Upper and lower limit of Dst index and its dependence on solar wind dynamic pressure

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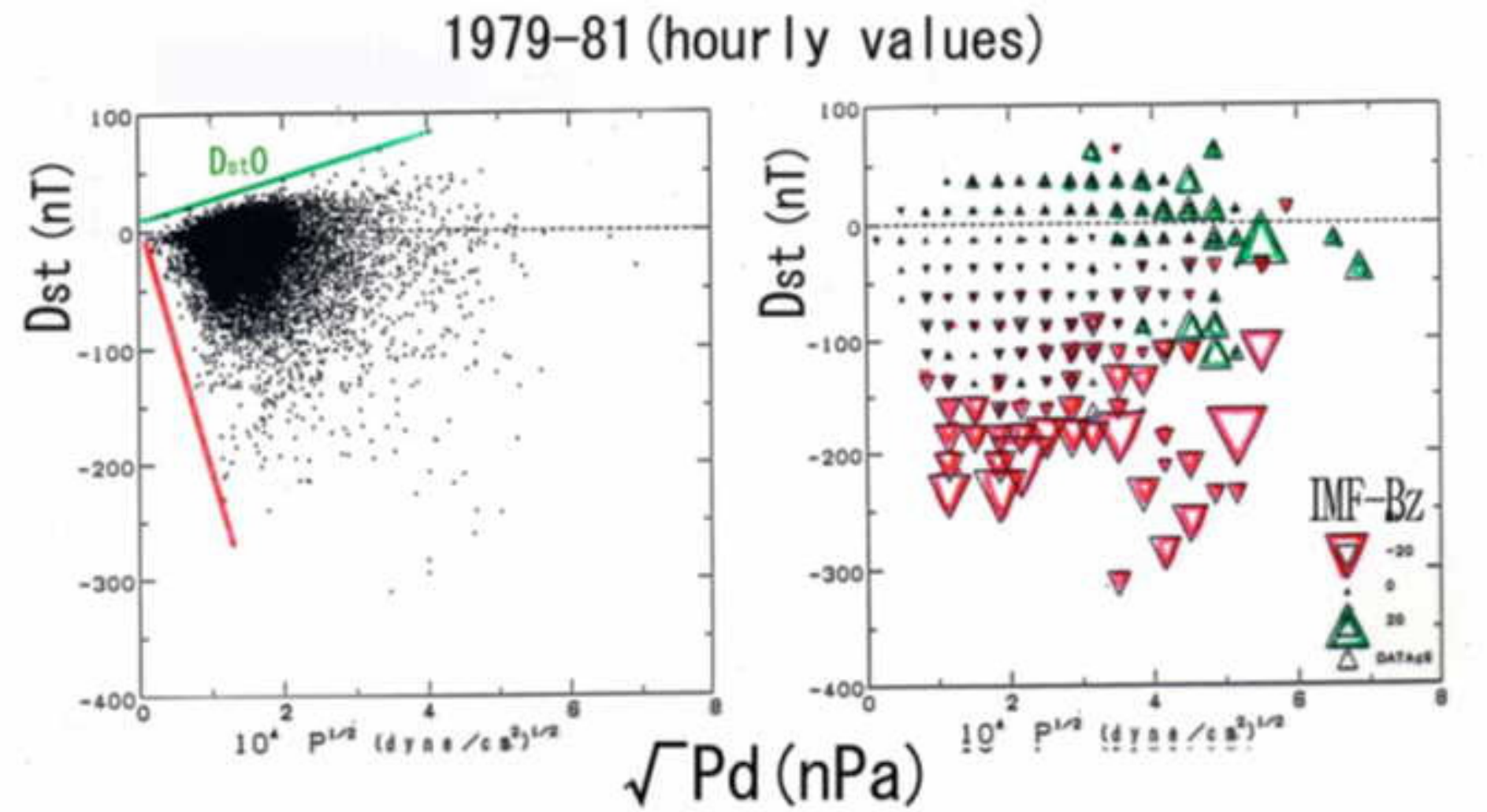
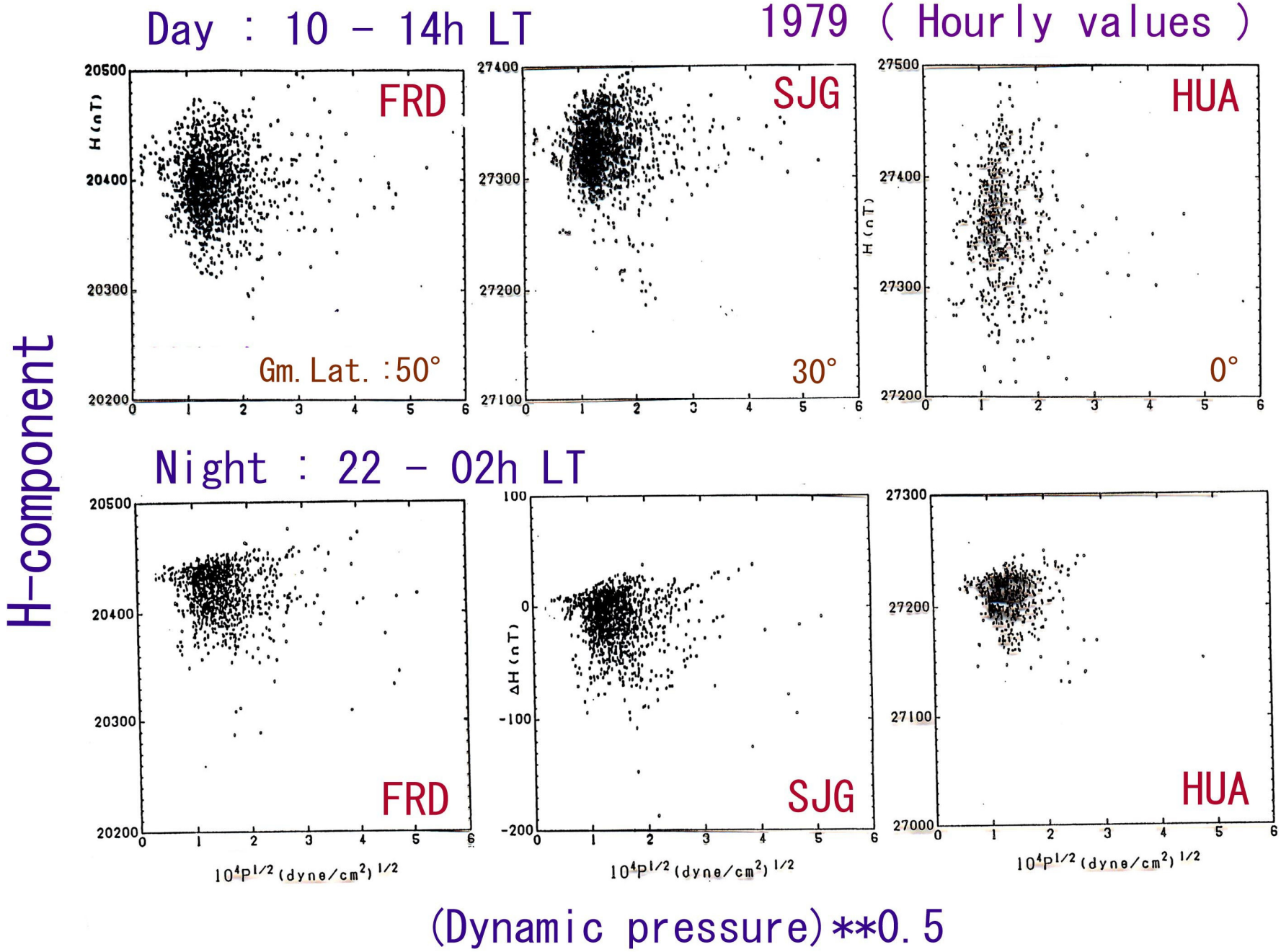
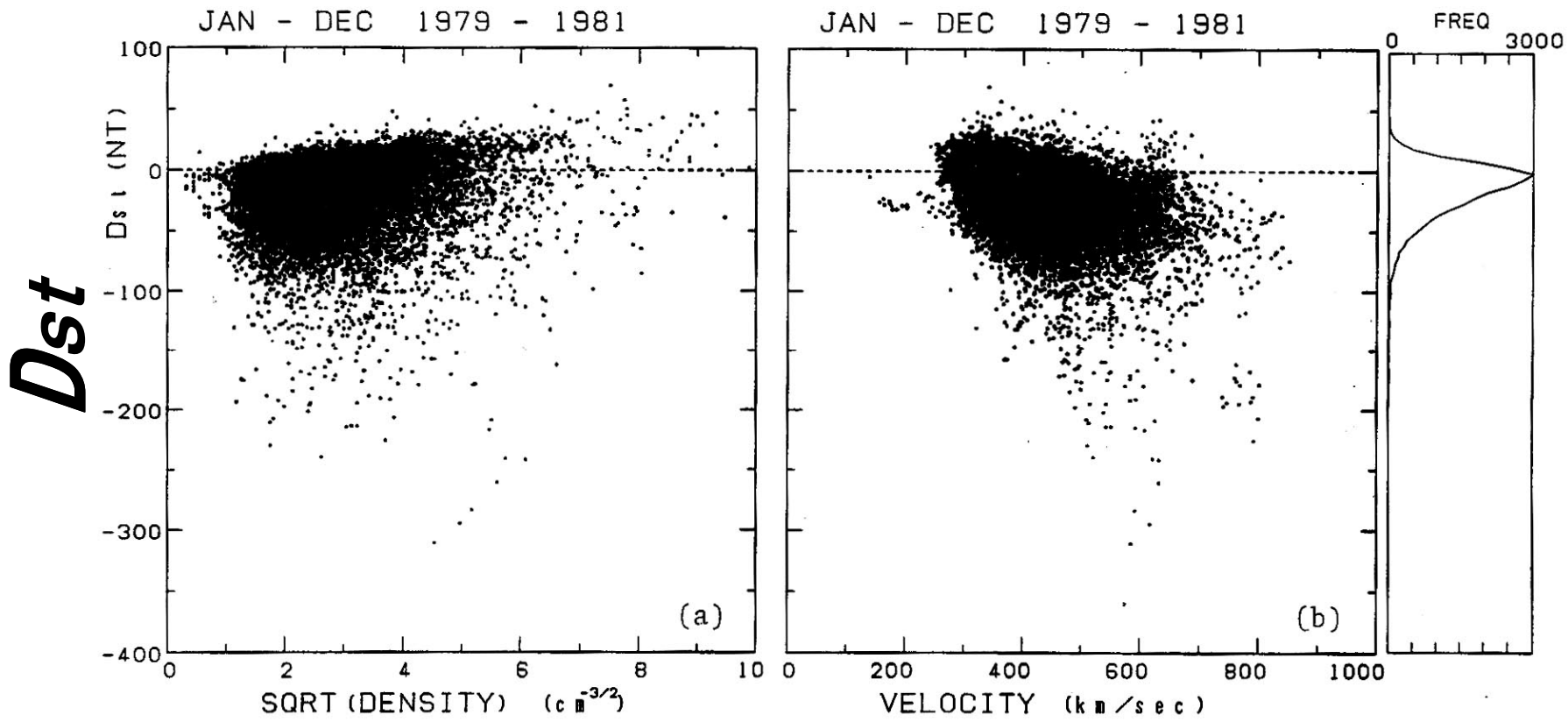
IUGONET Workshop　2017. 9.15　NICT



[Araki et al., 1993 ; Direct detection of solar wind dynamic pressure effect on ground geomagnetic field]


Day : 10 - 14h LT
1979 (Hourly values)
H-component
FRD
SJG
HUA
Gm.Lat.:50°
30°
0°
H(nT)
Night : 22 - 02h LT
ΔH(nT)
$10^4P^{1/2}$ (dyne/cm^2)$^{1/2}$
(Dynamic pressure)**0.5

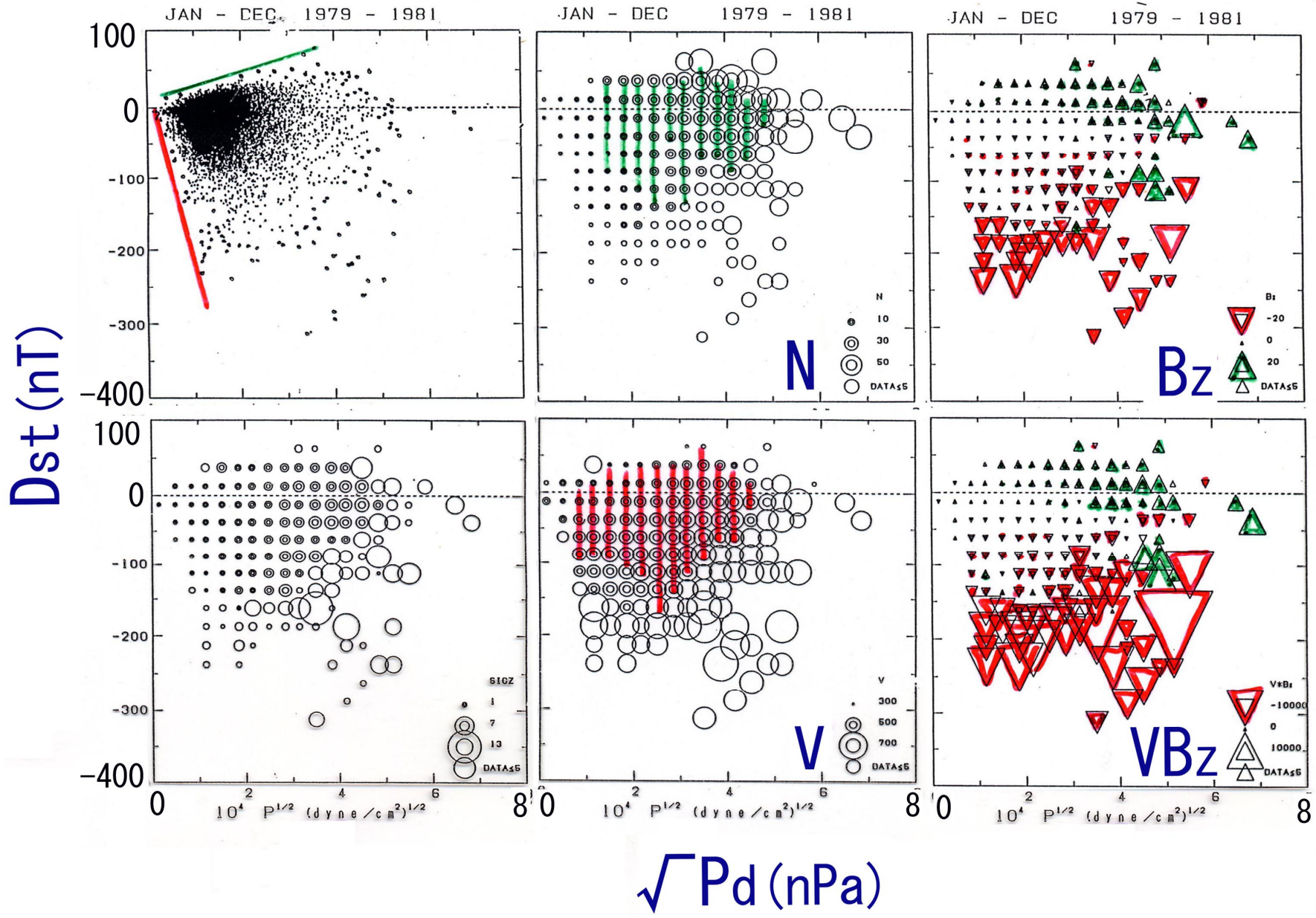


Dst

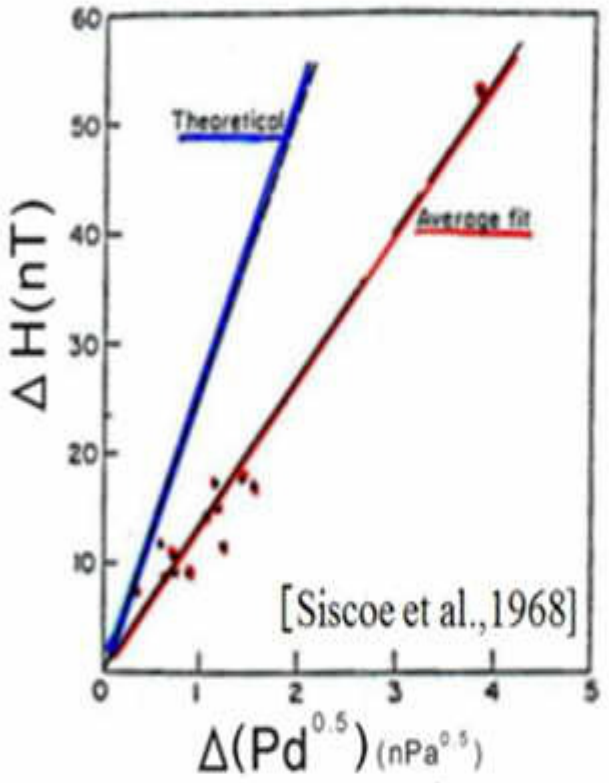
$\sqrt{N}$ V

$$[\ Pd = mNV^2\ ]$$

Jan-Dec 1979-1981 (hourly values)



Geomagnetic sudden commencement (SC) : a probe to detect solar wind dynamic pressure effects on geomagnetic field.



$$\Delta H_{SC} = \alpha\, \Delta(P_d^{0.5}) \qquad \alpha = kf\alpha$$

k: proportionality constant

f: solar wind-magnetosphere interaction ($f=1$)

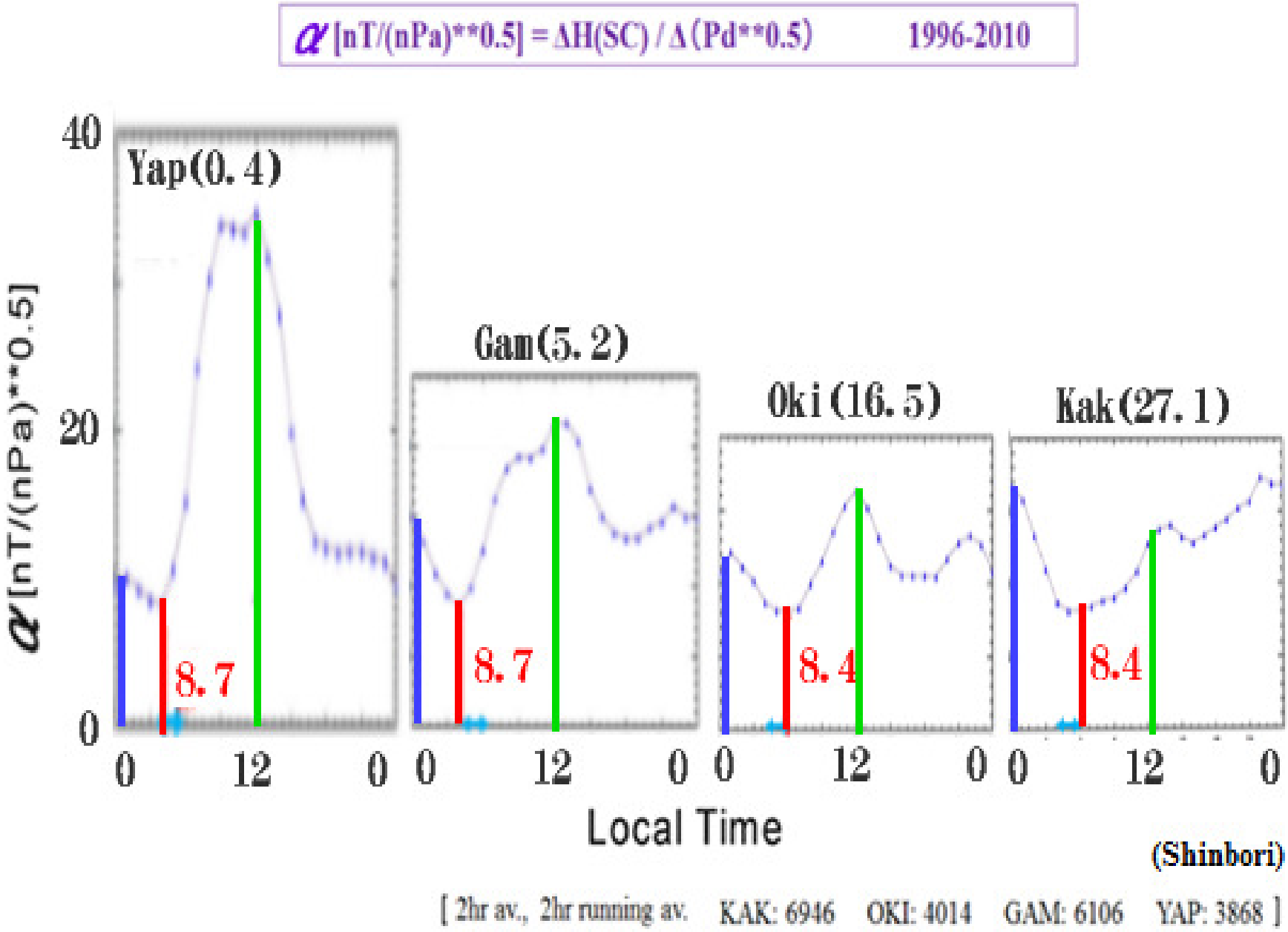
α: effect of currents induced in the Earth ($\alpha = 1.5$)

[Siscoe et al., 1968]

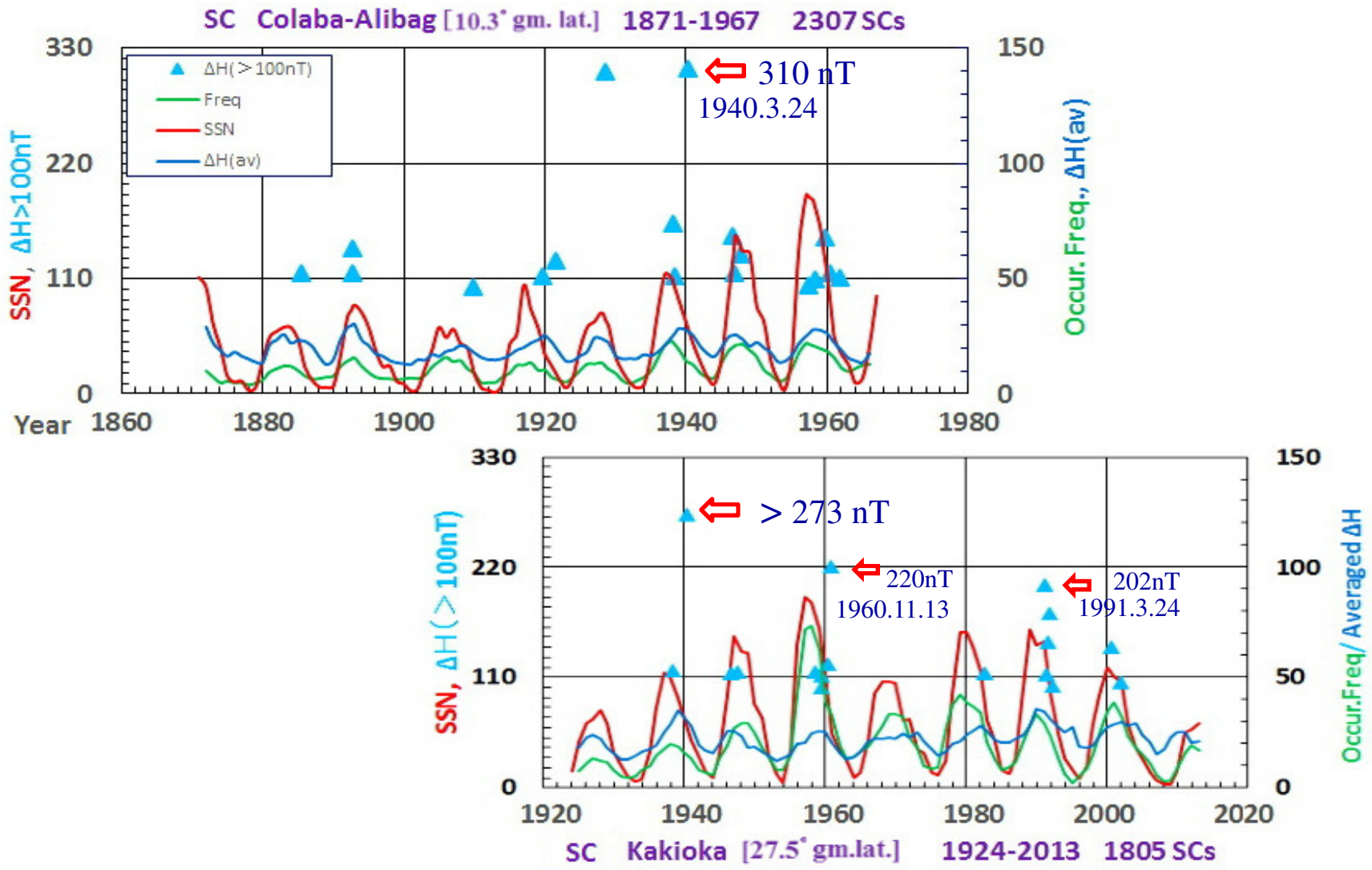
Table 1 Values of k [$\times 10^4 nT/dyne^{0.5}/cm$]

Present analysis [Araki et al., 1993]				
D_{st}	:1979-81			11.8
nighttime (22-02LT) H				
Fredericksburg	:1979-80			11.6
San Juan	:1979-81			10.7
Memambetsu	:1979-81			11.1
Past Analyses				
Mead	[1964]	theory(elastic interaction)		17.4
Siscoe et al.	[1968]	13 SIs		9.0 ± 2.0
		12 quiet days nighttime average		8.9 ± 2.9
Ogilvie et al.	[1968]	9 SCs		11.4 ± 1.5
Verzariu et al.	[1972]	19 hourly D_{st}		18.4
Su and Konradi	[1975]	36 hourly D_{st}		22.6
Burton et al.	[1975]	3 SCs		10.5
Smith et al.	[1986]	22 SCs		14
Lepping et al.	[1987]	9 SCs		8.5
Russell et al.	[1992]	18 SIs at 4 stations	average	11.0
			noon	12.0
			midnight	8.0

[Araki et al.; 1993]


α [nT/(nPa)**0.5] = ΔH(SC) / Δ(Pd**0.5) 1996-2010
Yap(0.4)
Gam(5.2)
Oki(16.5)
Kak(27.1)
8.7
8.7
8.4
8.4
α [nT/(nPa)**0.5]
40
20
0
0
12
0
Local Time
(Shinbori)
[2hr av., 2hr running av. KAK: 6946 OKI: 4014 GAM: 6106 YAP: 3868]

IAGA Bulletin No.33, 1973 Mayaud, P.N., A hundred year series of geomagnetic data 1868-1967



[Araki ; 2014]

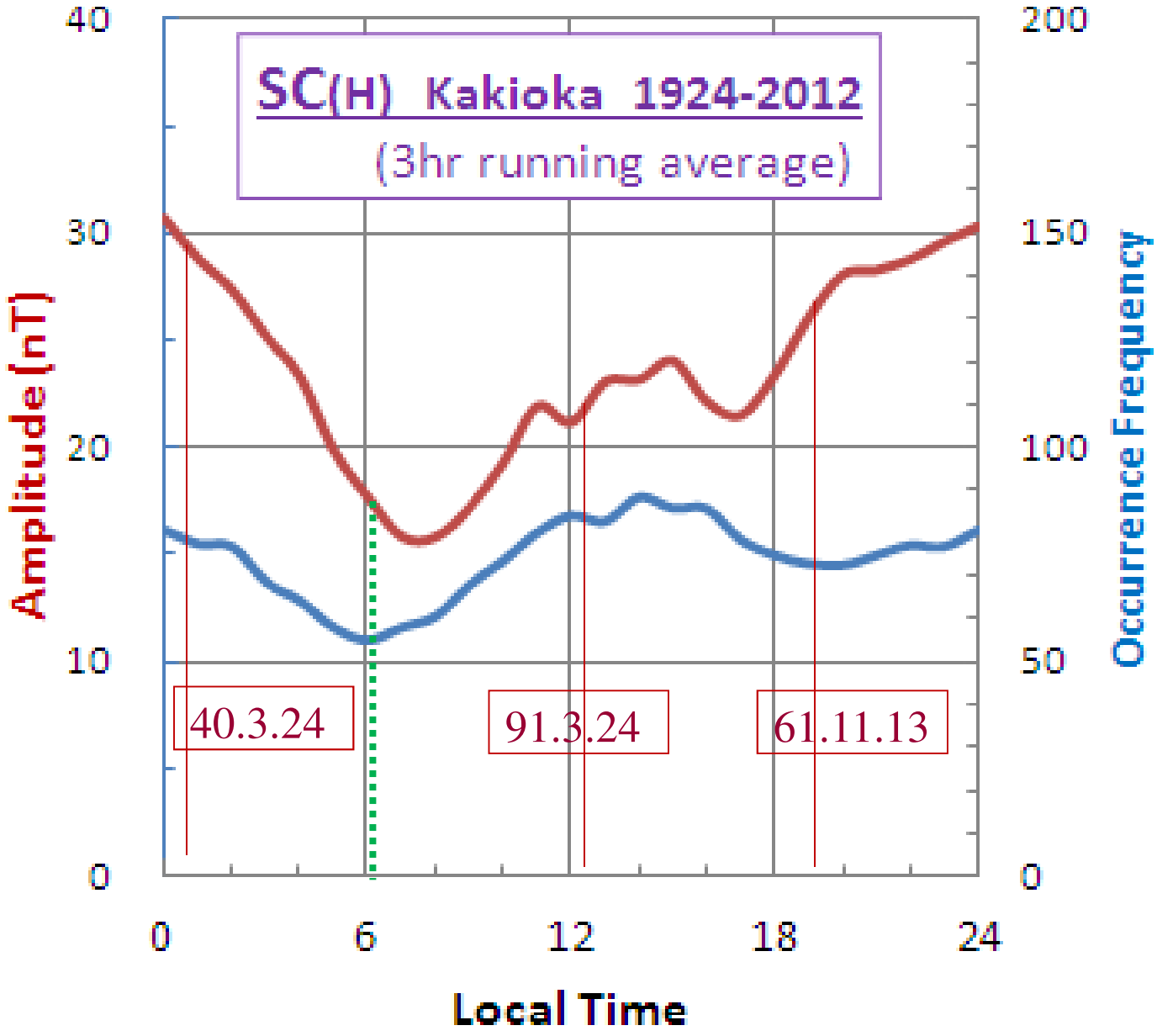
List of Geomag. Storm, Kaioka 1924-2014

Normalized amplitude at 6h LT

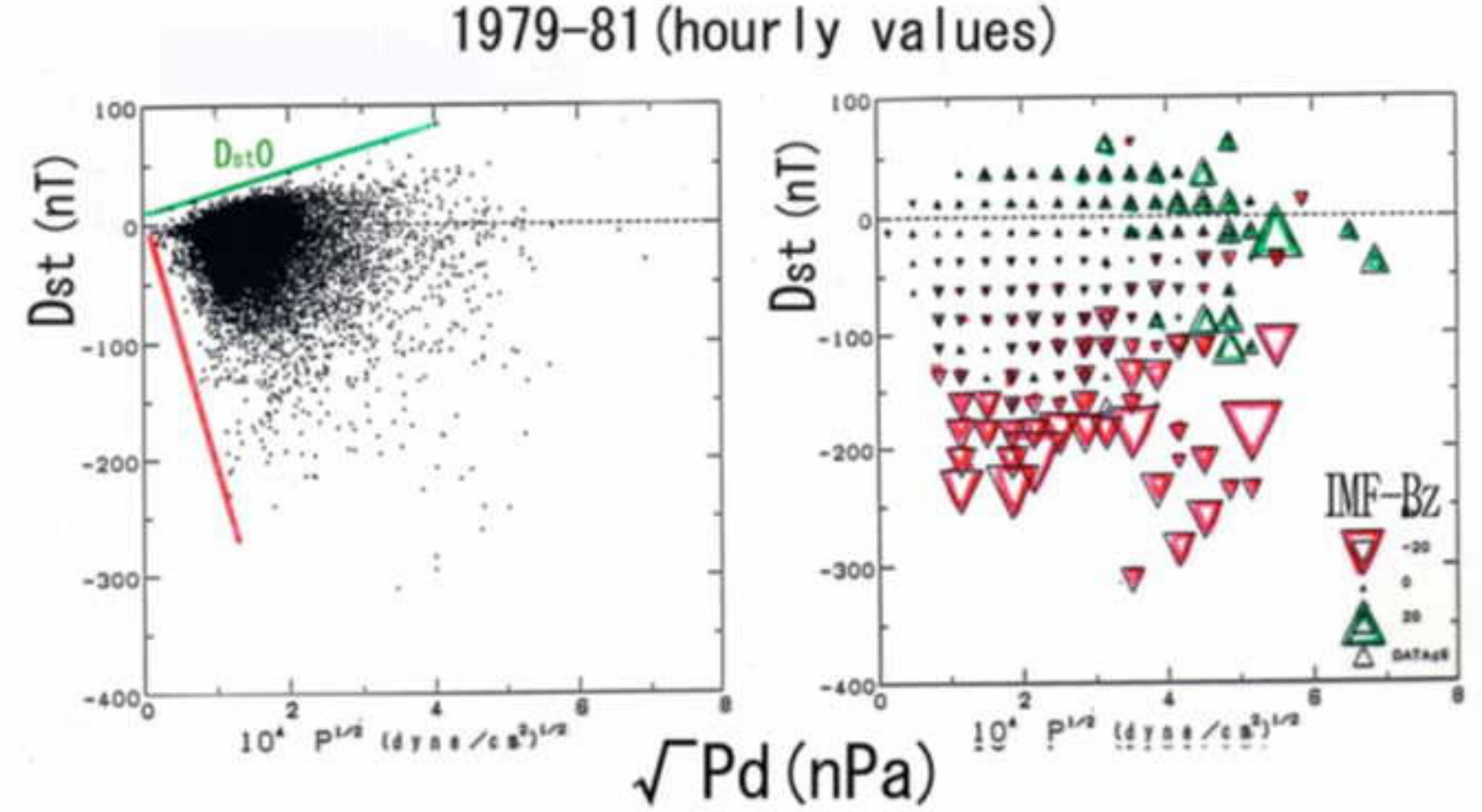
40.3.24
ΔH>273nT
↓
163nT

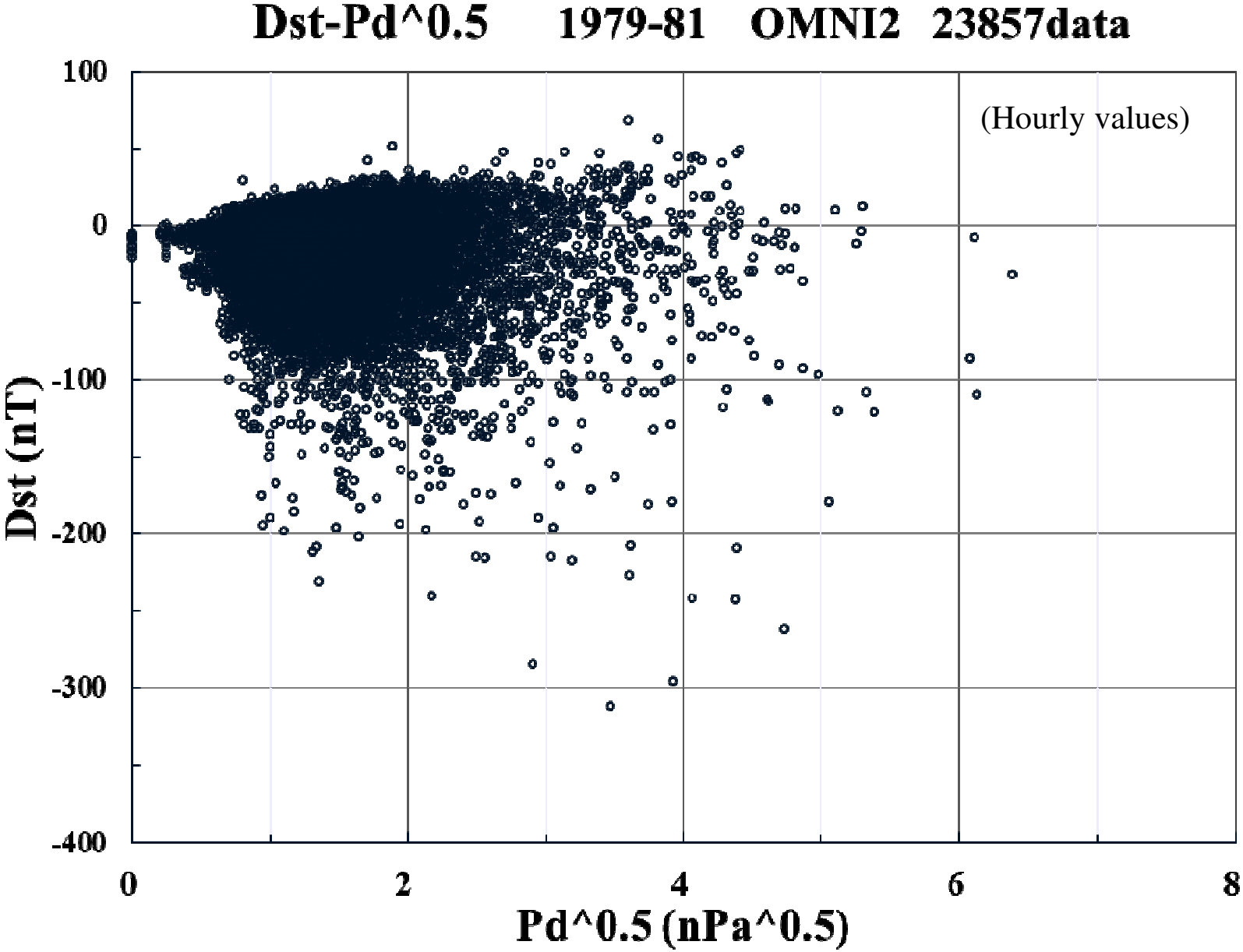
91.3.24
ΔH=202nT
⇓ ↓
162nT

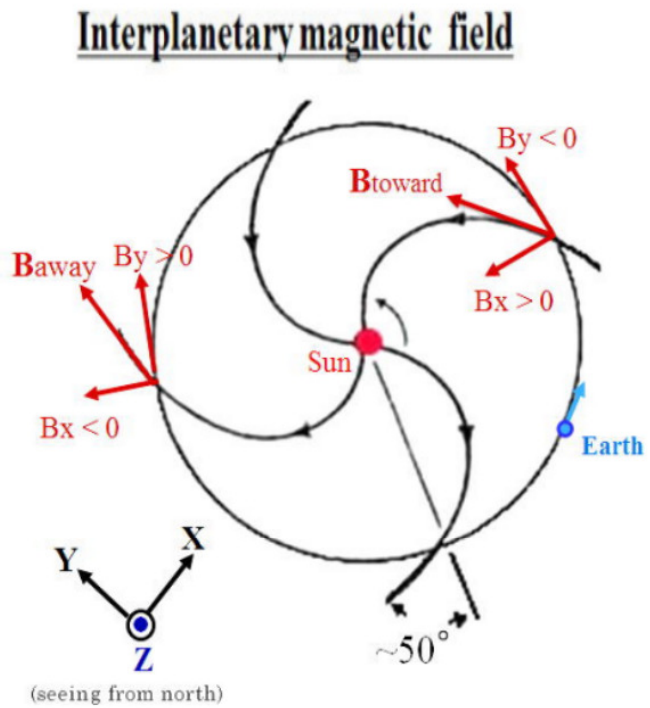
61.11.13
ΔH=220nT
↓
145nT

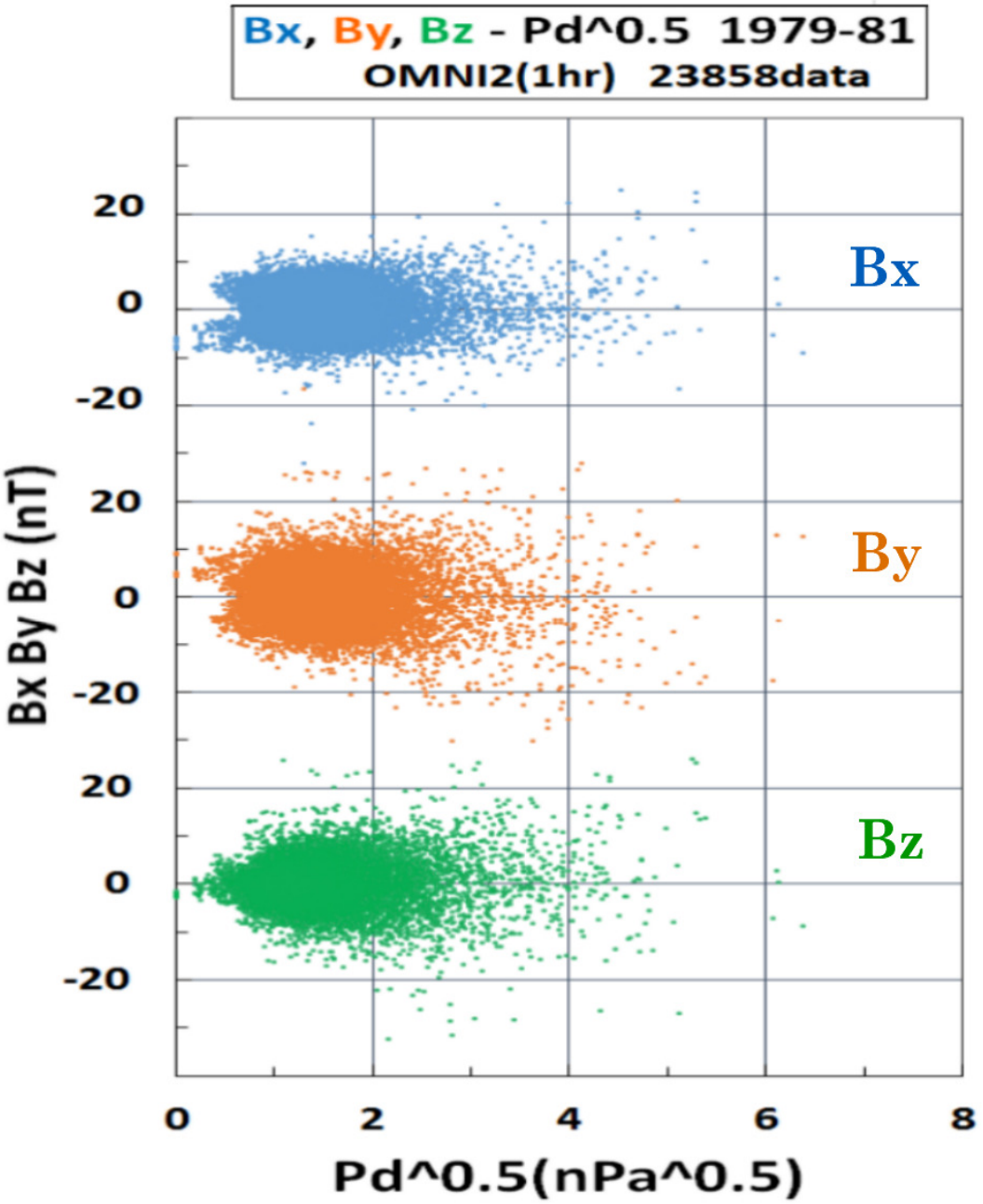


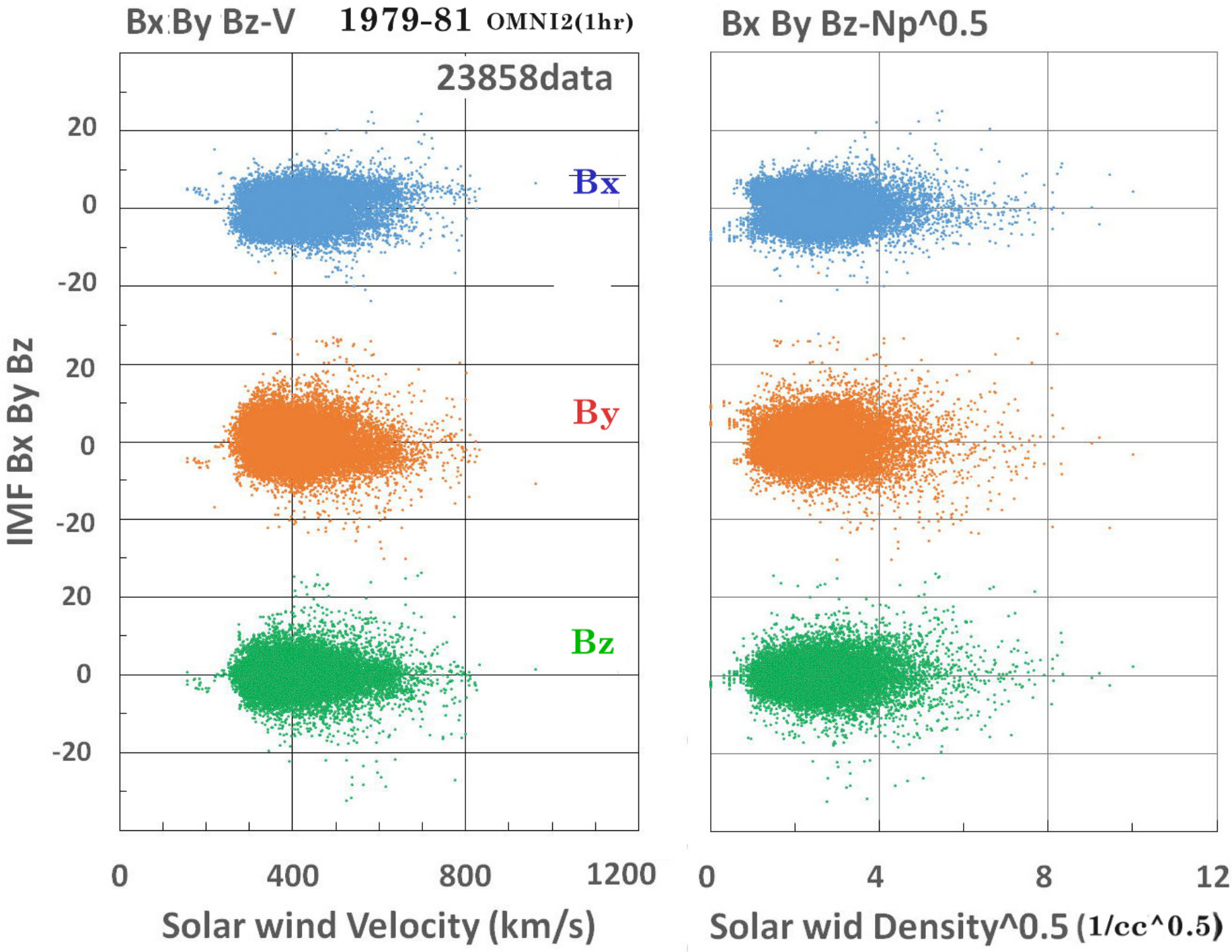
What causes the lower limit?




Dst-Pd^0.5 1979-81 OMNI2 23857data
(Hourly values)
100
0
-100
-200
-300
-400
Dst (nT)
0
2
4
6
8
Pd^0.5 (nPa^0.5)


Interplanetary magnetic field
By < 0
Btoward
Baway
By > 0
Bx > 0
Sun
Bx < 0
Earth
Y
X
Z
~50°
(seeing from north)


Bx, By, Bz - Pd^0.5 1979-81
OMNI2(1hr) 23858data
Bx By Bz (nT)
20
0
-20
20
0
-20
20
0
-20
Bx
By
Bz
0
2
4
6
8
Pd^0.5(nPa^0.5)


Bx By Bz-V 1979-81 OMNI2(1hr)
23858data
Bx
By
Bz
IMF Bx By Bz
20
0
-20
20
0
-20
20
0
-20
0
400
800
1200
Solar wind Velocity (km/s)
Bx By Bz-Np^0.5
0
4
8
12
Solar wid Density^0.5 (1/cc^0.5)

Summary

Scatter plots（Dst – Pd^0.5) provide useful information：

① Dst — Pd^05

upper envelope: linear increase → minimum ring current = Dsto

lower envelope: linear decrease → maximum ring current

② **IMF Bx·By·Bz — Pd^0.5 （Pd→ 0）**

IMF Bx By: → spiral pattern（By>Bx)

IMF Bz: → 0

③ IMF-Bx·By·Bz — Np^0.5 （Np→0）

similar to ②

④ IMF-Bx·By·Bz —V （V→0）

IMF-Bx·By·Bz → 0