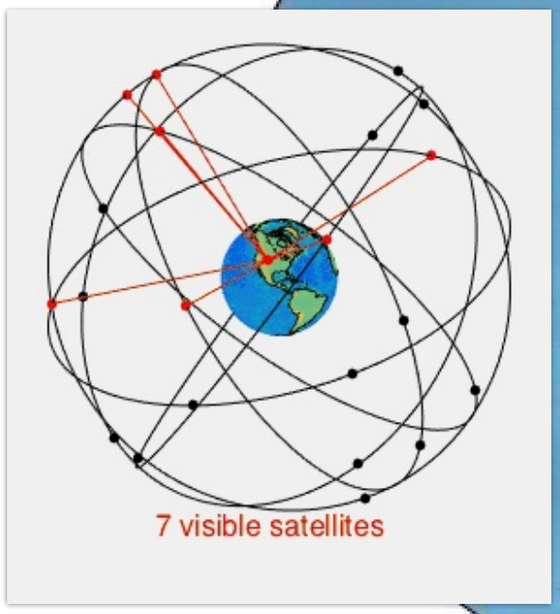
Wed 1330-1530 | Westcoast

2024 CEDAR: Plasma Structuring in the Polar Cap - Definition, Generation Mechanisms, and Properties of Polar Cap Patches

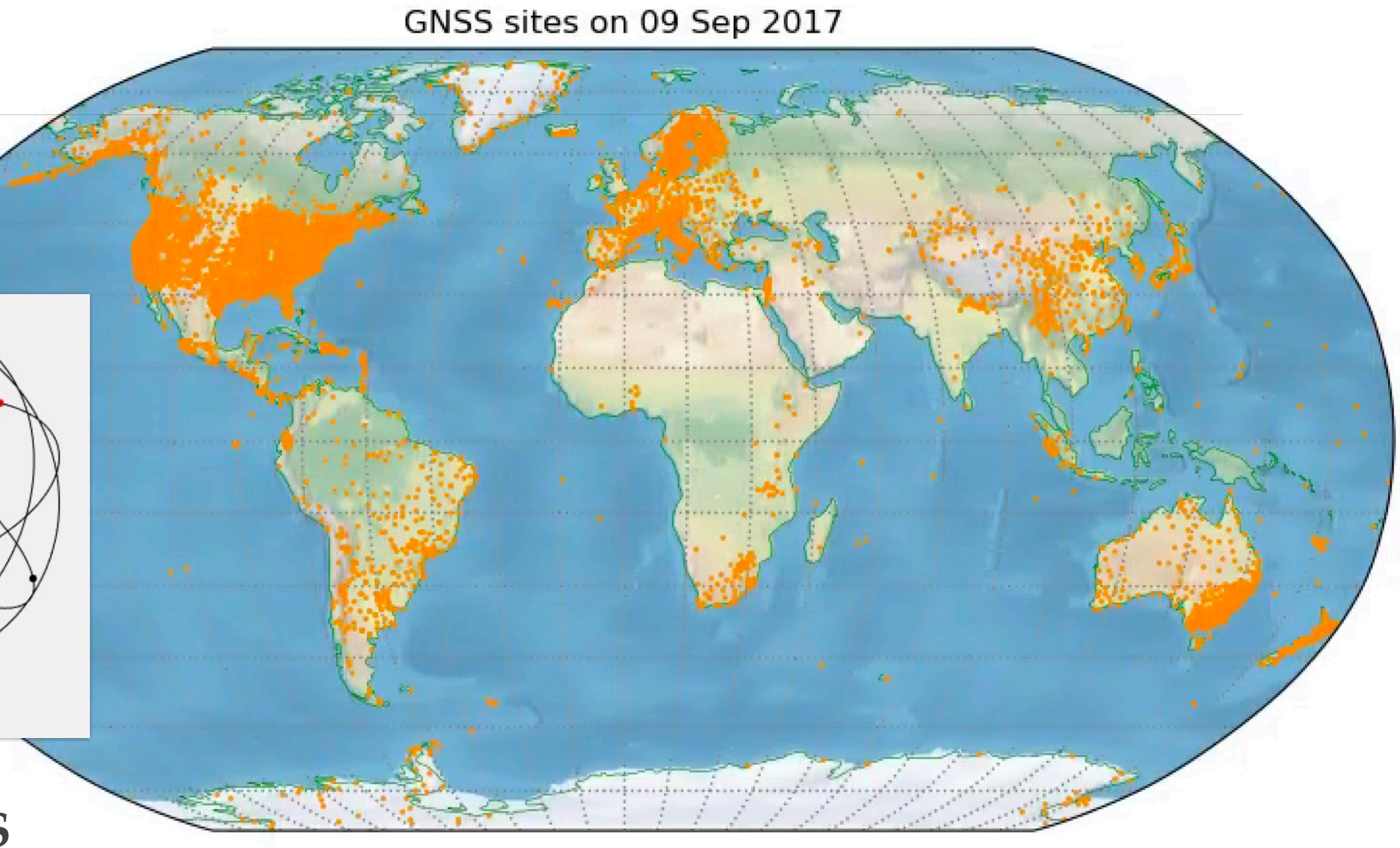
Transpolar traveling ionospheric disturbances

Shunrong Zhang

MIT GNSS TEC/dTEC from 6000+ Receivers

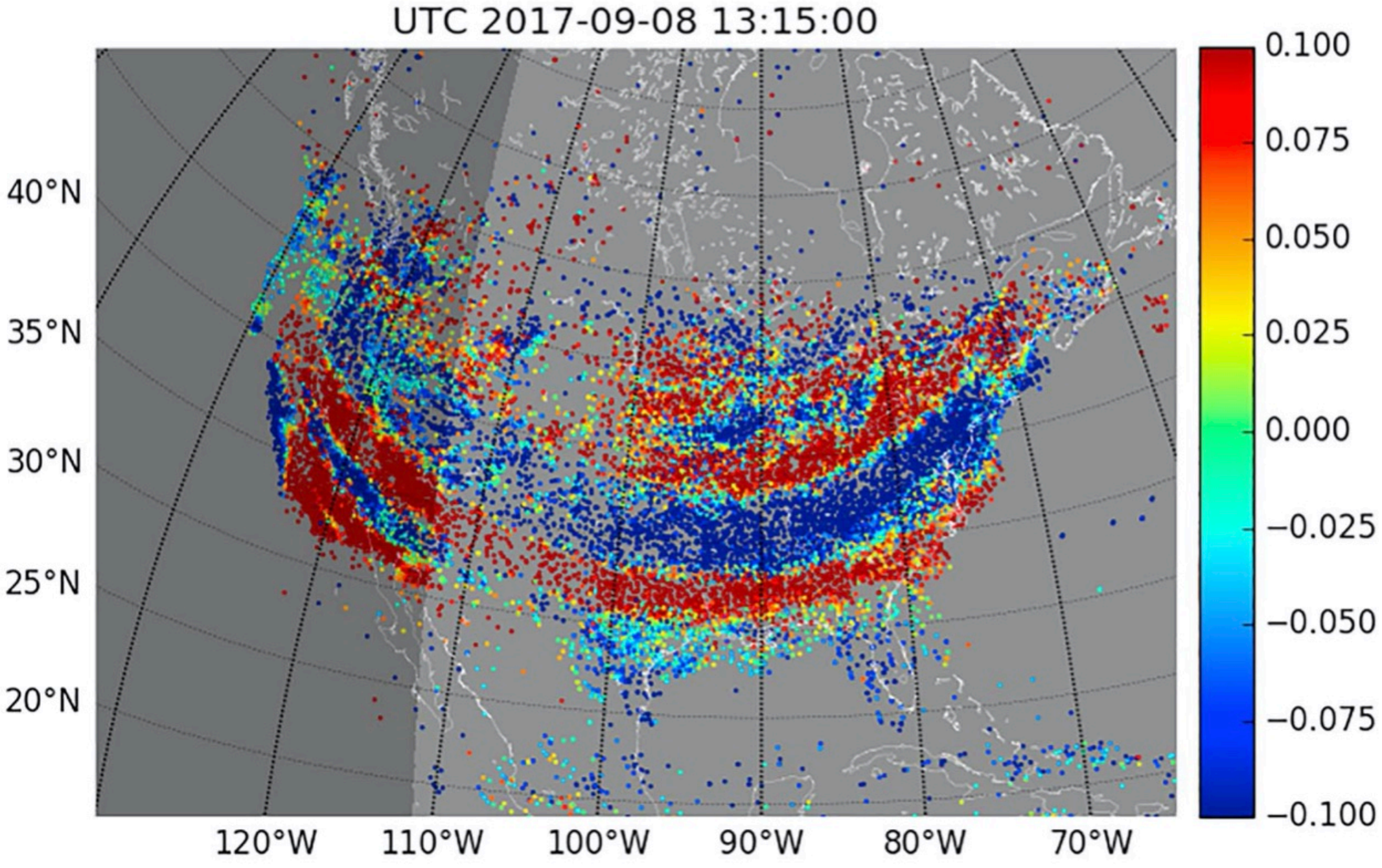


GPS
GLONASS
BeiDou



6000+ site
daily since year 2000
public access

Background: Storm-time TIDs

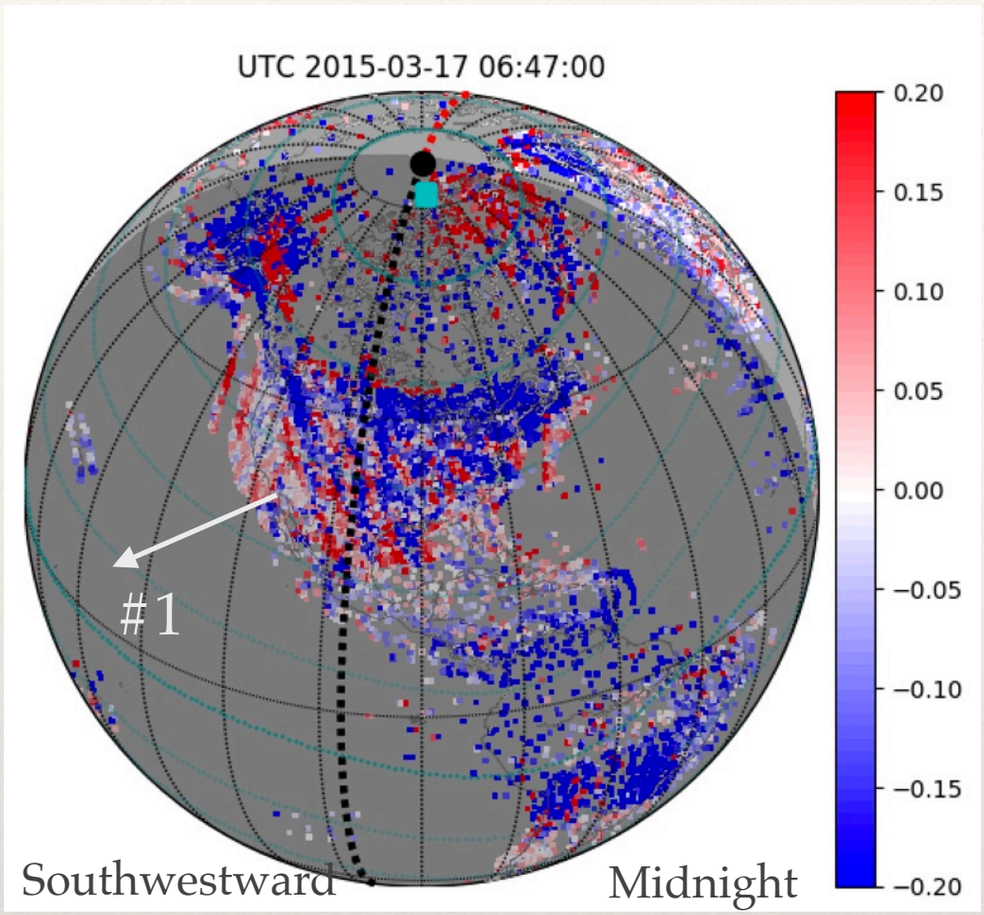


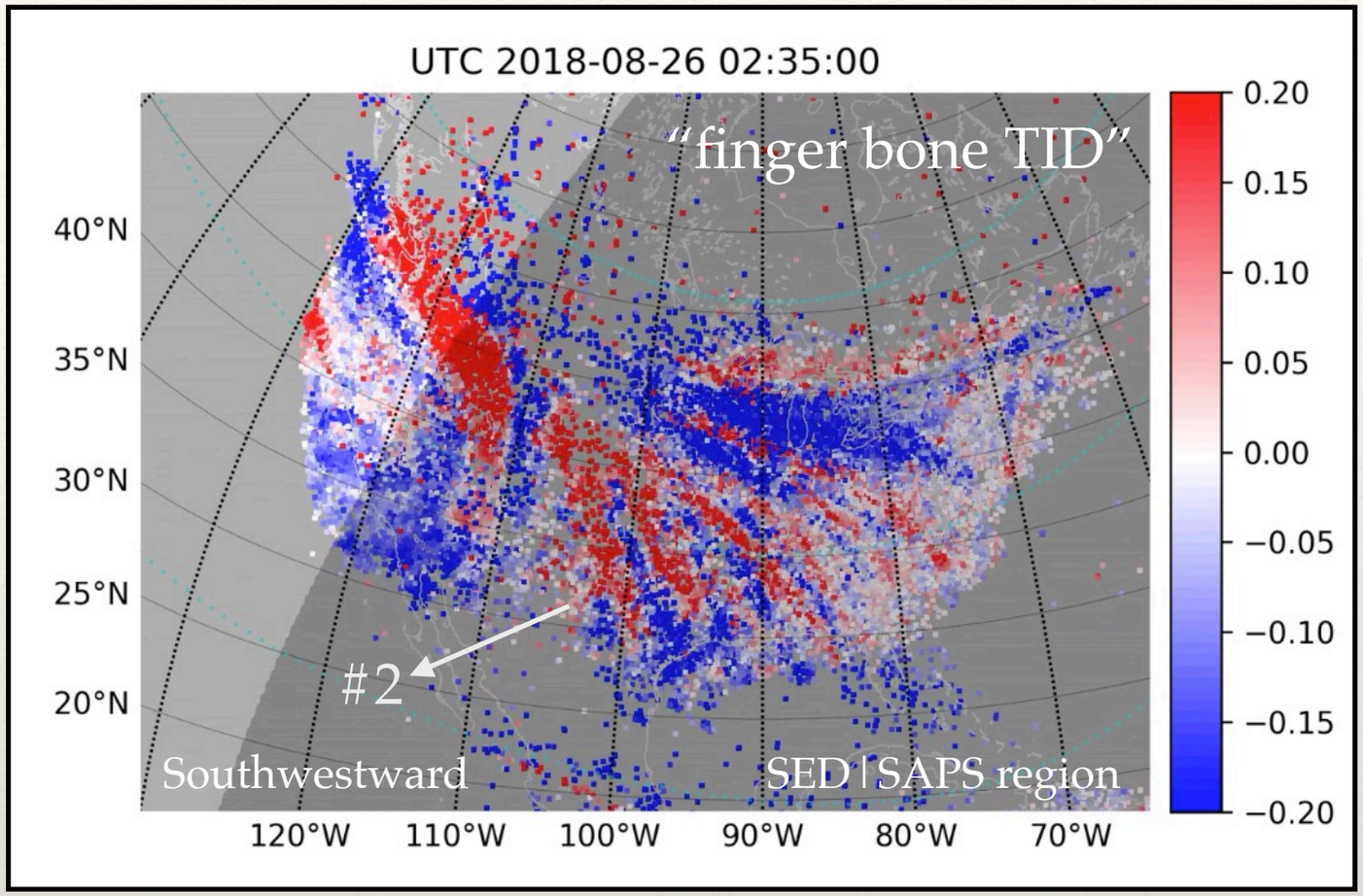
MIT HAYSTACK OBSERVATORY

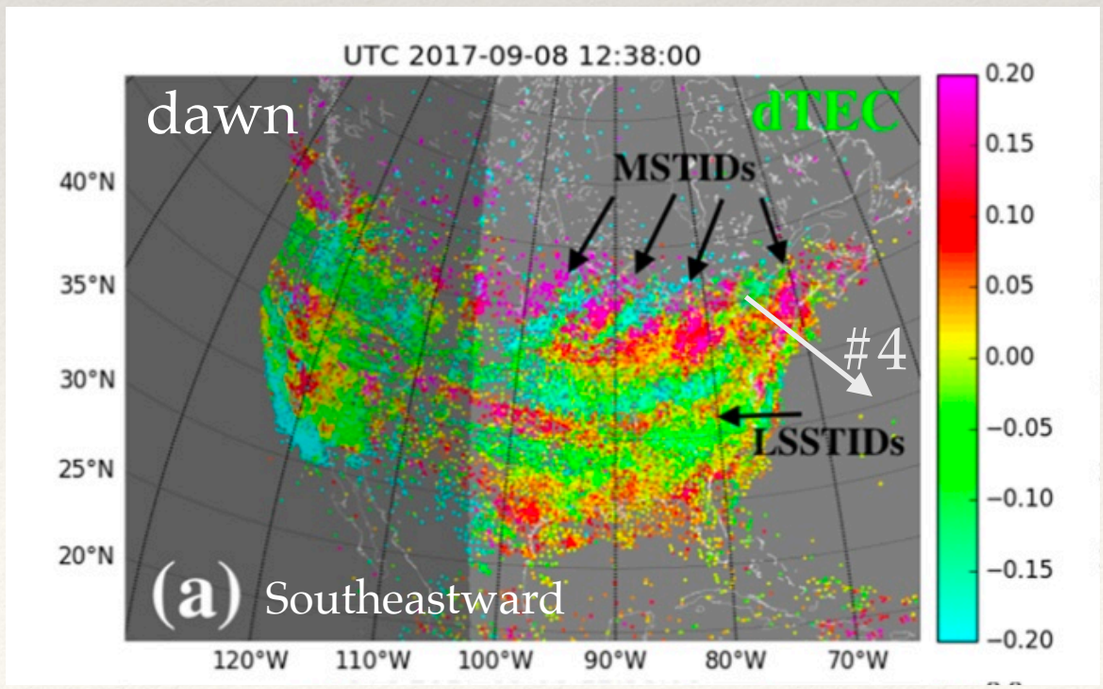
LSTIDs vs TADs | GWs

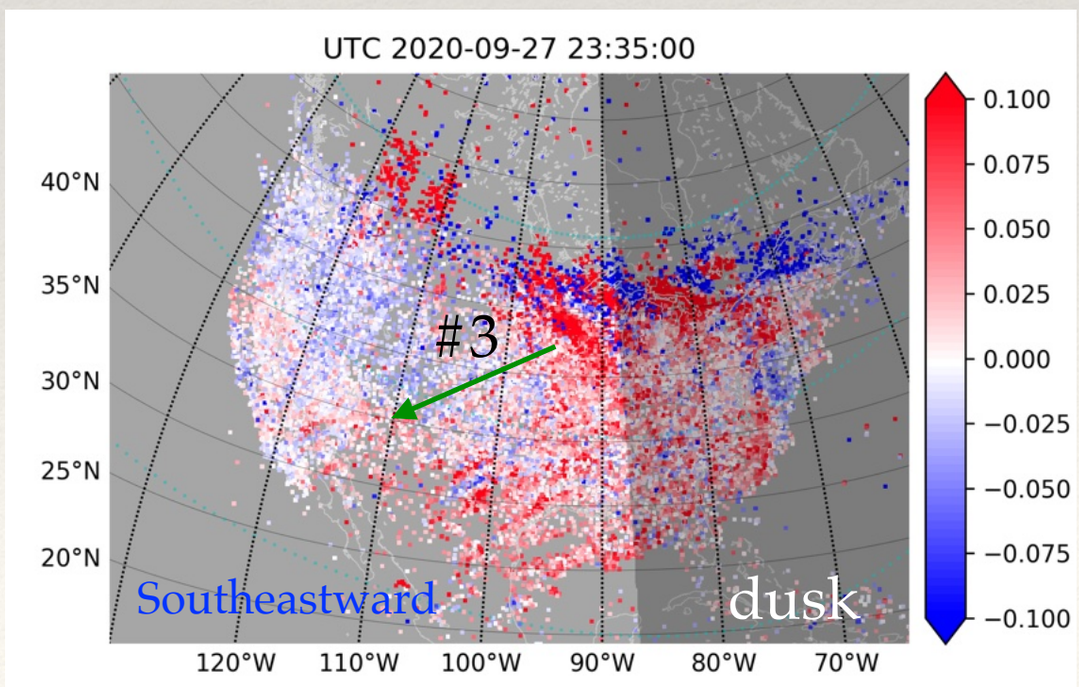
Storm-time MSTIDs at mid- and subauroral latitudes

My own classification





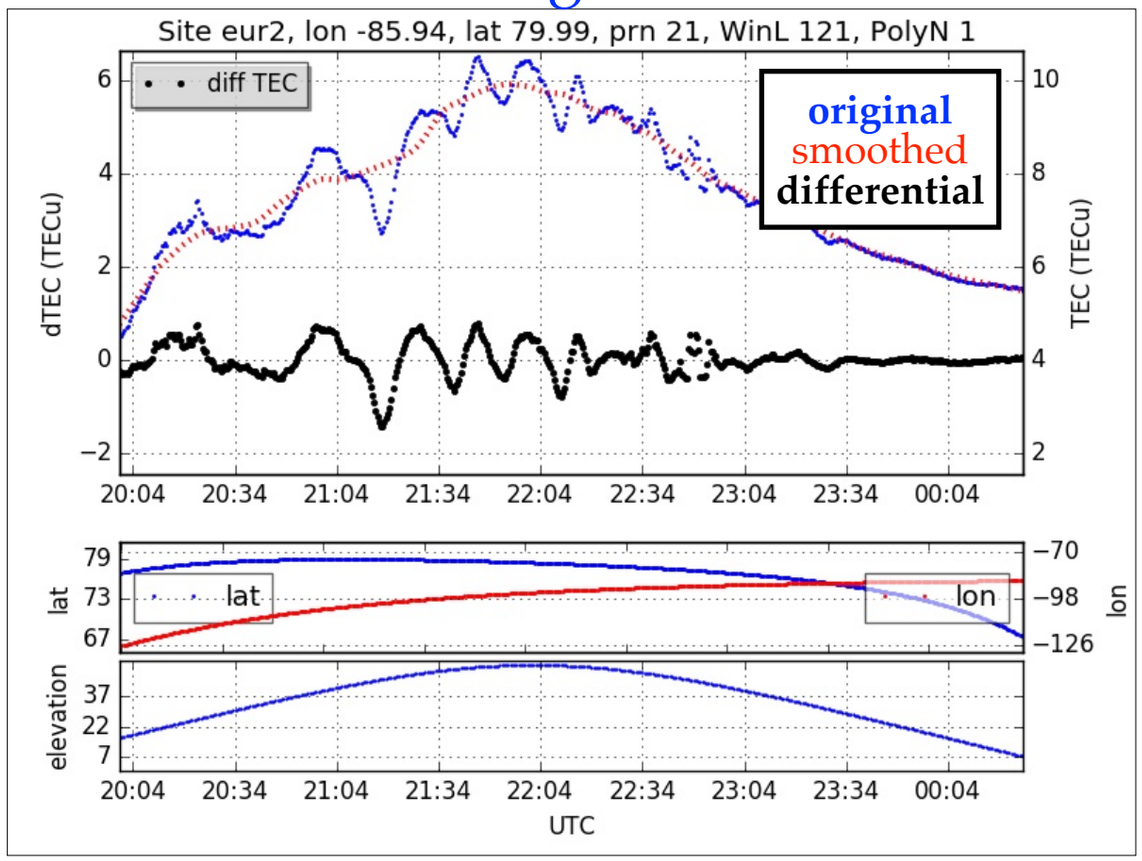




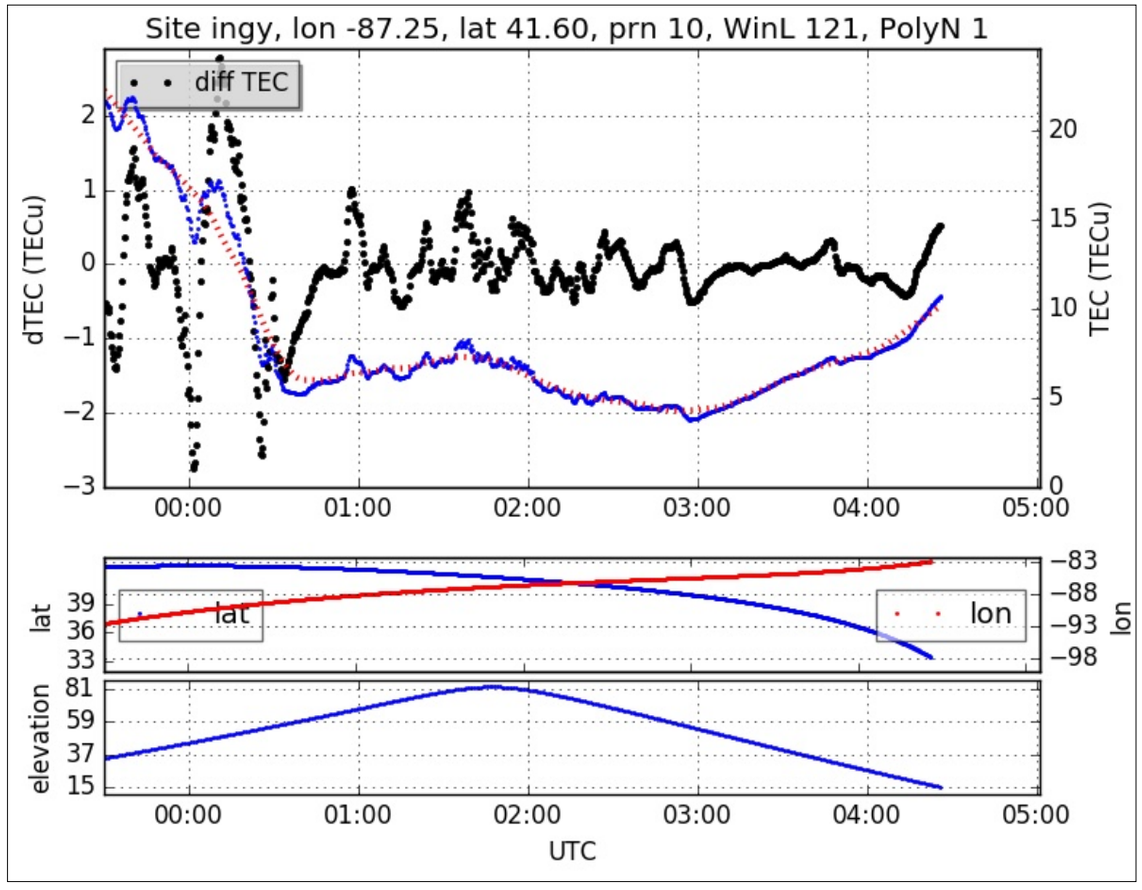
dTEC — Detecting Ionospheric Disturbances

Savitzky-Golay low-pass filter to provide background TEC variations that will be de-trended: similar to running averaging with sliding windows.

Polar region

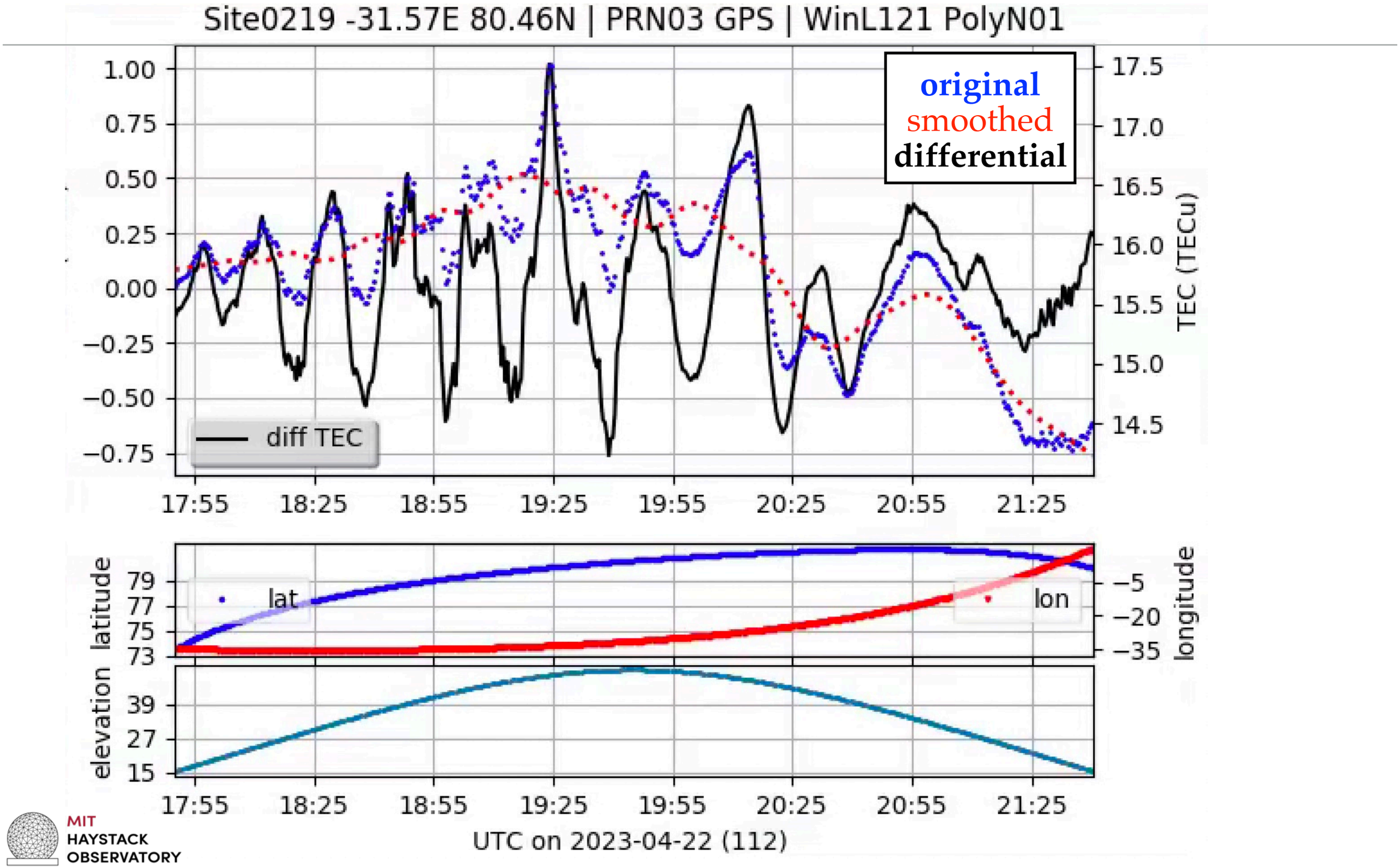


Midlatitude main trough region



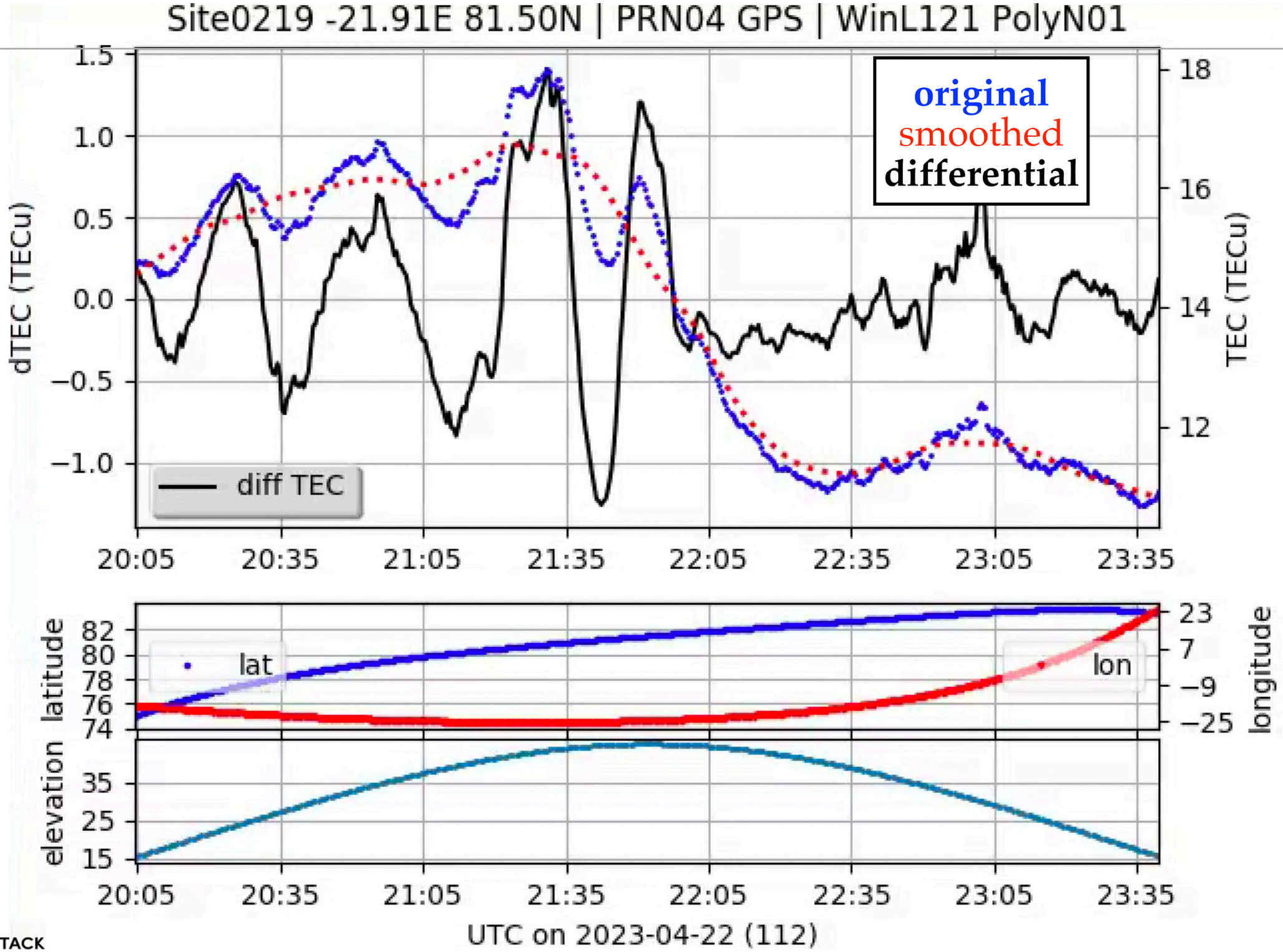
MIT HAYSTACK OBSERVATORY

April 24, 2023



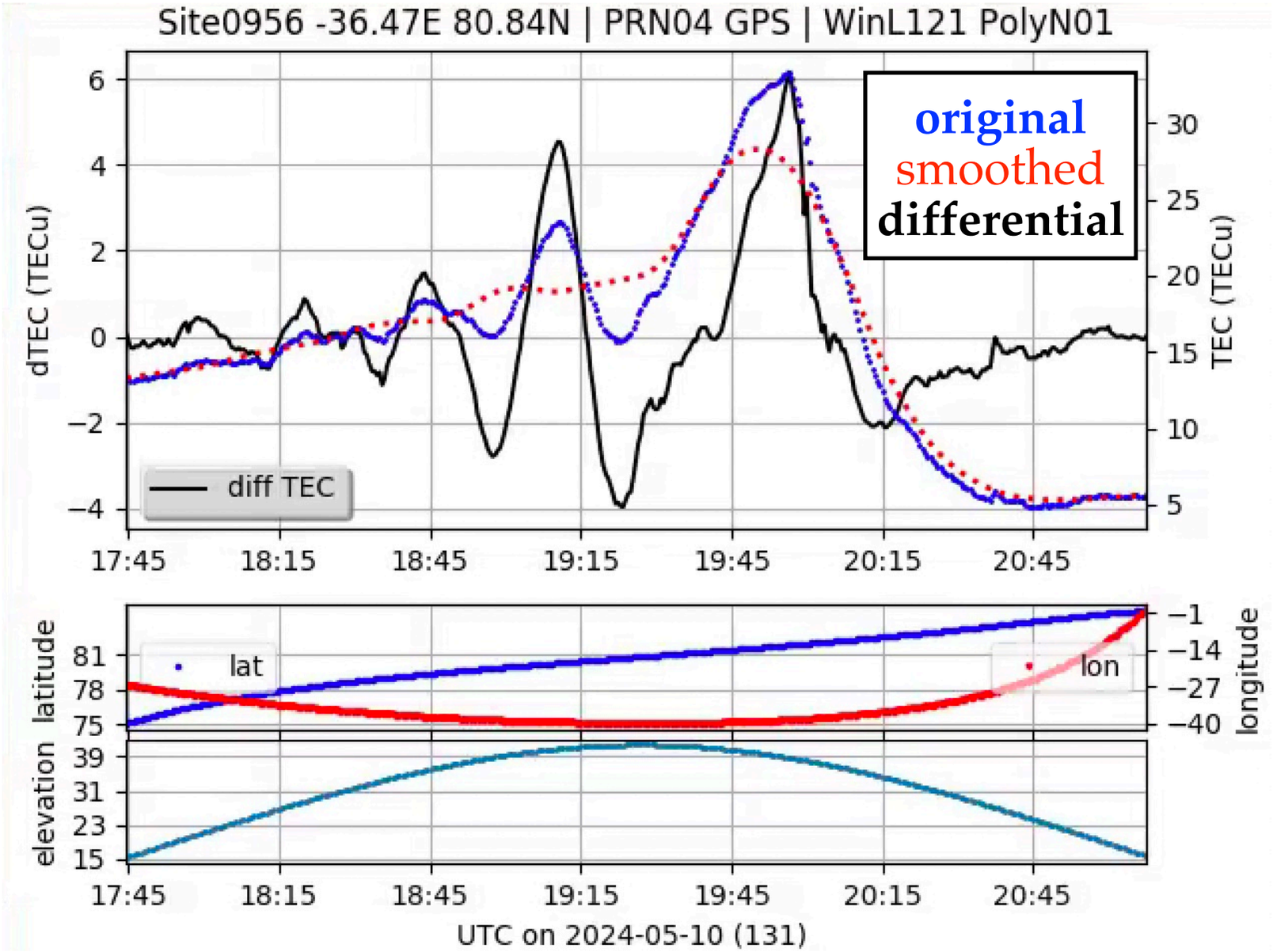
MIT HAYSTACK OBSERVATORY

April 22, 2023



MIT
HAYSTACK
OBSERVATORY

May 10, 2024



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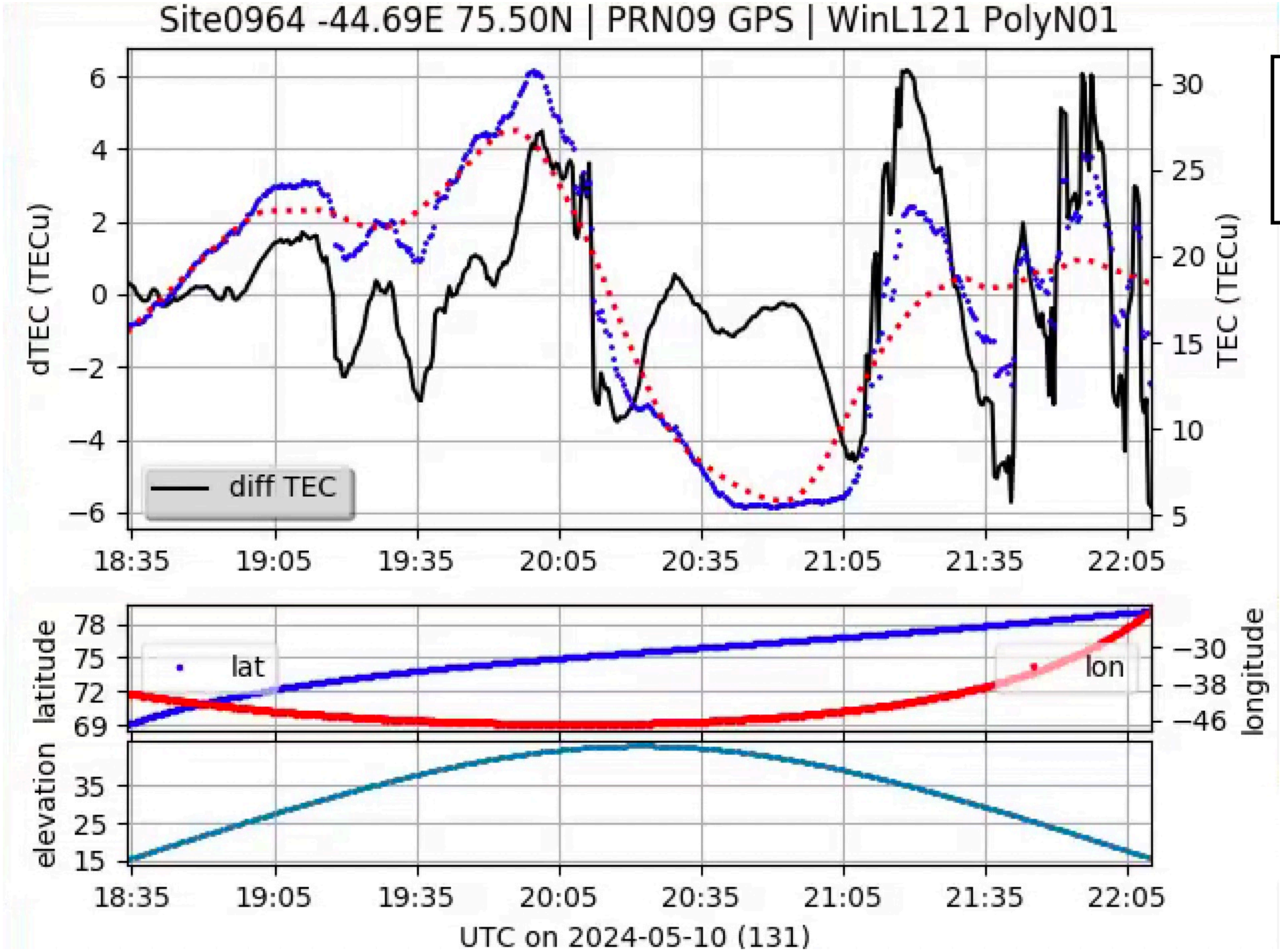
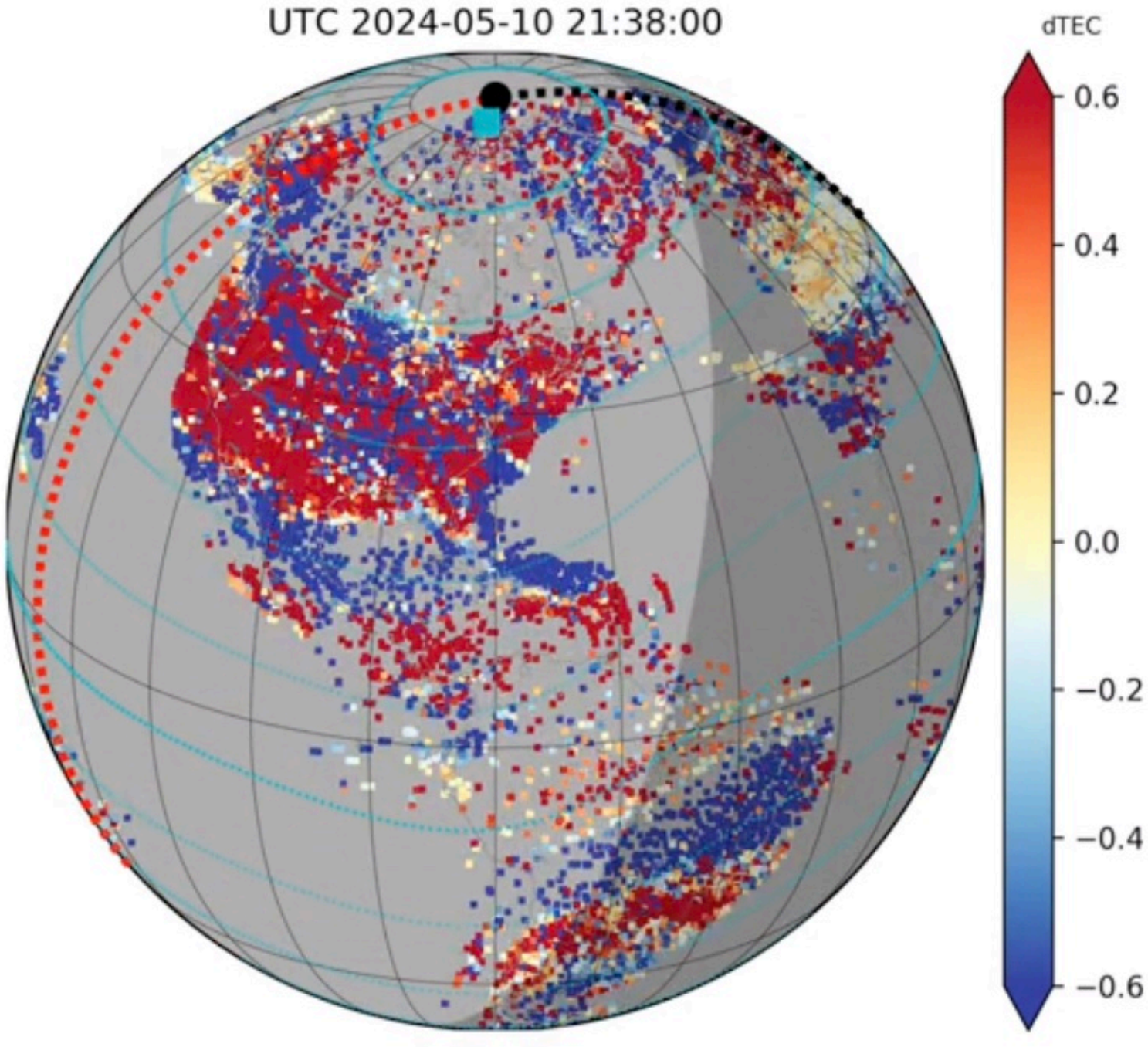
HAYSTACK
OBSERVATORY



original
smoothed
differential

MIT
HAYSTACK
OBSERVATORY

Mother's Day Storm



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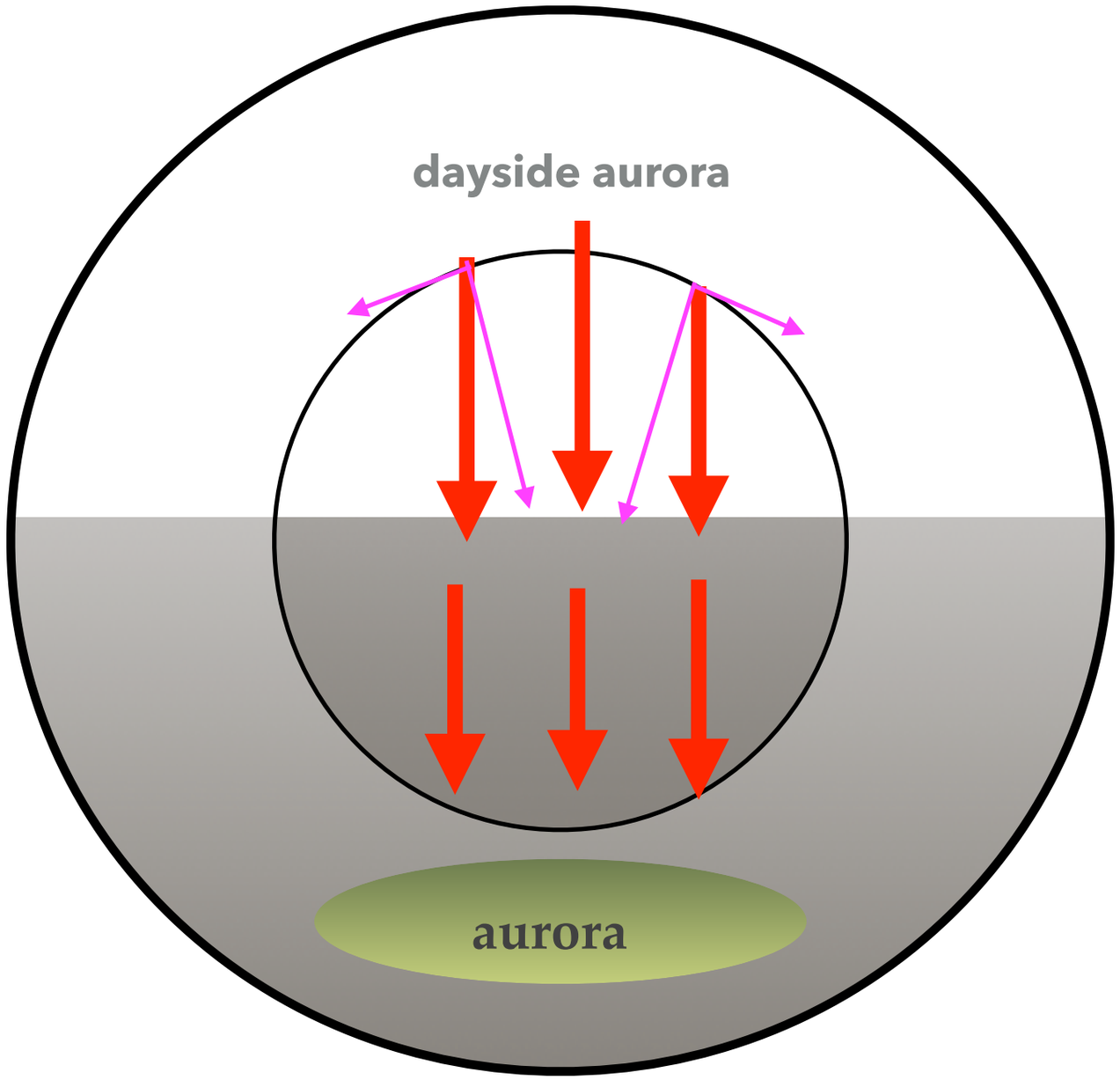
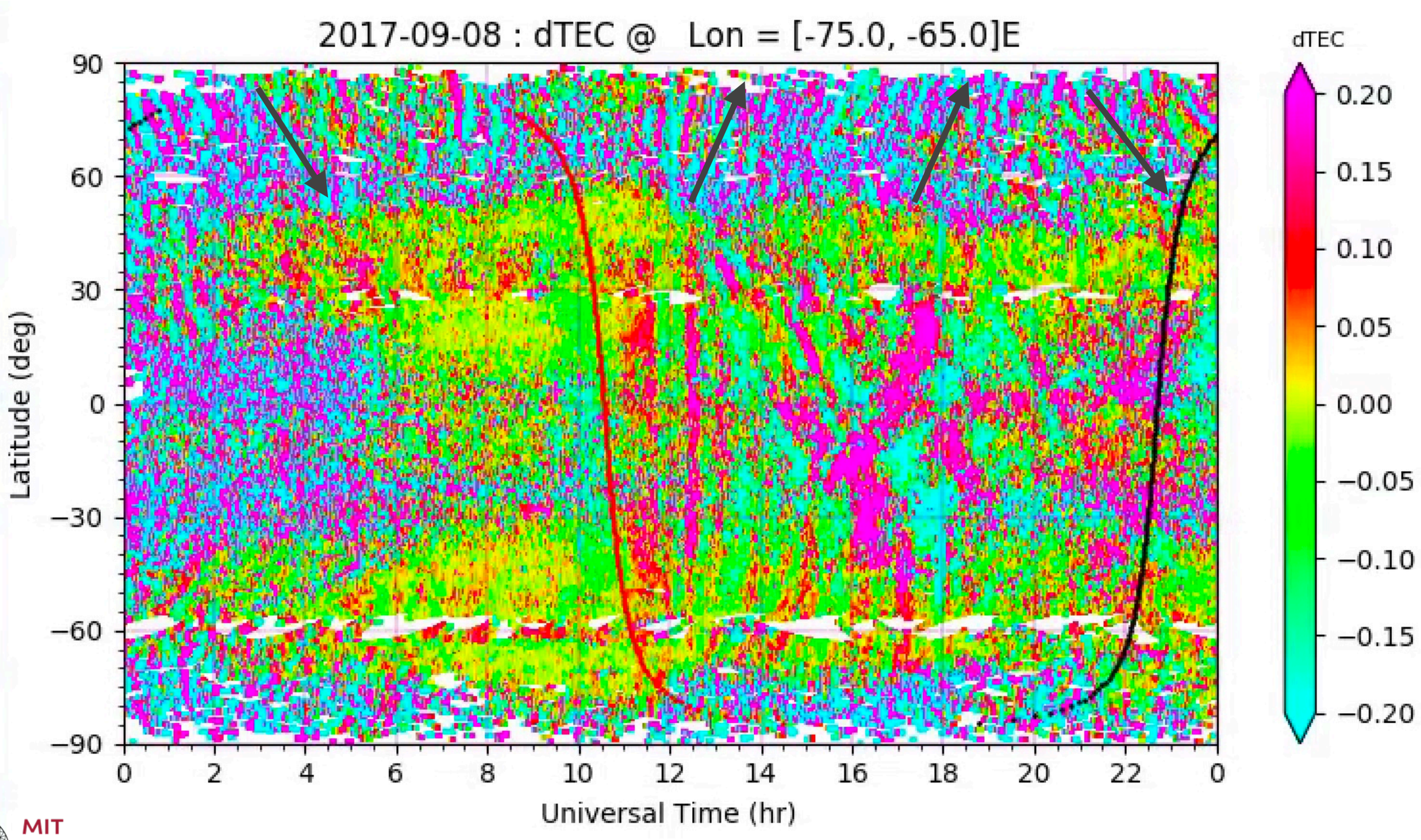
OBSERVATORY

Trans-polar TIDs



Zhang, S.-R., Erickson, P. J., Coster, A. J., Rideout, W., Vierinen, J., Jonah, O., & Goncharenko, L. P. (2019). Subauroral and polar traveling ionospheric disturbances during the 7-9 September 2017 storms. *Space Weather*, 2019SW002325. http://doi.org/10.1029/2019SW002325



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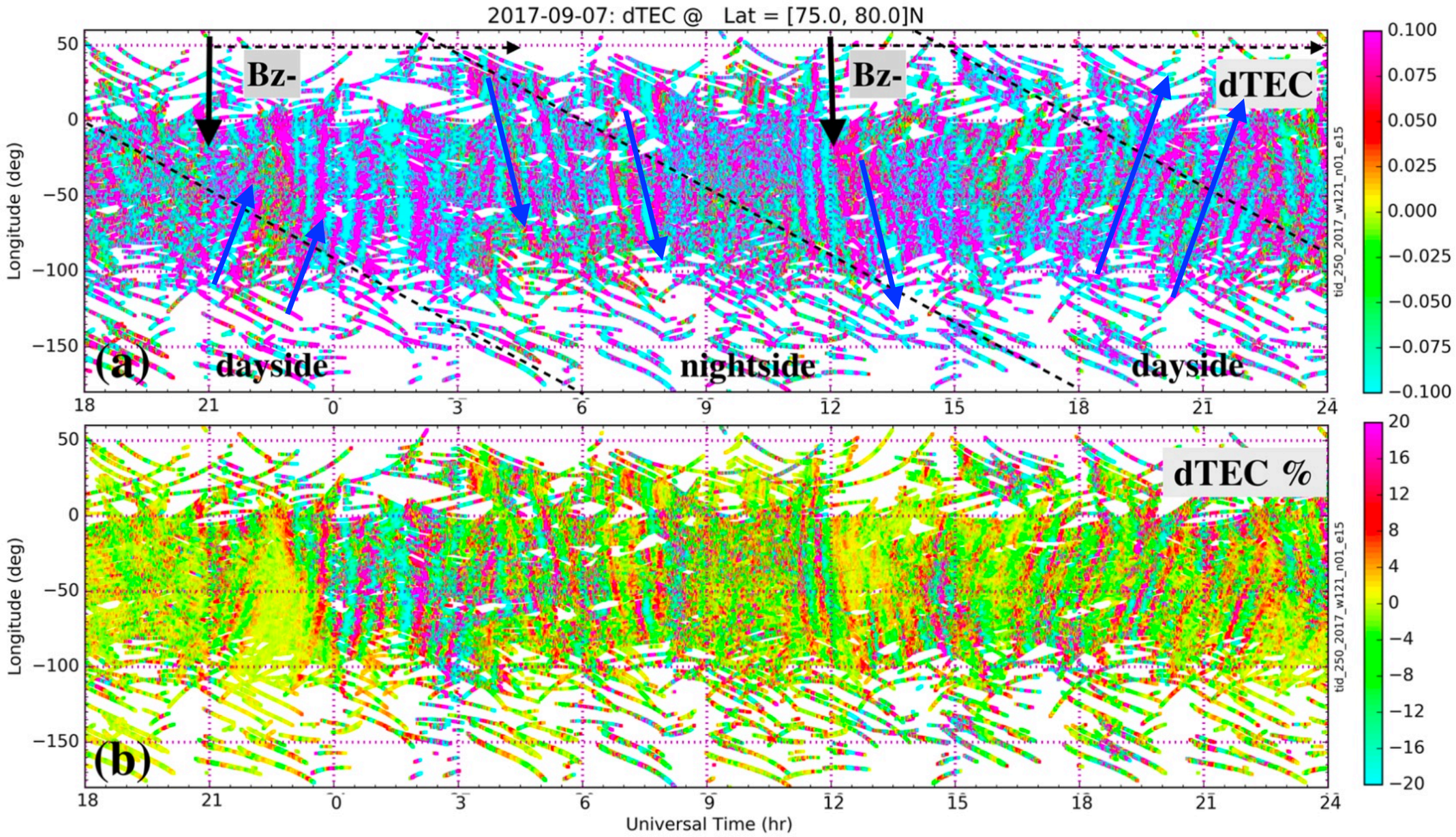
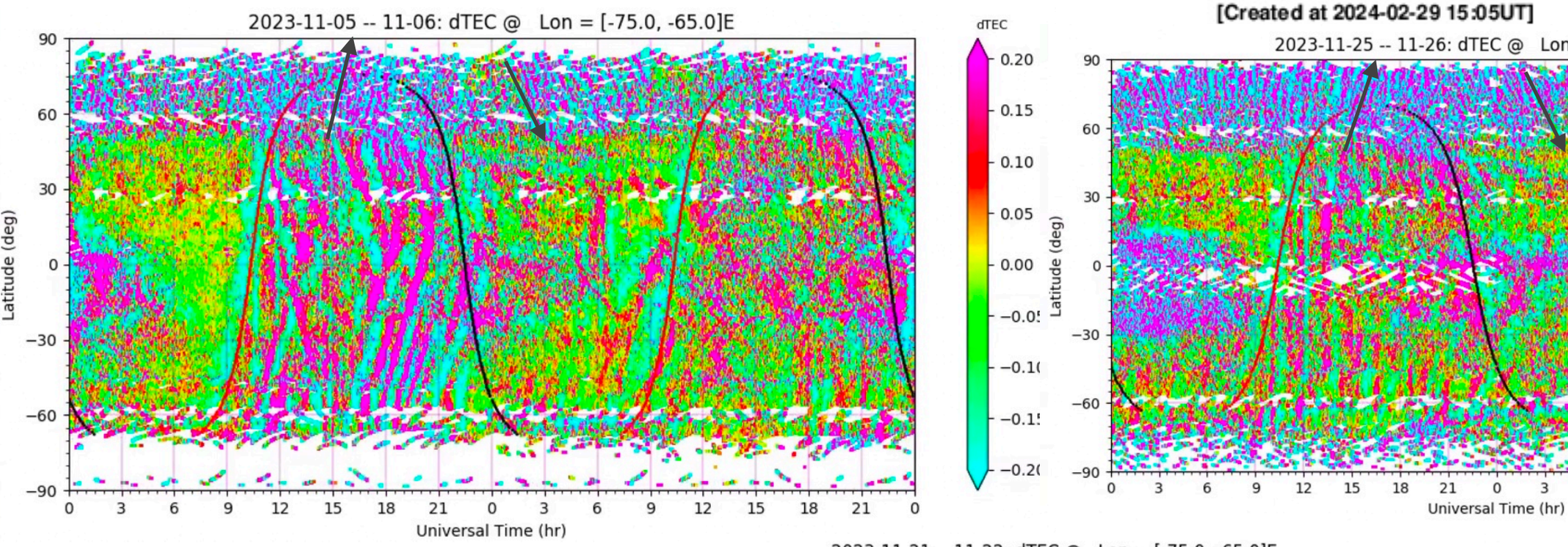
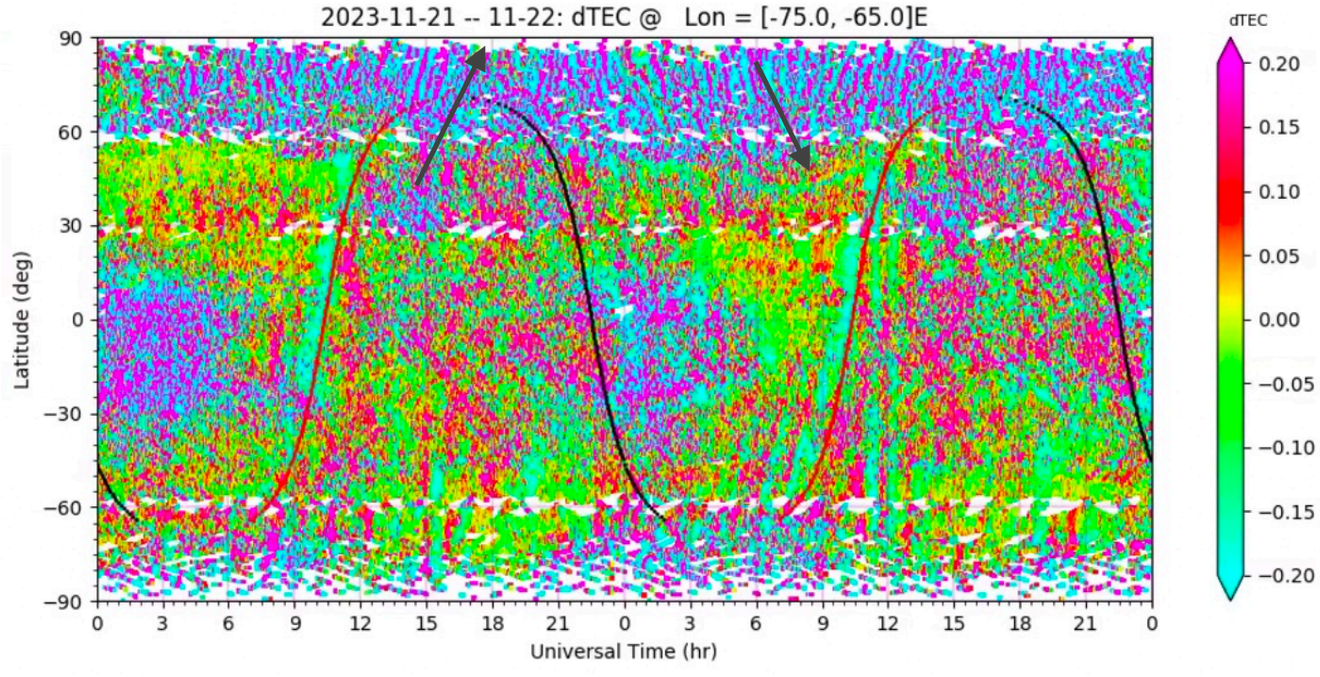
HAYSTACK
OBSERVATORY



MIT HAYSTACK OBSERVATORY

[Created at 2024-02-29 15:05UT]





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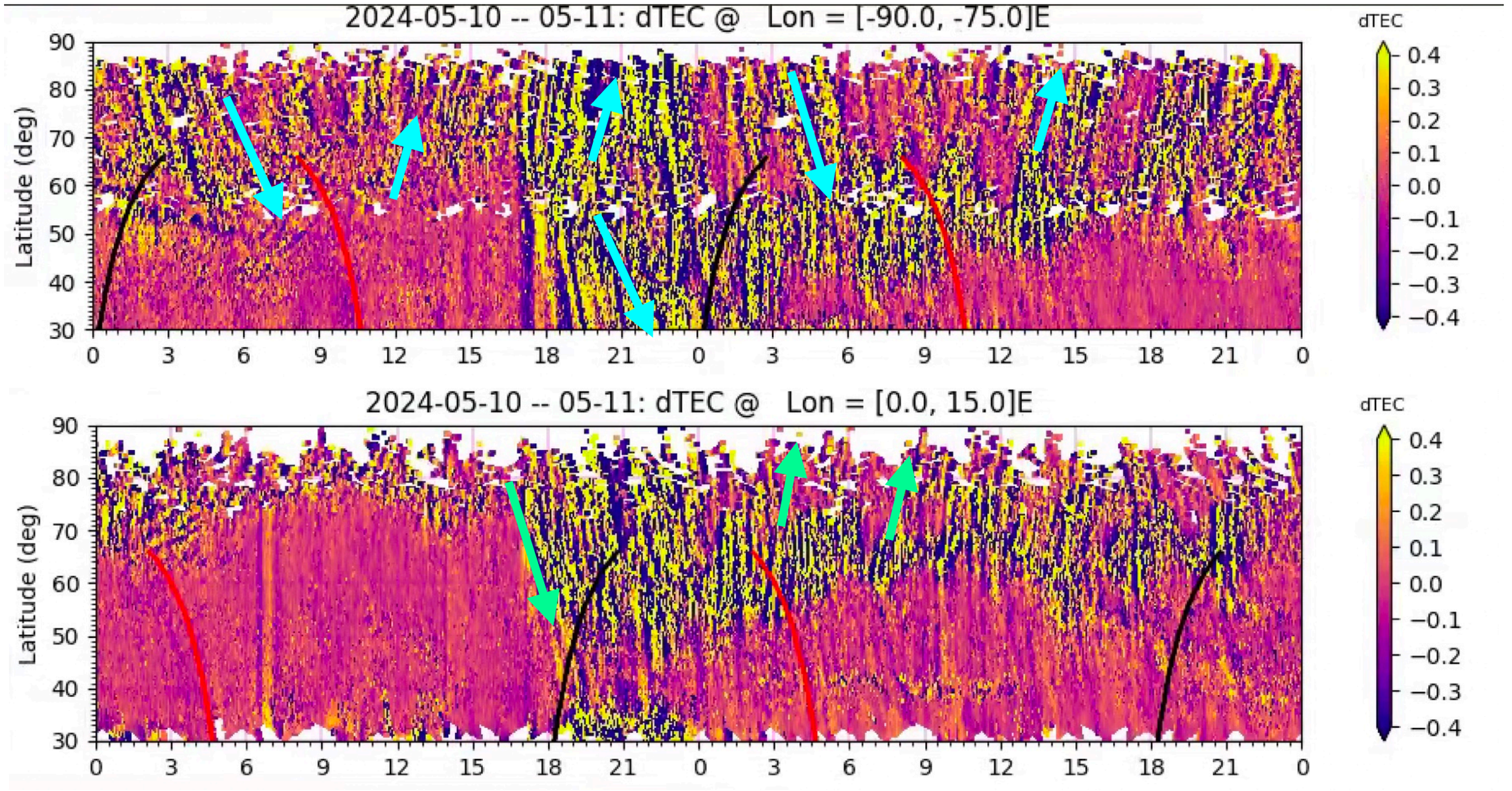
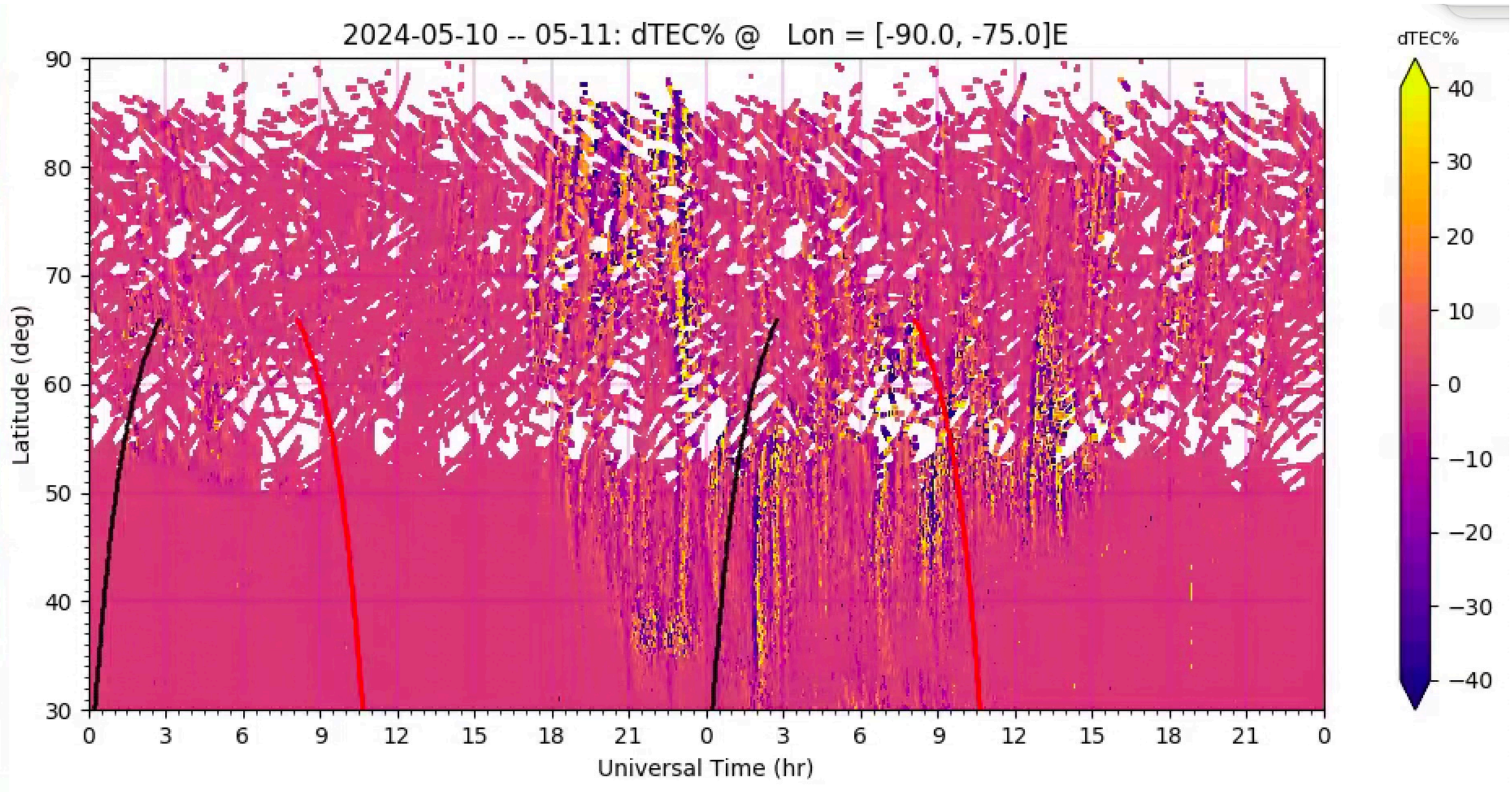
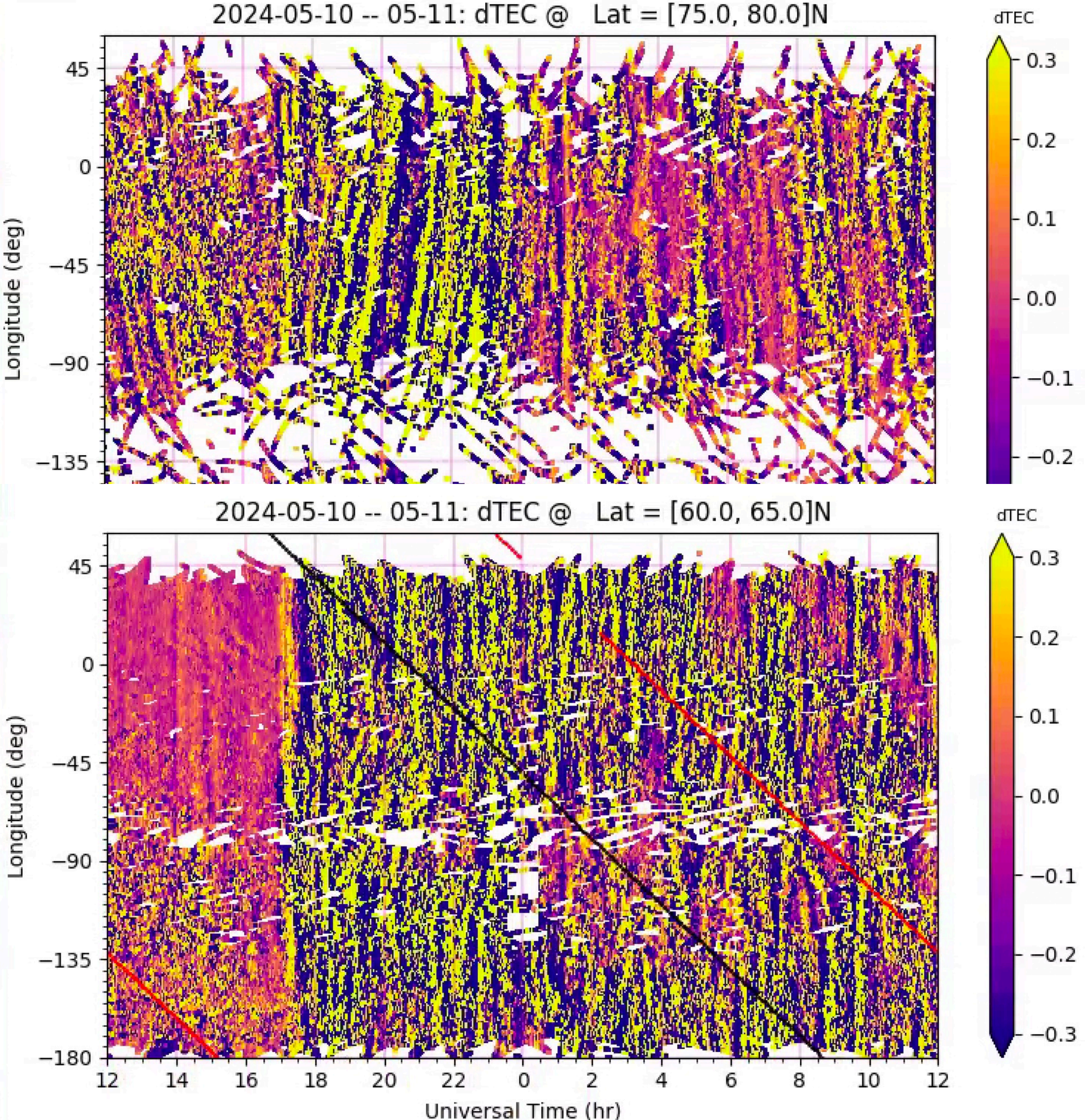
HAYSTACK
OBSERVATORY

Transpolar TIDs



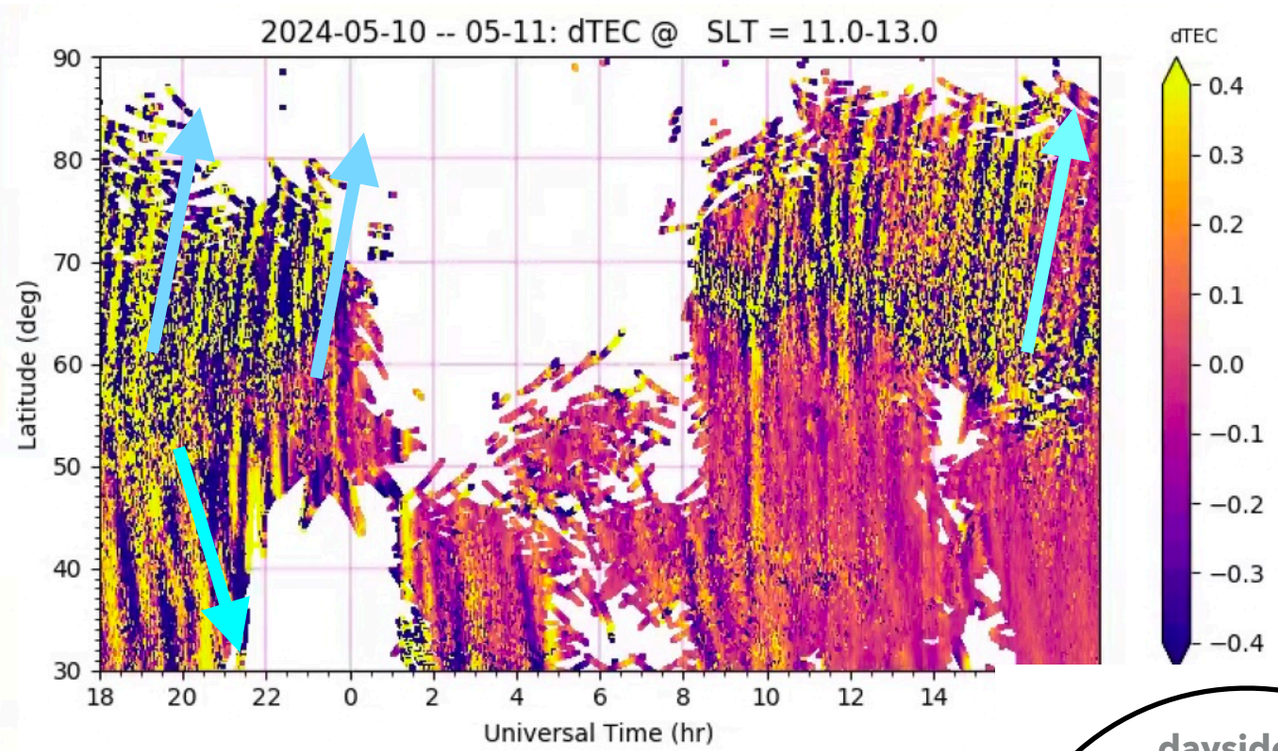
Transpolar TIDs: % Deviation



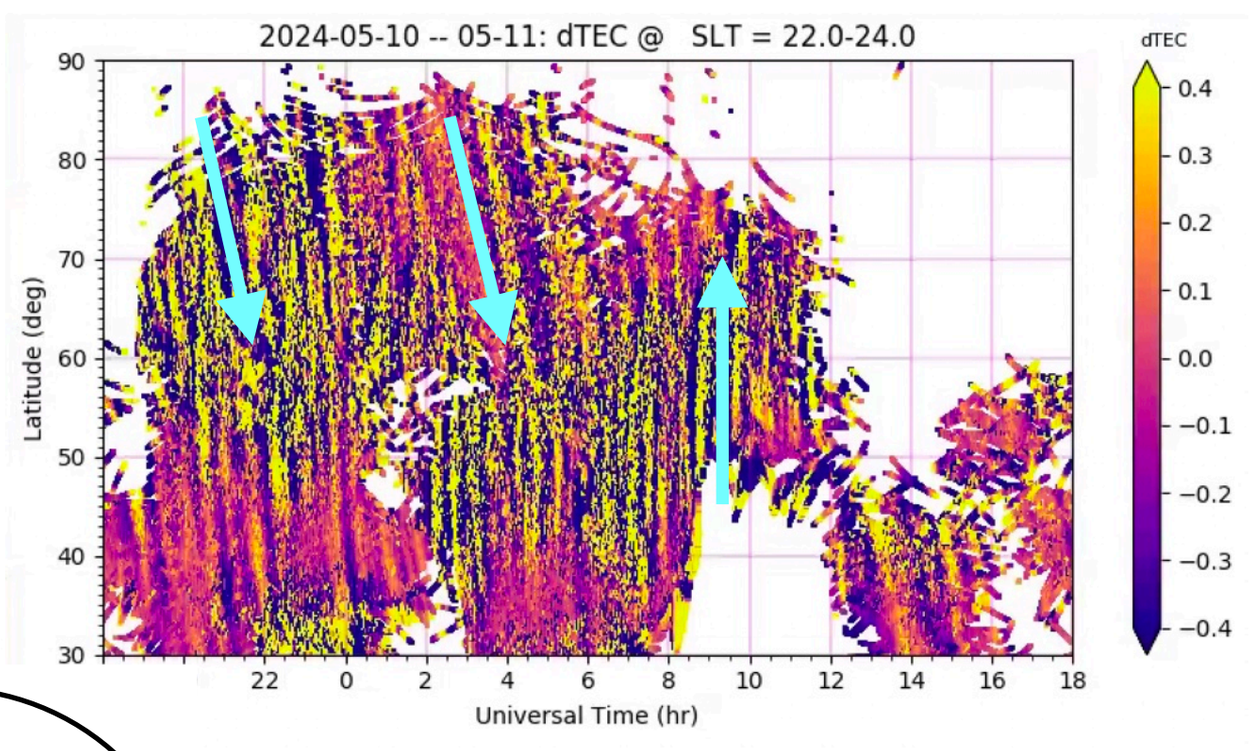

2024-05-10 -- 05-11: dTEC @ Lat = [75.0, 80.0]N
Longitude (deg)
45
0
−45
−90
−135
dTEC
0.3
0.2
0.1
0.0
−0.1
−0.2
2024-05-10 -- 05-11: dTEC @ Lat = [60.0, 65.0]N
Longitude (deg)
45
0
−45
−90
−135
−180
12
14
16
18
20
22
0
2
4
6
8
10
12
Universal Time (hr)
dTEC
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3

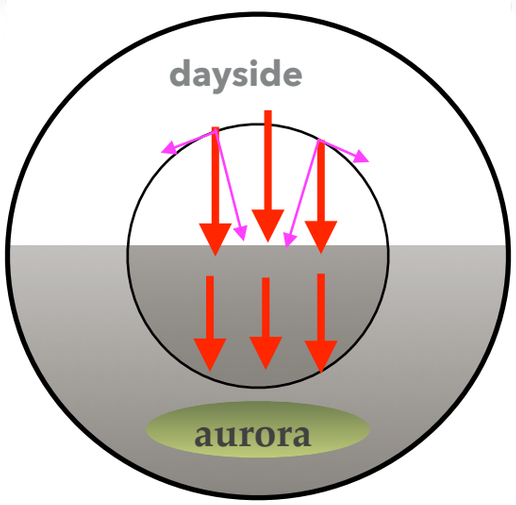
Transpolar TIDs (at Noon and Midnight Sectors)

noon

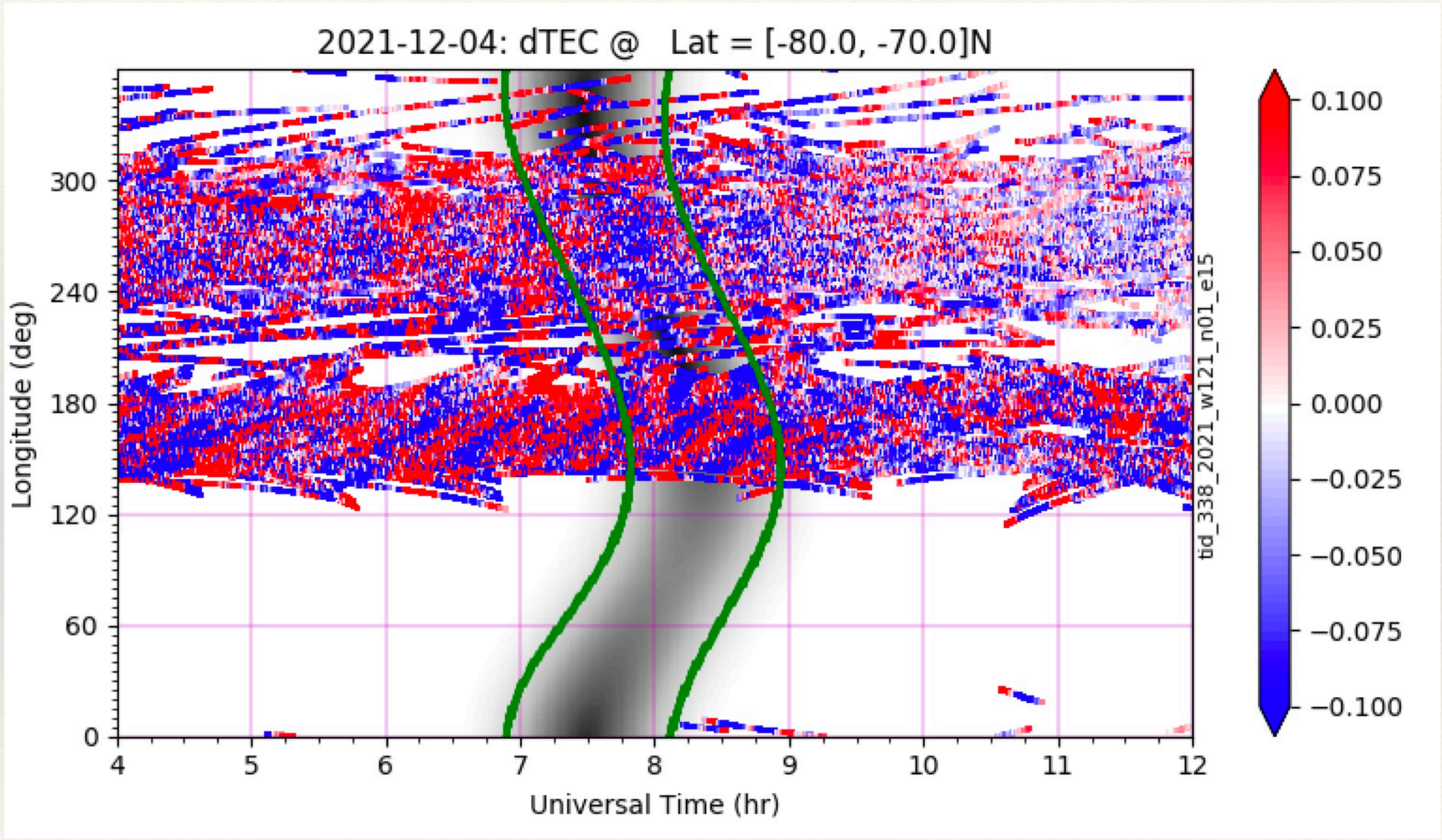


midnight





MIT HAYSTACK OBSERVATORY



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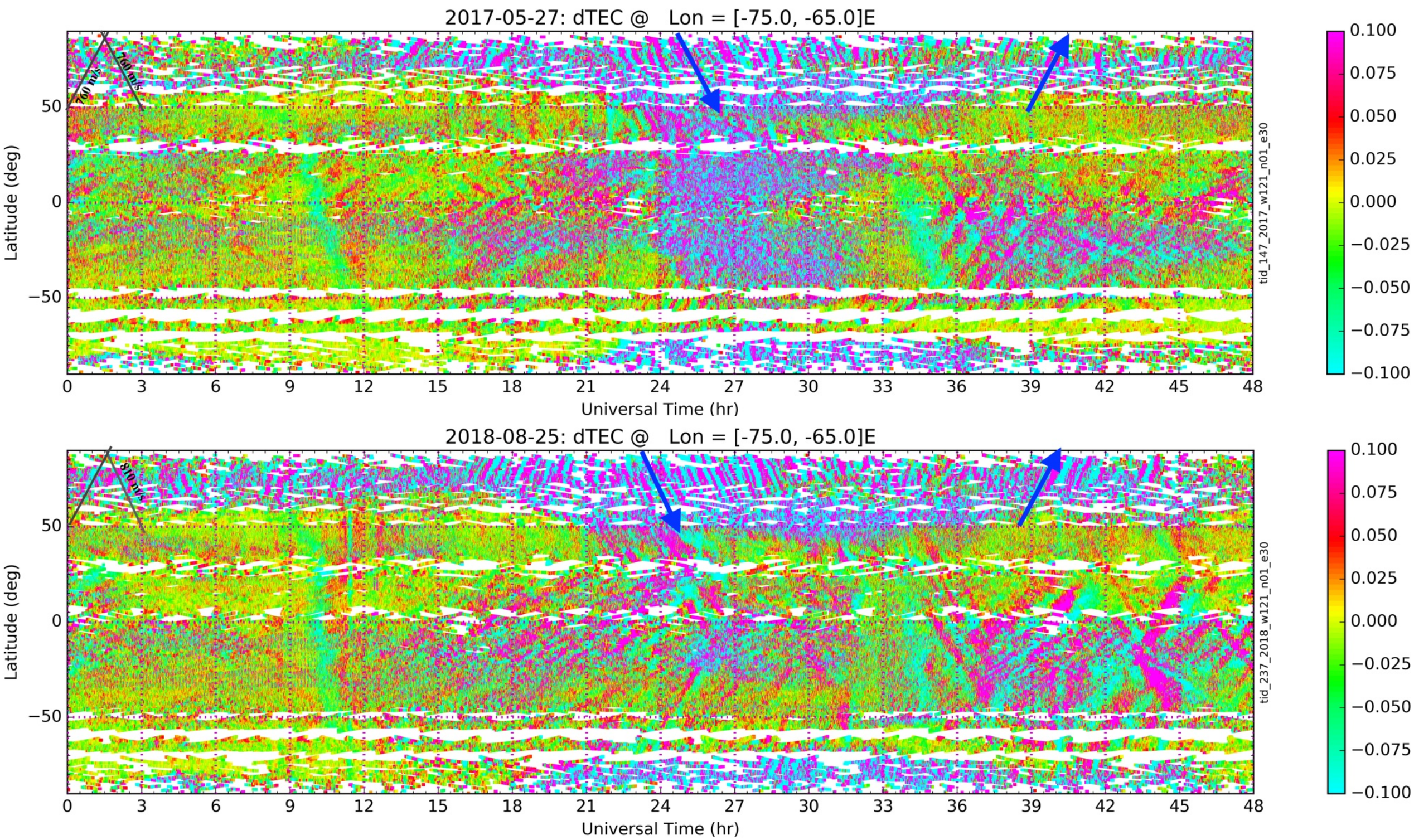
HAYSTACK
OBSERVATORY



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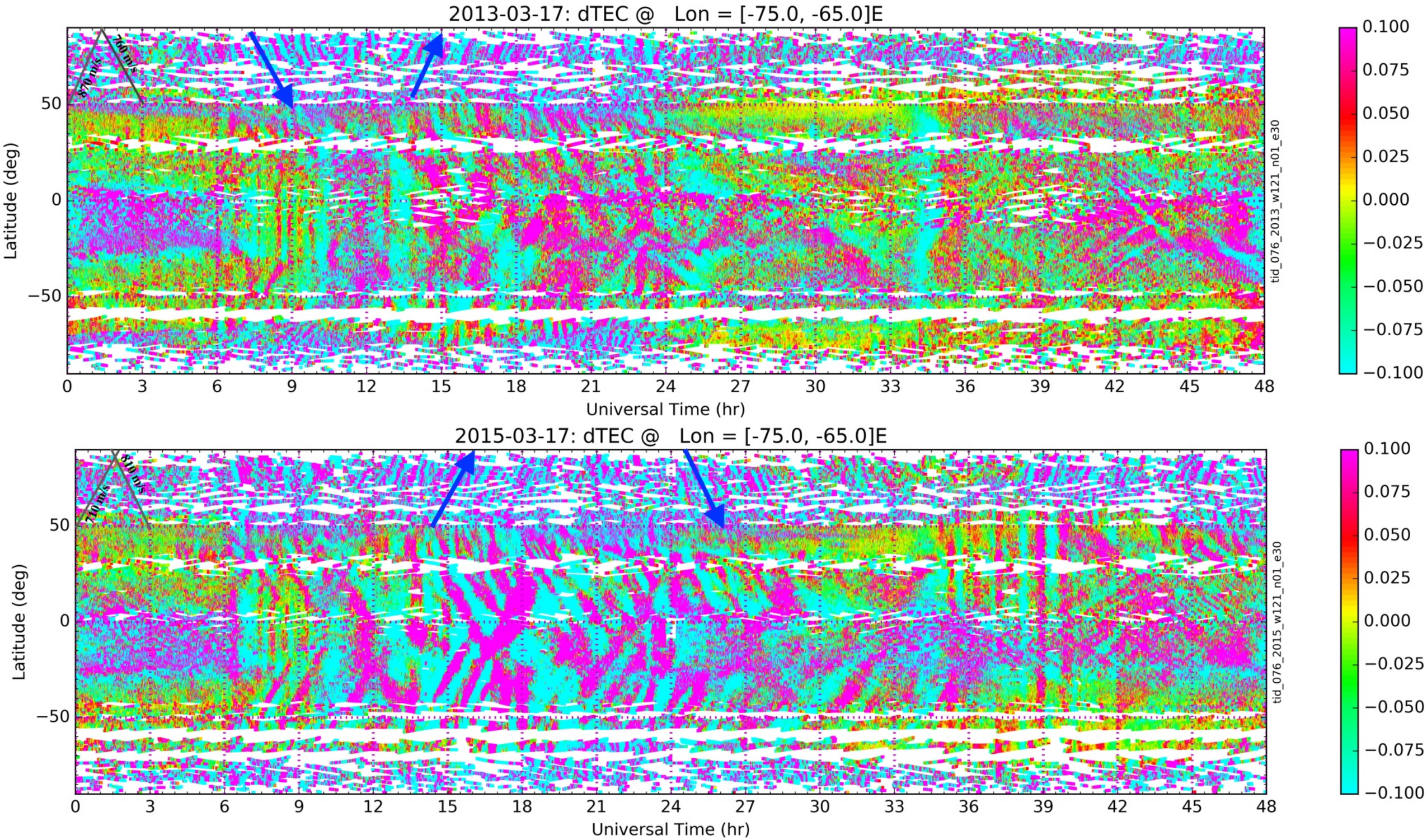
HAYSTACK
OBSERVATORY

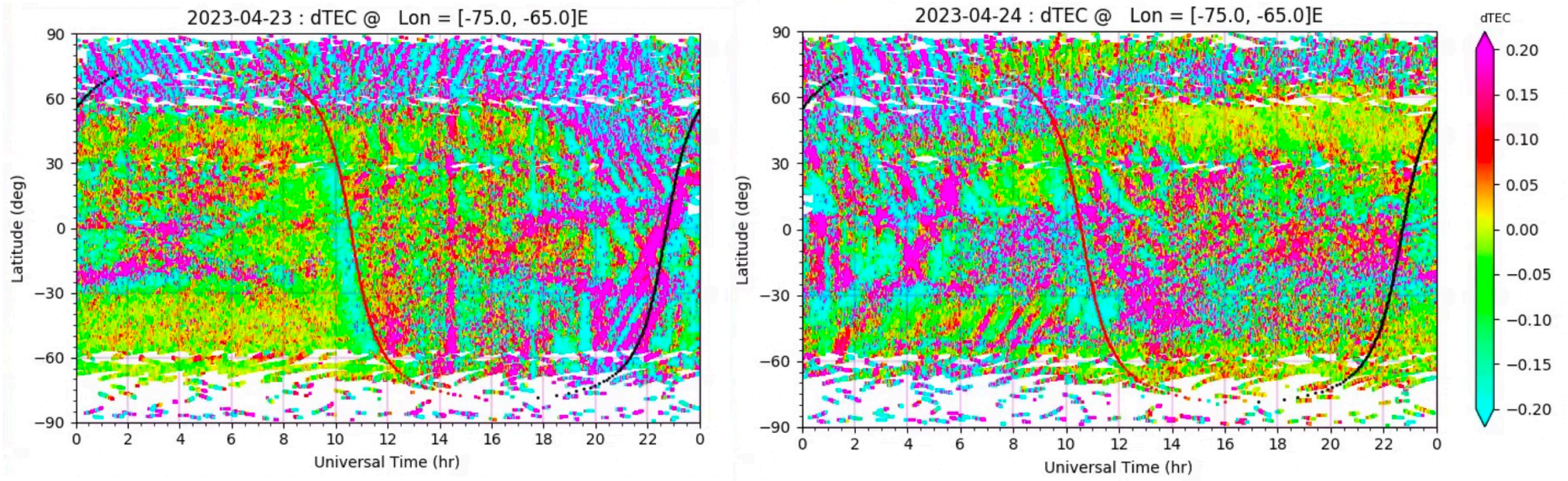
Massachusetts
Institute of
Technology

More cases



MIT HAYSTACK OBSERVATORY

Massachusetts Institute of Technology



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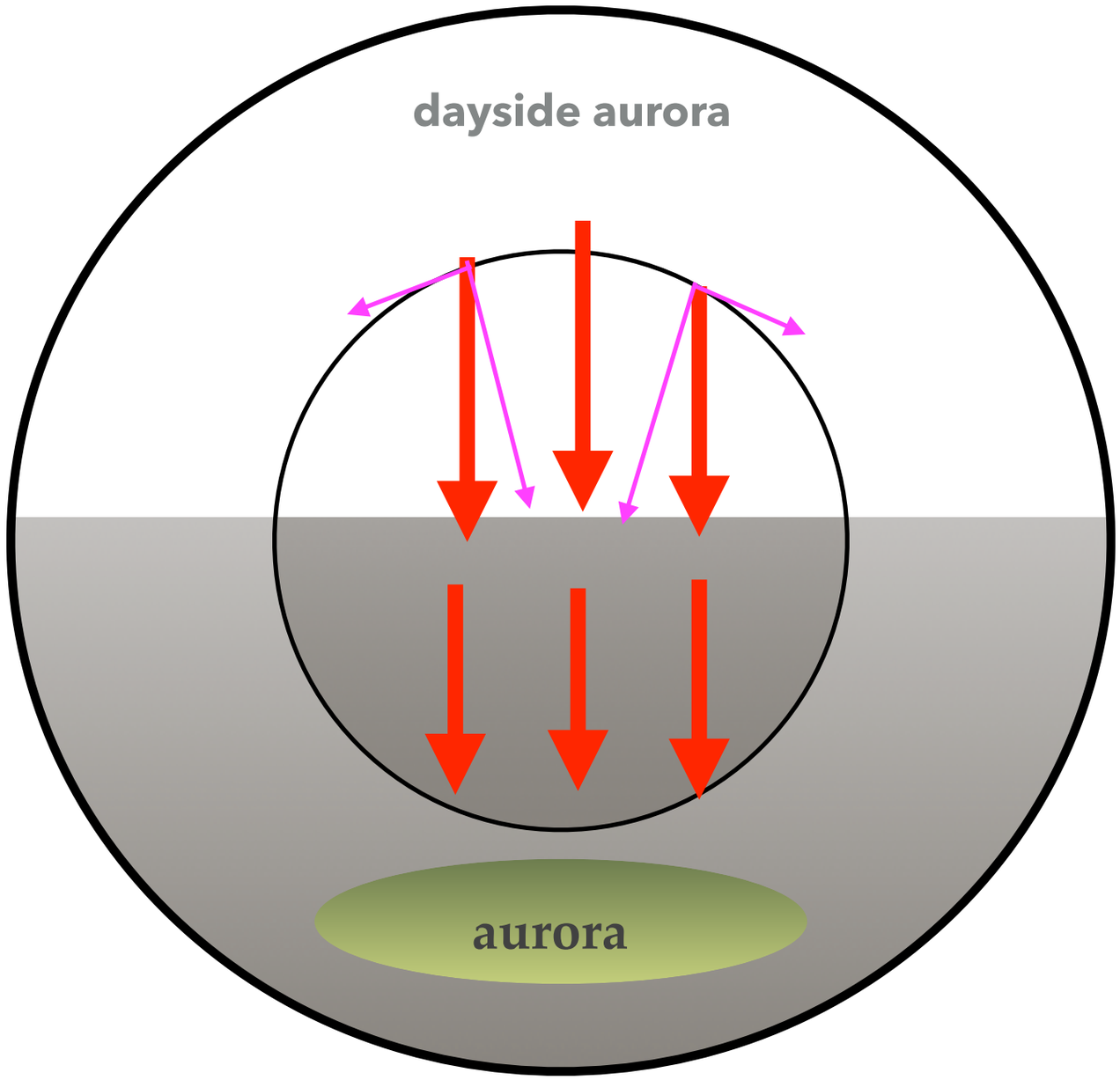
OBSERVATORY

Trans-polar TIDs

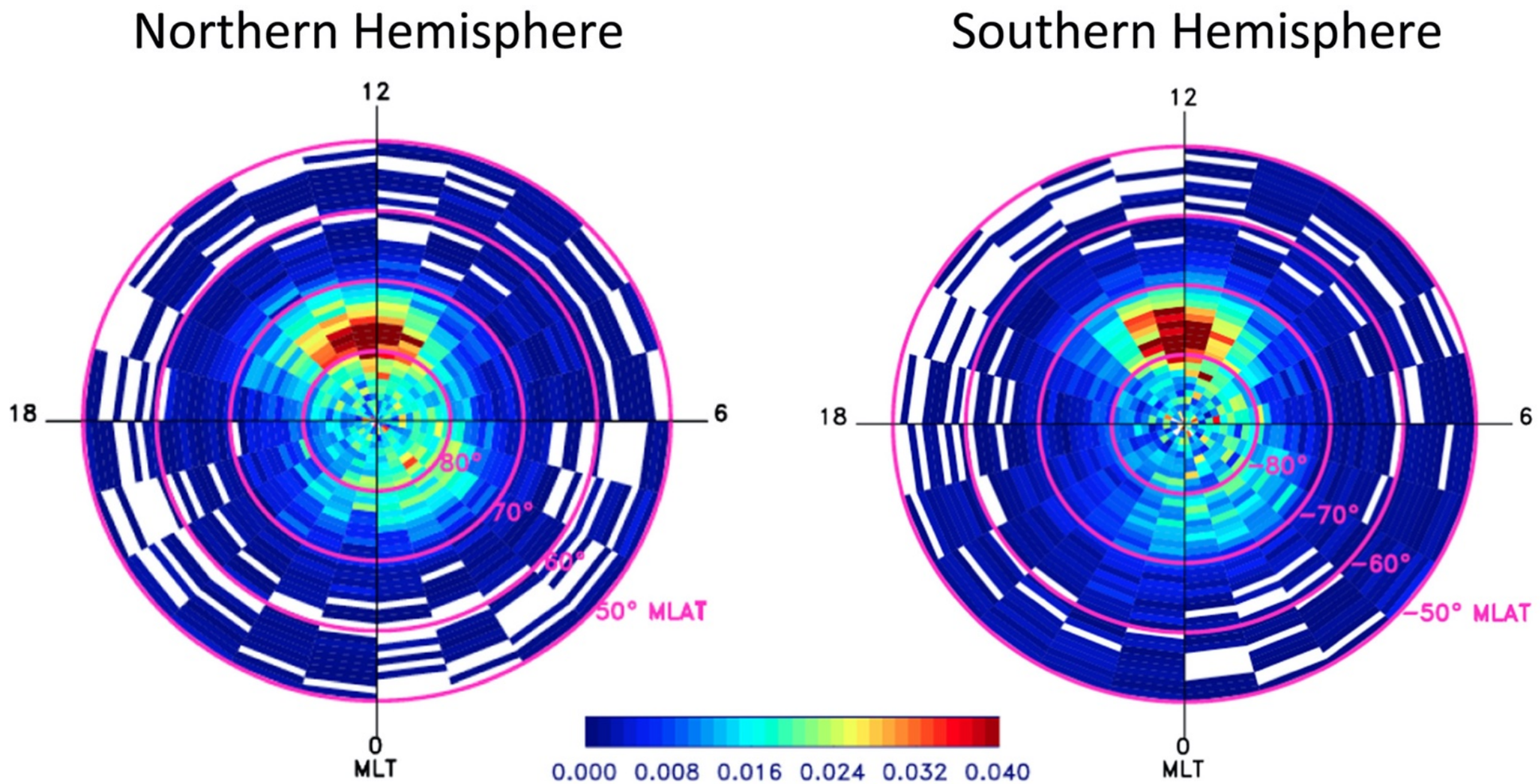


AGWs ?

Patches ?

Zhang, S.-R., Erickson, P. J., Coster, A. J., Rideout, W., Vierinen, J., Jonah, O., & Goncharenko, L. P. (2019). Subauroral and polar traveling ionospheric disturbances during the 7-9 September 2017 storms. *Space Weather*, 2019SW002325. http://doi.org/10.1029/2019SW002325

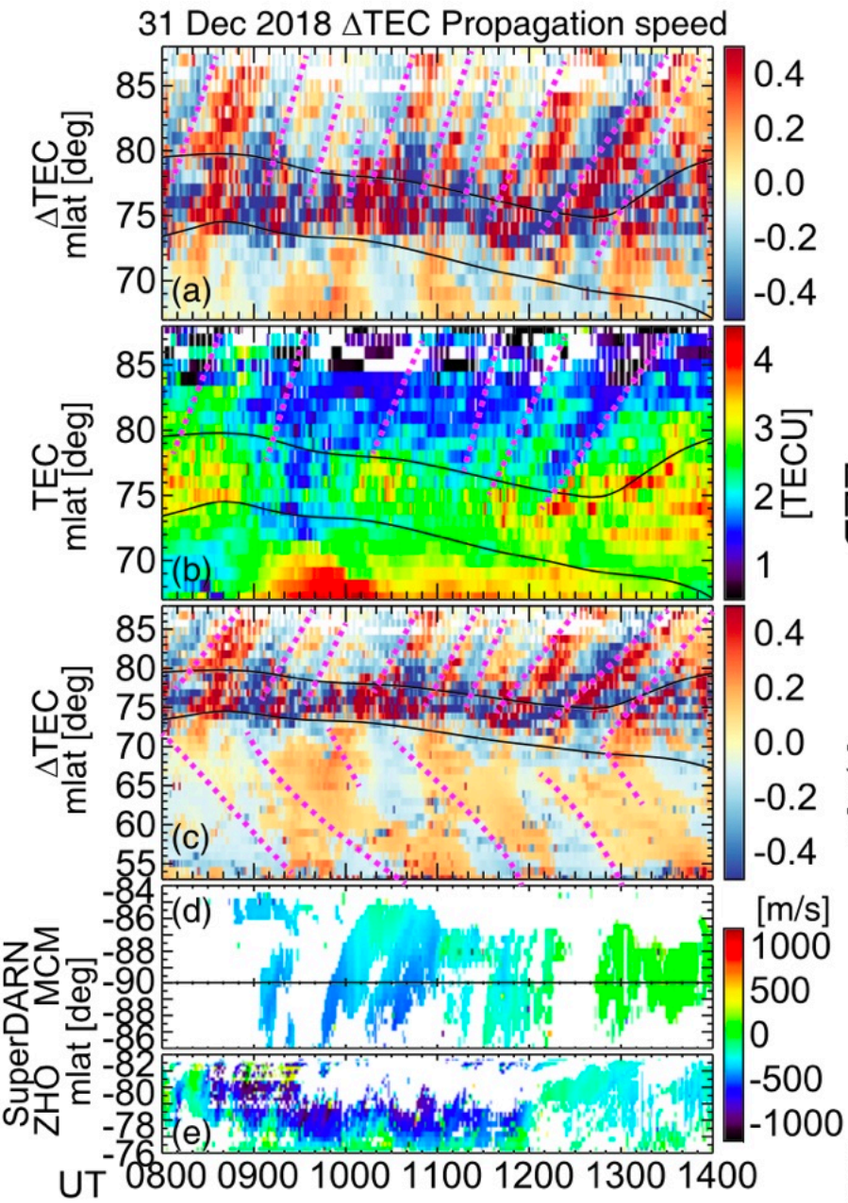
Dayside Cusp Heating (Neutral Density Climatology)

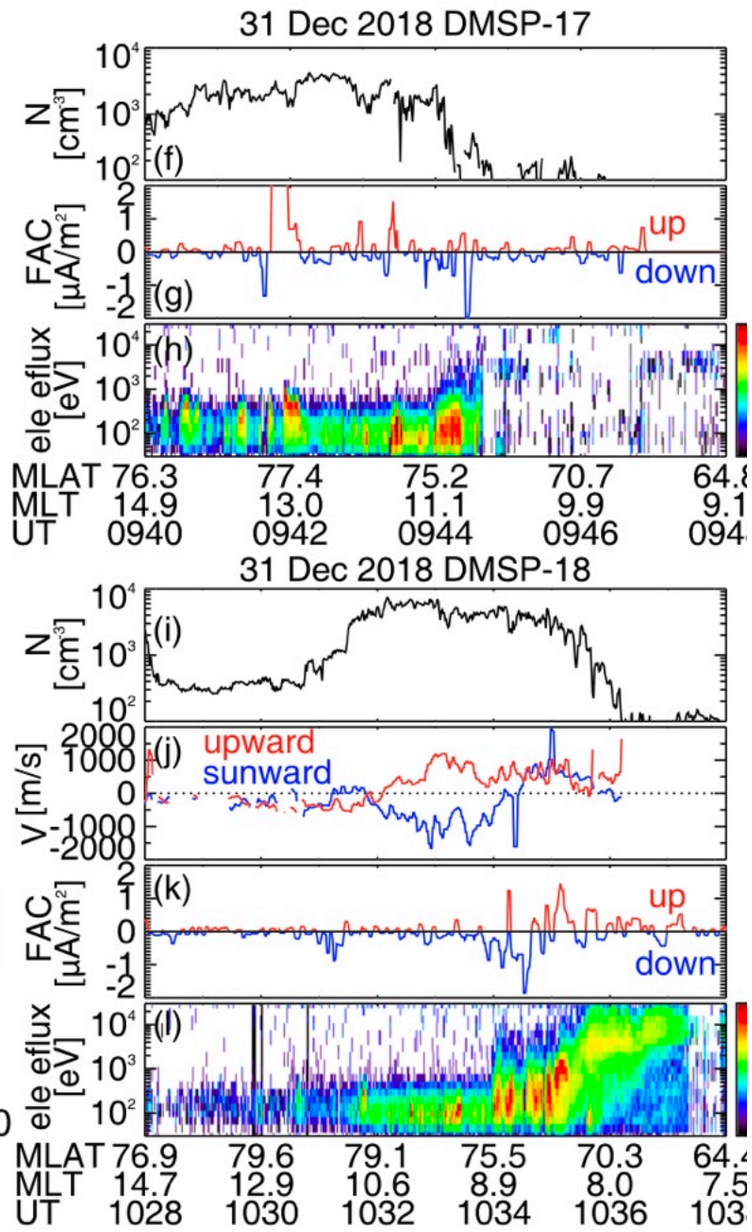


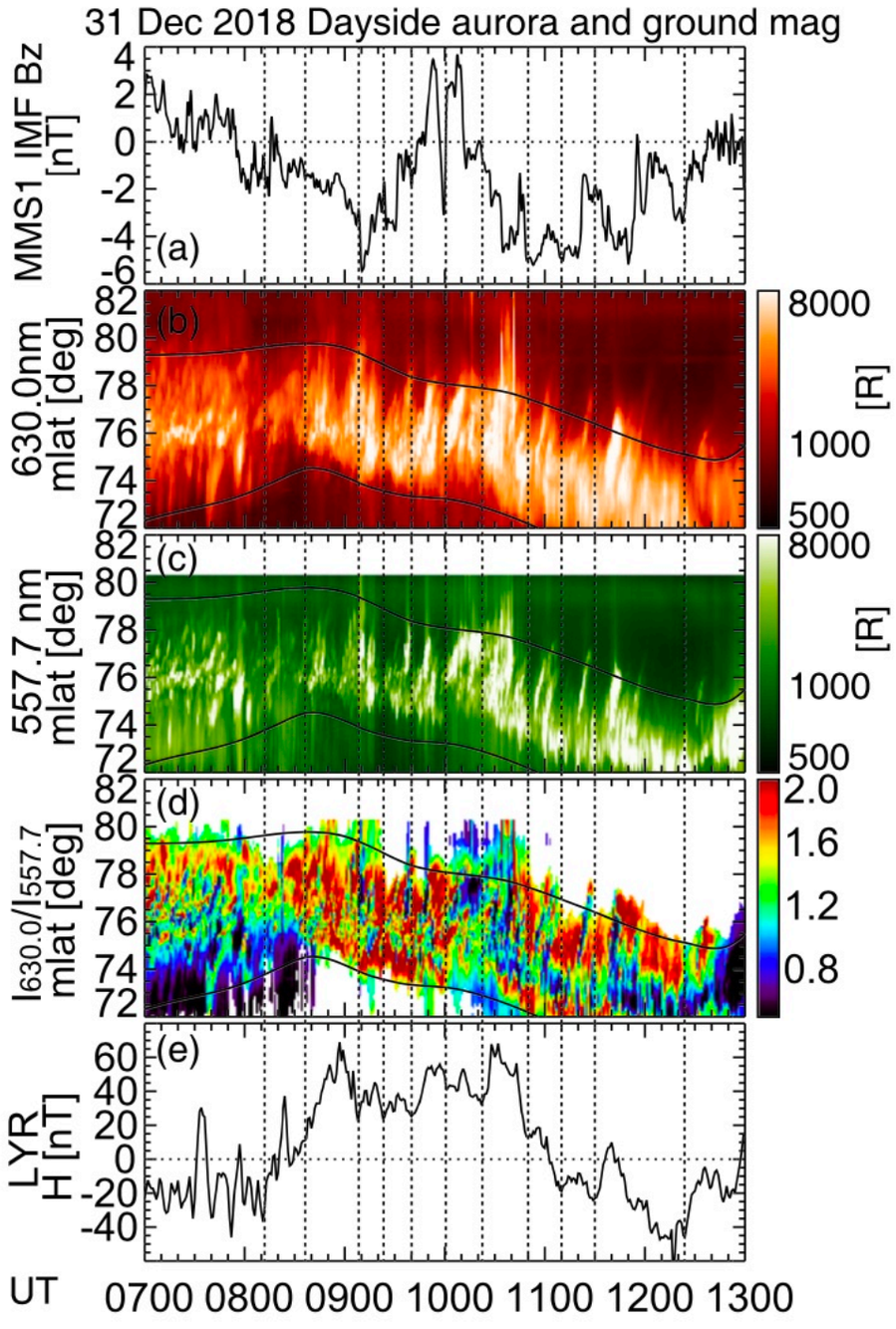
the spatial distribution of the normalized CHAMP neutral mass density maxima over the mission lifetime. the bin-normalized maxima as polar plots for both hemispheres, with the NH at left and SH at right

Huang, C. Y., Huang, Y., Su, Y.-J., Huang, T., & Sutton, E. K. (2017). High-latitude neutral mass density maxima. *Journal of Geophysical Research: Space Physics*, 122, 10,694– 10,711. https://doi.org/10.1002/2017JA024334

Polar Cap Patches Scenario







Nishimura, Y., Zhang, S.-R., Lyons, L. R., Deng, Y., Coster, A. J., Moen, J. I., et al. (2020). Source Region and Propagation of Dayside Large-Scale Traveling Ionospheric Disturbances. *Geophyical Research Letters, 47*(19), 619.

MIT HAYSTACK OBSERVATORY

Summary

- **Transpolar TIDs are frequently observed following IMF Bz southward turning**
  - Predominately anti-sunward possibly with zonal/ azimuth component
  - ~700-900 m/s speed
- Dayside auroral particles are likely associated with these TIDs
  - The dayside auroral heating may produce atmospheric heating and therefore GWs to drive transpolar TIDs?
- The reconnection related plasma patches may also convect anti-sunward causing TID-like patch dynamics.