Characteristics of daytime medium scale traveling ionospheric disturbances (MSTIDs) as observed by SWARM

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ESA’s SWARM Mission

- Constellation of 3 satellites with nearly polar orbits.
- Two of them Swarm-A and Swarm-C fly alongside each other with a separation of 1.5 degrees at an altitude of ~470 km.
- Swarm-B flies at an altitude of ~520 km.
- However, in the initial stages, the satellites flew close to each other.
- Electron density data obtained from onboard Langmuir Probe (LP) is used to study the TIDs along with magnetic field data.
- All the data can be obtained via ftp from “ftp://swarm-diss.eo.esa.int”
Traveling Ionospheric Disturbances (TIDs)

- In simple words, the TIDs are horizontally propagating wave-like structures in the electron density, observed in the F-layer.
- Medium scale traveling ionospheric disturbances (MSTIDs) are features of milatitude ionosphere with typical wavelengths of the order of ~100-500 km.
- The nighttime TIDS are mostly attributed to the Perkins instability whereas the daytime TIDs are understood to be mostly due to effects of gravity waves.
- However, the magnetically conjugate nature of the TIDs during both night- and day-time suggests there deep rooted relationship to the ionospheric electrodynamics.
Day-time TID (~ 10.5 LT): Simultaneous SWARM Vs TEC Observations

Night-time TID (~ 22.5 LT): Simultaneous SWARM Vs TEC Observations

[Kil et.al., 2017]
Density vs Magnetic fluctuations: Examples

TID without magnetic fluctuations

20140926, LT=11.0903, UT=6.0004

log(Ne)

100° ΔNe/Ne

ΔB⊥

ΔB∥

FAC

Magnetic Latitude (degree)

TID with magnetic fluctuations

20140928, LT=12.8086, UT=1.8426

log(Ne)

100° ΔNe/Ne

ΔB⊥

ΔB∥

FAC

Magnetic Latitude (degree)

Electron density in log scale as a function of magnetic latitude

Percentage density fluctuation a function of magnetic latitude

Magnetic fluctuation perpendicular to the ambient field direction as a function of magnetic latitude

Magnetic fluctuation parallel to the ambient field direction as a function of magnetic latitude

Field aligned current as a function of magnetic latitude
Cases with/without Magnetic Fluctuations (2014)

**Descending**

- Magnetic Fluctuations
- No Magnetic Fluctuations

**Ascending**

- Magnetic Fluctuations
- No Magnetic Fluctuations

TID cases vs. LT (Hour)
Density vs Magnetic fluctuations: Anti-Correlated?

ΔNe and Δ B are multiplied by factors to fit into same scale for better visualization
Density vs Magnetic fluctuations: Anti-Correlated?

$\Delta N_e$ and $\Delta B$ are multiplied by factors to fit into same scale for better visualization.
Density vs Magnetic fluctuations: Anti-Correlated?

$\Delta$Ne and $\Delta$B are multiplied by factors to fit into same scale for better visualization.

20140111, LT=10.1329, UT=12.979

Noise, not TID
Density vs Magnetic fluctuations: Anti-Correlated?

$\Delta$Ne and $\Delta$ B are multiplied by factors to fit into same scale for better visualization.
Conclusions

• Not all TIDs (as seen as density fluctuations) are associated with magnetic fluctuations.
• $\Delta N_e$ and $\Delta B_\perp$ are mostly anti-correlated.
• Needs more investigation.