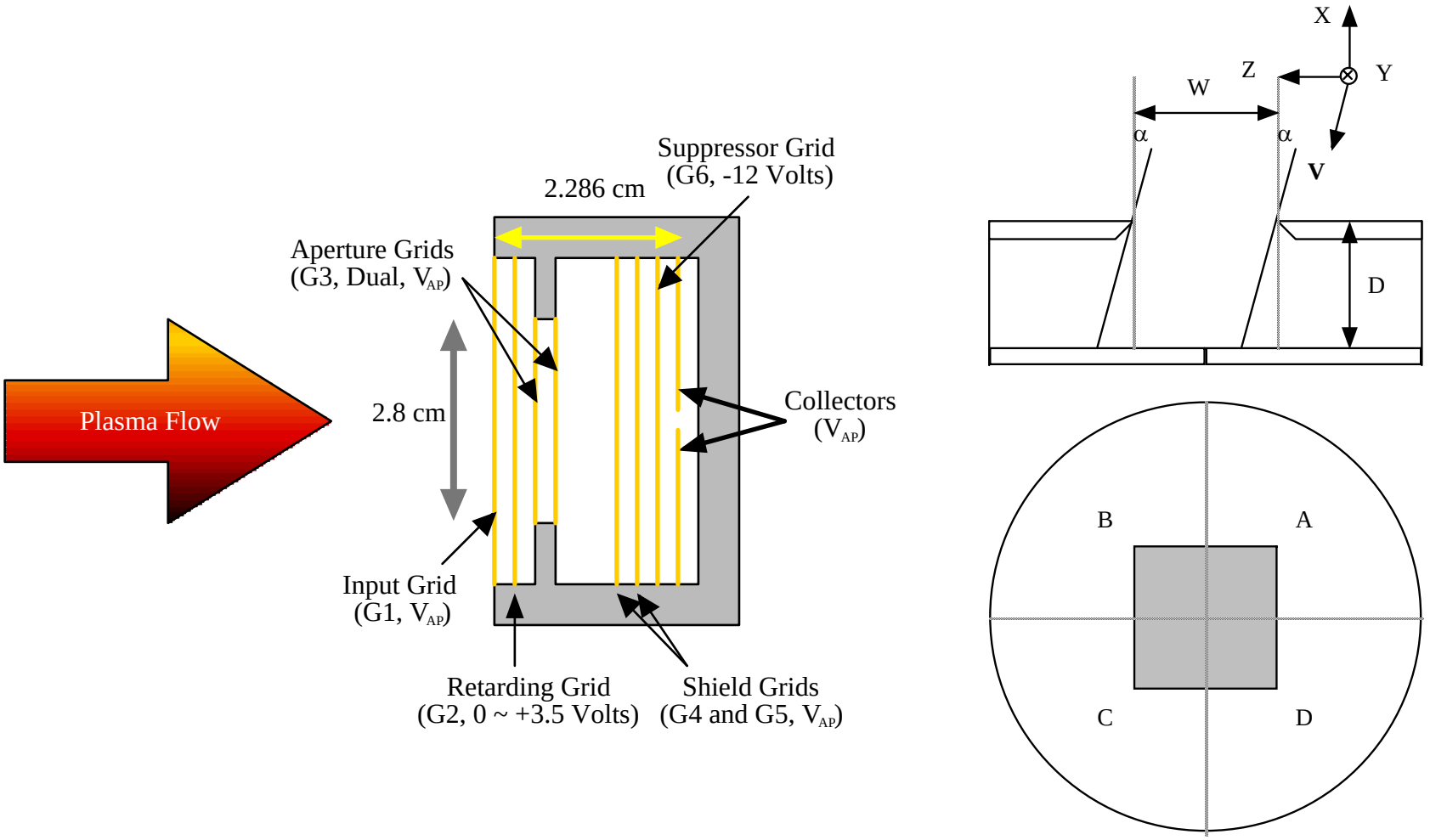
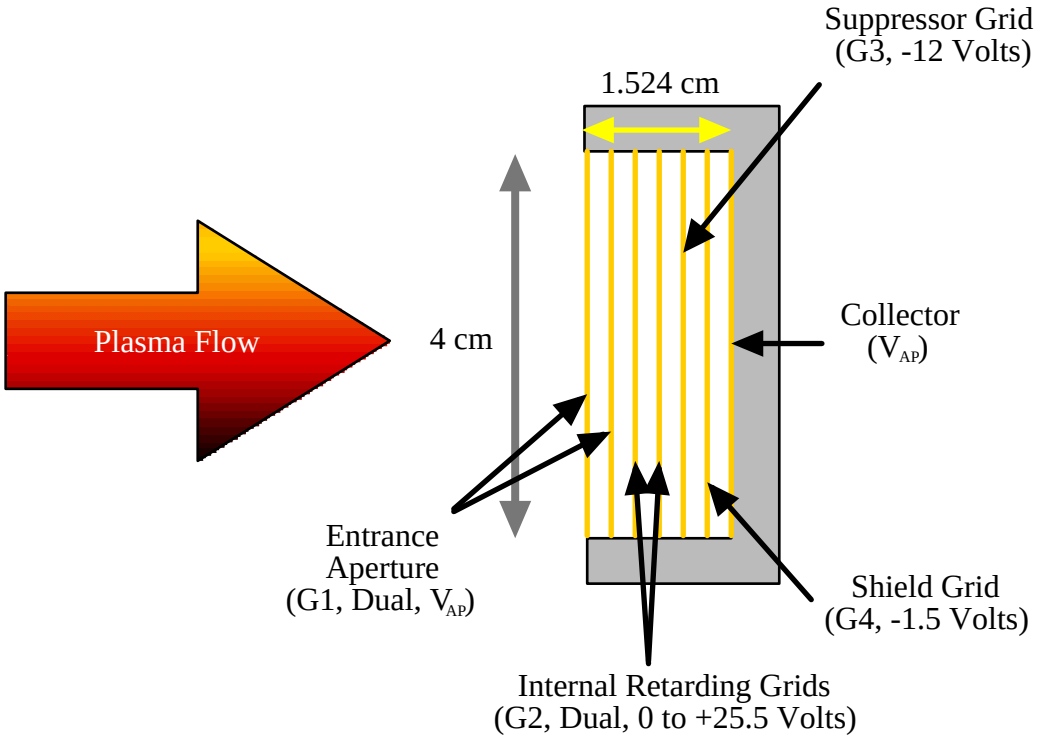
IPEI Payload

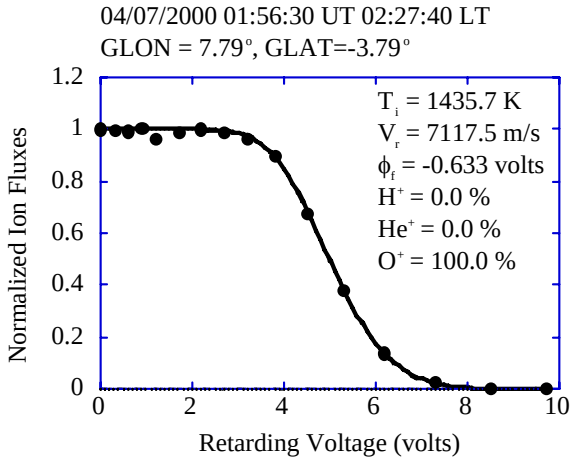
- One Ion Trap (IT).
  - To measure the total ion concentration at 32 Hz or 1024 Hz.
- A pair of Ion Drift Meters (+YDM and -YDM).
  - To measure the two cross-track ion flow velocities at 32 Hz or 1024 Hz.
- One Retarding Potential Analyzer (RPA).
  - To deduce ion composition, ion temperature and ram flow velocity at 1 or 2 Hz.

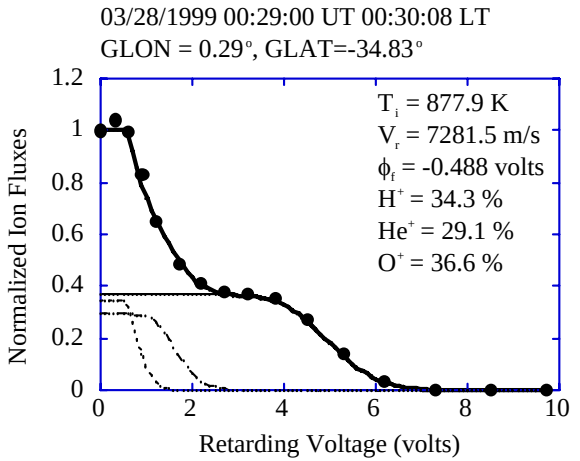
Ion Drift Meter (IDM) cross section



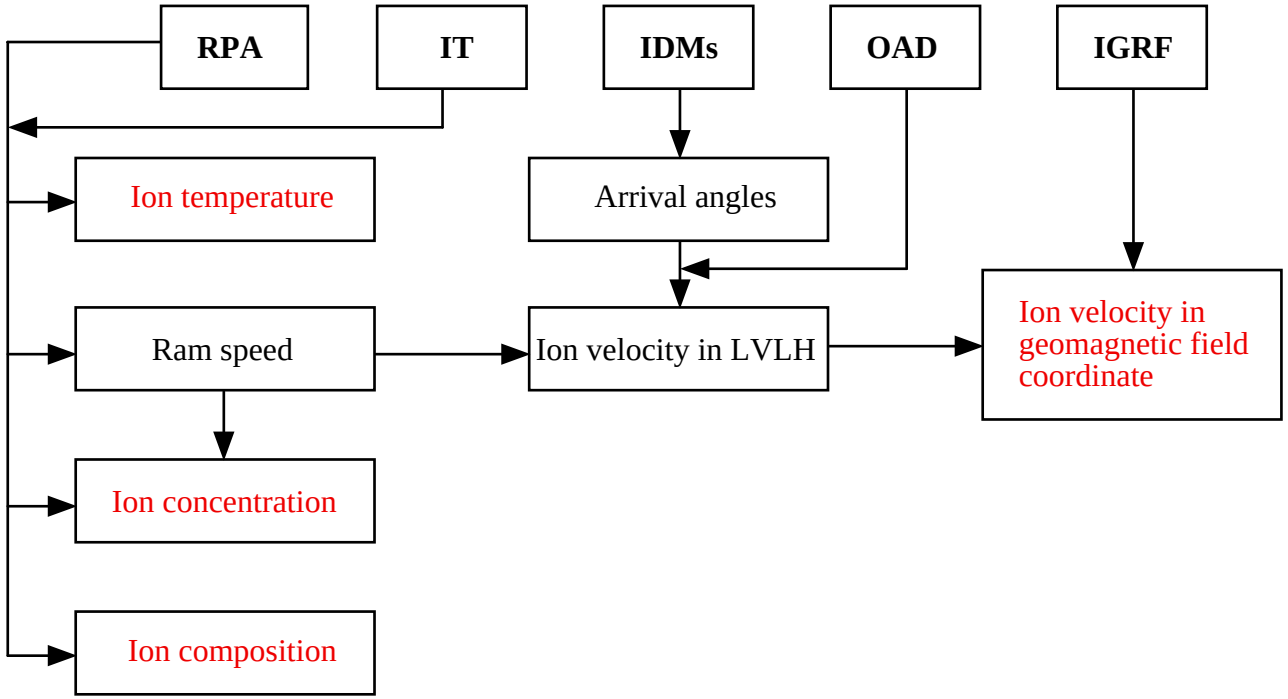
Retarding Potential Analyzer (RPA) cross section

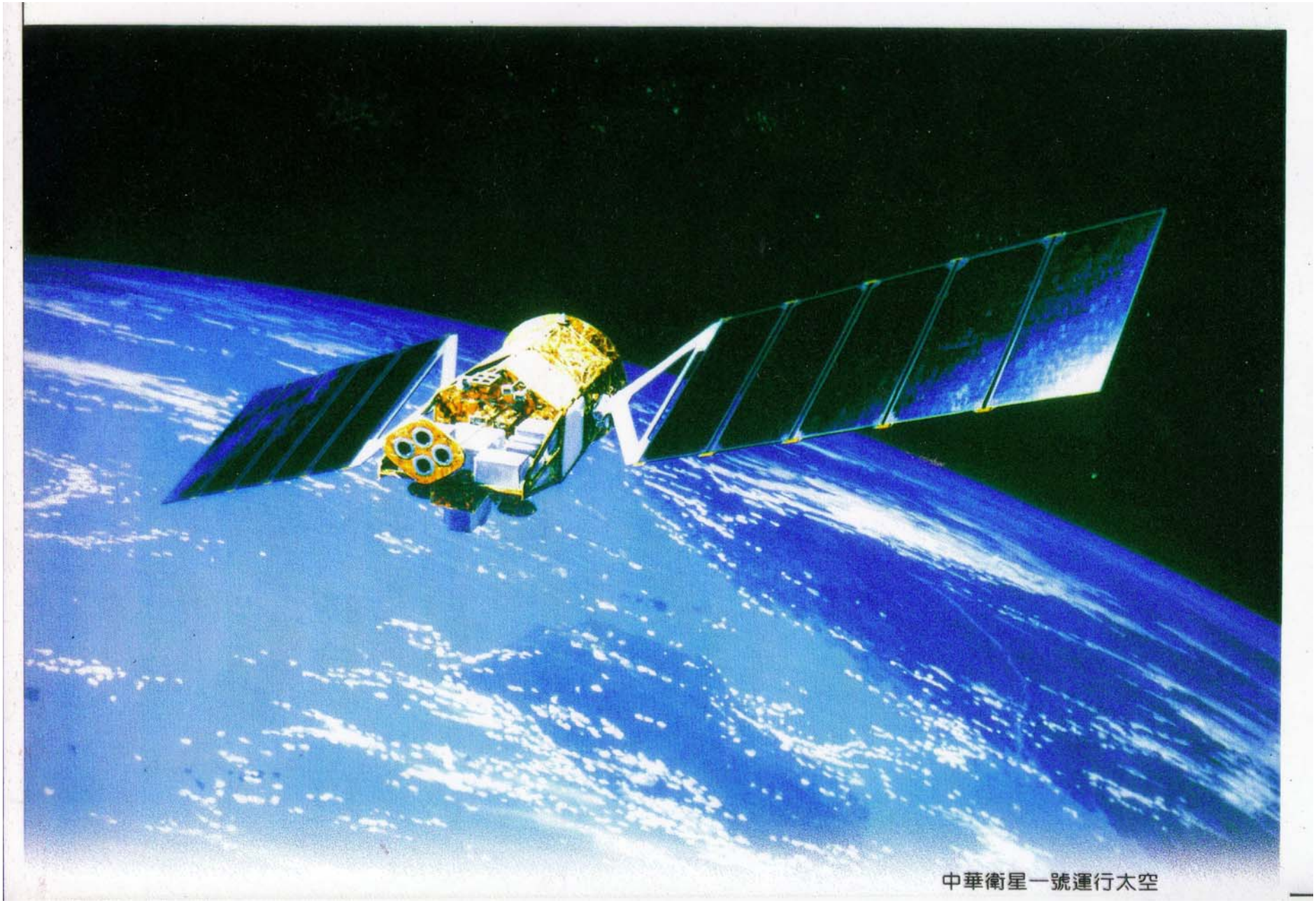






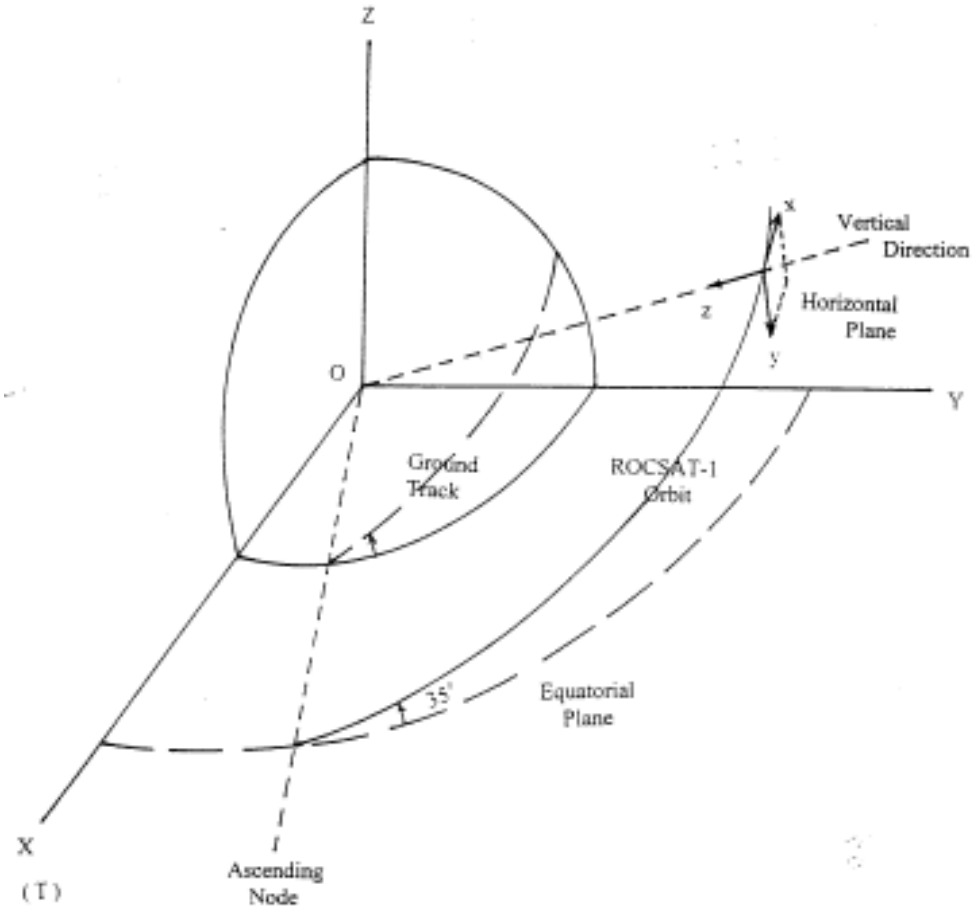
Ion parameters derived from IPEI instrument





中華衛星一號運行太空

Earth-Centered Inertia (ECI) Coordinate



Spacecraft Coordinate System

y: opposite to angular momentum

z: toward the Earth Center

x: $\hat{y} \times \hat{z}$ direction

Measurements on the ROCSAT spacecraft coordinate.

- Ion concentration (density), N, from IT.
  - Base on spacecraft velocity of 7.545 km/s.
- V_y and V_z flow components from +YDM and -YDM.
  - Use 7.545 km/s to convert flow velocity from measured deflection angle.
  - Measured V_y contains the Earth rotation induced co-rotation flow velocity.
- V_x (ram velocity) from RPA.

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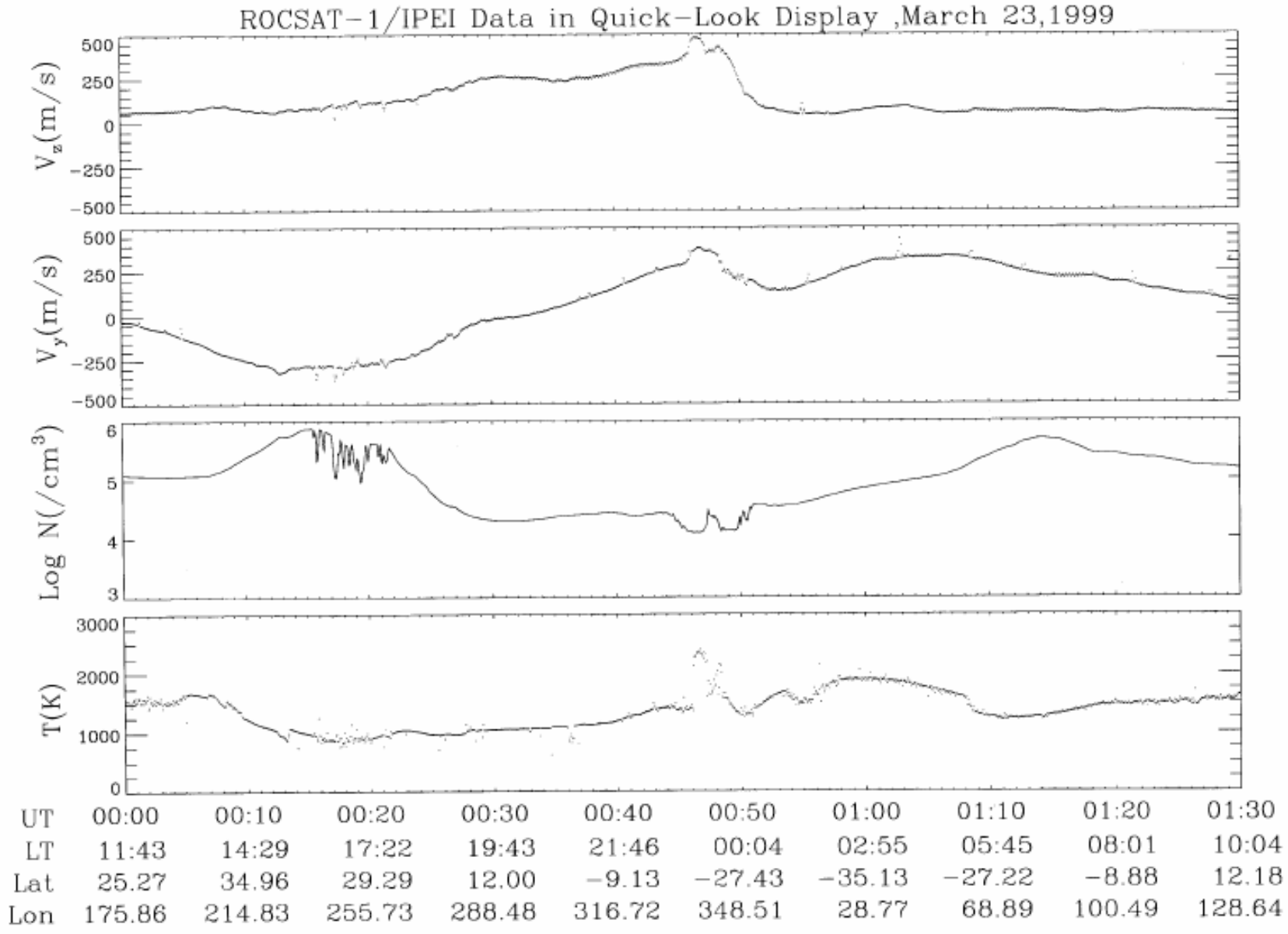
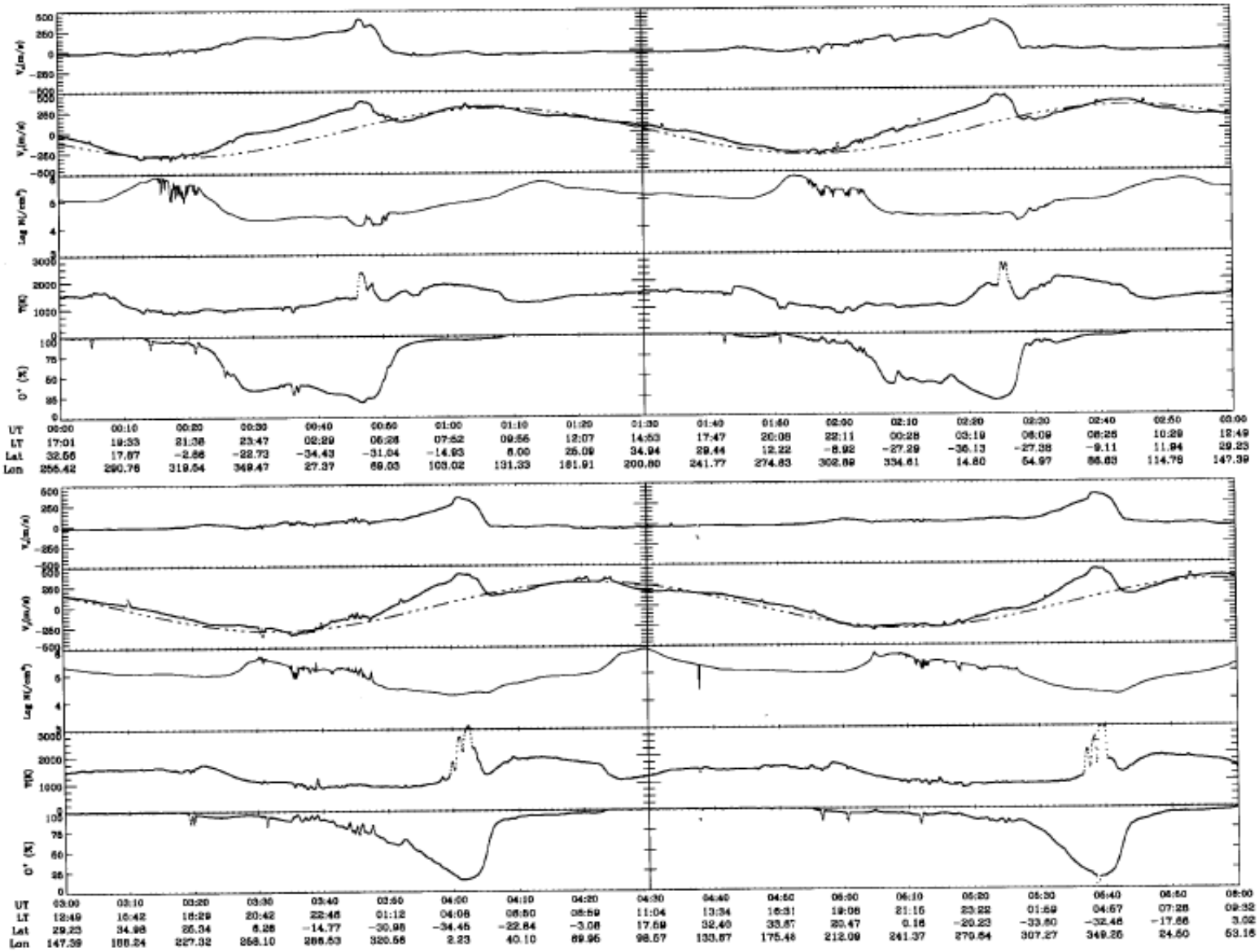

ROCSAT-1/IPEI Data in Quick-Look Display ,March 23,1999
V_z(m/s)
500
250
0
-250
-500
V_y(m/s)
500
250
0
-250
-500
Log N(/cm^3)
6
5
4
3
T(K)
3000
2000
1000
0
UT 00:00 00:10 00:20 00:30 00:40 00:50 01:00 01:10 01:20 01:30
LT 11:43 14:29 17:22 19:43 21:46 00:04 02:55 05:45 08:01 10:04
Lat 25.27 34.96 29.29 12.00 -9.13 -27.43 -35.13 -27.22 -8.88 12.18
Lon 175.86 214.83 255.73 288.48 316.72 348.51 28.77 68.89 100.49 128.64

ROCSAT-1/IPEI Data , March 23,1999



Co-rotation velociy

$$v_y^{cor} = \pm\omega_\oplus r(\cos^2 L - \cos^2 i)^{1/2}$$

(+ sign for north-bound orbit and

– sign for south-bound orbit)

$$v_x^{cor} = \omega_\oplus r \cos i = 418.19 \text{ m/s.}$$

$$V_{x/base} = V_{s/c} - v_x^{cor}$$

$$= 7.545 \text{ km/s} - 418.19 \text{ m/s}$$

$$= 7.027 \text{ km/s}$$

Measurement uncertainties.

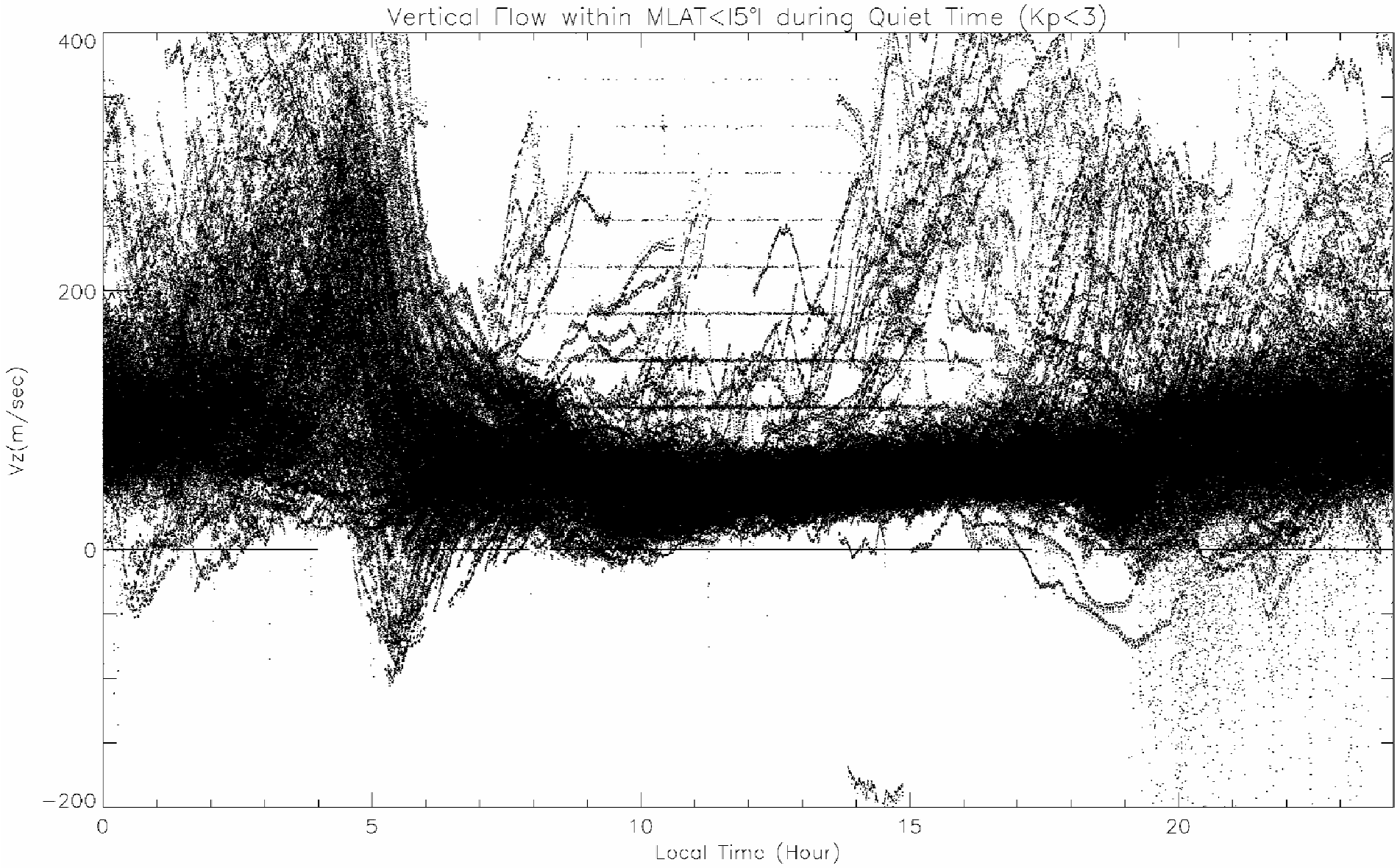
- Ion concentration (density).
  $\Delta N/N$ = 0.285% in one count error.
- V_y and V_z (cross-track component) from IDM.
  ΔV = 12.5 m/s from 0.1° error in deflection angle.
- V_x (ram velocity) from RPA.
  Largest uncertainty up to 5% based on reference velocity of $V_{x/base}$, that is ±350 m/s in uncertainty.
  - Another uncertainty is spacecraft potential.

$$\phi_f \propto \frac{KT_e}{e}$$

Systematic Bias in Measured V_y and V_z.

- Take V_z between ±5° in dip latitude and plot V_z against local-time for one season of data with K_p<3.
  - Average of V_z for all local-time

    $\overline{V_z} = 0$. If not, this is the system bias.


Vertical Flow within MLAT<|5°| during Quiet Time (Kp<3)
400
200
0
−200
Vz(m/sec)
0
5
10
15
20
Local Time (Hour)

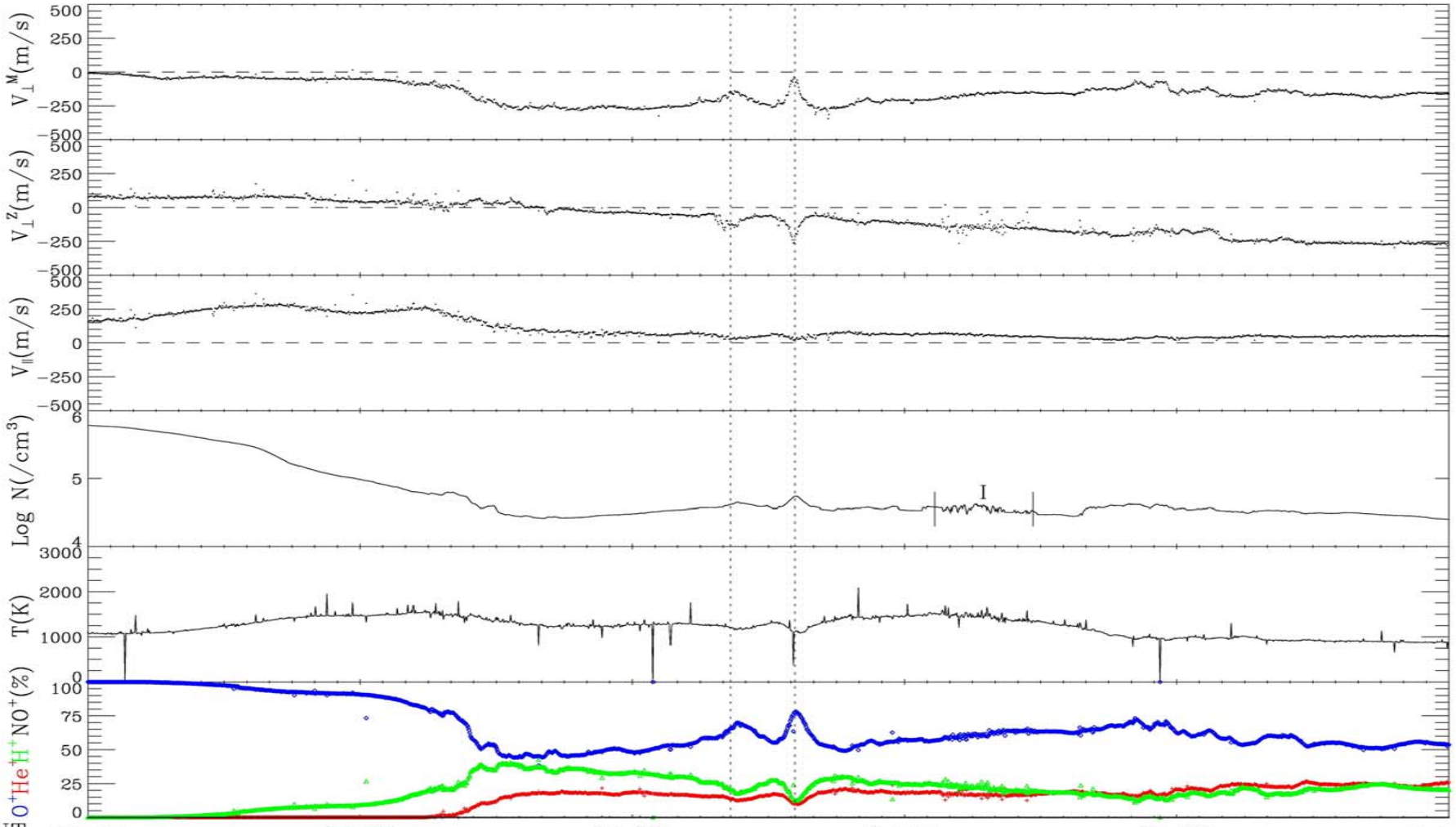
- $V_{z/bais}$ = 91.238, 70.977, 58.552, 54.820,
  33.493, 43.146, 39.683, 36.607,
  31.967, 39.936, 28.111, 20.849,
  15.314, 29.546, 15.589, 10.487,
  15.948, 20.641, 17.992, 18.057,
  15.855, 32.573 m/s
  for Spring, Summer, Autumn and Winter of 1999, 2000, 2001, 2002, 2003, and 2004, respectively.

- Swap the operation between +YDM and -YDM.
  - Compare the performance between the two Drift Meters.
  - $V_{y/bias} = V_{z/bias} - 46$ m/s.

Measurements of geophysical quantities on Earth rotation coordinate system (as observed by a ground experiment).

- Use IGRF (International Geomagnetic Reference Model) to obtain $\underset{\sim}{B}$ field at ROCSAT location.
- Remove V_y^{cor} and biases of V_y and V_z .
- Remove V_{ram} in V_x due to spacecraft motion.
- Project the resultant V_x, V_y, and V_z in $\underset{\sim}{B}$ coordinate to obtain $V_\perp{}^M$ (radial), $V_\perp{}^Z$ (zonal), and $V_{||}$ (parallel) components of flow velocity.

IPEI LV_1 Data Quick-Look Display 00/008(01/08) Page: 1



UT	04:15	04:21	04:27	04:33	04:39	04:45
LT	19:35	20:47	22:05	23:33	01:15	03:03
Lat	−4.44	8.23	20.04	29.45	34.62	34.08
Lon	230.06	246.73	264.57	285.20	309.19	334.66
DLat	−0.58	14.76	30.43	40.29	38.17	30.47

Important Notes on Accuracy of $V_{\perp}^{M}$ (radial), $V_{\perp}^{Z}$ (zonal), and $V_{\parallel}$ (parallel) components.

- Uncertainty of ±350 m/s in V_x has been introduced in all geophysical flow components.
- $V_{\perp}^{M}$ in low latitude is almost identical to ($-V_z$). No V_x is included so that it is very reliable.
- Uncertainty from V_x has been introduced in $V_{\perp}^{Z}$ and $V_{\parallel}$.
- $V_{\perp}^{Z}$ and $V_{\parallel}$ can be used to study the relative change in flow velocity due to geophysical variations. But can not be used to study the long-term behavior of the flow velocity because the result may be biased by the uncertainty in V_x.