Observations of a positive storm phase on Sep 10, 2005

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Solar activity

- \( F10.7: 72-119 \)
- Solar flares on Sep 6-17: 10 X-class, 26 M-class
- Sep 8: X5.4, 20:52-21:17 UT
Geomagnetic conditions, Sep 8-12

- IMF, solar wind pressure, solar wind speed from the Wind satellite
- SWP impulse on Sep 9 at 13:34 UT and on Sep 11 at 01:01 UT
• Positive storm phase observed on Sep 10
Millstone Hill ISR Ne, Sep 8 and 10
Geomagnetic conditions, Sep 9-10
Electron density at 350 km

Increase in Ne at 350 km reaches a factor of 5 at 19:30 UT
Increase is observed throughout the day (LT=UT-5)
Electron temperature at 350 km

Decrease in $T_e$ is observed after $\sim$14 UT, reaching 1300 K by 19:30 UT
Ion temperature at 350 km

Ion temperature increased by 100-150 K
Ionospheric parameters at 19 UT
Ionospheric parameters at 17 UT

- Ne
- Ti
- Te
- Vup
NmF2 and hmF2

NmF2:
- Increase after ~12 UT;
- Factor of 3 increase at 19:30 UT
- ~50% increase before 17 UT

hmF2:
- 220 – 260 km on Sep 8
- ~360 km on Sep 10
- 100-110 km increase at ~19 UT
- ~20-40 km increase before 16:30 UT
Electric field

- Enhancement in the eastward electric field at 15-20 UT
- Maximum eastward electric field \( \sim 6.3 \text{ mV/m} \) at 16:30 UT
- No large variations in the northward electric field before 20 UT
Meridional wind (quiet)

Quiet time wind: poleward in the morning and daytime, equatorward at night
On Sep 10 meridional wind turns equatorward after ~14 UT, reaches ~100 m/s at 17-19 UT
Millstone Hill NmF2, e-field and wind

NmF2

Millstone Hill ISR, Zenith antenna, September 2005

wind

Millstone Hill meridional wind, September 2005

E-field

Millstone Hill Electric field, September 2005
Arecibo ISR, Sep 7-10

Positive storm phase over Arecibo on Sep 10
Arecibo ISR, 342 km

- Ne increases after ~13 UT, reaching a factor of 2.5 at 21 UT
- Maximum increase in Ne at ~340 km is observed ~1.5 hours later than over Millstone Hill
Arecibo ISR at 342 km

Ne, Arecibo IS Radar, Sep 2005, 342 km

Te, Arecibo IS Radar, Sep 2005, 342 km

Vo, Arecibo IS Radar, Sep 2005, 342 km
Arecibo ISR at 21 UT
Arecibo ISR, 19 UT

Peak height on Sep 10 increased by ~100 km
Upward vertical drift on Sep 10
Maximum vertical drift is at ~200 km
Arecibo ISR, ion drift at 330 km

Northward

Eastward

Antiparallel
GPS TEC, Sep 8 and 10, 19 UT

Sep 8

Quiet time low-to-midlatitude daytime TEC - ~ 20 TEC units

Sep 10

~40 TEC units; increase in TEC by a factor of 2
GPS TEC differential map, 19 UT

Increase in TEC at latitudes up to ~50N; stronger in the northern hemisphere

SED formes in the Western Hemisphere
By 21 UT, increase in TEC is observed at lower latitudes
Increase in TEC at latitudes < 40N
SED ~ 5-10 TEC un
HP and meridional wind

[Graph showing HP, North hemisphere over time]

[Graph showing Millstone Hill ISR meridional wind, m/s over time]
HP and wind, Sep 9

Hp peak at 14:04-14:46 UT

Wind is equatorward by 15:20 UT
HP peaks at 16:13, 17:55, 19:37 UT

Wind surges at 17:10-19:00 UT and at 21:15 UT

Wind is more equatorward ~1-1.5 hour after peaks in HP
Hp and Kp

- Maeda et al., JGR, 1989 (statistical study, 7 years, 22574 power inputs):
  \[ HP(GW) = -2.78 + 9.33Kp \]

- Sep 10, 2005 case, Kp=5:
  - expected HP \( \approx 44 \) GW
  - measured HP = 200-250 GW

- Equatorward wind measured over Millstone Hill results from unusually high auroral power input
Summary

• A strong positive phase is observed during a moderate storm (Kp=5, Dst=-50)
• At Millstone Hill (42.6N, 54MLat) increase in Ne at 350 km is factor of 5; increase in NmF2 is a factor of ~3. Maximum increase is observed at 19:30 UT.
• At Millstone Hill both eastward electric field and equatorward wind are important before ~17 UT; after ~17 UT contributions from the wind are dominant.
• At Arecibo (18.3N, 32 MLat) increase in Ne is a factor of 2.5 by 21 UT
• No variations in the eastward electric field over Arecibo
• Positive antiparallel drift of 30-40 m/s over Arecibo – indication of equatorward wind.
• Large equatorward wind results from unusually high auroral heating.
Sondrestrom ISR, E-field

Sondrestrom electric field

EPE, mV/m

UT, hrs

EPN, mV/m

UT, hrs