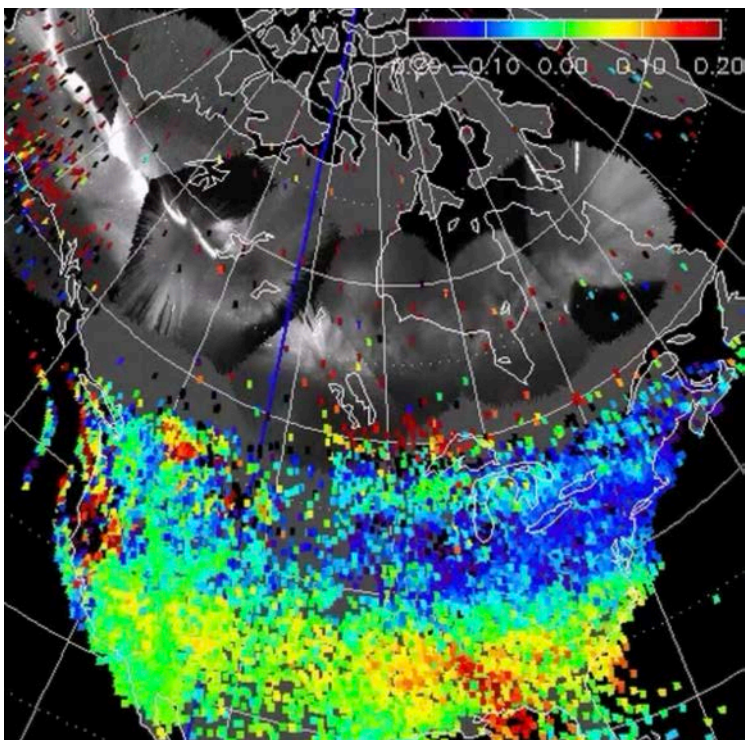
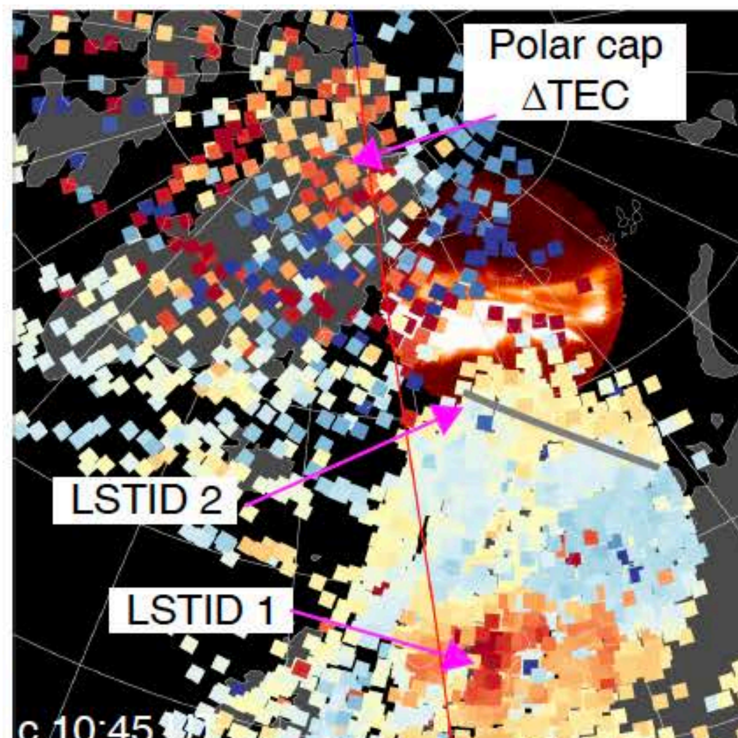
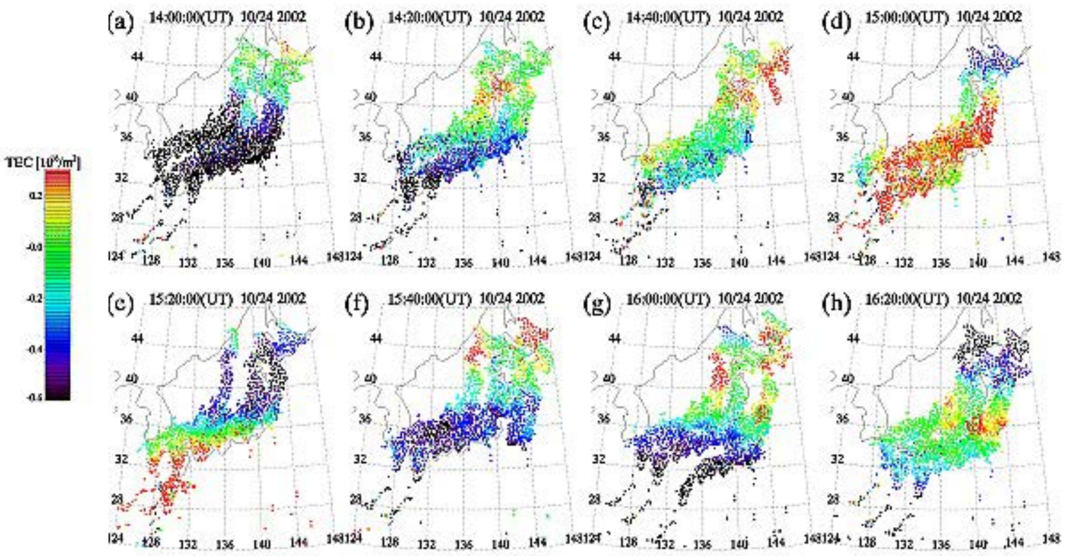
Generation and propagation of dayside and nightside LSTIDs

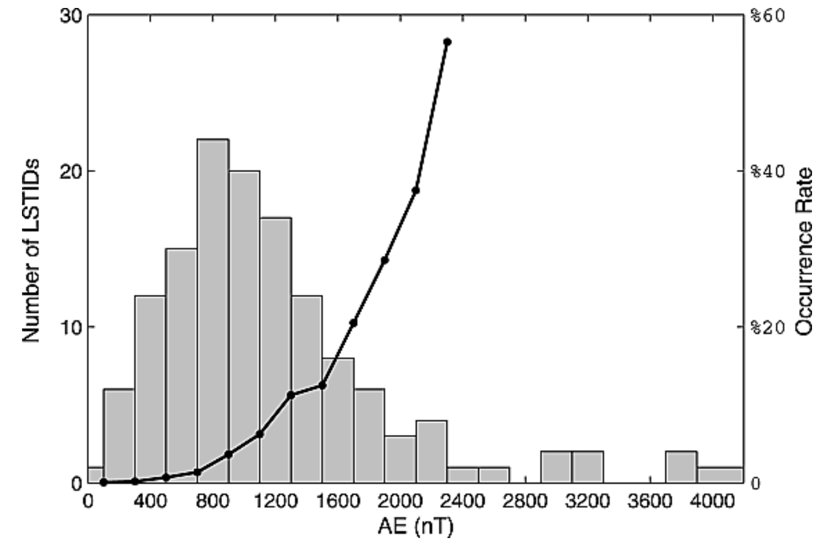
Toshi Nishimura, S. Zhang, L. Lyons, Y. Deng, A. Coster, J. Moen, L. Clausen, W. Bristow, N. Nishitani





Large-scale traveling ionosphere disturbance (LSTID)

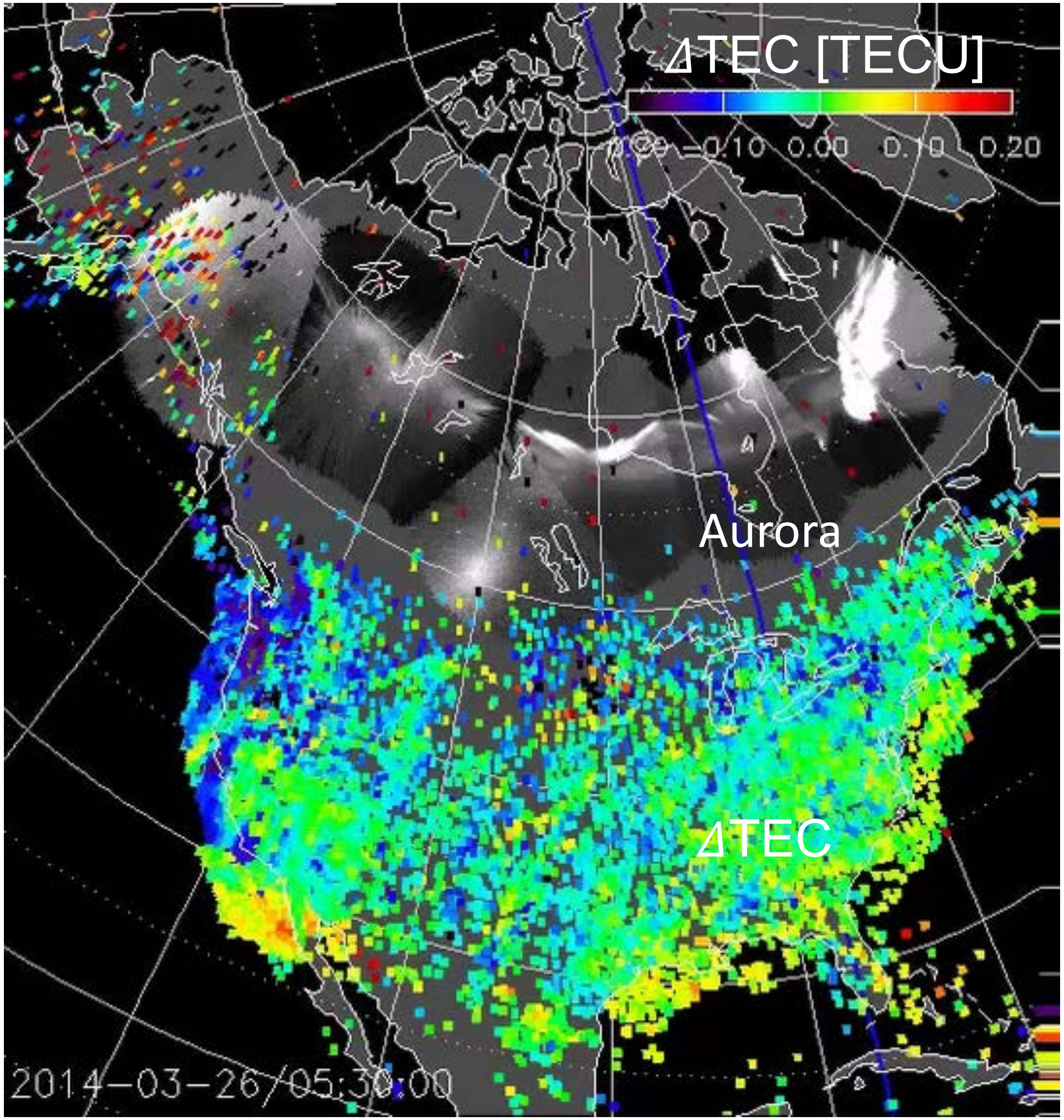




[Tsugawa et al., 2004; Ding et al., 2008]

- More frequent during high auroral activity
- Most LSTID researches use low-mid latitude data without identifying the source region.

Nightside LSTID

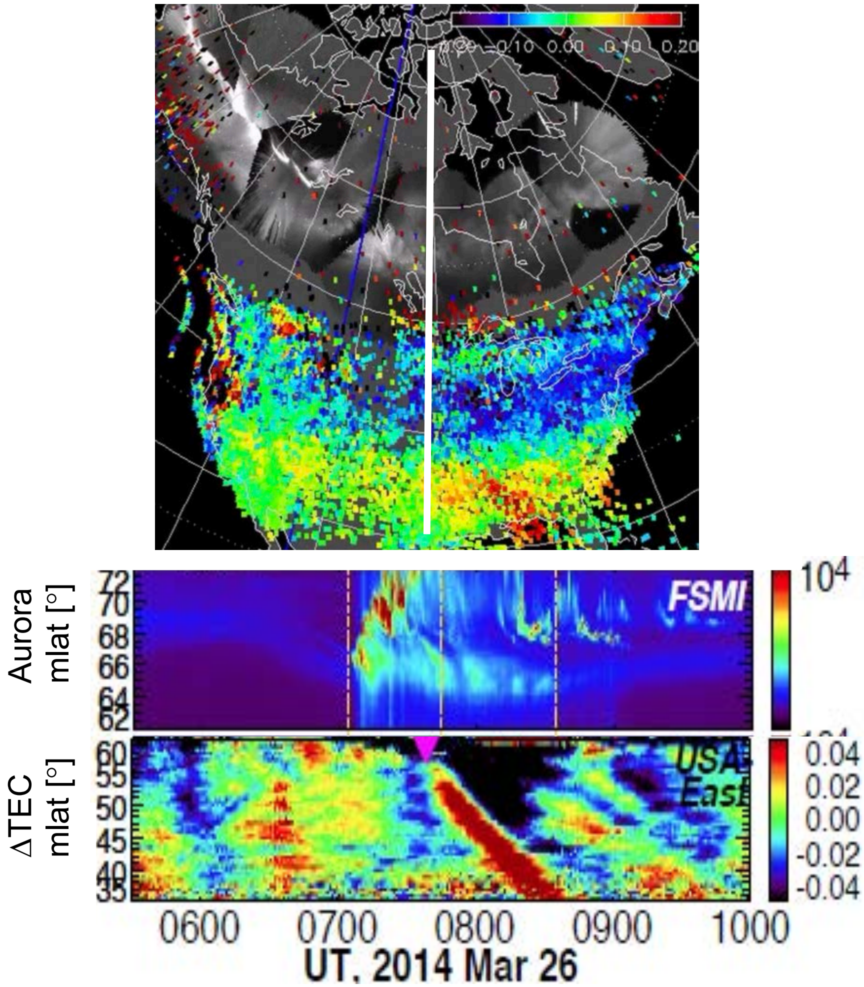


LSTID emerges out of the auroral oval after an auroral substorm.

It provides evidence that abrupt heating in the auroral oval creates LSTID.

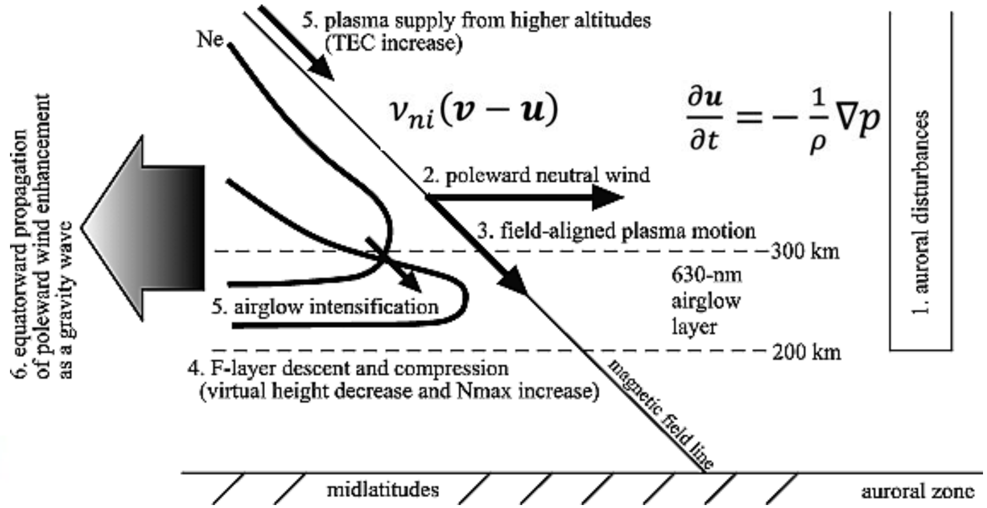
[Lyons et al., 2019]

Nightside LSTID



[Lyons et al., 2019]

Latitude-time representation of the aurora and TEC

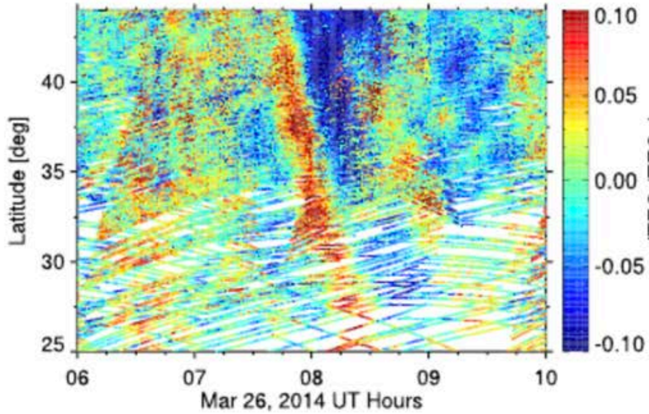


[Shiokawa et al., 2002]

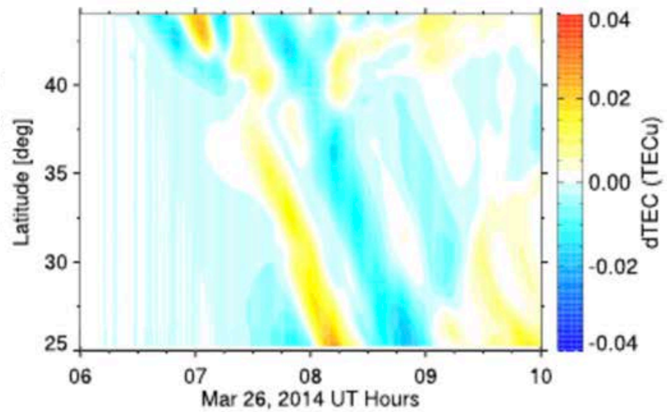
Wind enhancement propagates and oscillates plasma (traveling thermospheric disturbances: TAD)

Nightside LSTID

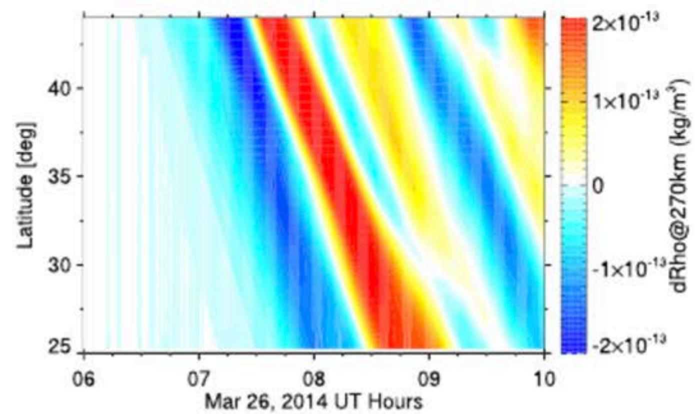
Measured **Δ**TEC



Simulated **Δ**TEC



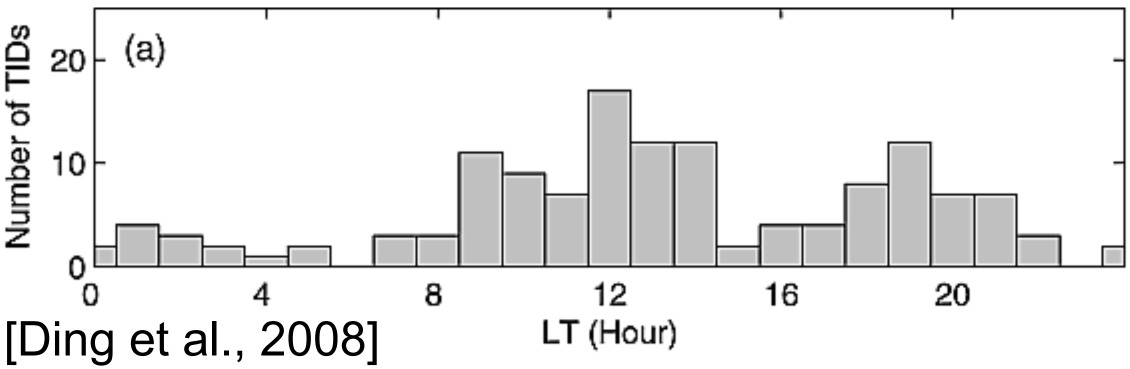
Simulated **Δ**(neutral density)



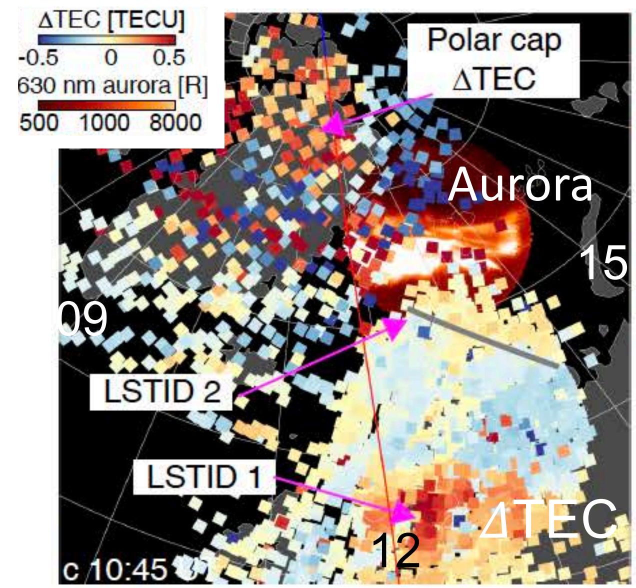
[Sheng et al., 2019]

The ionosphere-thermosphere simulation (GITM) successfully reproduced the TEC and neutral density perturbation.

Dayside LSTID



[Ding et al., 2008]



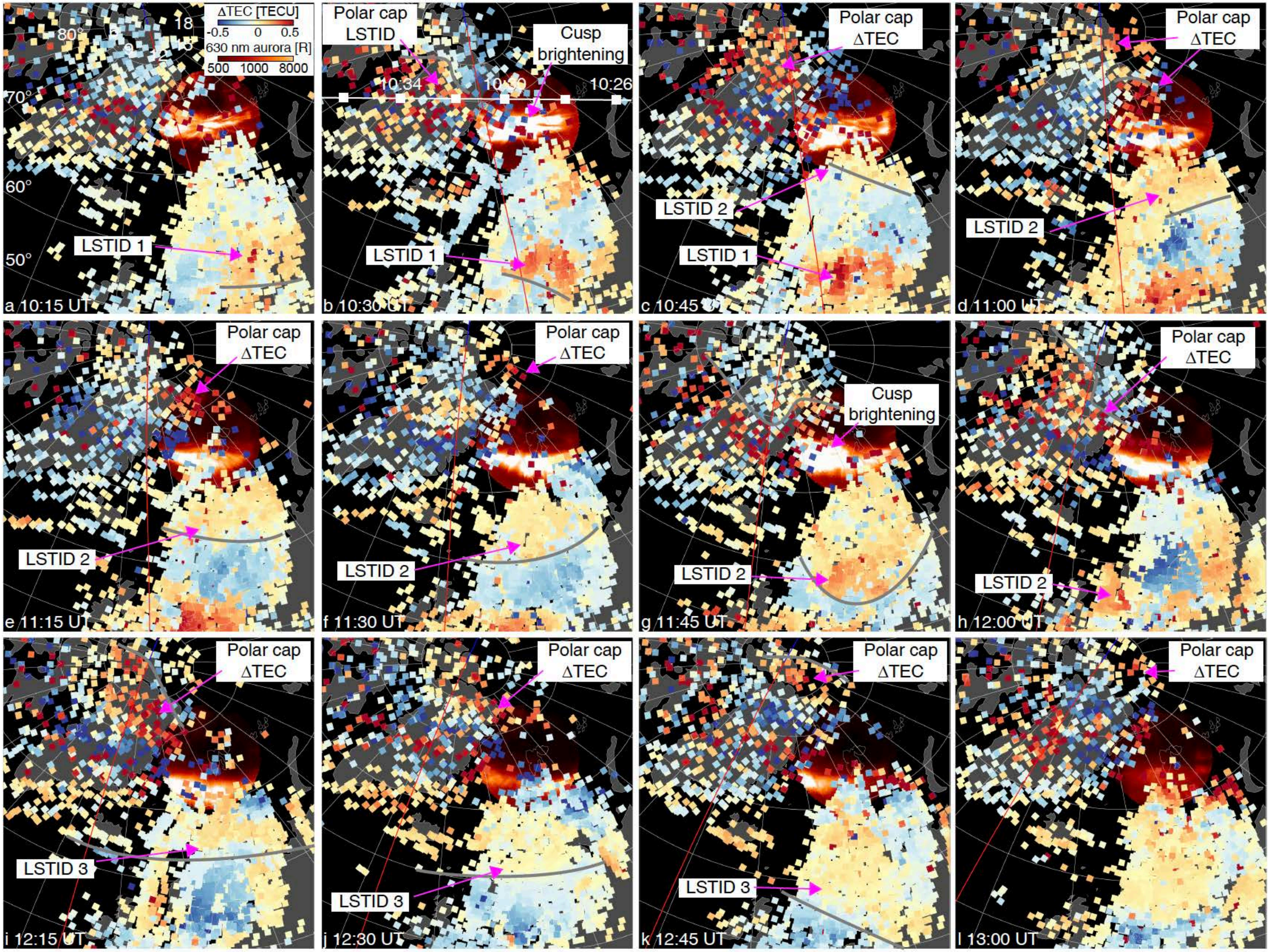
While aurora is most dynamic in the night, LSTID is most frequent near noon.

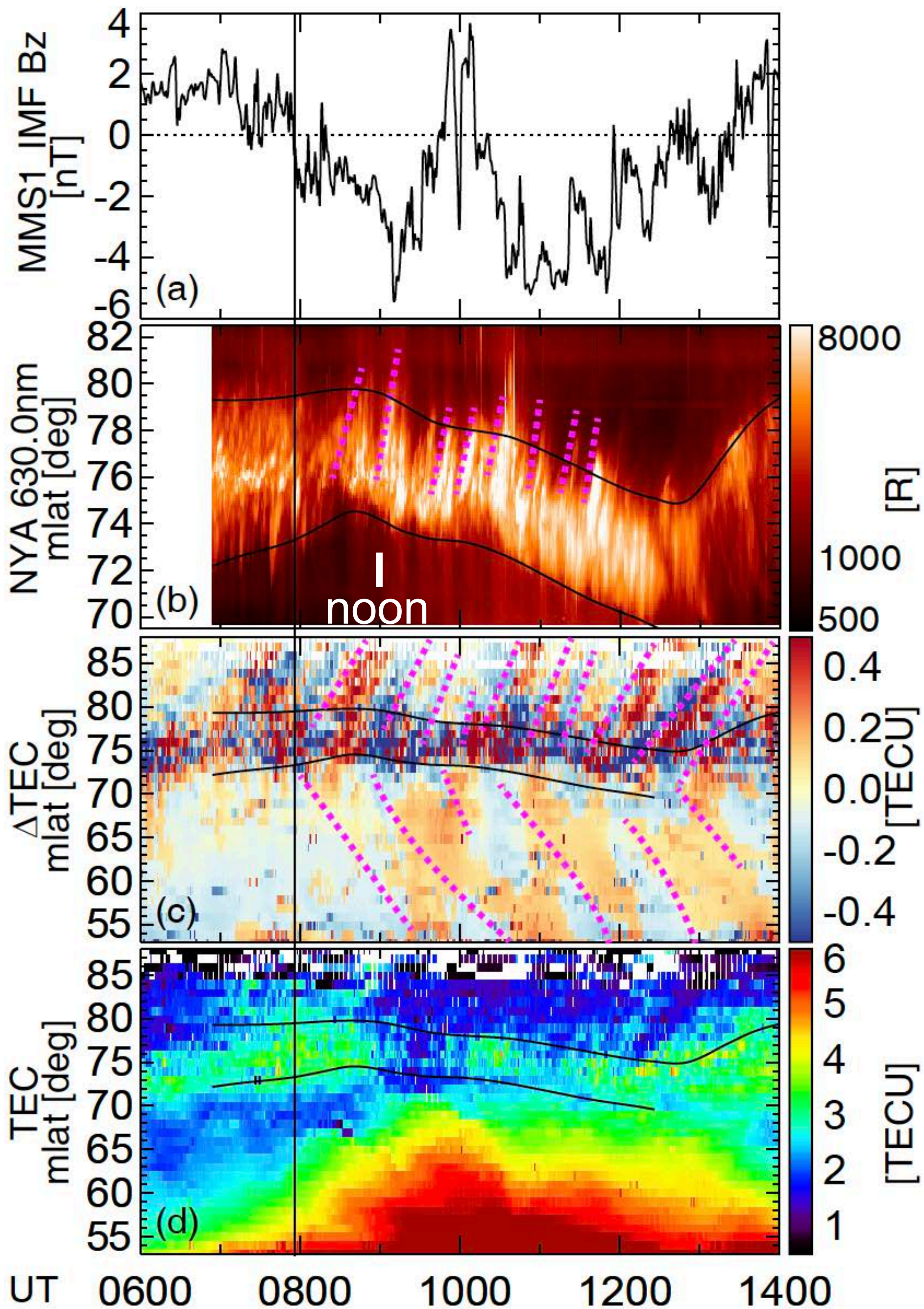
- Where is the source region of dayside LSTIDs?
  Dayside aurora or nightside aurora?
- What does determine the period of LSTIDs?
  Periodic energy input? Internal I-T processes?

We take advantage of wide coverage and high-resolution TEC and dayside auroral imaging.

2-d evolution of dayside aurora and ΔTEC

31 Dec 2018





Time series

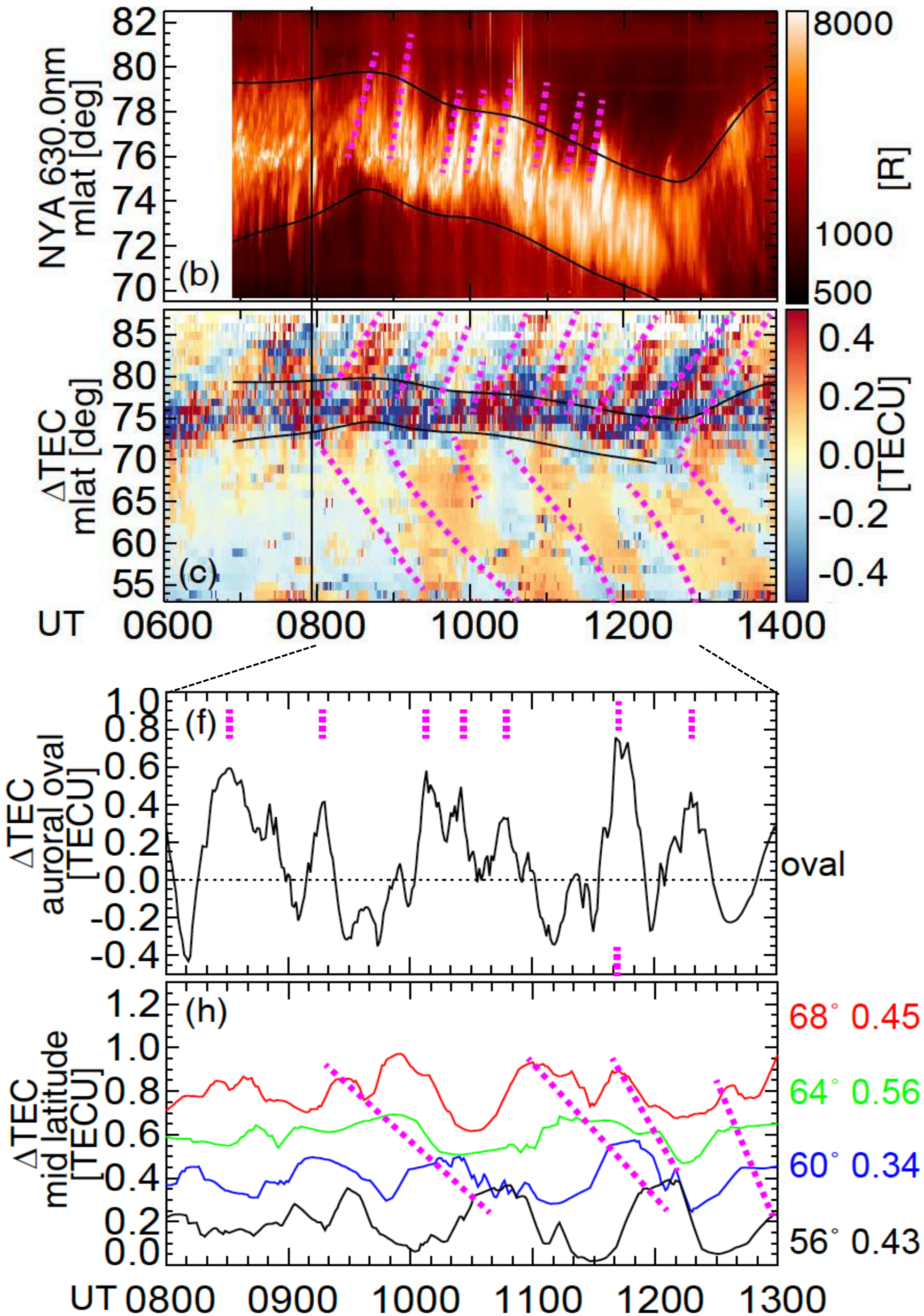
IMF southward turning

Dayside auroral (cusp) quasi-periodic brightening and PMAFs

LSTIDs were generated in the dayside auroral oval. Propagating both poleward and equatorward.

Likely driven by enhanced energy input during southward IMF.

[Nishimura et al., 2020]



Equatorward propagation

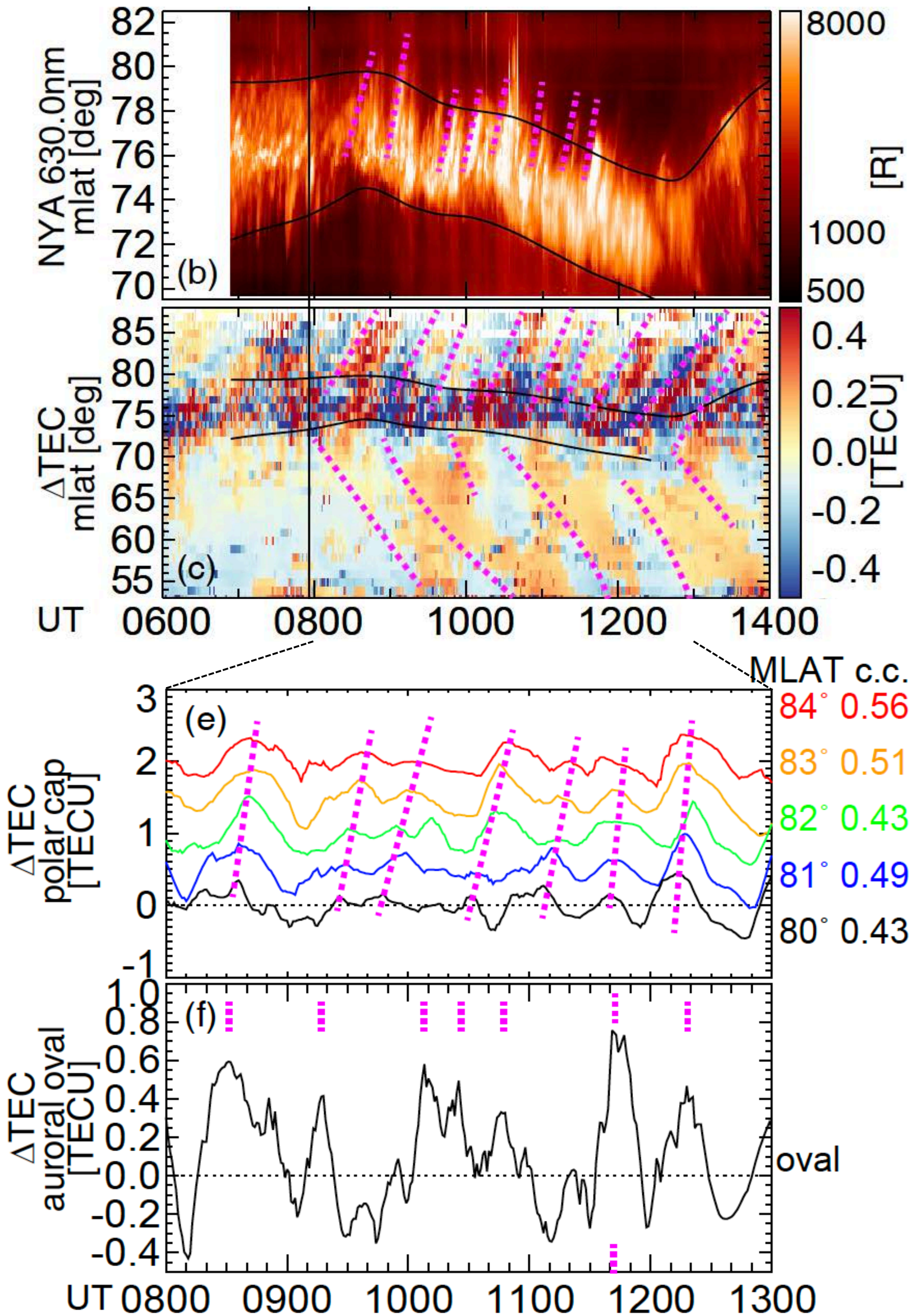
LSTIDs originate near the oval equatorward boundary and propagate equatorward.

Correlating with the major TEC enhancements in the auroral oval.

Dayside auroral heating creates LSTID.

Dayside aurora lasts long and occurs frequently, giving high occurrence of dayside LSTID.

Poleward propagation

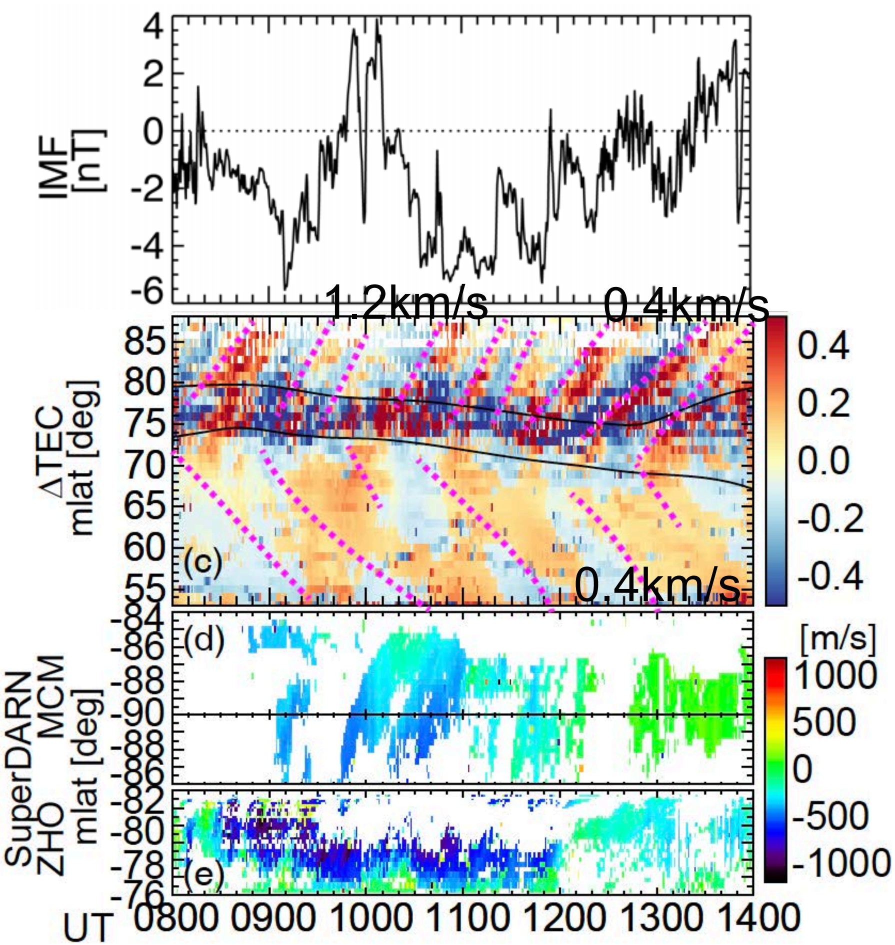


Most ΔTEC pulses have corresponding PMAFs.

Quasi-periodic electron precipitation creates rapid TEC enhancements, which propagate poleward.

The period varies. Not coherent oscillation but driven by variable auroral forcing.

Relation to plasma flow



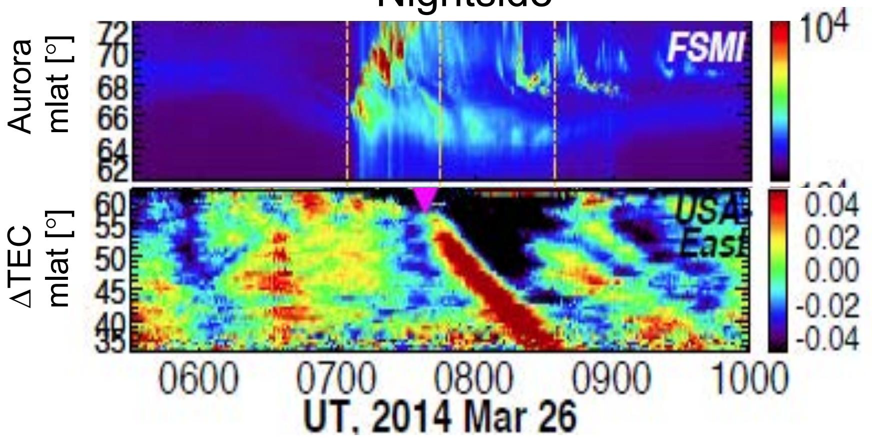
The poleward plasma flow (negative radar Doppler velocity) weakened when the IMF turned northward.

The equatorward-propagating *Δ*TEC is unaffected and against convection. Consistent with thermospheric gravity waves.

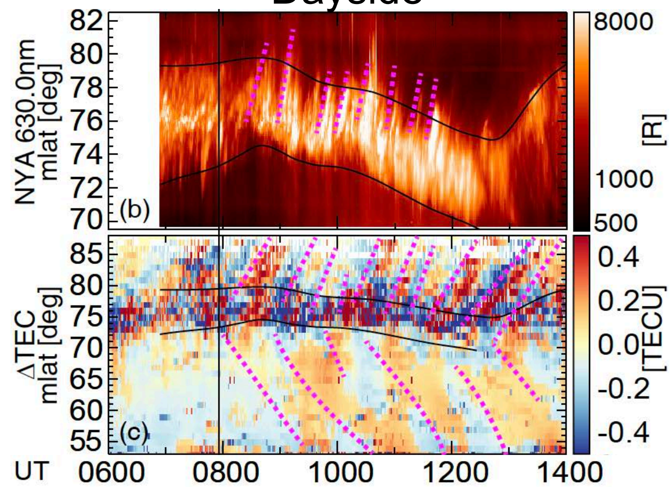
The poleward-propagating *Δ*TEC slowed down. Follows the convection speed.

Summary

Nightside

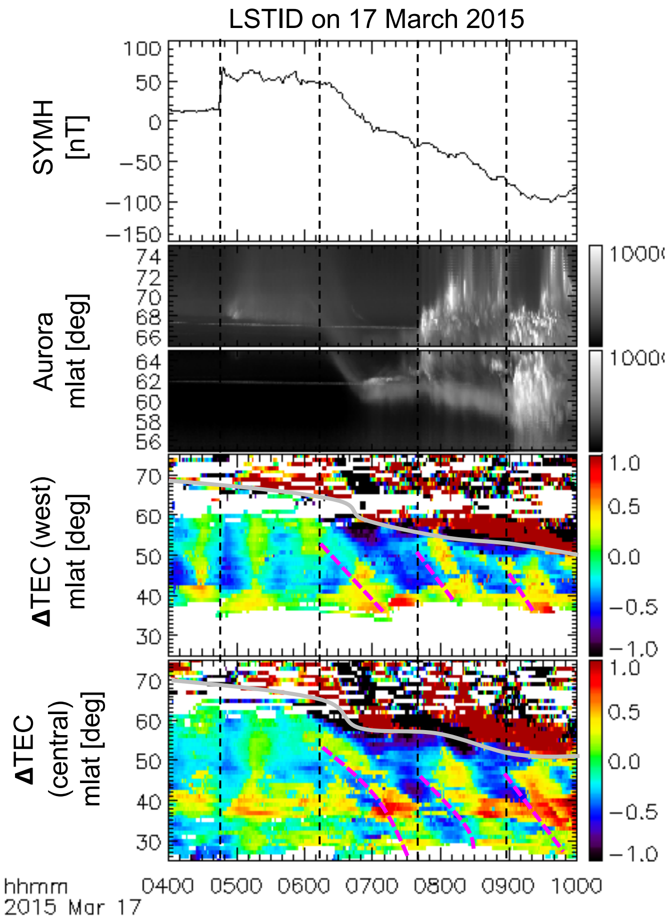


Dayside



- We investigated the source and propagation of nightside and dayside LSTID events using TEC and auroral imaging.
- **Nightside**: Strongly related to auroral activity. Driven by auroral heating. LSTID.
- **Dayside mid-latitude**: Related to major auroral activity. LSTID.
- **Dayside polar cap**: Related to each auroral activity. ExB?

Questions



- Is nightside LSTID caused by auroral heating [Shiokawa et al., 2002] or subauroral heating [Zhang et al., 2017; Guo et al., 2018]?
  - It is difficult to separate in TEC data.
  - Satellite-dependent biases exist.
- How do we understand longitude and latitude dependent propagation?
  - Neutral temperature, coupling to E-region,
  - Vertical propagation
- How much do ExB and TAD contribute to polar cap *Δ*TEC?
- How much do TID/TAD contribute to momentum and transfer in the ionosphere-thermosphere system?