [Connect data points]
Paper: [US Letter]
Character size(0.5-2.0): [ ]
X-Axis style: [Default]
Y-Axis style: [Default]
Plot Symbol: [None]
Symbol Size(0.1-4.0): [ ]
Color Table(0-40): [0]
Image size (pixels): X: [640] Y: [480]
Foreground Color Index: [ ] (0-255)
Background Color Index: [ ] (0-255)

[Submit] [Reset]

Fig. 2. Entry WWW-page for the ATMOweb interface for the OGO-6 data.

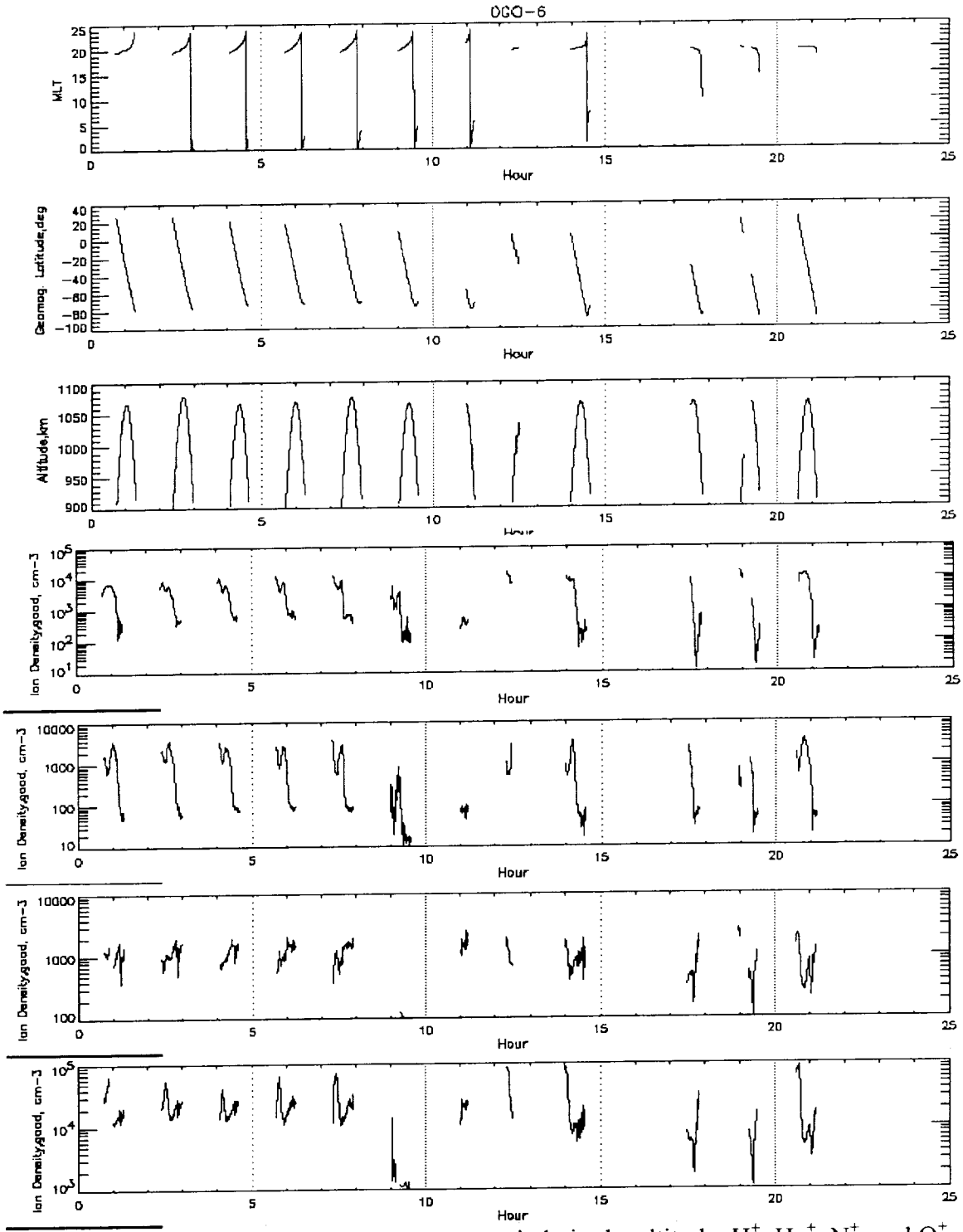


Fig. 3. OGO-6 panel plots of MLT, geomagnetic latitude, altitude, H^+, He^+, N^+, and O^+ densities (altitude filter=900-1100km) for March 5, 1970.

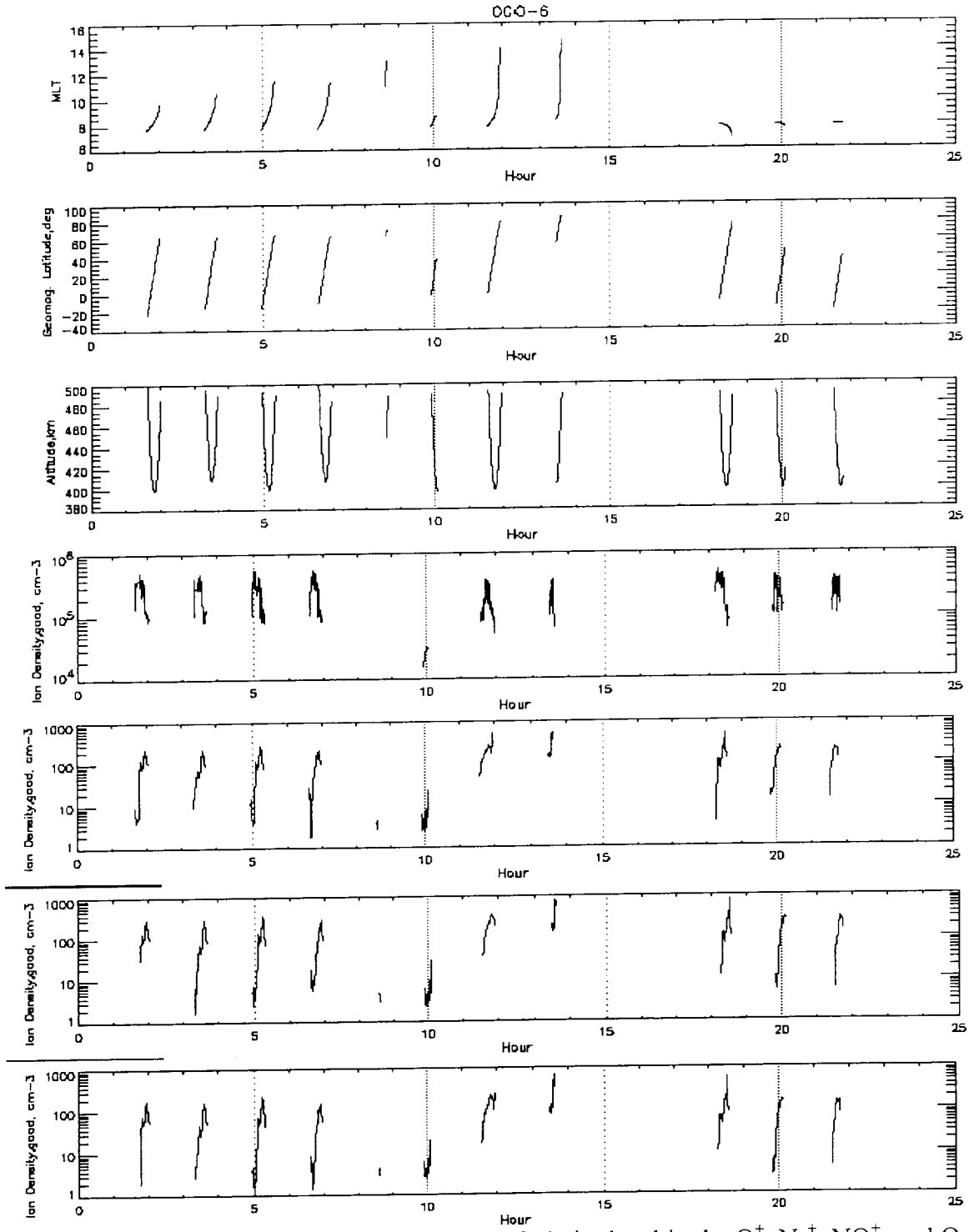


Fig. 4. OGO-6 panel plots of MLT, geomagnetic latitude, altitude, O^+, N_2^+, NO^+, and O_2^+ densities (altitude filter: 300-500 km) .

FTPWeb Helper

to select different options to produce scatter plots , linear regression fit or listings

OGO 6 Bennett Ion Mass Spectrometer Data

This home page provides access to data from the OGO 6 BIMS experiment for the time period from June 12, 1969 to December 31, 1970 in ASCII format. The instrument measures the ion densities of seven ion species (H+, He+, N+, O+, N2+, NO+, O2+). Each data record lists the density and orbit parameters for one specific density measurement. The ASCII data set also contains needed spacecraft position data, IGRF model parameters, and indices.

Time Resolution: ~40 seconds

This data set and its description are located at NSSDC's anonymous FTP site nssdcftp.gsfc.nasa.gov in directory
ftp://nssdcftp.gsfc.nasa.gov/spacecraft_data/ogo/ogo6/plasma_bims/ni_40s_ascii/

Time spans of data set: 1969-06-12 - 1969-12-01 and 1970-03-01 - 1970-12-31

Please enter your selections and then click on the *Submit* button.

Select an activity
(●) Scatter plot/regression fit (N#<30000 points) ( ) List Numeric data

Enter start and stop dates: year,month,day(YYYYMMDD)
Start time [19700301] Stop time [19700306]

Select Ion
(●) H+ ( ) He+ ( ) N+ ( ) O+ ( ) N2+ ( ) NO+ ( ) O2+

Select X and Y axes for any two variables

Variable Name	X/Y Axes	Format of ASCII files	Optional values: Low	High
Magnetic Local Time in decimal hours	( ) X ( ) Y	F5.2		
Geodetic Latitude, Degrees	( ) X ( ) Y	F6.2		
Geodetic Longitude, Degrees	( ) X ( ) Y	F6.2		
Geomagnetic Latitude, Degrees	( ) X ( ) Y	F6.2		
Altitude,km	(●) X ( ) Y	F7.2		
Dip - Magnetic inclination, deg.	( ) X ( ) Y	F5.1		
L-shell	( ) X ( ) Y	F5.2		
L-code (1- correct; 2 - not correct; 3 - approx. used)	( ) X ( ) Y	I1		
3-hourly Ap magnetic index	( ) X ( ) Y	I3		
3-hourly Kp magnetic index	( ) X ( ) Y	I2		
F10.7 - Daily solar radio flux	( ) X ( ) Y	I3		
R - Daily sunspot number	( ) X ( ) Y	I3		
Ion Density (good data), cm-3 for the selected ion	( ) X (●) Y	E10.4		
Ion Density (all data), cm-3 for the selected ion	( ) X ( ) Y	E10.4		
Orbit number	( ) X ( ) Y	I5		
Eclipse Flag (0 - not in eclipse; 1 - in eclipse)	( ) X ( ) Y	I1		

[Submit] [Reset]

Advanced plot selections (optional)

View Mode: [Create inline GIF output] Character size(0.5-2.0): [ ]
Plot Symbol: [Plus] Symbol Size(0.1-4.0): [ ]
Image size (pixels): X: [640] Y: [640] Connect Type: [Show points only]

[Submit] [Reset]

Fig. 5. Entry WWW page for OGO-6 scatter plots.

Scatter Plot and Linear Fit of ogo6 data from 19690612 to 19701231
Number of points in plot and fit: 5072
Constraints on parameter values:
Ion index (4, 4)
MLT (11, 12)

X - Dip Latitude
Y - Altitude,km
Cr - Correlation coefficient

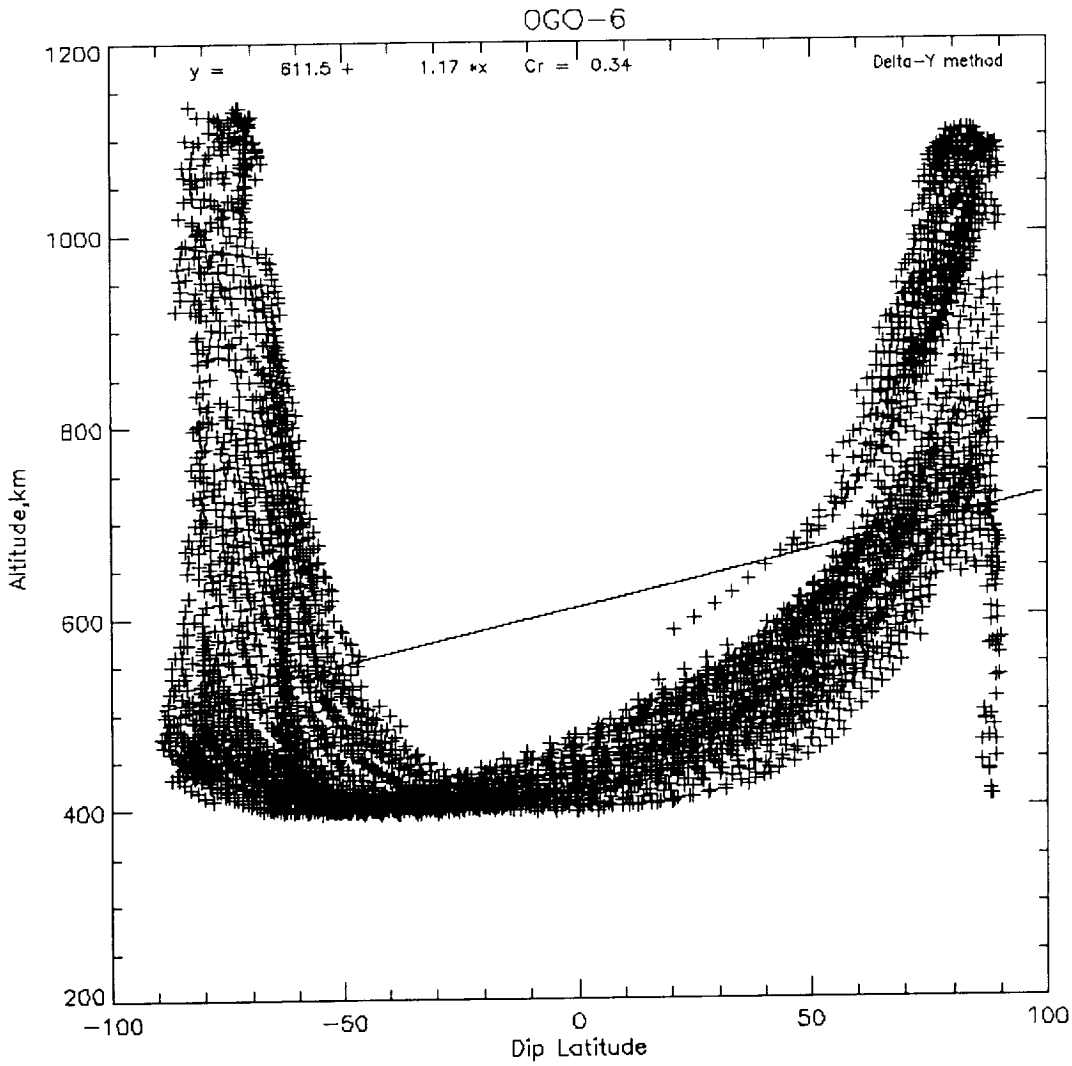


Fig. 6. Dip Latitude versus altitude scatter plot for OGO-6 data for MLT=11-12.

Scatter Plot and Linear Fit of ogo6 data from 19690612 to 19701231
Number of points in plot and fit: 8141
Constraints on parameter values:
Ion index (4, 4)
MLT (0., 2)

X - Dip Latitude
Y - Altitude,km
Cr - Correlation coefficient

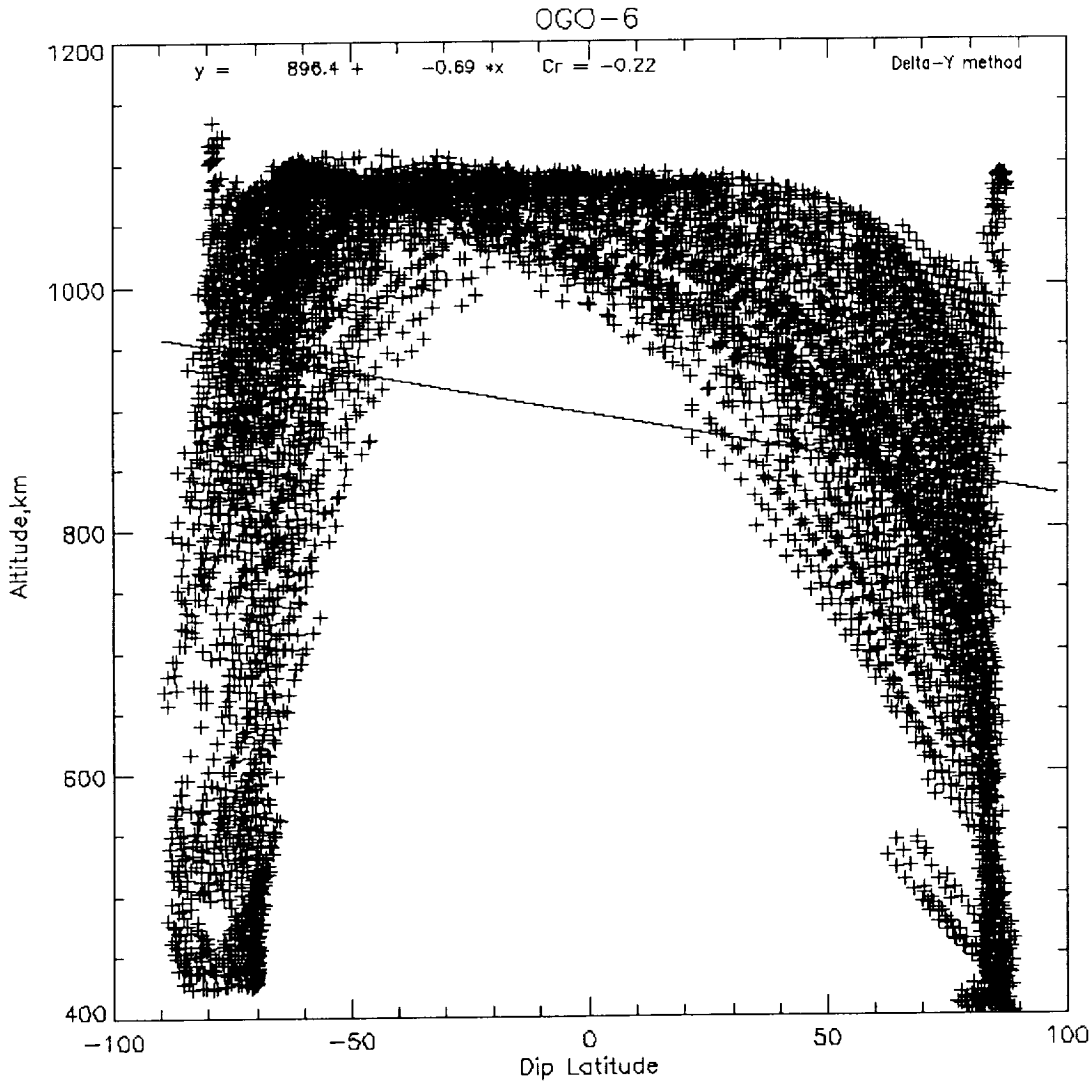


Fig. 7. Same as Figure 5 for magnetic local time 0 to 2.

Scatter Plot and Linear Fit of ogo6 data from 19690612 to 19701231
Number of points in plot and fit: 3220
Constraints on parameter values:
Ion index (3, 3)
MLT (11, 13)
Altitude,km (300, 500)

X - Geomag. Latitude,deg
Y - Ion Density,good, cm-3
Cr - Correlation coefficient

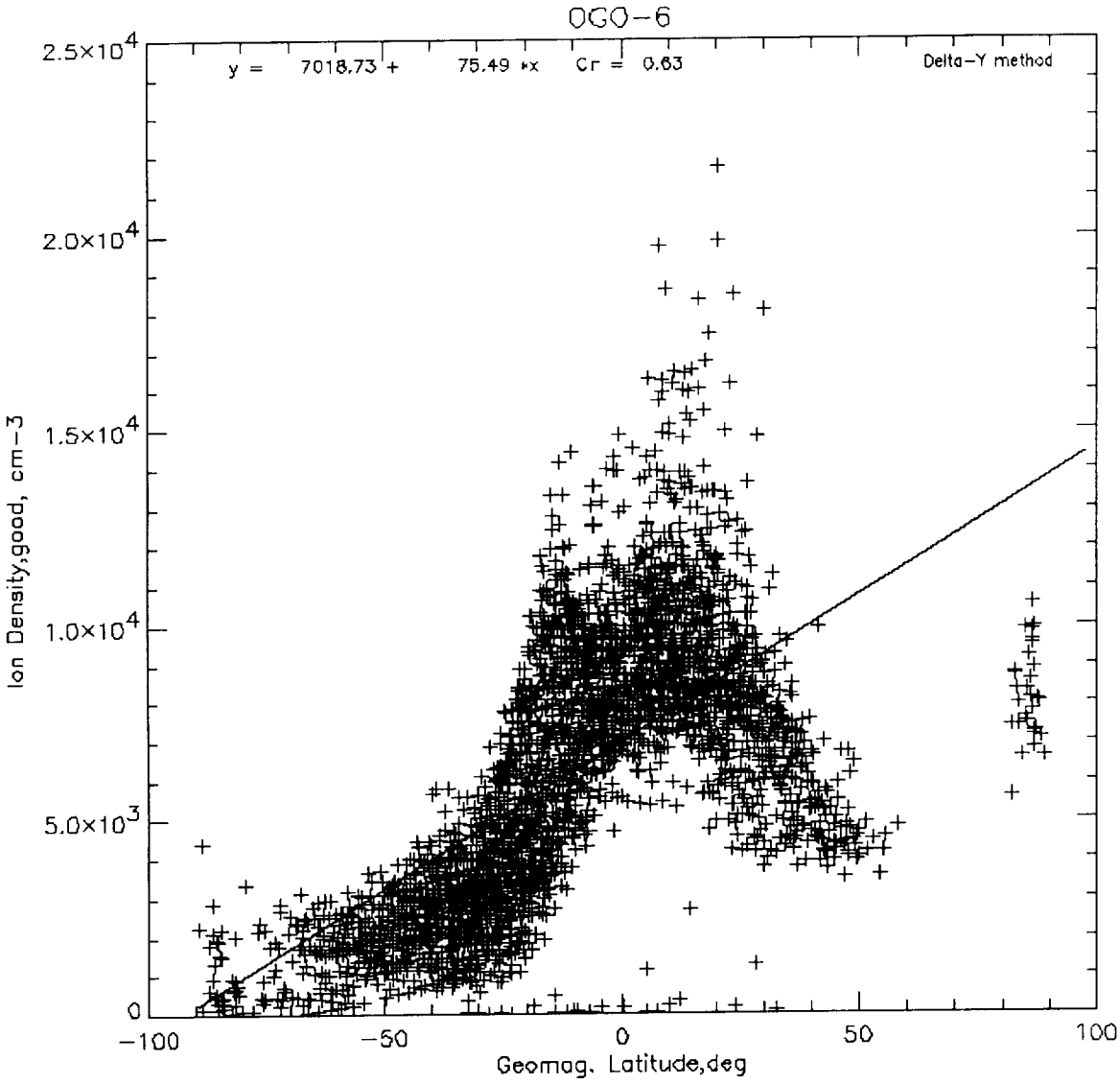


Fig. 8. OGO-6 N^+ density vs geomagnetic latitude for MLT=11-13 and h=300-500 km.

Scatter Plot and Linear Fit of ogo6 data from 19690612 to 19701231
Number of points in plot and fit: 4271
Constraints on parameter values:
Ion index (4, 4)
MLT (11, 13)
Altitude,km (300, 500)
Ion Density,good, cm-3 (0., 6.e5)

X - Geomag. Latitude,deg
Y - Ion Density,good, cm-3
Cr - Correlation coefficient

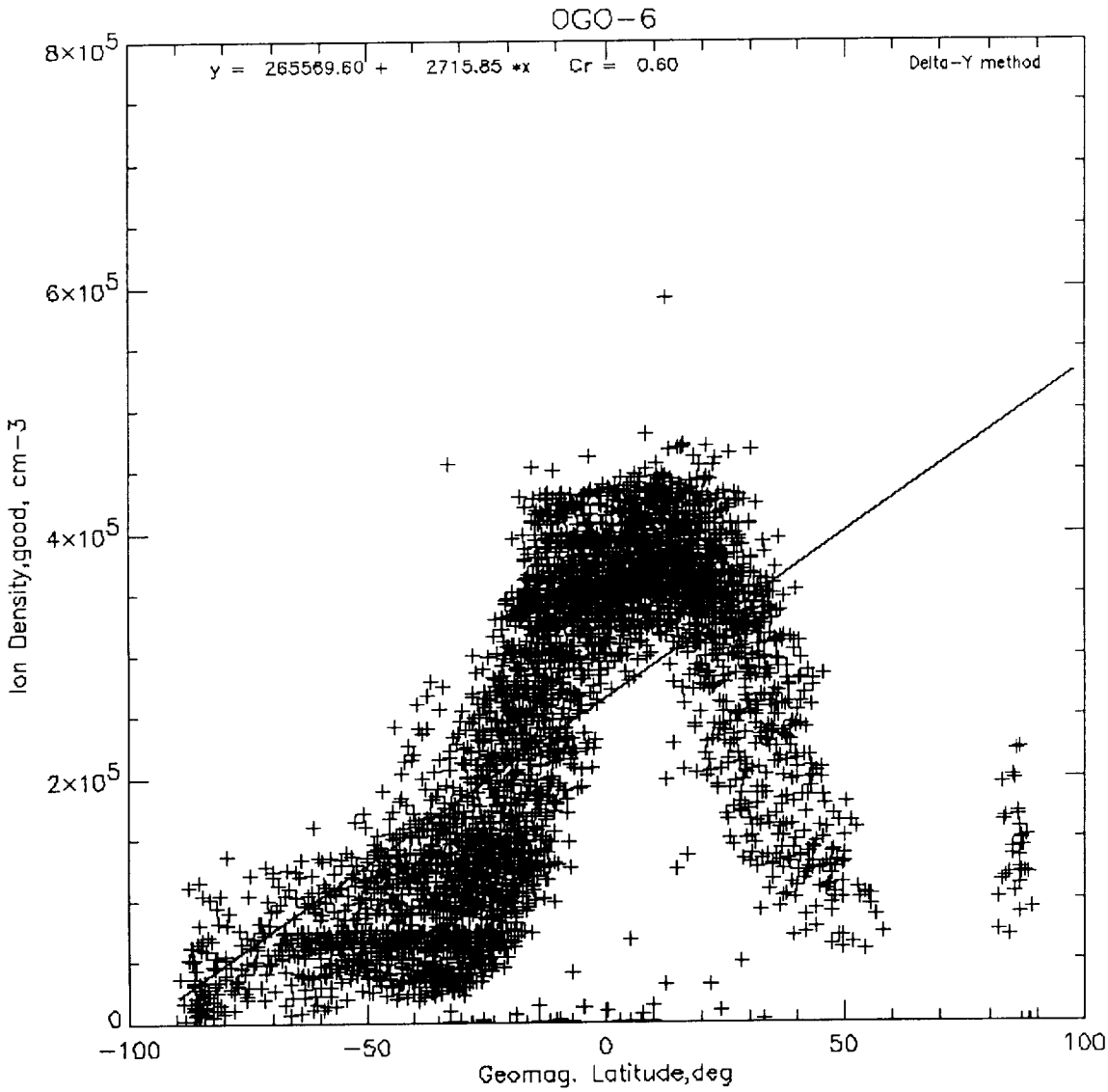


Fig. 9. OGO-6 O^+ density vs geomagnetic latitude for MLT=11-13 and h=300-500 km.

Scatter Plot and Linear Fit of ogo6 data from 19690612 to 19701231
Number of points in plot and fit: 2787
Constraints on parameter values:
Ion index (1, 1)
MLT (0., 2)
Altitude,km (1000, 1200)
Ion Density,good, cm-3 (0., 1.e5)

X - Geomag. Latitude,deg
Y - Ion Density,good, cm-3
Cr - Correlation coefficient

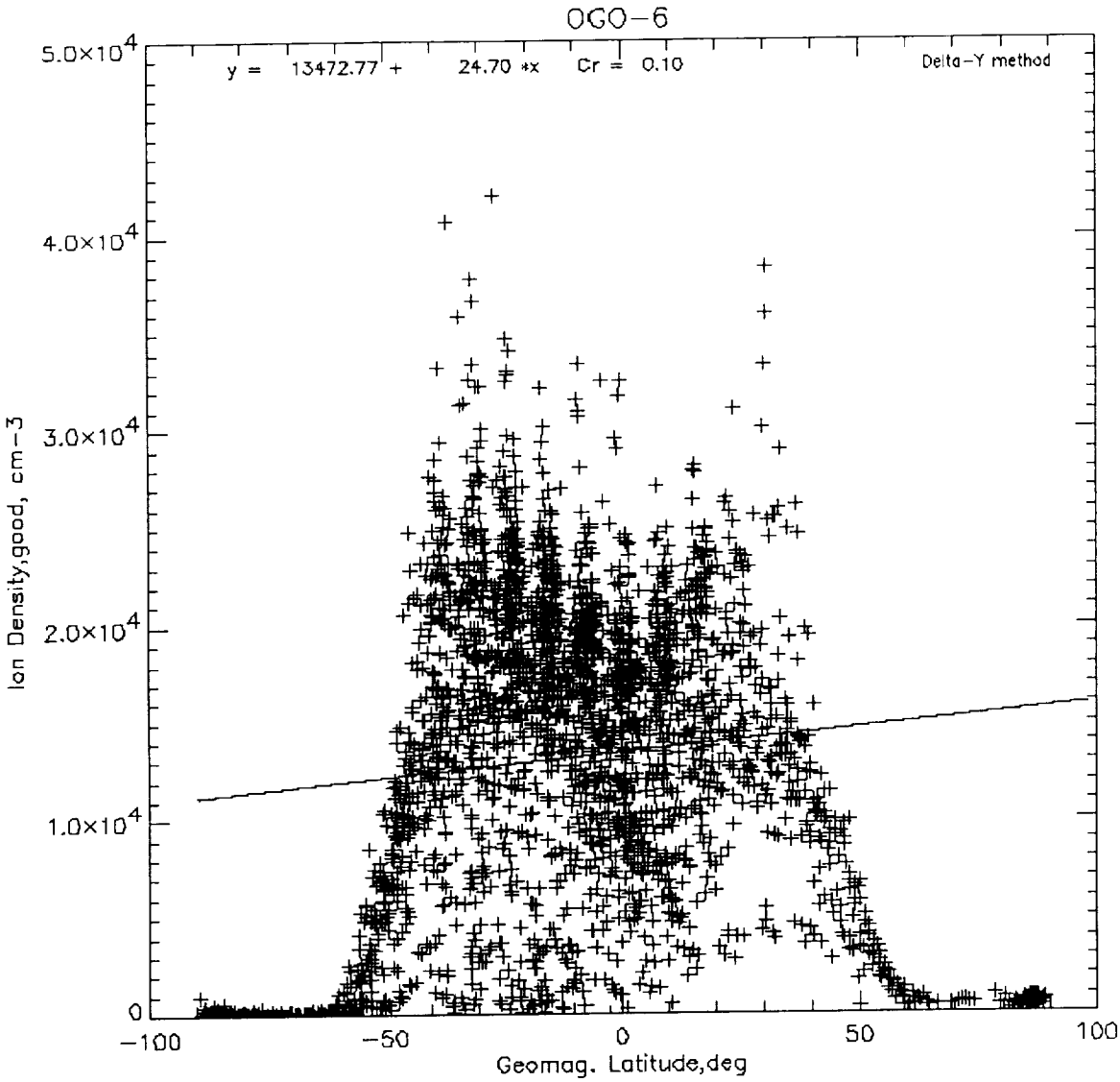


Fig. 10. OGO-6 H^+ density vs geomagnetic latitude for MLT=0-2 and h=1000-1200 km.

Scatter Plot and Linear Fit of ogo6 data from 19690612 to 19701231
Number of points in plot and fit: 4233
Constraints on parameter values:
Ion index (2, 2)
MLT (0., 2)
Altitude,km (1000, 1200)
Ion Density,good, cm-3 (0., 5.e3)

X - Geomag. Latitude,deg
Y - Ion Density,good, cm-3
Cr - Correlation coefficient

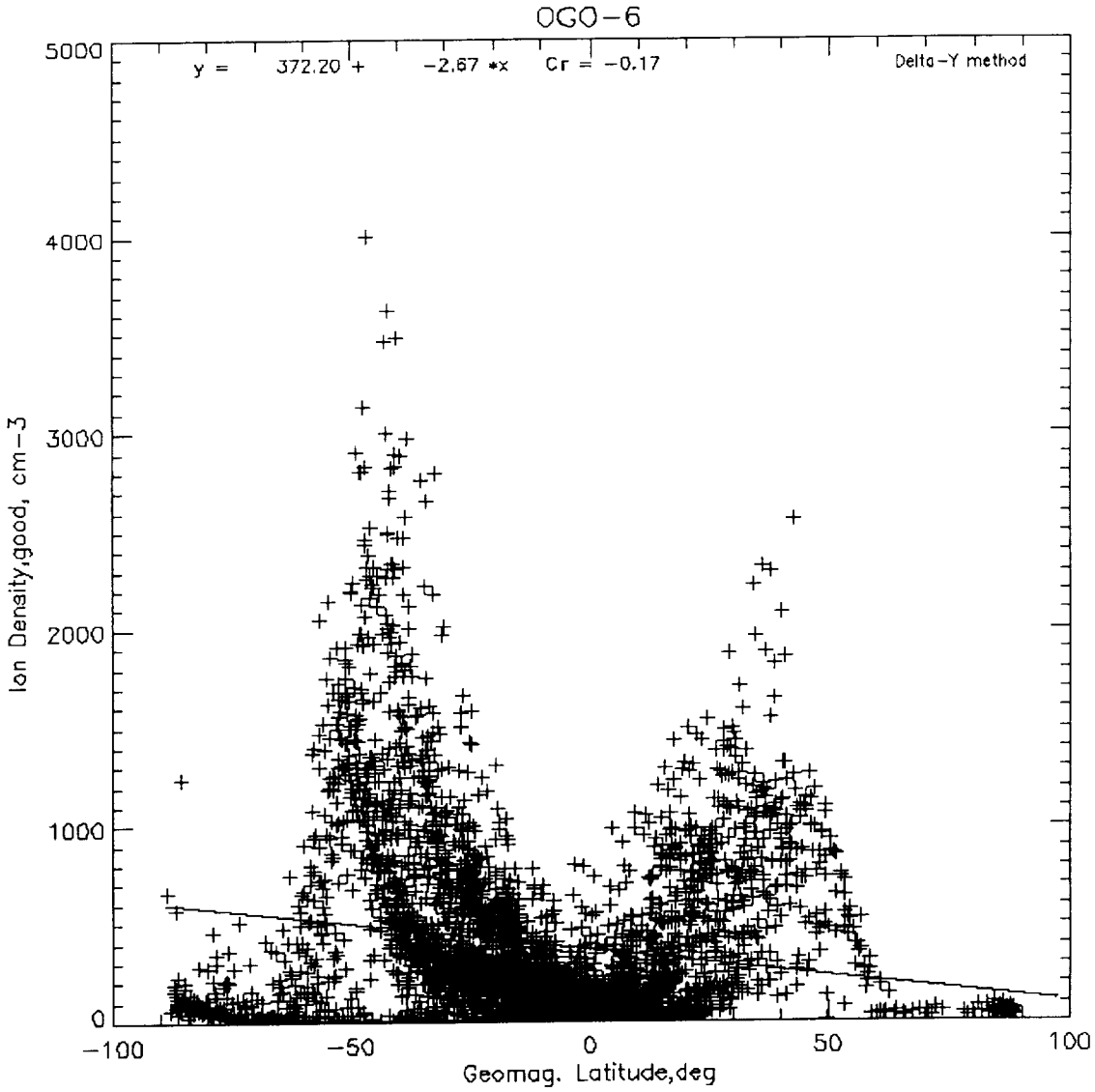


Fig. 11. OGO-6 He^+ density vs geomagnetic latitude for MLT=0-2 and h=1000-1200 km.

Scatter Plot and Linear Fit of ogo6 data from 19690612 to 19701231
Number of points in plot and fit: 961
Constraints on parameter values:
Ion index (1, 1)
MLT (0., 2)
Geomag. Latitude,deg (65, 85)
Ion Density,good, cm-3 (0., 2000)

X - Ion Density,good, cm-3
Y - Altitude,km
Cr - Correlation coefficient

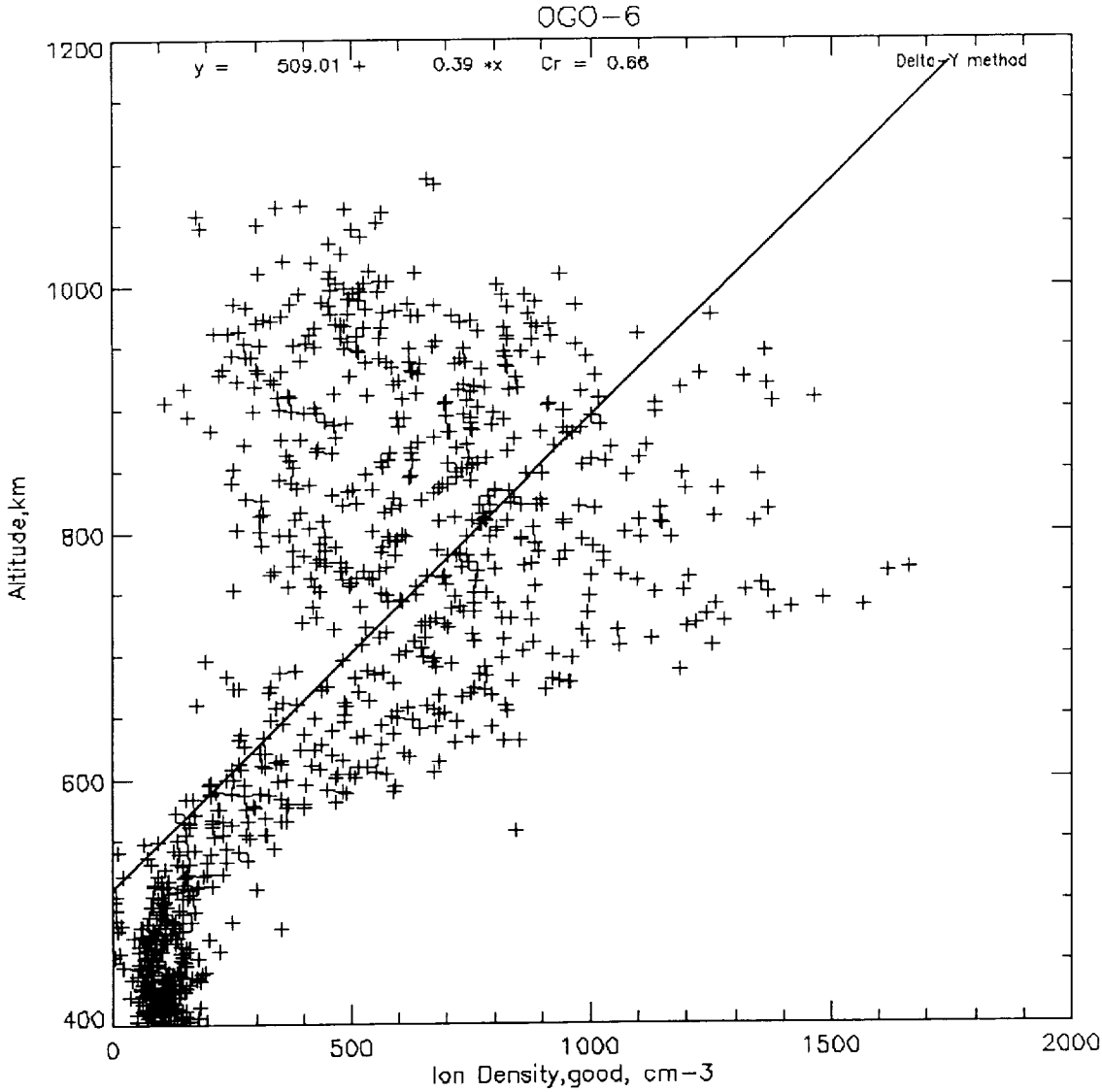


Fig. 12. OGO-6 H^+ density vs altitude for MLT=0-2 and geomagnetic latitude=65-85.

Scatter Plot and Linear Fit of ogo6 data from 19690612 to 19701231
Number of points in plot and fit: 890
Constraints on parameter values:
Ion index (4, 4)
MLT (0., 2)
Geomag. Latitude,deg (65, 85)

X - Ion Density,good, cm-3
Y - Altitude,km
Cr - Correlation coefficient

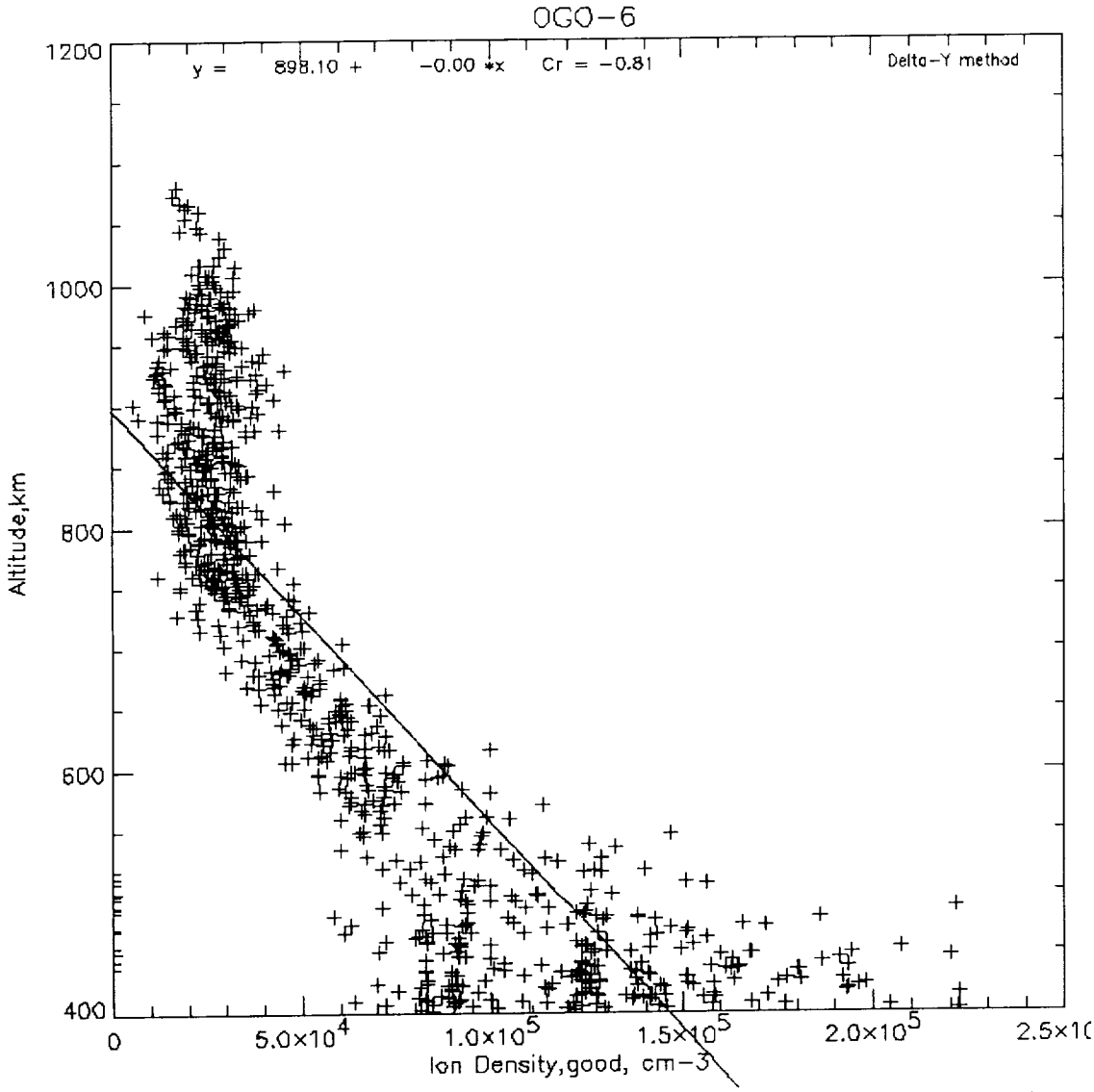


Fig. 13. OGO-6 O^+ density vs altitude for MLT=0-2 and geomagnetic latitude=65-85.

Scatter Plot and Linear Fit of ogo6 data from 19690612 to 19701231
Number of points in plot and fit: 694
Constraints on parameter values:
Ion index (3, 3)
MLT (0., 2)
Geomag. Latitude,deg (65, 85)

X - Ion Density,good, cm-3
Y - Altitude,km
Cr - Correlation coefficient

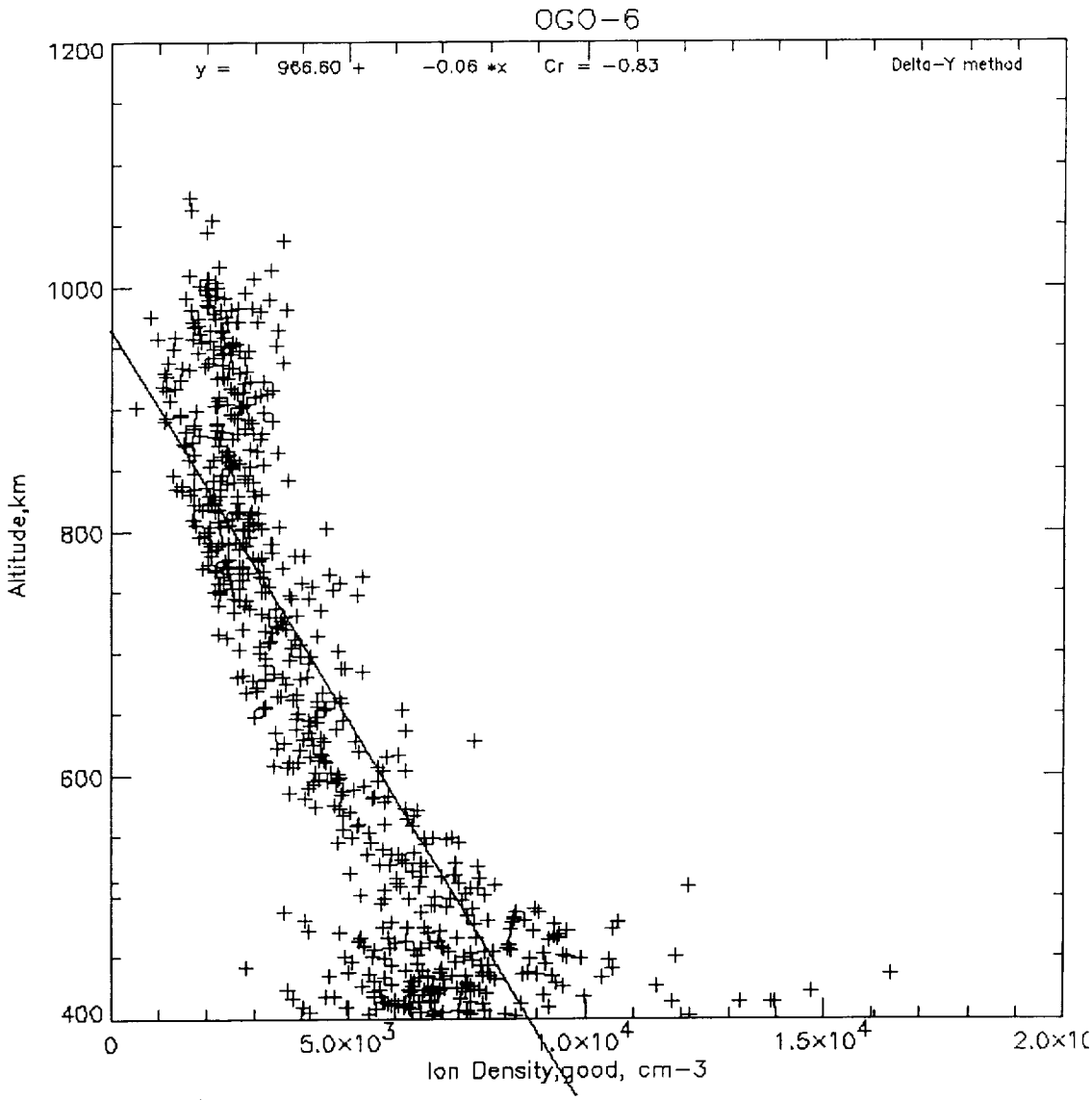


Fig. 14. OGO-6 N^+ density vs altitude for MLT=0-2 and geomagnetic latitude=65-85.

APPENDIX A: ABSTRACTS OF PAPERS PRESENTED

IRI 2001 Workshop, INPE, Brazil, June 25-29, 2001

Old Satellite Sounder and Insitu Data Reprocessed for Ionospheric Modeling

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Accurate descriptions of the solar cycle variations of ionospheric parameters are an important goal of ionospheric modeling. Reliable predictions of these variations are of essential importance for almost all applications of ionospheric models. Unfortunately there are very few global data sources that cover a solar cycle or more. In an effort to expand the solar cycle coverage of data readily available for ionospheric modeling, we have reprocessed a number of satellite data sets from the sixties and seventies and have made them online accessible on the WWW as part of NSSDC's ftp archive and it's ATMOWeb retrieval and plotting system.

We report about two data restoration efforts supported through NASA's Applied Information Systems Research Program (AISRP). The first project involves the digitization and inversion of topside sounder ionograms from the ISIS satellites. The ionograms are digitized at GSFC from the original analog telemetry tapes and are available online in binary and CDF format from the project homepage at http://nssdc/space/isis/isis-status.html (over 300,000 ionograms as of Jan 2001). An automatic topside ionogram scaler with true height algorithm (TOPIST) has been developed at UML and will be used to obtain electron density profiles from the ionograms. This processing effort will produce a unique database mapping the topside ionosphere over more than a solar cycle.

Data made available through the second effort include the Langmuir Probe data from the BE-B, DME-A, Alouette 2, ISIS 1, 2 and Ariel 4 satellite missions, Retarding Potential Analyzer (RPA) data from the ISIS 1, OGO-6, AEROS A and B satellites, and Ion Mass Spectrometer (IMS) data from DME-A, AE-B, OGO-6, ISIS-2, and ESRO 4. With tehir global coverage over more than two solar cycles these data sets are a valuable asset for improvement studies of the IRI model. The data are being made available online through NSSDC's ATMOWeb system (http://nssdc.gsfc. nasa.gov/atmoweb/). ATMOWeb already provides access to the Hinotori RPA data and to the Unified Abstract (UA) data from the Atmosphere Explorer C, D, and E, and the Dynamics Explorer 2 (merged 15 second data from most of the instruments on these satellites).

Asian Pacific Radio Science Conference, Tokyo, Japan, August 3-8, 2001

Old Satellite Data Reprocessed for Ionospheric Modeling

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Accurate descriptions of the solar cycle variations of ionospheric parameters are of essential importance for almost all applications of ionospheric models. Unfortunately there are very few global data sources that cover a solar cycle or more. In an effort to expand the solar cycle coverage of data readily available for ionospheric modeling, we have reprocessed a number of satellite data sets from the sixties and seventies and have made them online accessible on the WWW as part of our ATMOWeb system.

This data restoration effort is supported through NASA's Applied Information Systems Research Program (AISRP). Data made available online include the Langmuir Probe data from the BE-B, DME-A, Alouette 2, and ISIS 1 satellite missions. Retarding Potential Analyzer (RPA) and Impedance Probe data from the AEROS A and B satellites will be loaded online shortly. The ATMOWeb system already provides access to the Hinotori RPA data and to the Unified Abstract (UA) data from the Atmosphere Explorer C, D, and E, and the Dynamics Explorer 2 (merged 15 second data from most of the instruments on these satellites).

Other data sets that are now being considered for inclusion on ATMOWeb are the Ion Mass Spectrometer data from OGO 6, ISIS 2, and ESRO 4 and the RPA data from ISIS 1 and OGO 6. This combined ATMOWeb data source will provide global ion and electron density and temperature data for more than one solar cycle.

Applied Information Systems Research Program, Principal Investigators' Annual Meeting, Johns Hopkins University, Applied Physics Laboratory, 15-18 October 2001

Ionospheric Electron/Ion Densities and Temperatures on WWW

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Accurate descriptions of the solar cycle variations of ionospheric parameters are of essential importance for almost all applications of ionospheric models. Unfortunately there are very few global data sources that cover a solar cycle or more. In an effort to expand the solar cycle coverage of data readily available for ionospheric modeling, we are reprocessing a number of satellite data sets from the sixties and seventies and are making them online accessible on the WWW. The ATMOWeb interface (ATMOWeb http://nssdc.gsfc.nasa.gov/atmoweb) lets user browse, plot and download data online.

Data made available online so fare include the Langmuir Probe data from the BE-B, DME-A, Alouette-2, and ISIS-1 satellite missions, the Retarding Potential Analyzer (RPA) data from the AEROS-A and Hinotori satellite missions, and the Ion Mass Spectrometer (IMS) data from the OGO-6 satellite mission. The ATMOWeb system provides also access to the Unified Abstract (UA) data from the Atmosphere Explorer C, D, and E, and the Dynamics Explorer 2 (merged 15-second data from most of the instruments on these satellites).

Data sets now being prepared for inclusion on ATMOWeb are the Ion Mass Spectrometer data from AE-B and ISIS-2. Data sets considered for future processing are the LP data from Ariel-3, -4, and ISIS-2, RPA data from AEROS-B, and IMS data from ISS-b. The combined ATMOWeb data source will provide global ion and electron density and temperature data for more than one solar cycle.

International Union of Radio Science (URSI), General Assembly,
Maastricht, The Netherlands, August 19 – 23, 2002

International Reference Ionosphere (IRI), Task Force Activity,
International Centre for Theoretical Physics (ICTP), Trieste, Italy, August 5 – 9, 2002

Ionopsheric Data for two solar cycles available online

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We report about a project that has as its goal to make a large volume of ionospheric satellite insitu data from the sixties, seventies and early eighties easily accessible for public use. The original data exist in various machine-specific, highly compressed, binary encoding on 7-, or 9-track magnetic tapes. The intend is to decode the data format and convert all data sets to a common ASCII data format and add solar and magnetic indices for user convenience. The original intend of producing CD-ROMs with these data has meanwhile been overtaken by the rapid development of the Internet. Most users now prefer to obtain the data directly online and greatly value WWW-interfaces to browse, plot and subset the data. Accordingly, the focus has shifted to making the data available online on the anonymous ftp site of NASA's National Space Science Data Center (NSSDC) at ftp://nssdcftp.gsfc.nasa.gov/spacecraft_data/ and on the development of a WWW-interface (ATMOWeb, http://nssdc.gsfc.nasa.gov/atmoweb/) to help users study the data and select interesting time periods.

The data considered by this project include data sets from the Alouette 1, BE-B (Explorer 22), Alouette 2, DME-A (Explorer 31), AE-B (Explorer 32), AE-C, -D, -E, OGO-6, ESRO-4, ISIS-1, -2, AEROS-1, -2, Taiyo, ISS-b, Hinotori and DE-2 satellites. The data are primarily electron and ion densities and temperatures measured by Langmuir Probes, Retarding Potential Analyzers, and Ion Mass Spectrometers flown on these satellites. The time resolution of the measurements is typically seconds to minutes.

This database covering almost two solar cycles is a unique asset for studies of the variation and variability of ionospheric parameters. It will be an important element in the quest for a better understanding of ionospheric plasma processes and for improved predictions of ionospheric Space Weather. Current models are still very limited in their predictive capabilities especially at equatorial and auroral latitudes. Better descriptions of the seasonal, solar cycle, and magnetic stormtime variation patterns are expected with the usage of our multi-satellite database. The data will be also a valuable resource for updating ionospheric models with measured parameters for these earlier time periods.