A Non-Local Spread-F-like Event Over Arecibo as the Possible Result of a Solar Wind Pressure Pulse

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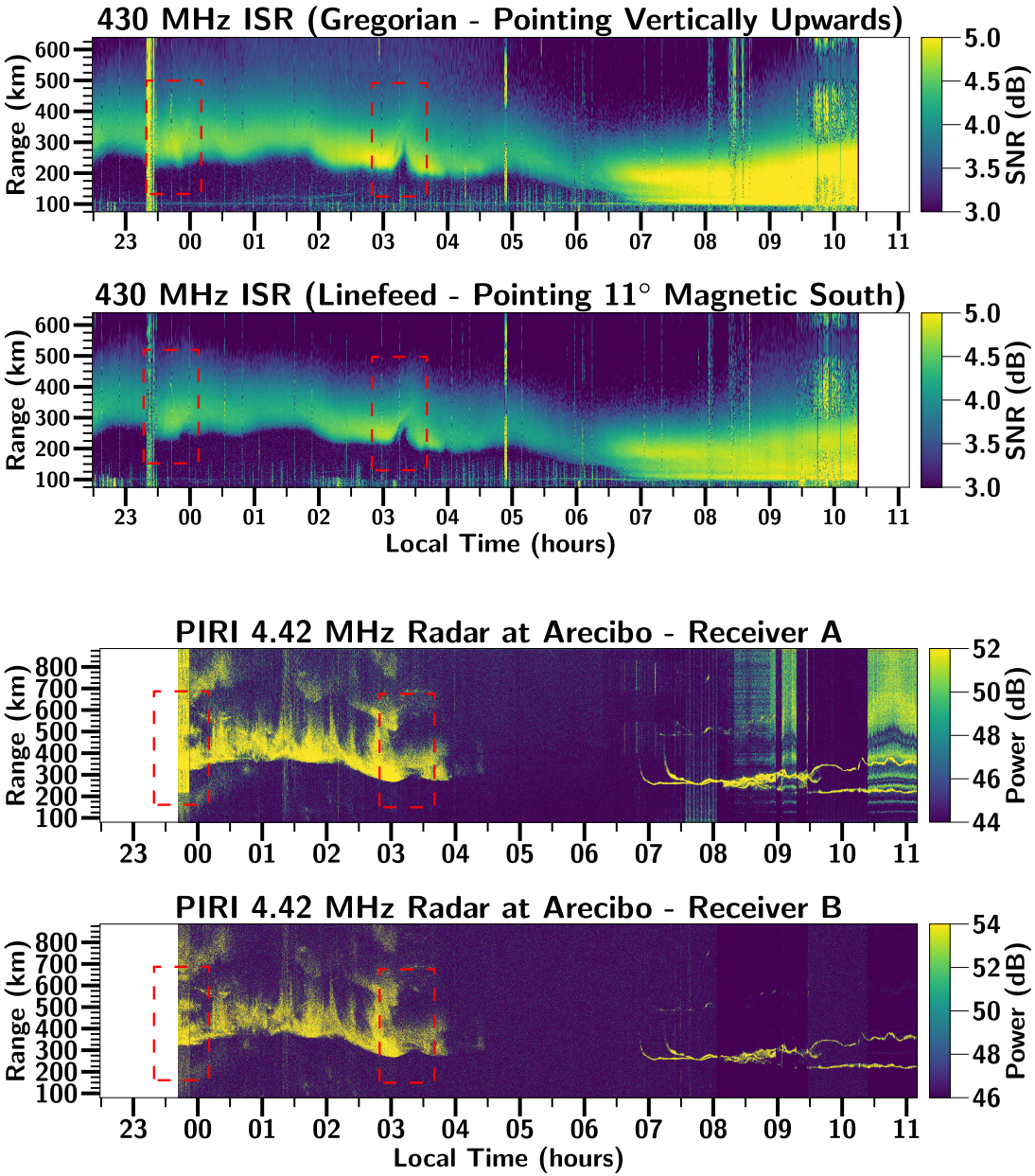
Motivation

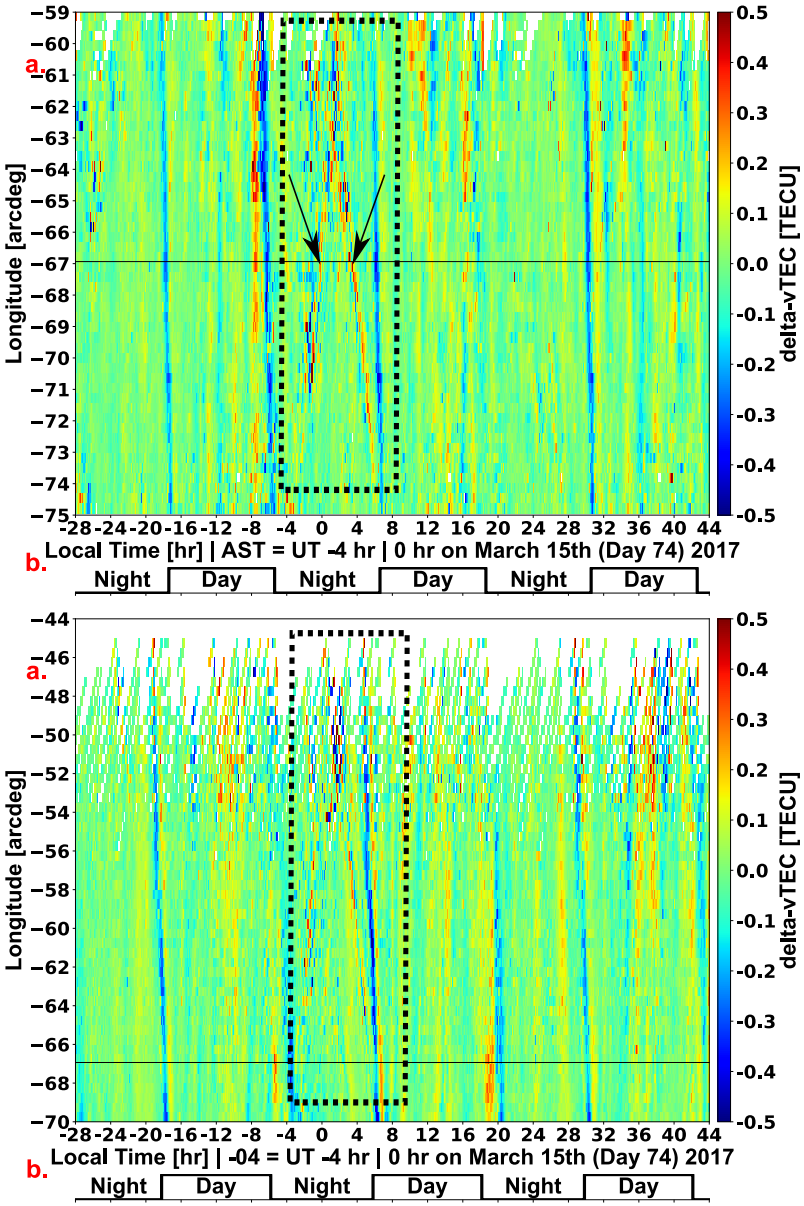
- Using diverse data sets, we demonstrate that an apparently local (Arecibo, Puerto Rico) spread-F-like ionospheric upwelling event observed under geomagnetically quiet conditions with an HF radar and the Arecibo Observatory (AO) Incoherent Scatter Radar (ISR) is likely the local manifestation of a mesoscale or larger ionospheric response to a relatively weak solar wind pressure pulse and B-field realignment event. Additionally, GNSS-TEC (in keogram format), the NASA OMNI, and the SuperMAG datasets were used to establish the (mesoscale/global) wide-context of the local, deep-context radar results.

430 MHz ARECIBO ISR and 4.42 MHz HF Radar

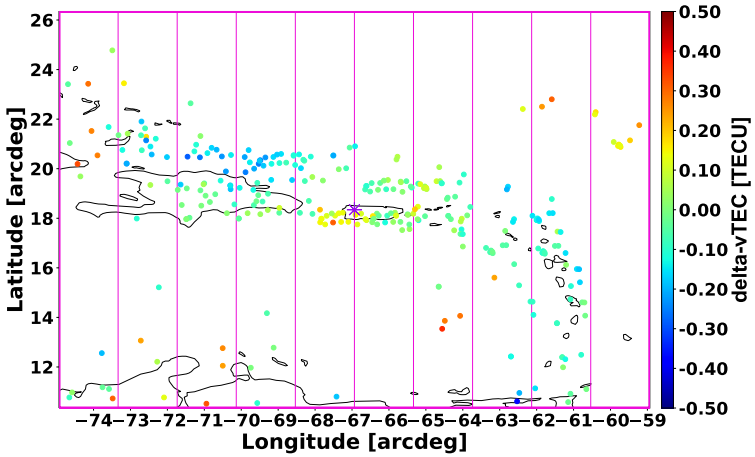


- Deep-Context ISR observations reveal an ionosphere upwelling event (14/15 March 2017; Kp 2) with km-scale substructure that is usually associated with local Perkins-like instabilities possibly initiated by one of a variety of suspect "triggers" such as AGWs.
- Hybrid Deep/Wide Context HF radar reveals range-spread SpF over the entire nighttime period.

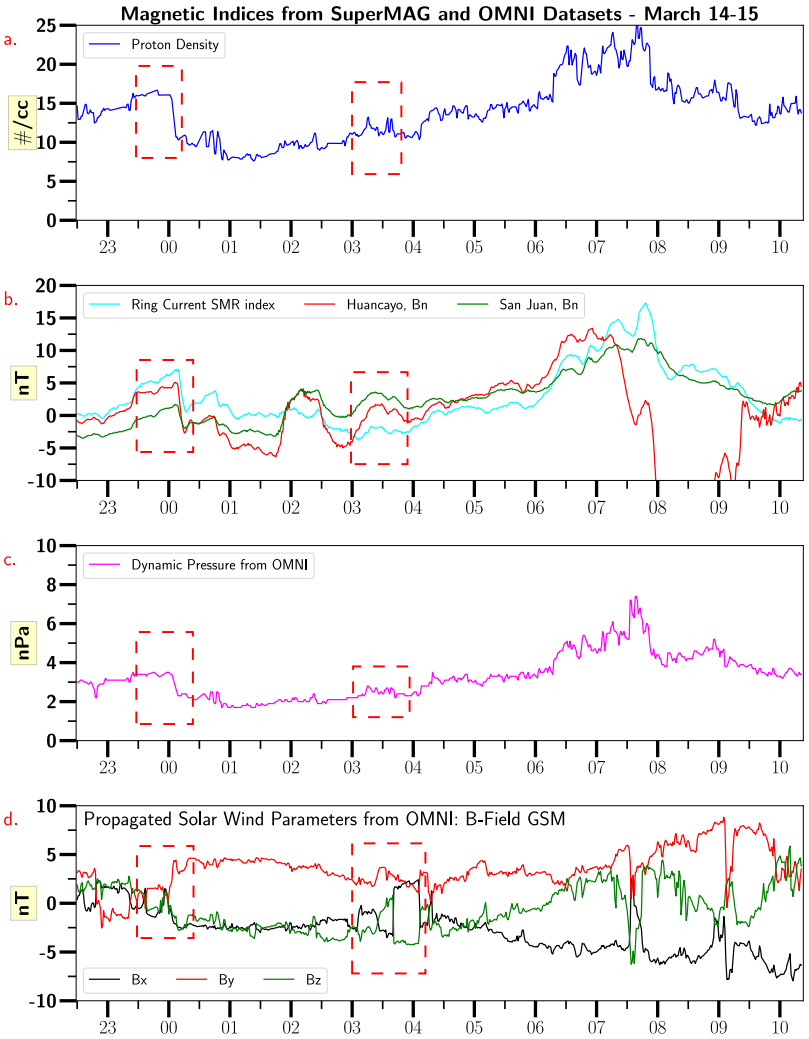
Keogram Framework and delta-vTEC Keograms



- (top left) AO-sector delta-vTEC keogram with ∼36 km longitudinal slicing and 16° latitudinal/30 s averaging reveals the AO-radar SpF upwelling event to be imbedded in a mesoscale electrodynamic process. The arrows indicate the times of the AO ISR (red box) events shown in slide 3.
- (bottom left) AO-conjugate-sector delta-vTEC keogram (∼ 55 km longitudinal resolution & 25° latitudinal/30 s averaging) appears to mirror the AO keogram results.
- (below) Example 30 s "frame" from the AO-sector delta-vTEC 350 km F-region pierce-point sampling map "movies".



Relevant Solar Wind & Magnetospheric Activity Metrics During Spread-F Period.



- OMNI & SuperMAG data plots for the relevant radar and delta-vTEC keogram results. The red boxes correspond to those in slide 3. A sudden decrease in solar wind proton concentration and simultaneous shift in B-field properties seems to be associated with the onset of ionospheric activity at AO and with AO-sector mesoscale delta-vTEC activity. A corresponding sharp decrease in the superMag ring current index is also observed.

Conclusion

- "Local" ionospheric spread-F-like activity at AO appears to be embedded within a mesoscale delta-vTEC feature revealed in the keograms and likely associated with a small solar wind pressure decrease and B-field realignment. The combination of deep-context radar results and wide-context delta-vTEC results suggests a complex, electrodynamic system-of-systems, ionospheric response to a relatively small solar wind feature impacting the dayside magnetosphere. The wide range of ground-based instruments was critical to this analysis.

Thank you! Questions?

– We would appreciate any feedback!
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