The occurrence of plasma bubbles in Asian sector and their relationship with vertical drifts using ROCSAT-1/IPEI Data

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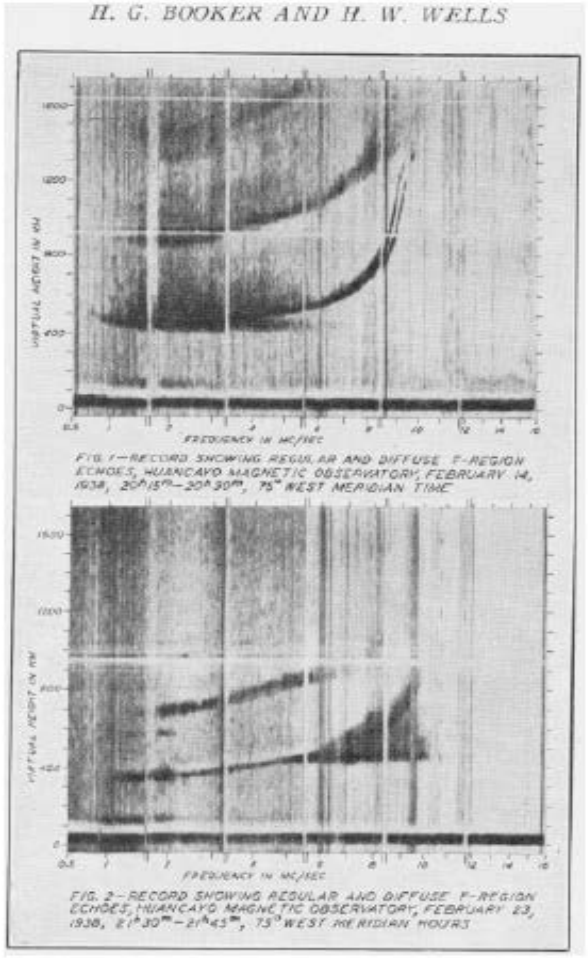
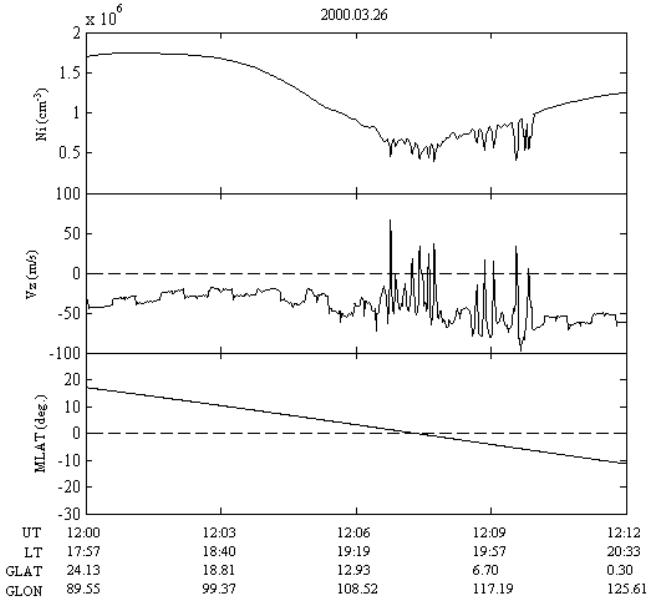
Content

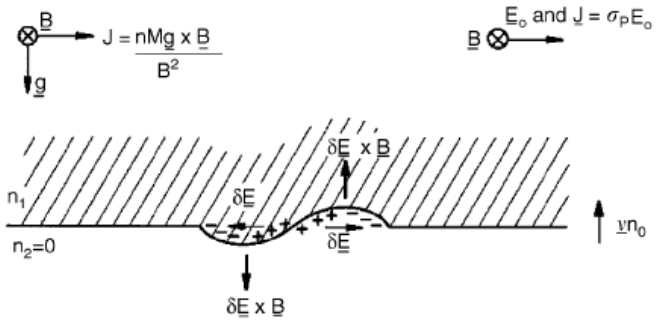
- Introduction
- The occurrence of plasma bubbles at low latitudes from ROCSAT-1 observation
- The vertical drifts inside the plasma bubbles and the relationship with PRE
- The plasma bubbles at post-midnight during geomagnetic storms
- Summary

Equatorial Spread F (ESF)





ROCSAT-1 plasma bubble observation



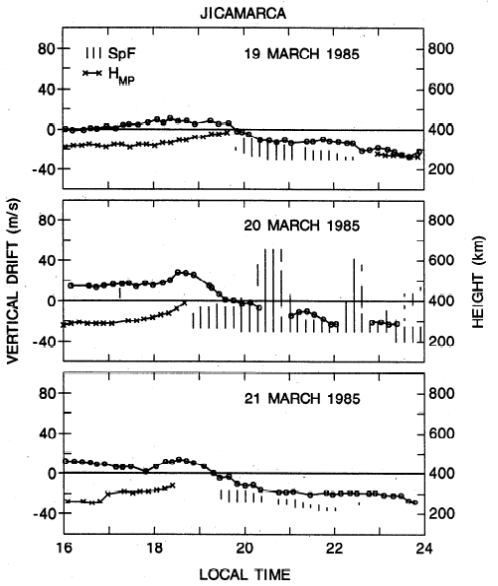
●Originally observed the “diffuse echoes” from an ionosonde in Huancayo

（Booker and Wells, 1938）

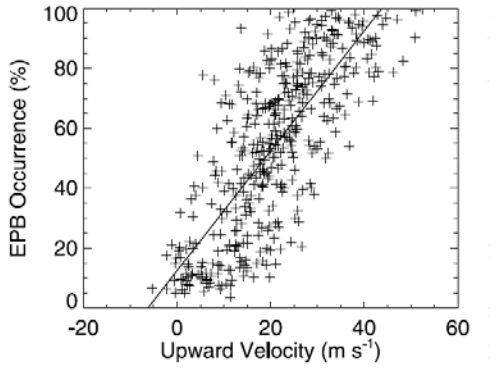
$$\gamma_{GRT} = \frac{E_{x0}'}{LB}\cos\sigma + \frac{g}{\upsilon_{in}L}\cos\sigma + \frac{E_{z0}'+U_x B}{LB}\sin\sigma$$

PRE and plasma bubbles

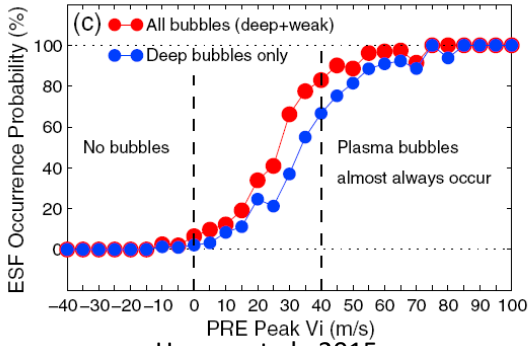
- Fejer et al.(1999) suggested that the Rayleigh-Taylor instability could happen with the PRE persisting for more than 30 minutes, and this PRE may just be a daily variation.
- Kudeki and Bhattacharyya (1999) indicated that the PRE itself is an important mechanism of producing R-T instability.
- Abdu (2001) indicated that the vertical drift is not the only factor for describing the production of plasma bubbles.
- Kil et al.(2009) suggested that PRE is in favor of producing the R-T instability, but it is not the determination for plasma bubbles. The seed mechanism of producing the R-T, such as the gravity wave, wind share is still the necessary conditions.
- Huang et al.(2015) analyzed the plasma bubbles from C/NOFS observation in low sloar activity, and showed The ESF occurrence becomes larger than 80% when the PRE is greater than 40m/s.



Fejer et al.,1999



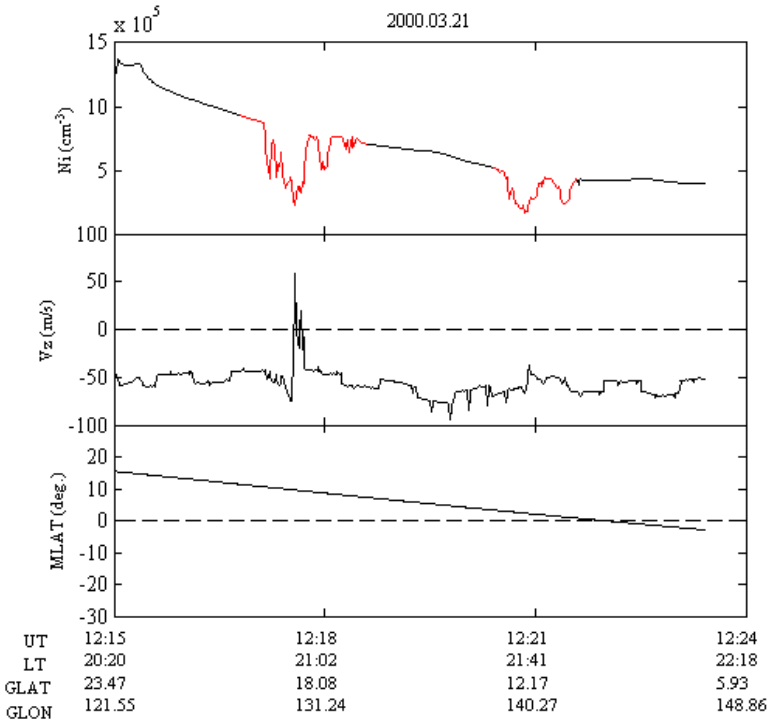
Kil et al., 2009

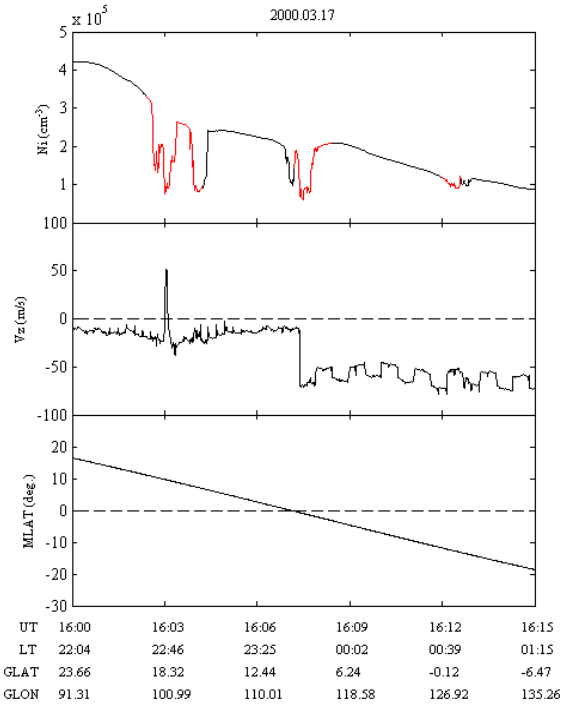


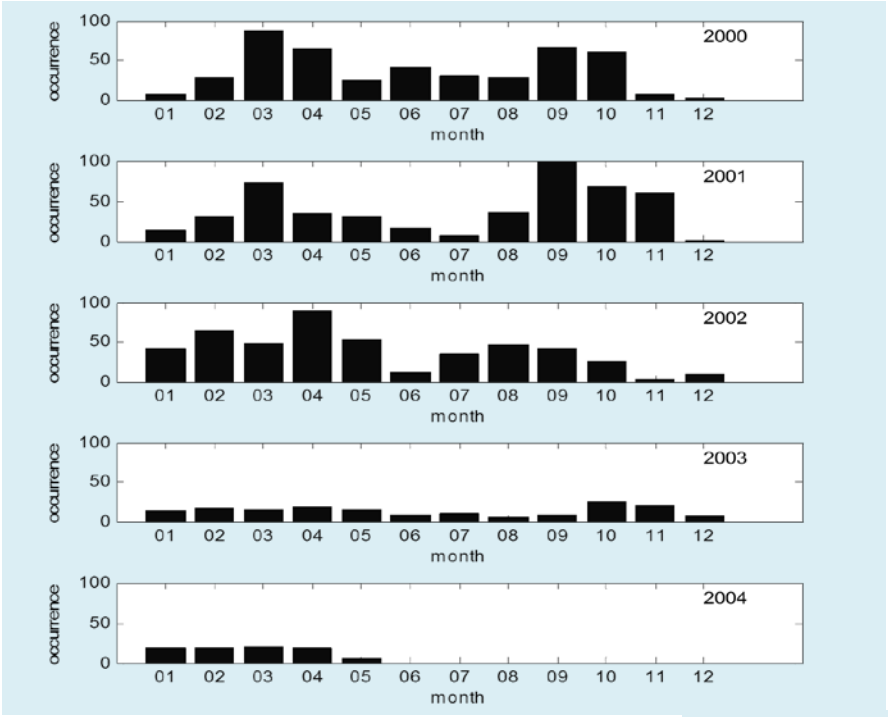
Huang et al., 2015

Data we used

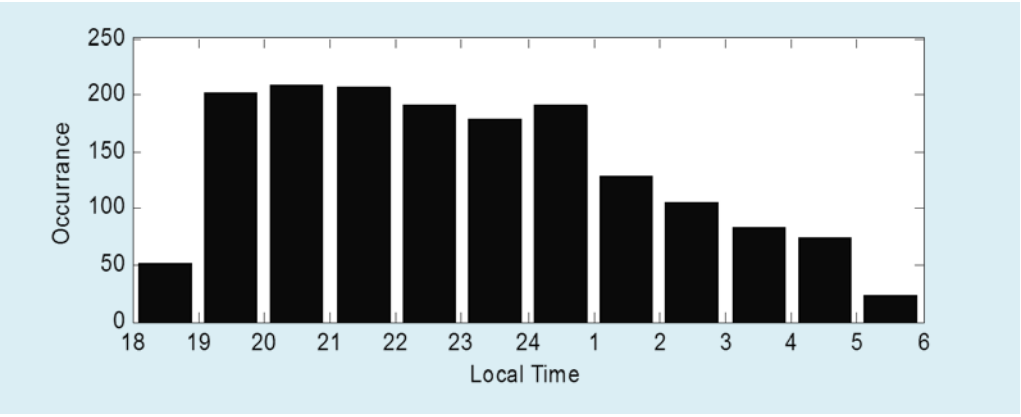
- ROCSAT－1，2000～2004年
- Region：90～150°E，－35～35°N
- The plasma bubble events survey：the plasma density depletions or fluctuaions



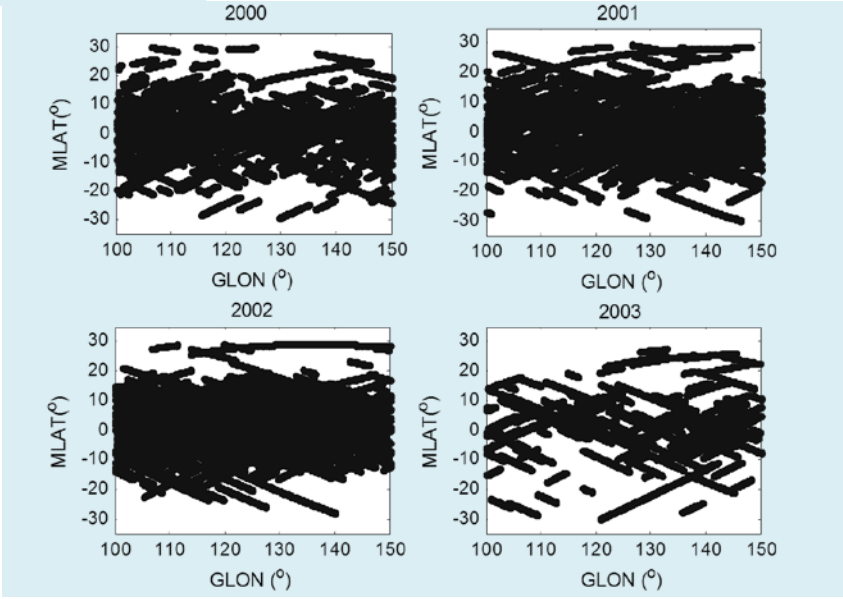




The occurrence of plasma bubble at different years



The occurrence of plasma bubble Via Local time



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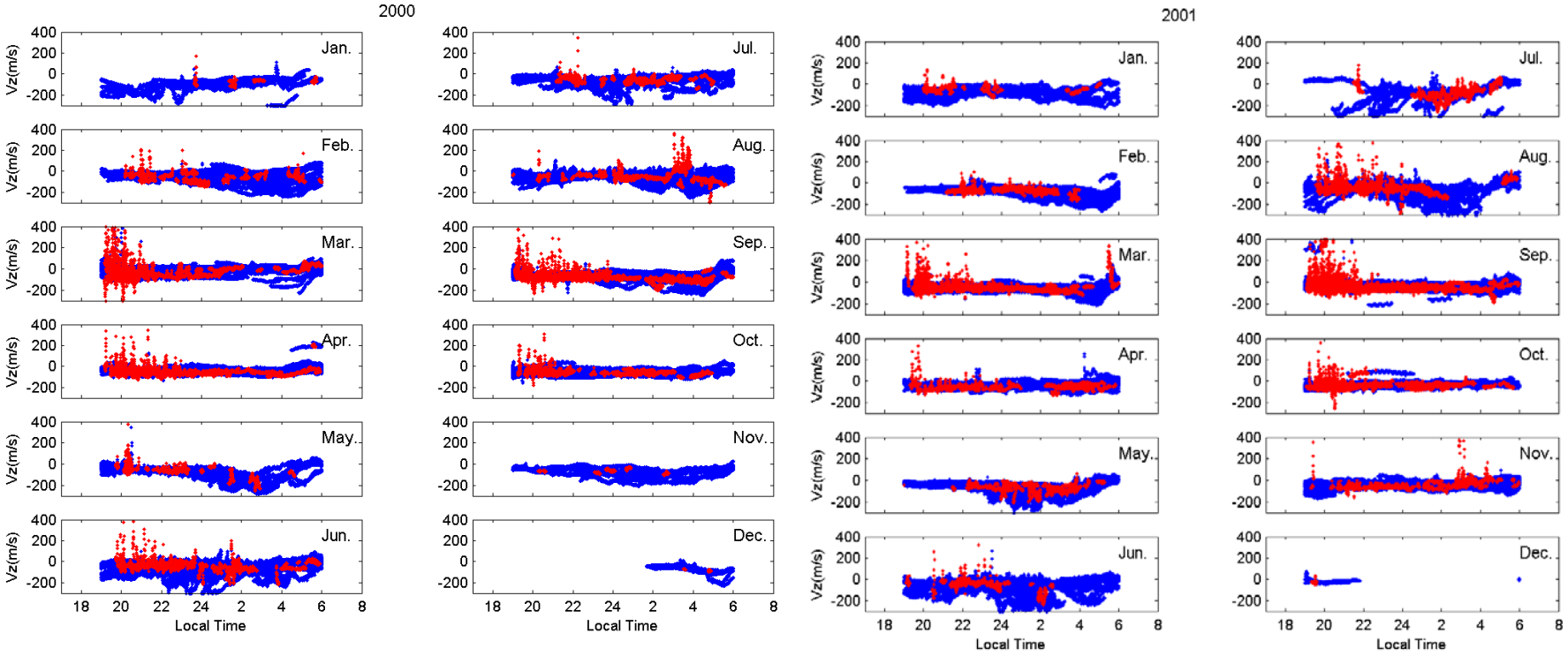
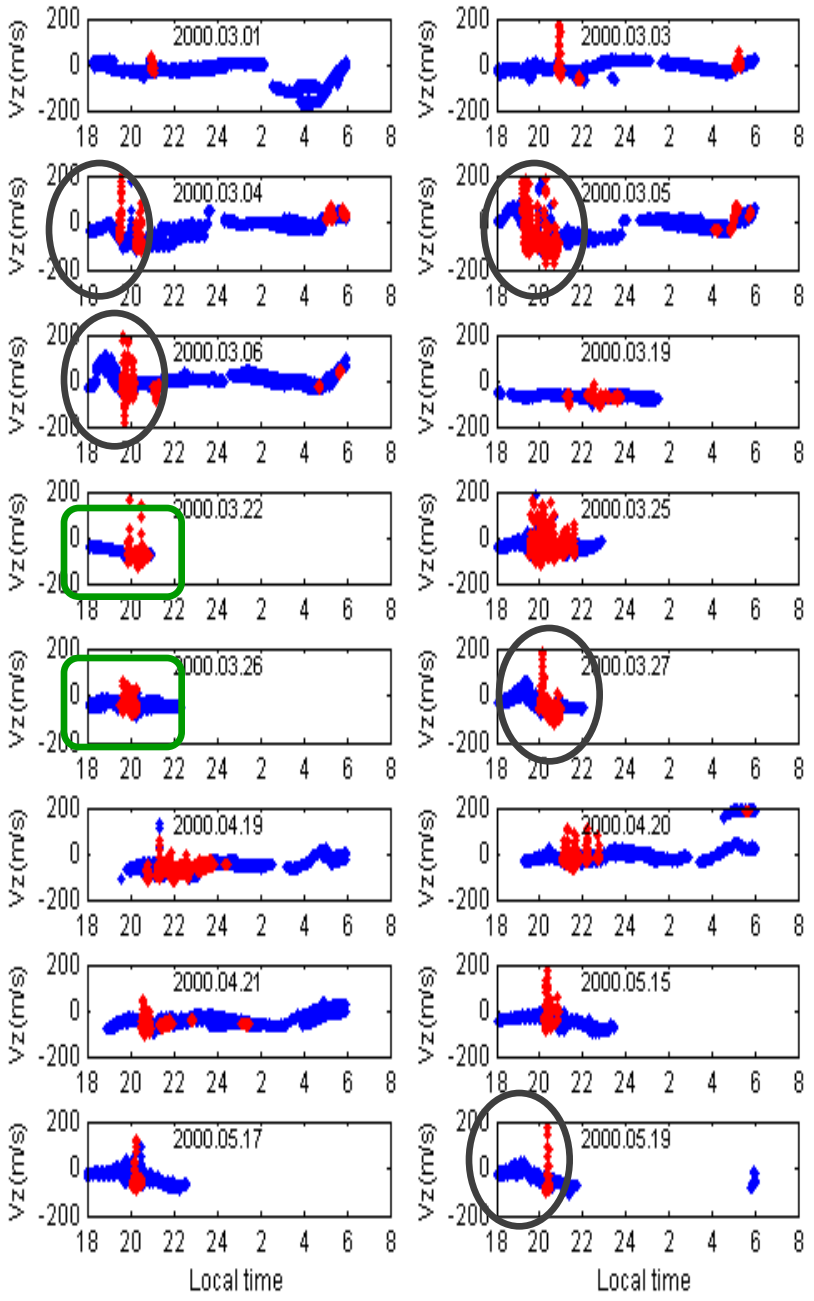
What we are interested in:

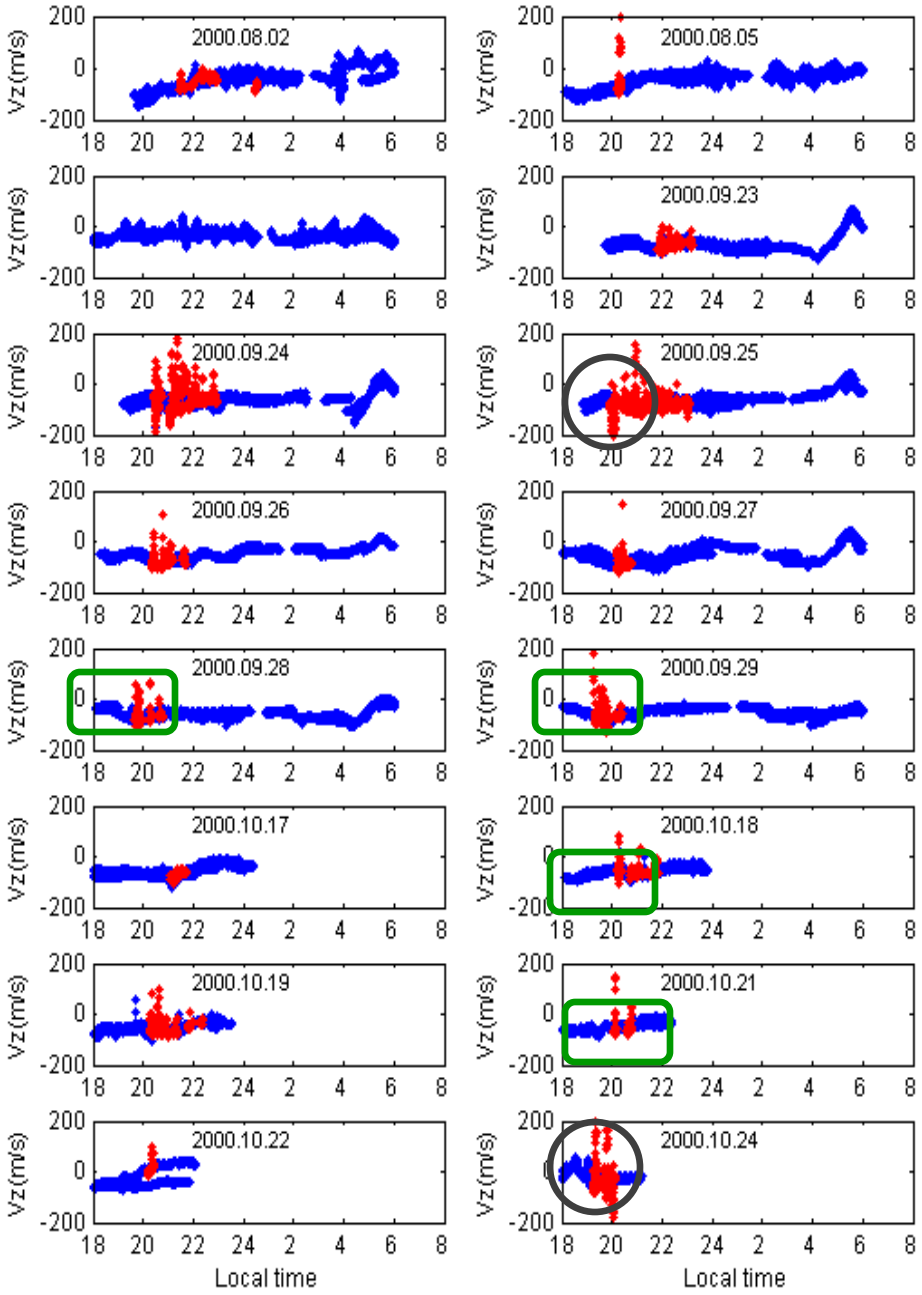
- Are all the plasma bubbles be associated with the disturbance vertical drift (polarized eastward electric field).
- Are there always the pre-reversal enhancement of vertical drift before the plasma bubbles.
- What is the difference of plasma bubbles at pre-midnight and post midnight.

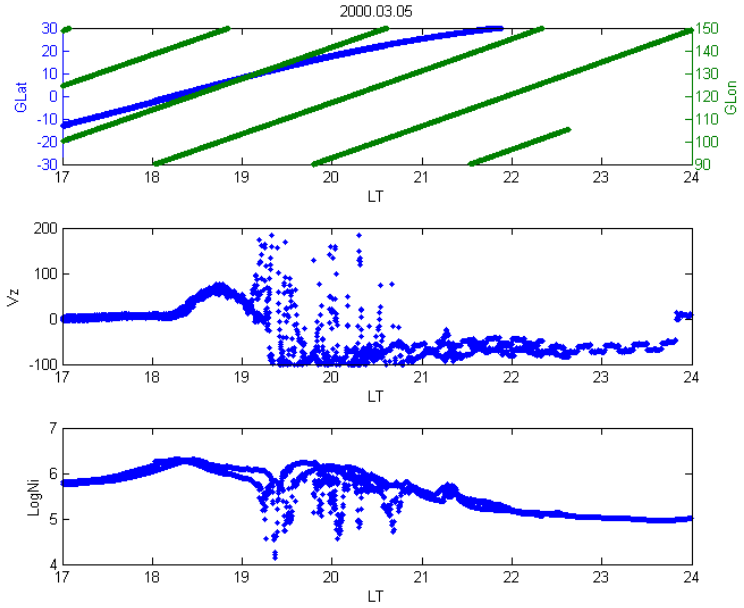
The vertical drift inside the plasma bubbles

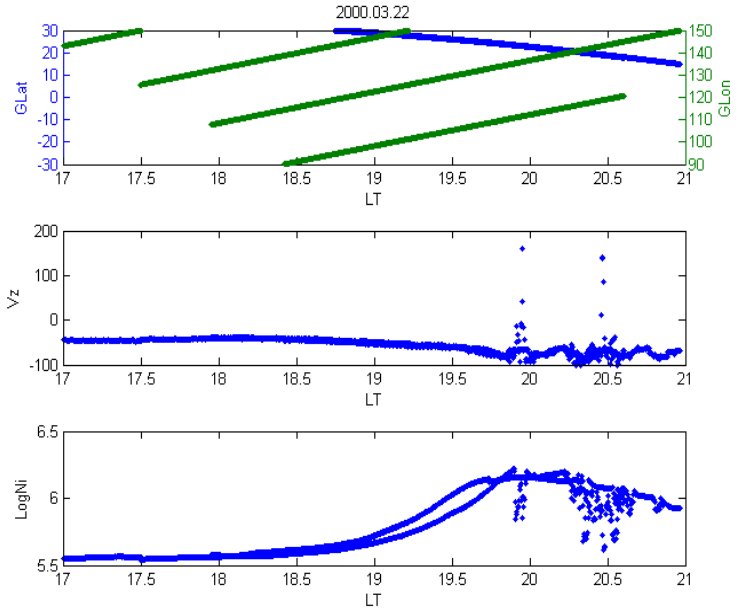


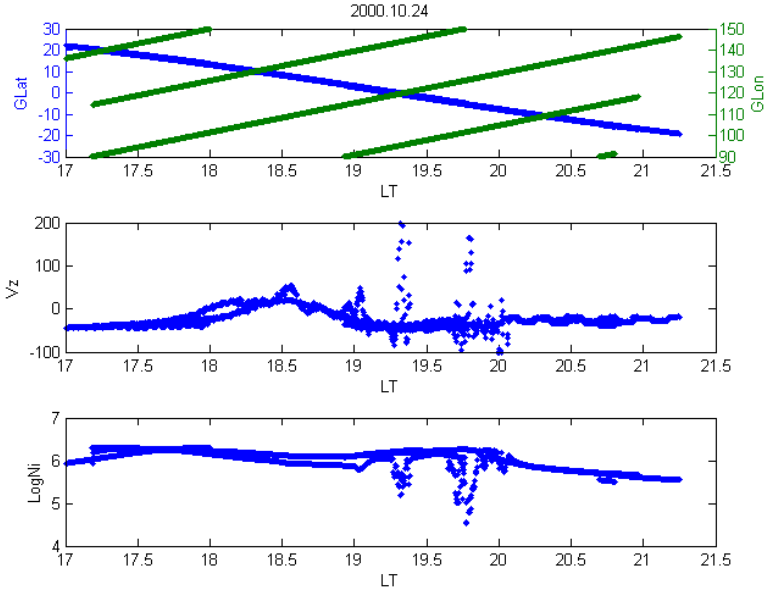
- The enhancement of vertical drift (polarized eastward electric field) with the bubbles at pre-midnight
- Mainly no polarized eastward electric field existed at post midnight.

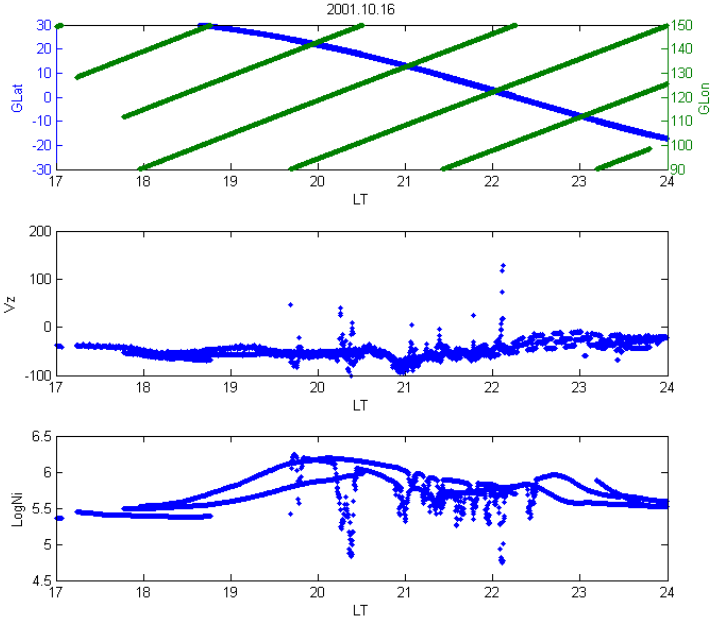

2000.03.01
2000.03.03
2000.03.04
2000.03.05
2000.03.06
2000.03.19
2000.03.22
2000.03.25
2000.03.26
2000.03.27
2000.04.19
2000.04.20
2000.04.21
2000.05.15
2000.05.17
2000.05.19
Vz(m/s)
Local time

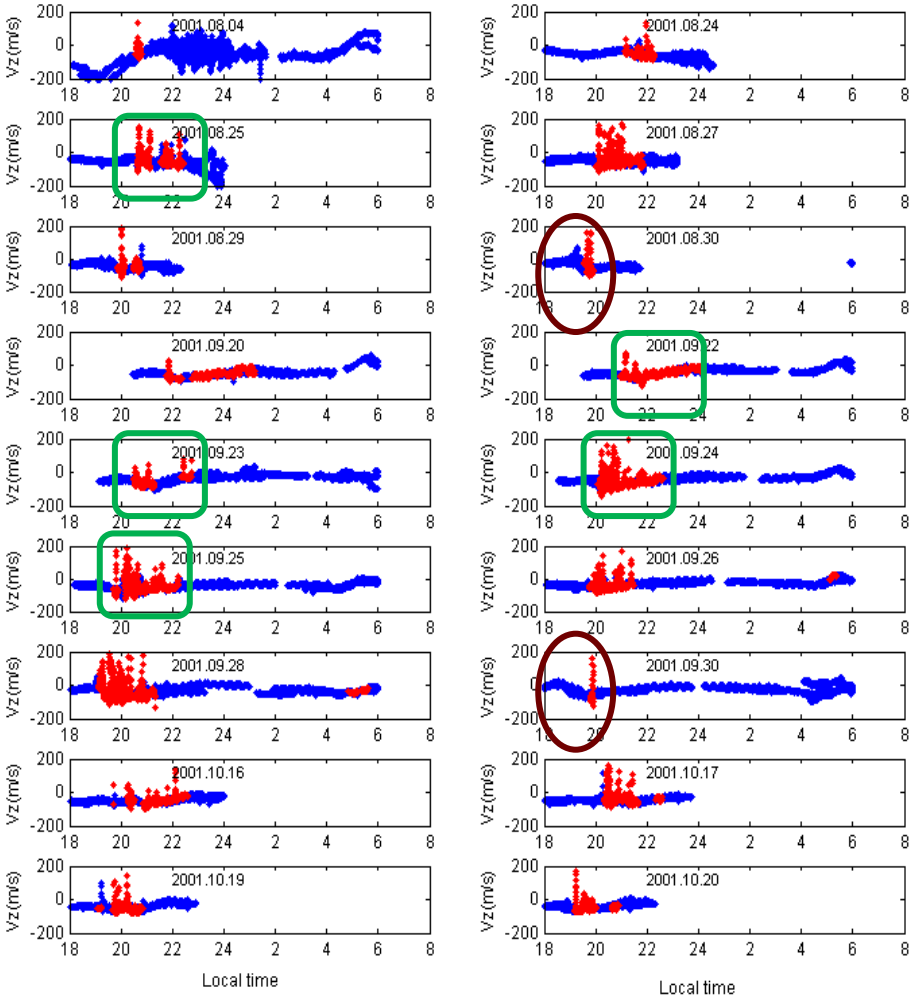

2000.08.02
2000.08.05
2000.09.23
2000.09.24
2000.09.25
2000.09.26
2000.09.27
2000.09.28
2000.09.29
2000.10.17
2000.10.18
2000.10.19
2000.10.21
2000.10.22
2000.10.24
Vz(m/s)
Local time


2000.03.05
GLat
GLon
LT
Vz
LogNi

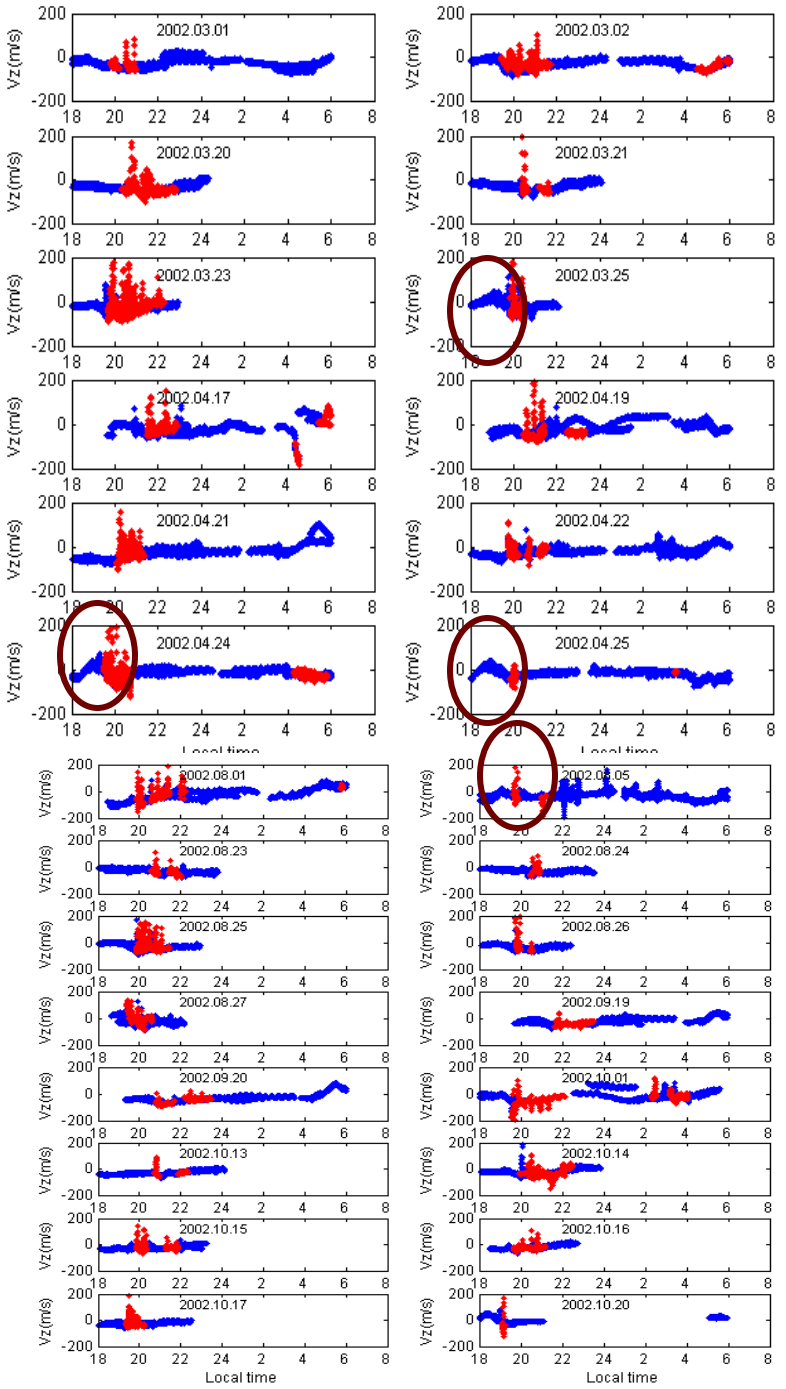

2000.03.22
GLat
GLon
LT
Vz
LogNi


2000.10.24
GLat
GLon
LT
Vz
LogNi


2001.10.16
GLat
GLon
LT
Vz
LogNi

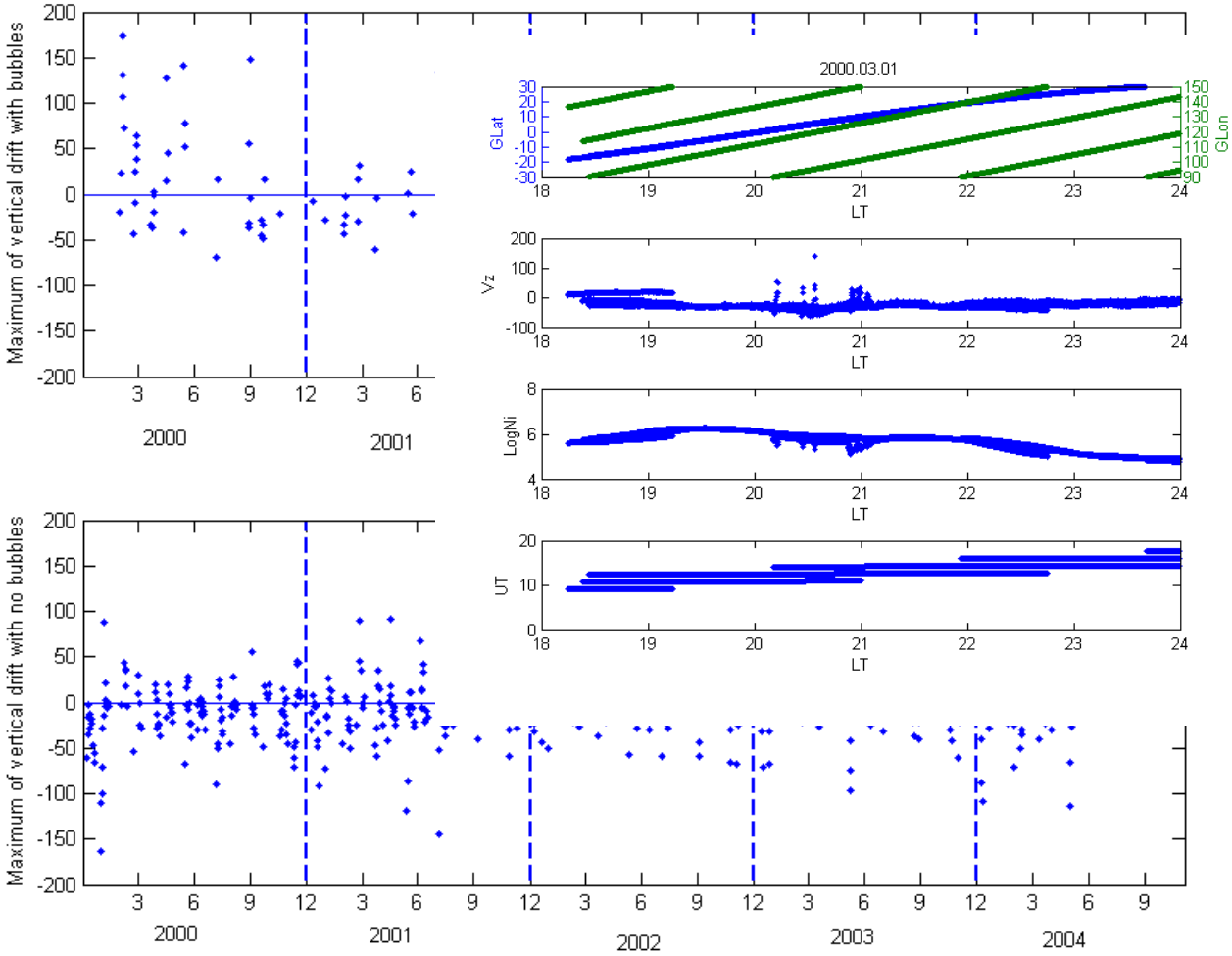

2001.08.04
2001.08.24
2001.08.25
2001.08.27
2001.08.29
2001.08.30
2001.09.20
2001.09.22
2001.09.23
2001.09.24
2001.09.25
2001.09.26
2001.09.28
2001.09.30
2001.10.16
2001.10.17
2001.10.19
2001.10.20
Vz(m/s)
Local time

2001


2002.03.01
2002.03.02
2002.03.20
2002.03.21
2002.03.23
2002.03.25
2002.04.17
2002.04.19
2002.04.21
2002.04.22
2002.04.24
2002.04.25
2002.08.01
2002.08.05
2002.08.23
2002.08.24
2002.08.25
2002.08.26
2002.08.27
2002.09.19
2002.09.20
2002.10.01
2002.10.13
2002.10.14
2002.10.15
2002.10.16
2002.10.17
2002.10.20
Vz(m/s)
Local time

- The maximum vertical drift between 17LT and the start time of the plasma bubbles from -15ºN~15ºN

- The maximum vertical drift between 17LT and 20LT from -15ºN~15ºN



- The maximum of vertical drift before the plasma bubbles is larger than that in the days with no bubbles. This means the PRE is very important for the plasma bubbles.
- If the maximum of vertical drift greater than 50, the plasma bubbles are always occurred.
- Still some day's bubbles with no PRE

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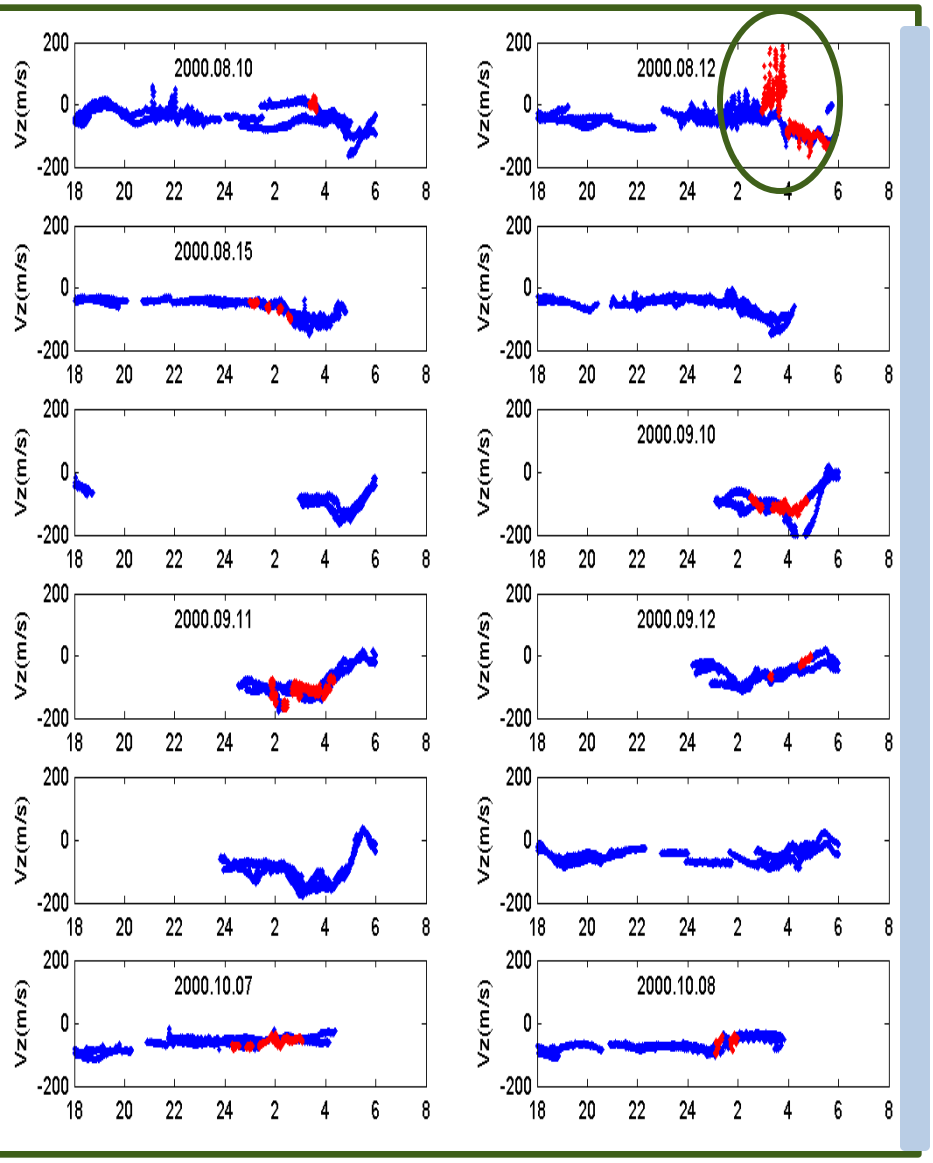
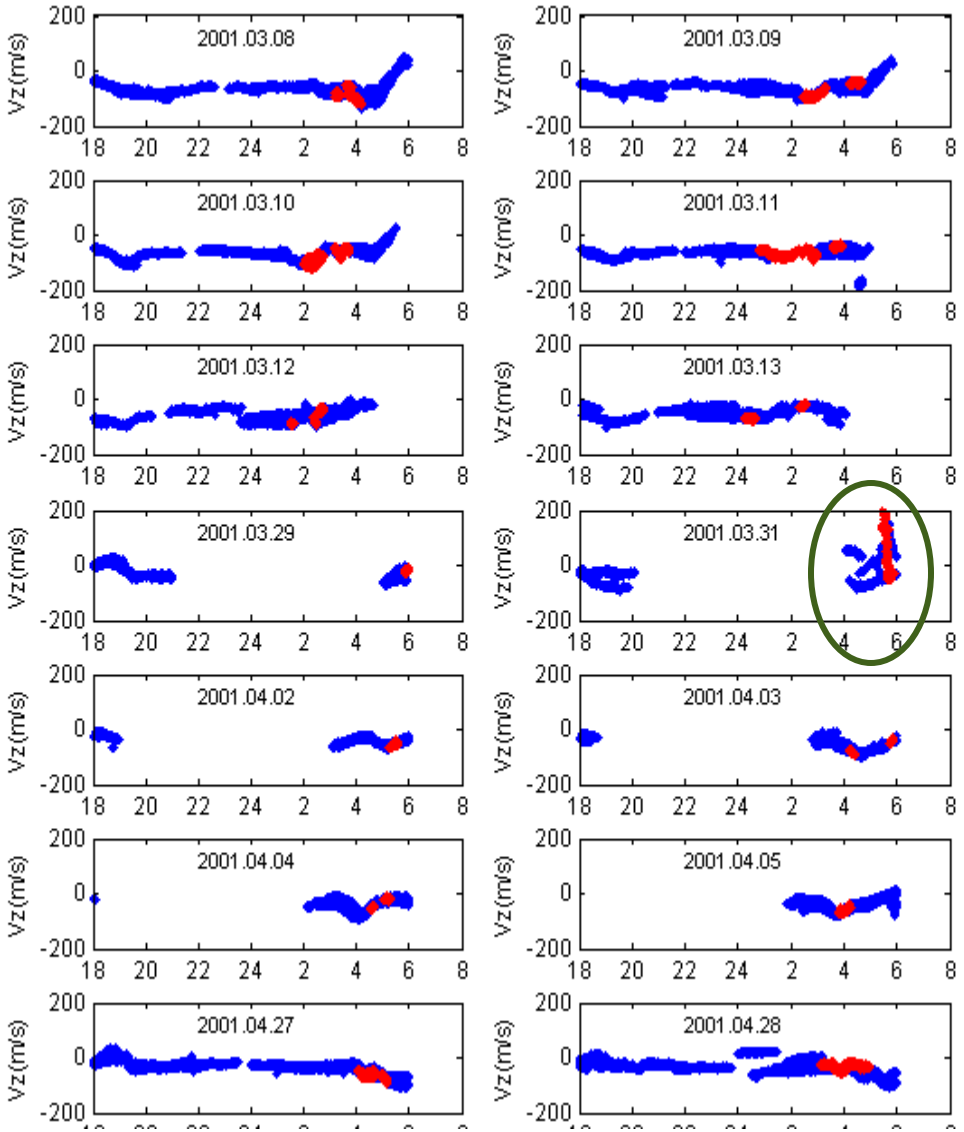
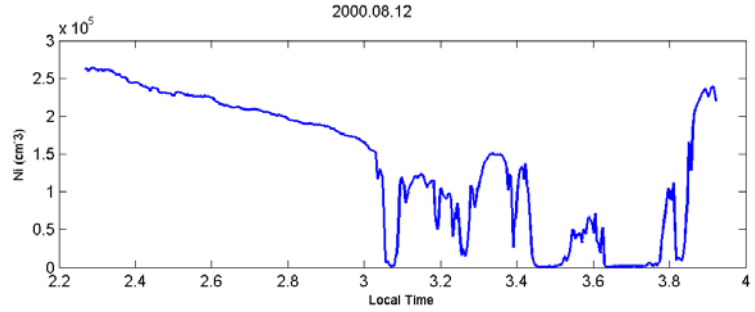
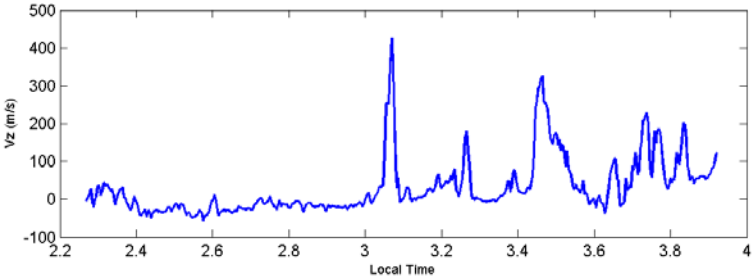
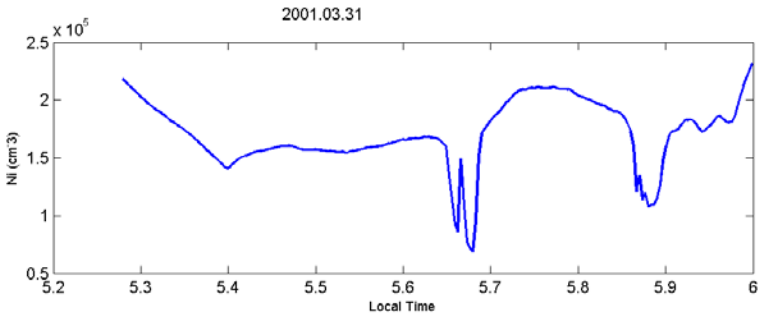
The vertical drift and plasma bubble at post-midnight

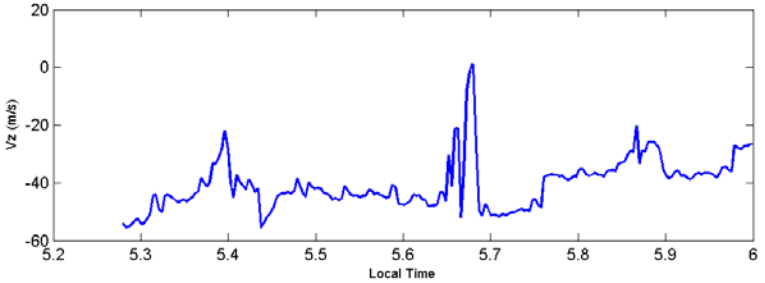


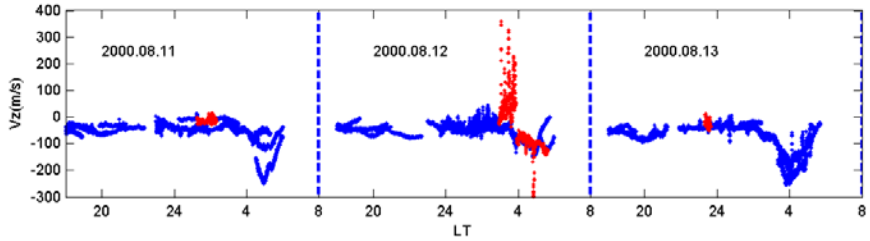


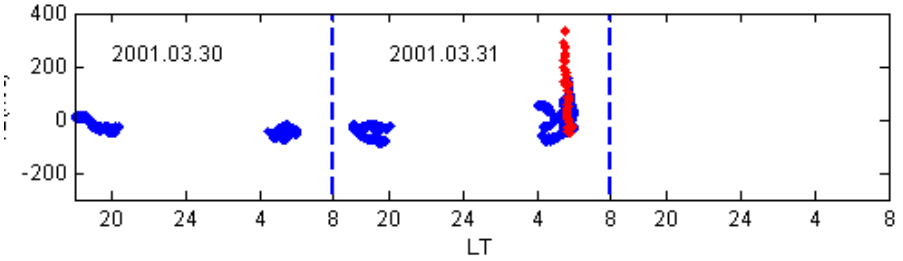

2000.08.12
x 10^5
Ni (cm^3)
Local Time

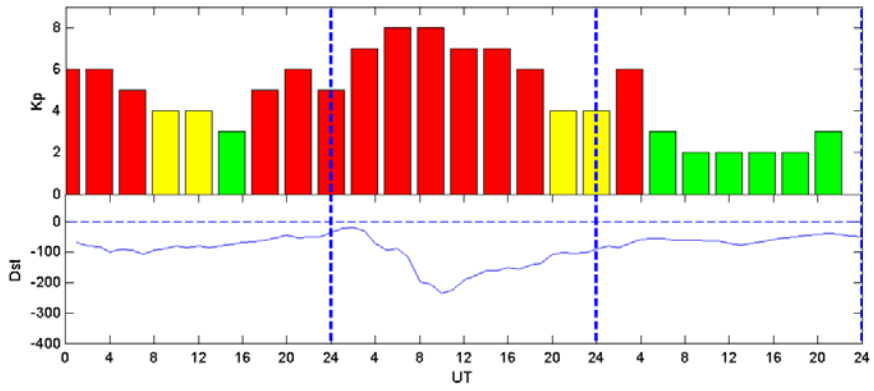

Vz (m/s)
Local Time

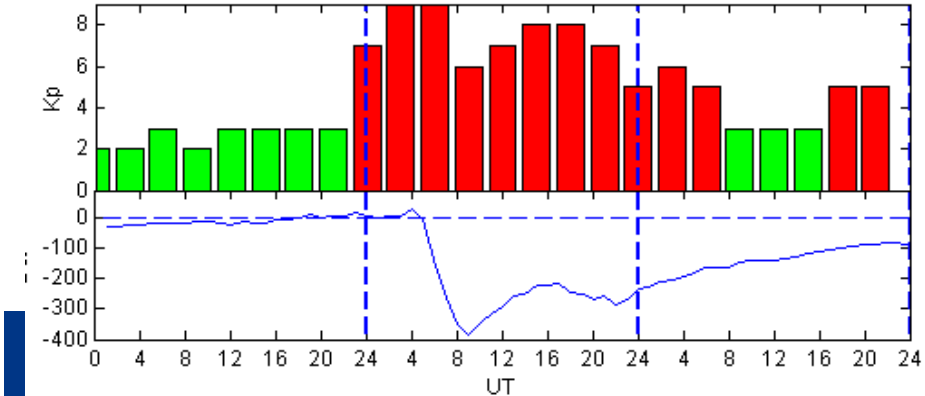

2001.03.31
x 10^5
Ni (cm^3)
Local Time

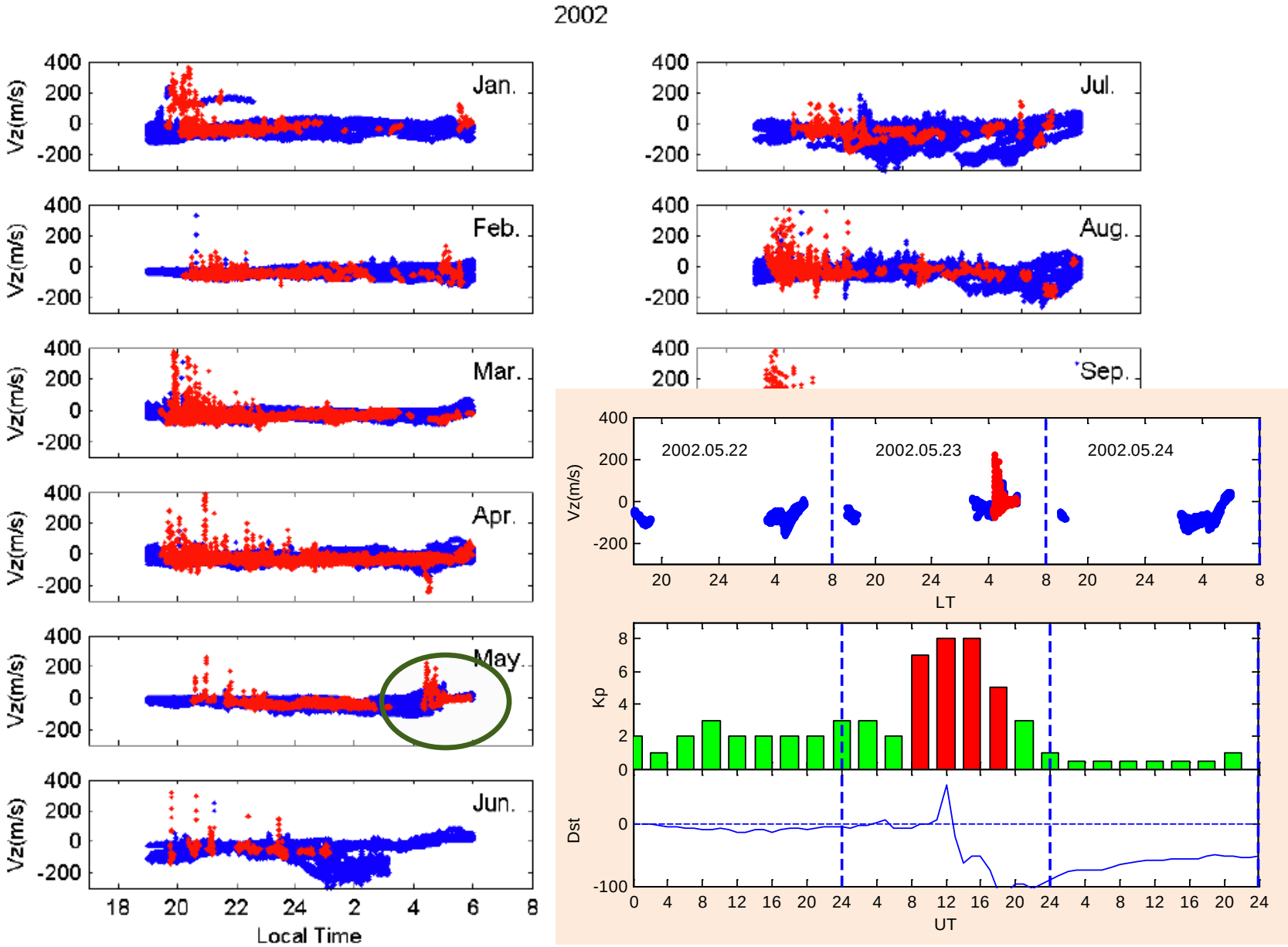

Vz (m/s)
Local Time

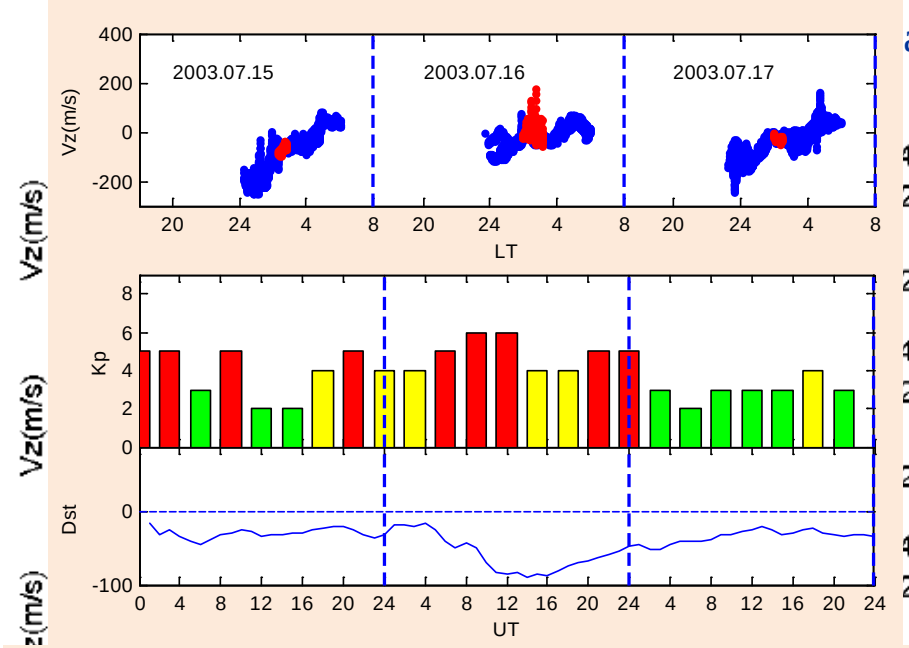

2000.08.11
2000.08.12
2000.08.13
Vz(m/s)
LT

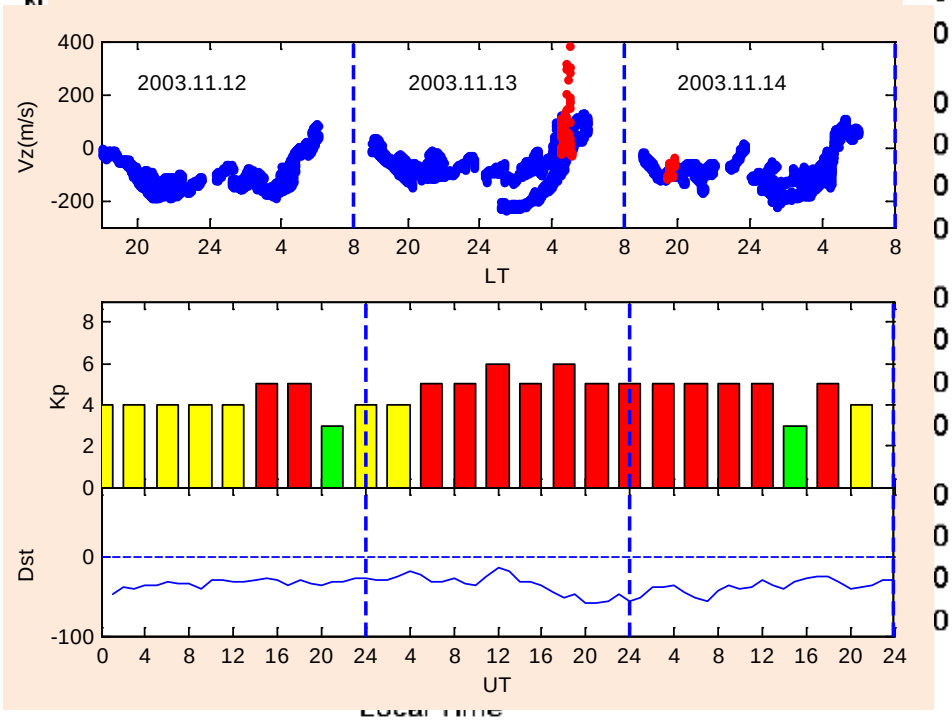

2001.03.30
2001.03.31
LT

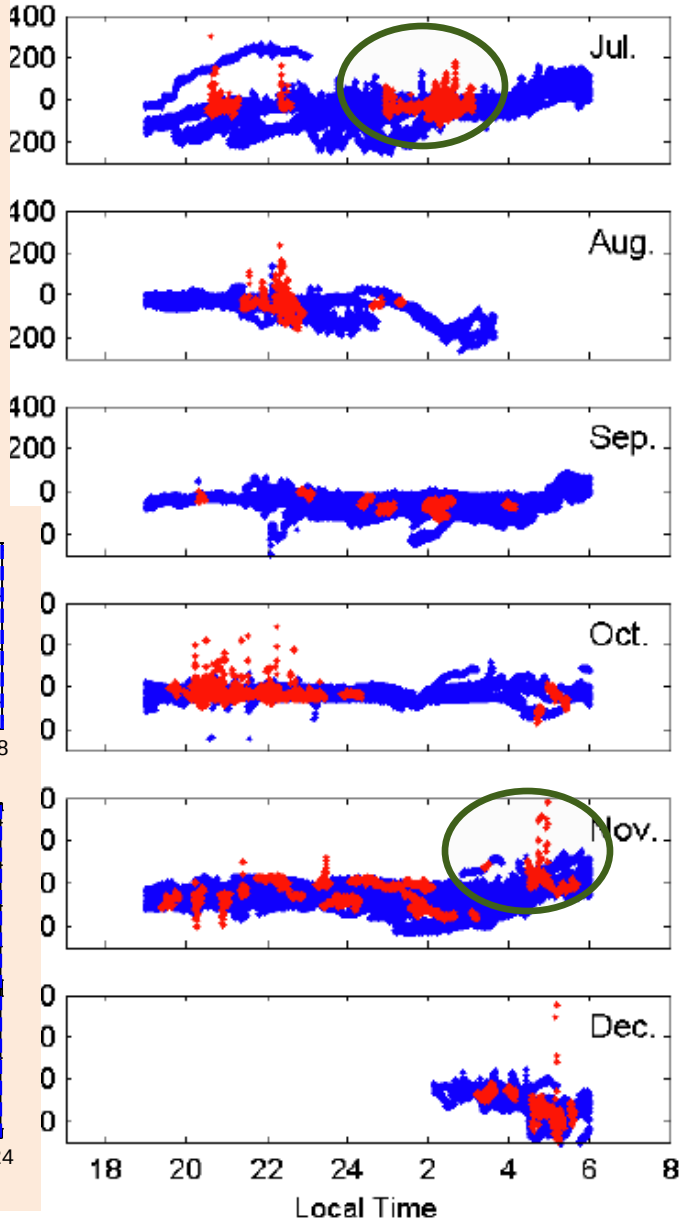

Kp
Dst
UT

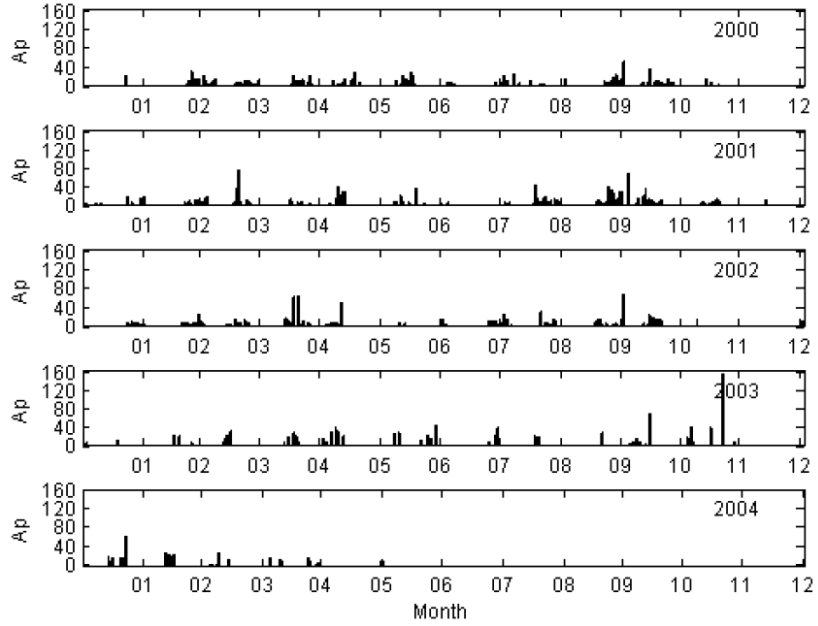

Kp
UT


2002
Jan.
Feb.
Mar.
Apr.
May.
Jun.
Jul.
Aug.
Sep.
Vz(m/s)
400
200
0
-200
18
20
22
24
2
4
6
8
Local Time
2002.05.22
2002.05.23
2002.05.24
LT
Kp
Dst
-100
0
4
8
12
16
20
UT

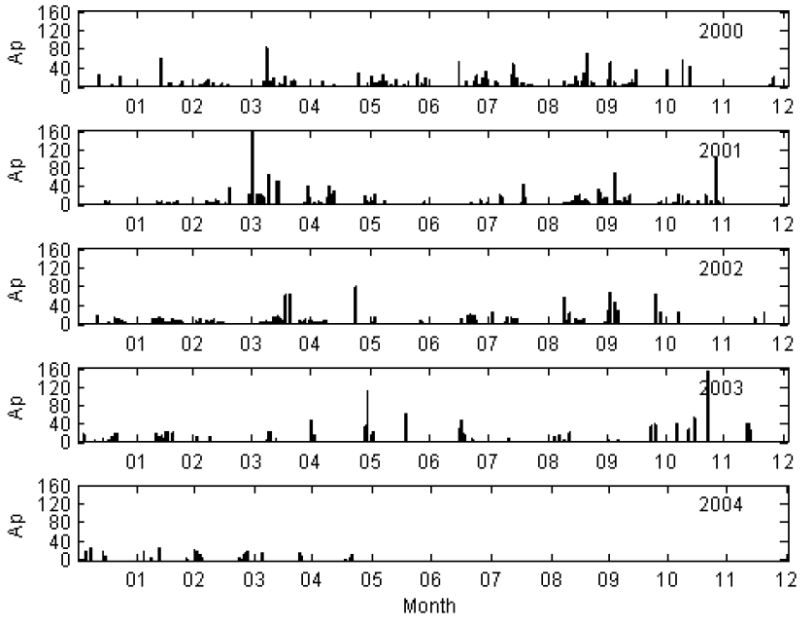

2003.07.15
2003.07.16
2003.07.17
Vz(m/s)
LT
Kp
Dst
UT


2003.11.12
2003.11.13
2003.11.14
Vz(m/s)
LT
Kp
Dst
UT

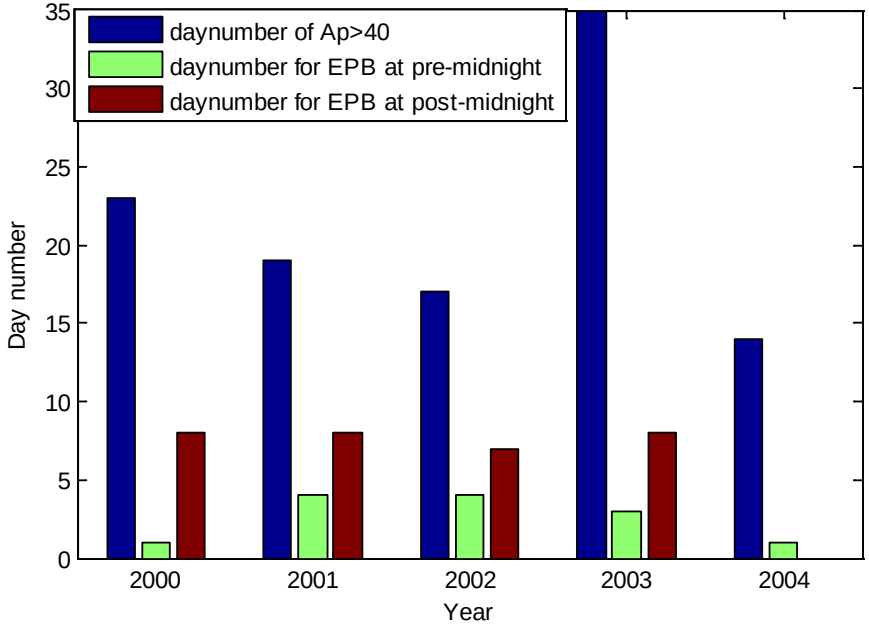

Jul.
Aug.
Sep.
Oct.
Nov.
Dec.
Local Time

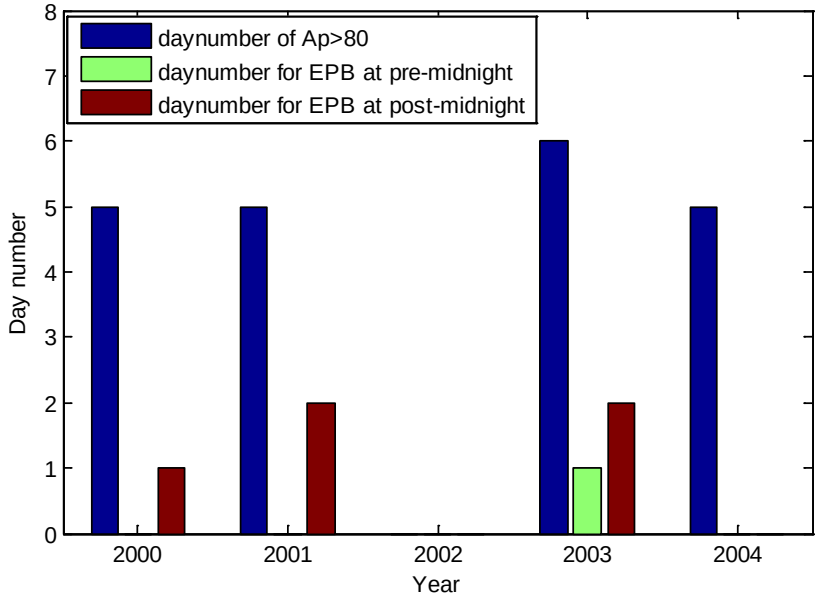


The AP in the days which have pre- midnight plasma bubbles

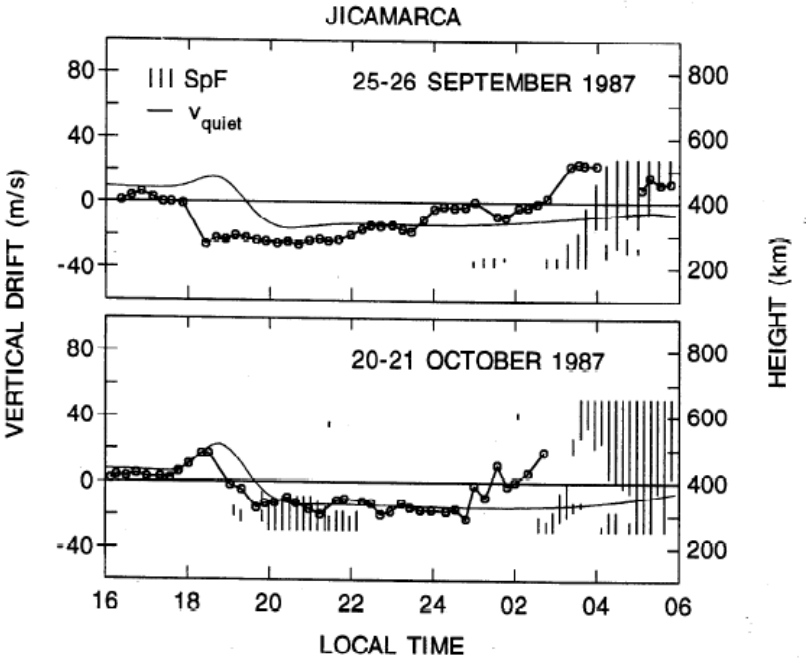


The AP in the days which have post -midnight plasma bubbles

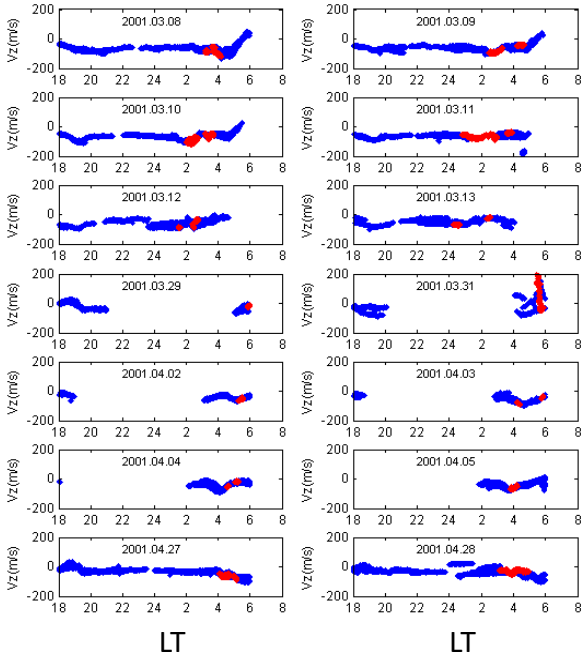




- The post-midnight (or pre-sunset) plasma bubbles relatively got few studies, the gradient drift instability driven by neutral wind , that is ion has not the same velocity with wind, may be possible for the plasma occurrence (macDougall,1998).
- However , the vertical drift was still considered an important factor at post-midnight. Fejer(1999) and Abdu(2001) reported that the post-midnight ESF mainly happened when the downward drift is small or at pre-reversal time.



Fejer, 1999



Summary

- The occurrence of the plasma bubbles is higher in high solar activity than that in low solar activity. In the spring and autumn of high solar activity, about 50 percent days have the plasma bubbles observed.
- The pre-midnight plasma bubbles are always associated with polarized electric field.
- At post-midnight, the plasma bubbles can be trigged by disturbed eastward electric field during magnetic storms.
- The pre-reversal vertical enhancement is important for producing plasma bubbles. When PRE great than 50m/s, the plasma bubbles always occurred. However, there are still some days with plasma bubbles observed when PRE is not significant.

Acknowledgements

- The ROCSAT-1 data is from National Central University, Taiwan. We gratefully acknowledge for their help.

Thank you for your Attention!