



# Thermospheric Densities and Ionospheric Conditions During the Starlink Destruction Event

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# Background - A (not so) friendly atmosphere

February 2022

The screenshot shows a news article from Reuters' Commodities News section. The headline reads "Solar storm disables 40 newly launched SpaceX satellites". It was written by Steve Gorman and published on February 9, 2022. The article indicates a 3-minute read time and includes social sharing icons for Facebook and Twitter.

REUTERS

COMMODITIES NEWS FEBRUARY 9, 2022 / 11:57 AM / UPDATED 9 MONTHS AGO

Solar storm disables 40 newly launched SpaceX satellites

By Steve Gorman

3 MIN READ [f](#) [t](#)

The screenshot shows a news article from SpaceNews. The headline reads "Dozens of Starlink satellites from latest launch to reenter after geomagnetic storm". It was written by Jeff Foust and published on February 9, 2022.

SPACENEWS

Dozens of Starlink satellites from latest launch to reenter after geomagnetic storm

by Jeff Foust — February 9, 2022

The screenshot shows a tweet from Michael Sheetz (@thesheetztweetz). The tweet includes a video link and a confirmation source. The video shows several bright streaks against a dark background, likely representing satellites reentering the atmosphere.

Michael Sheetz @thesheetztweetz

A few of the Starlink satellites were spotted burning up on reentry above Puerto Rico on Feb. 7:

Video source: [youtube.com/watch?v=a7KUSN...](https://youtube.com/watch?v=a7KUSN...) and confirmation:

The screenshot shows a news article from CNBC. The headline reads "SpaceX to lose as many as 40 Starlink satellites due to space storm". It was published on Wednesday, February 9, 2022, at 10:53 AM EST and updated at 6:42 PM EST.

CNBC

MARKETS BUSINESS INVESTING TECH POLITICS CNBC TV INVESTING CLUB & PRO MAKE IT

INVESTING IN SPACE

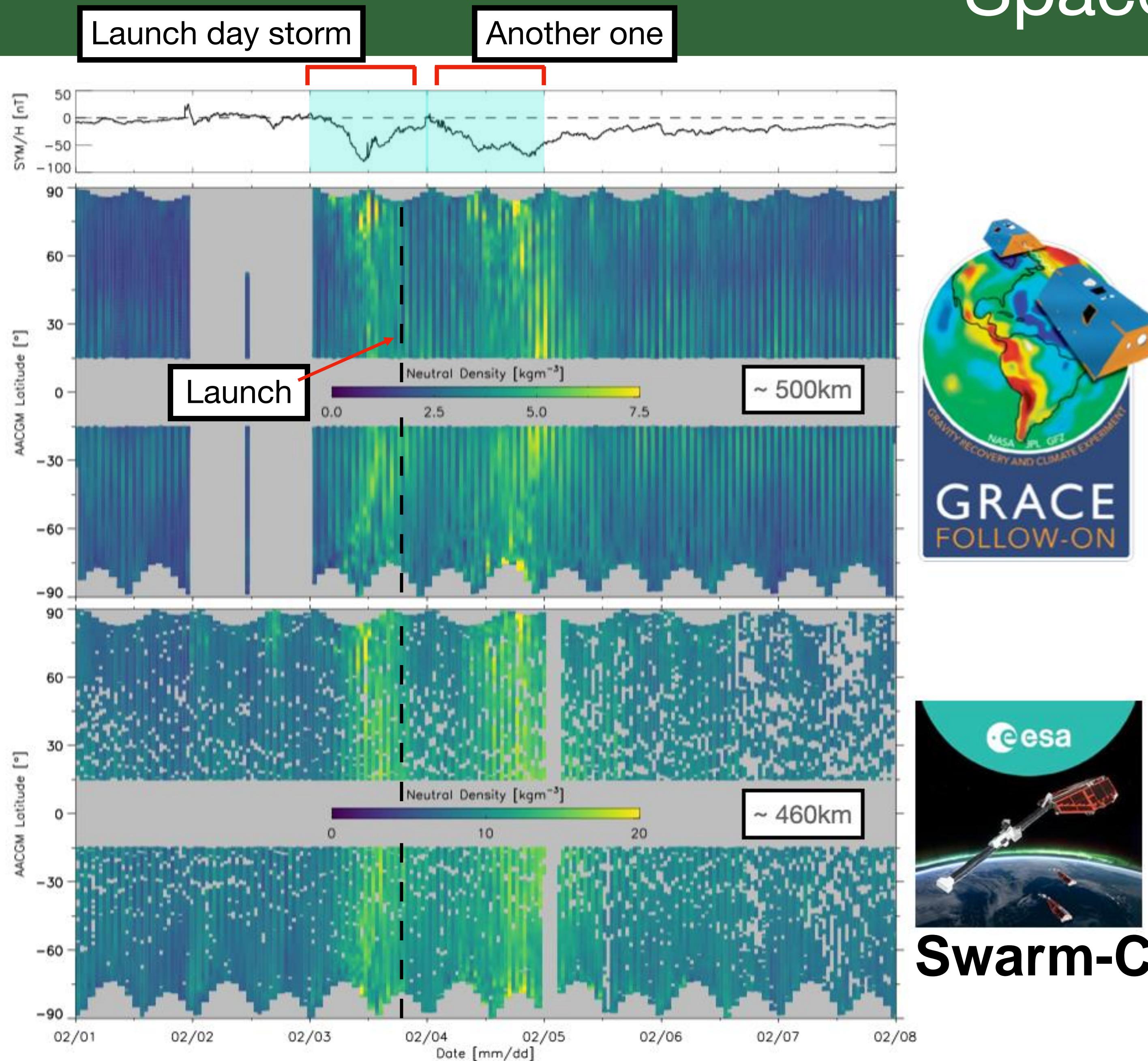
SpaceX to lose as many as 40 Starlink satellites due to space storm

PUBLISHED WED, FEB 9 2022-10:53 AM EST | UPDATED WED, FEB 9 2022-6:42 PM EST

# Starlink debris over Puerto Rico - 07/02/2022



# Spacecraft neutral densities



**Starlink staging altitude:**  
~210km

## Pros:

- Cheap launch
- Bad satellites de-orbit by themselves

## Cons:

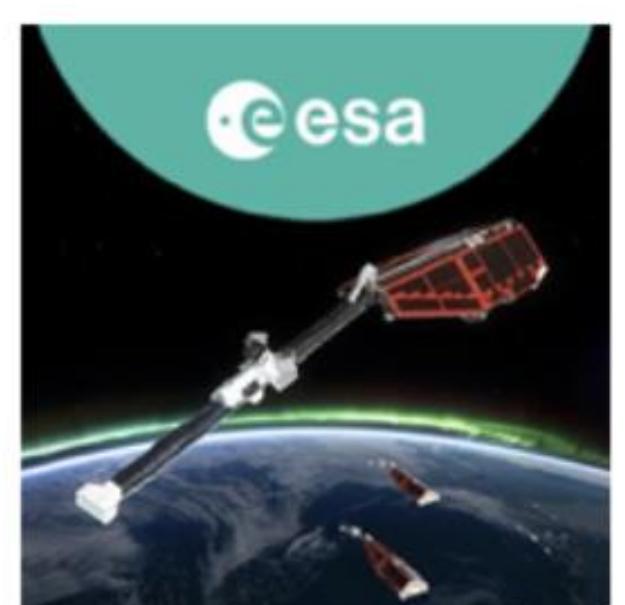
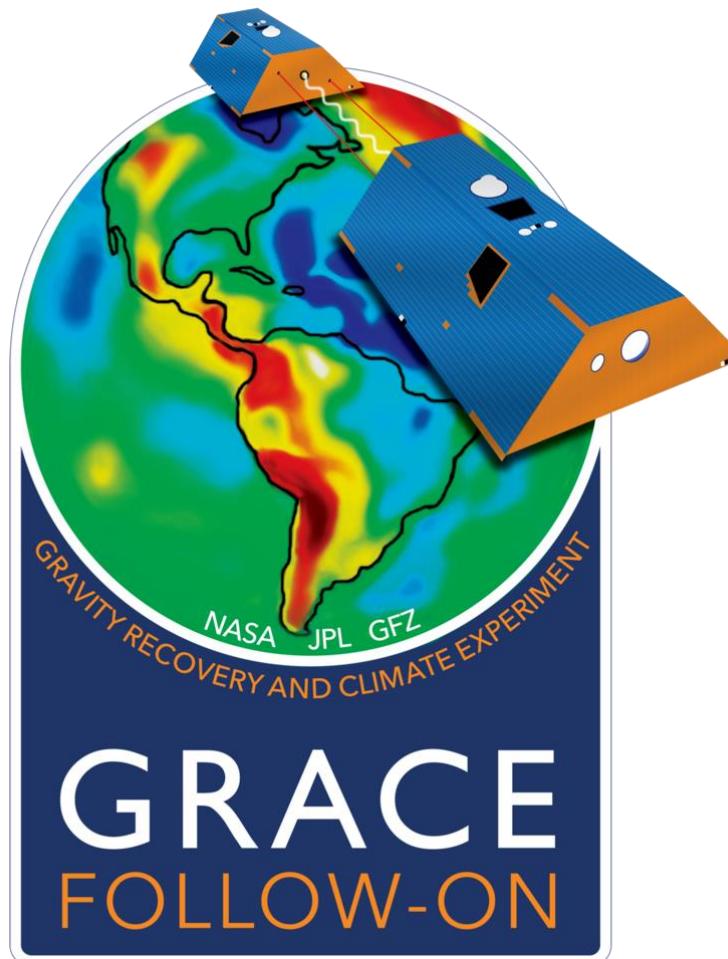
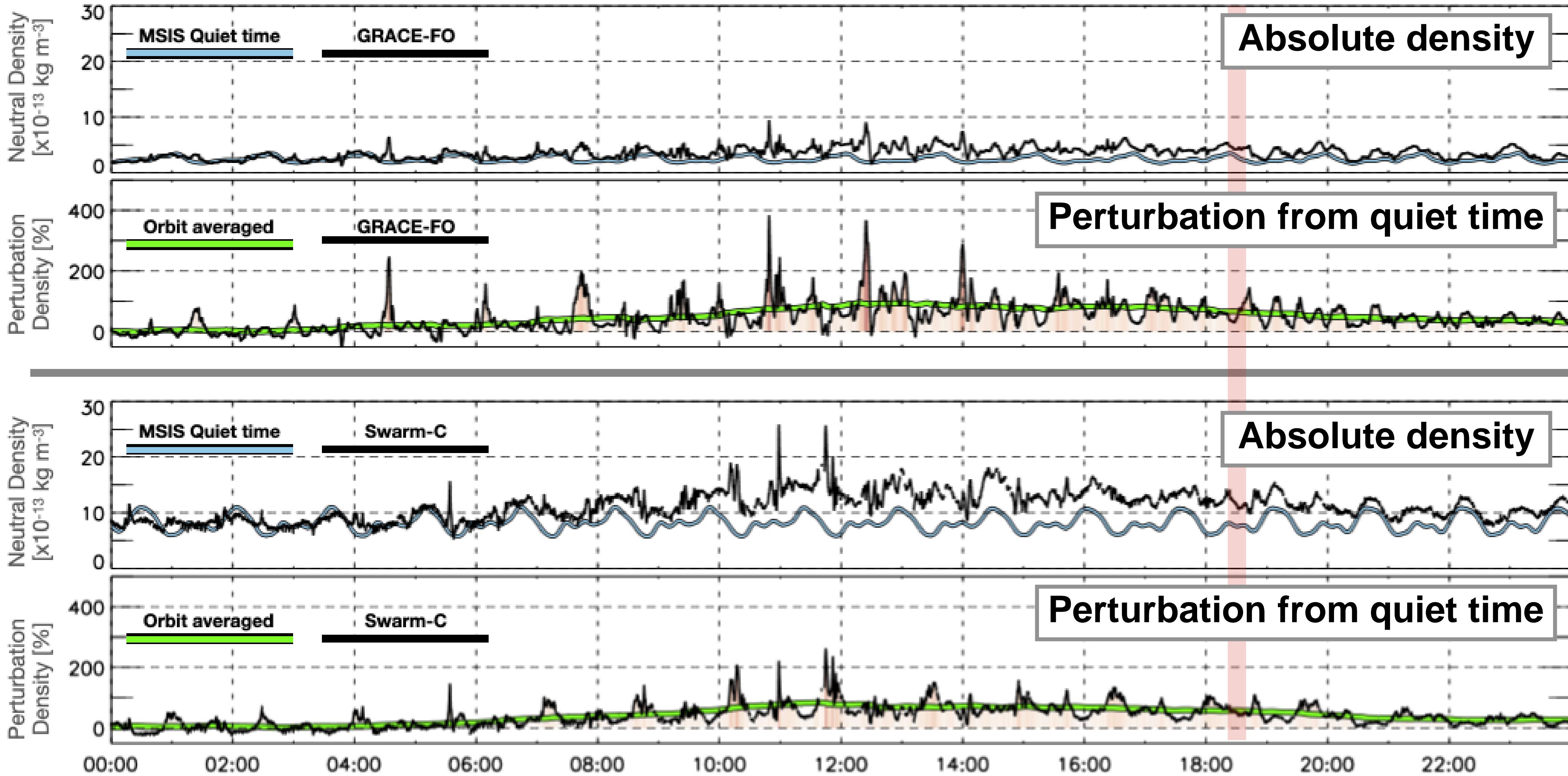
- Any moderate geomagnetic activity is bad

**Swarm-C**

# Perturbations from quiet time

Subtracting MSIS quiet time model (ap=3)

Launch day - 2022/02/03

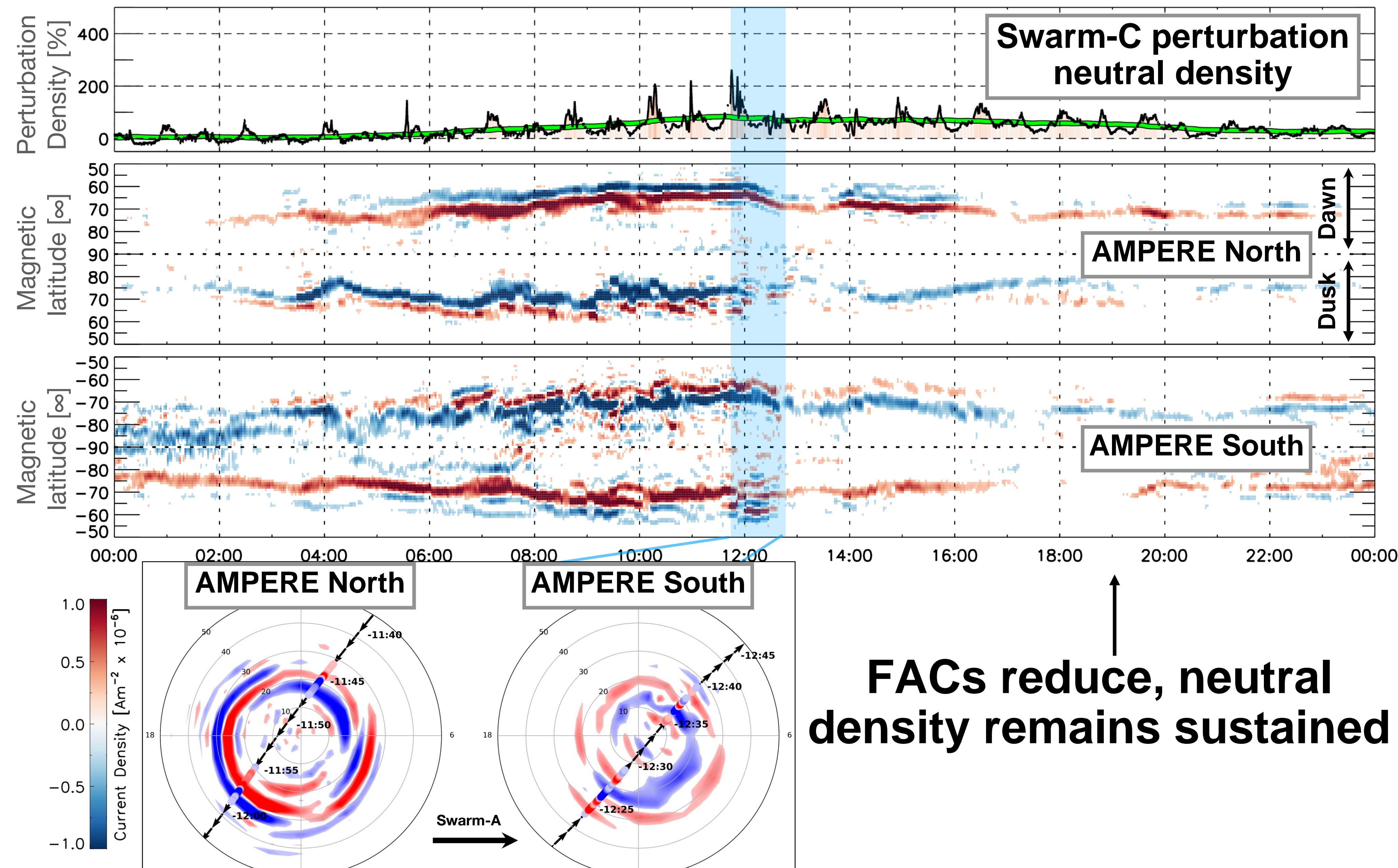


**Swarm-C**

# The role of the ionosphere

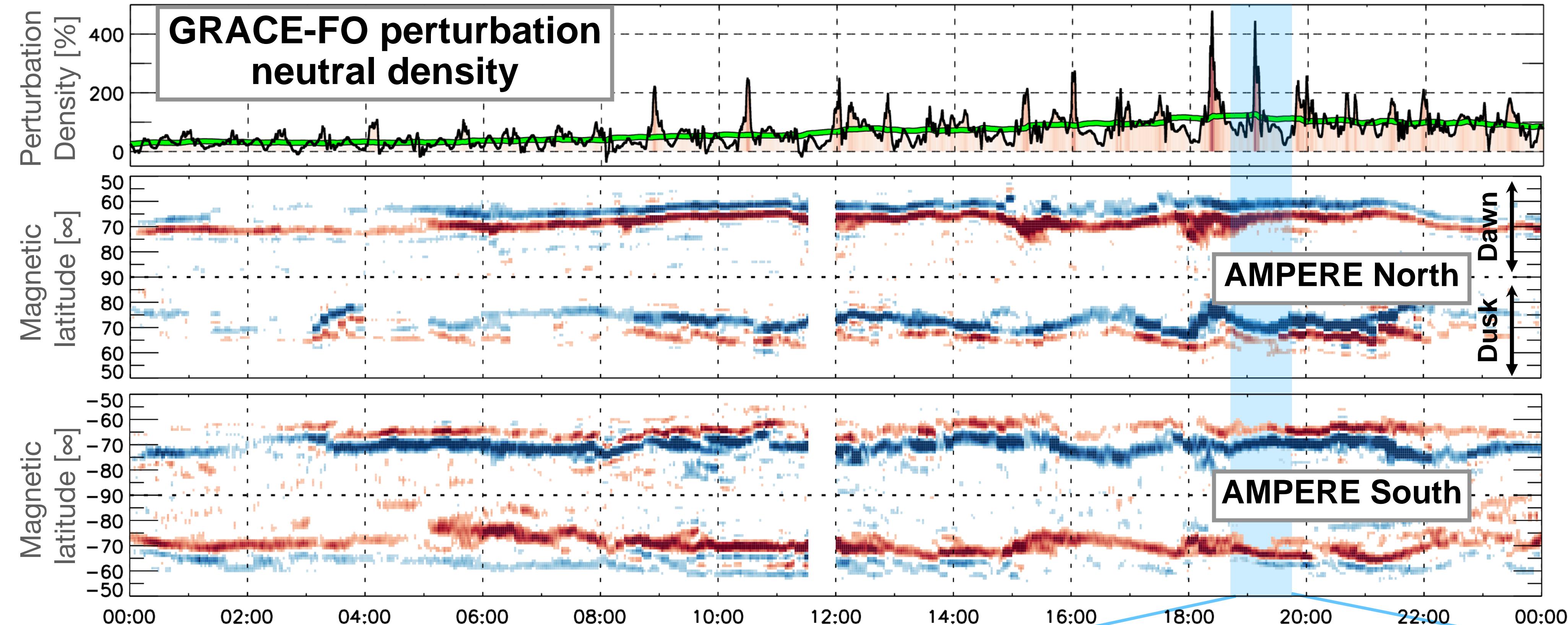
Launch day - 2022/02/03

Dusk - dawn  
keograms of  
**AMPERE**  
field-aligned  
currents



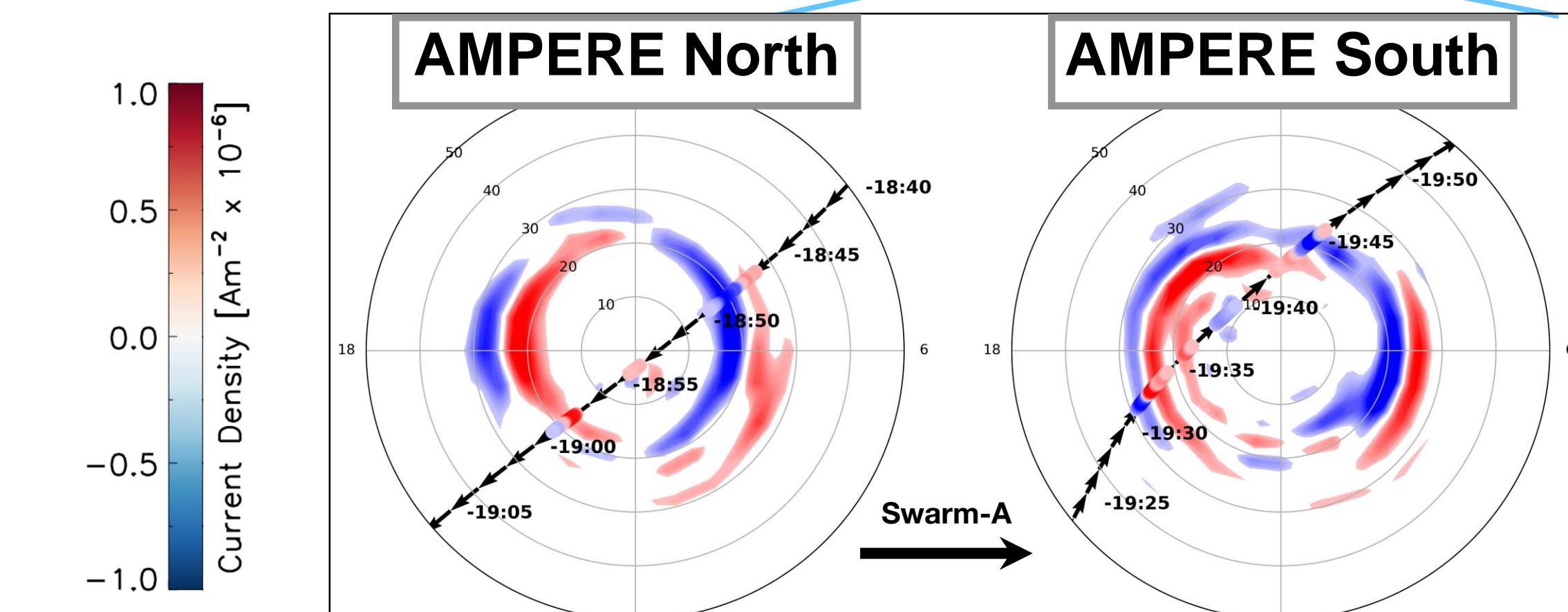
# The role of the ionosphere

Day after launch - 2022/02/04



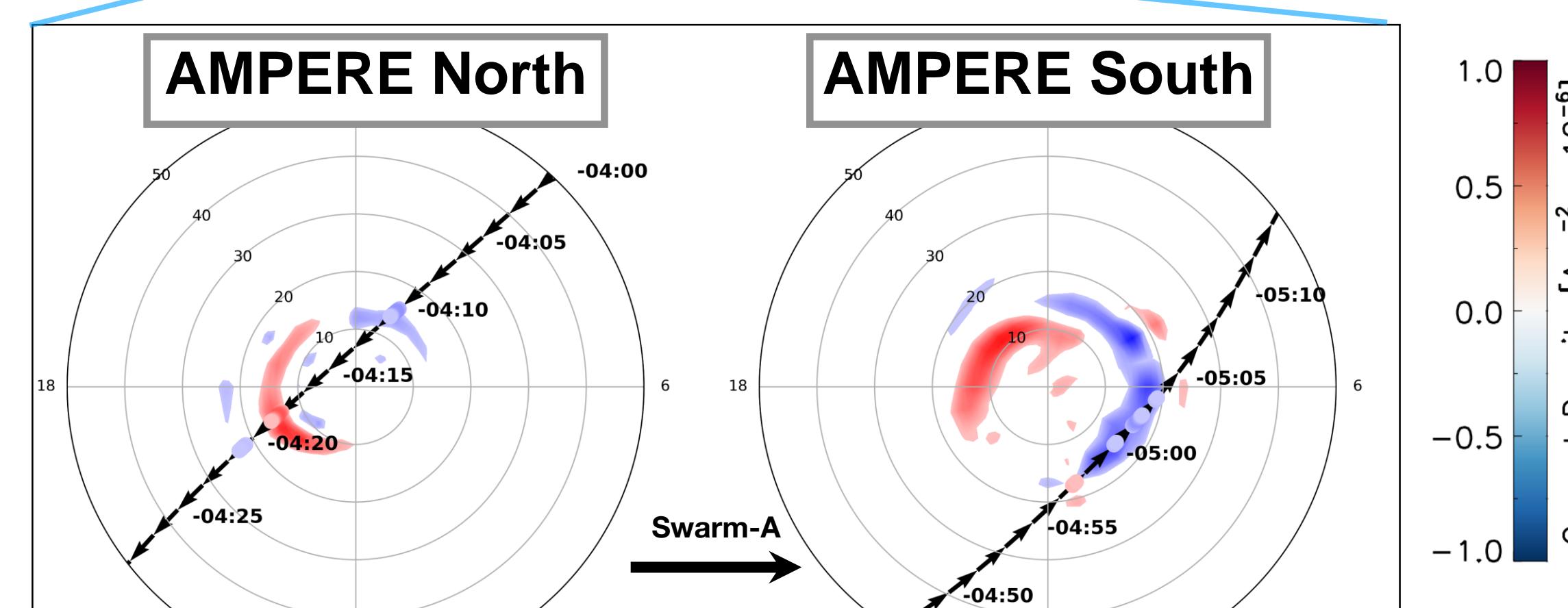
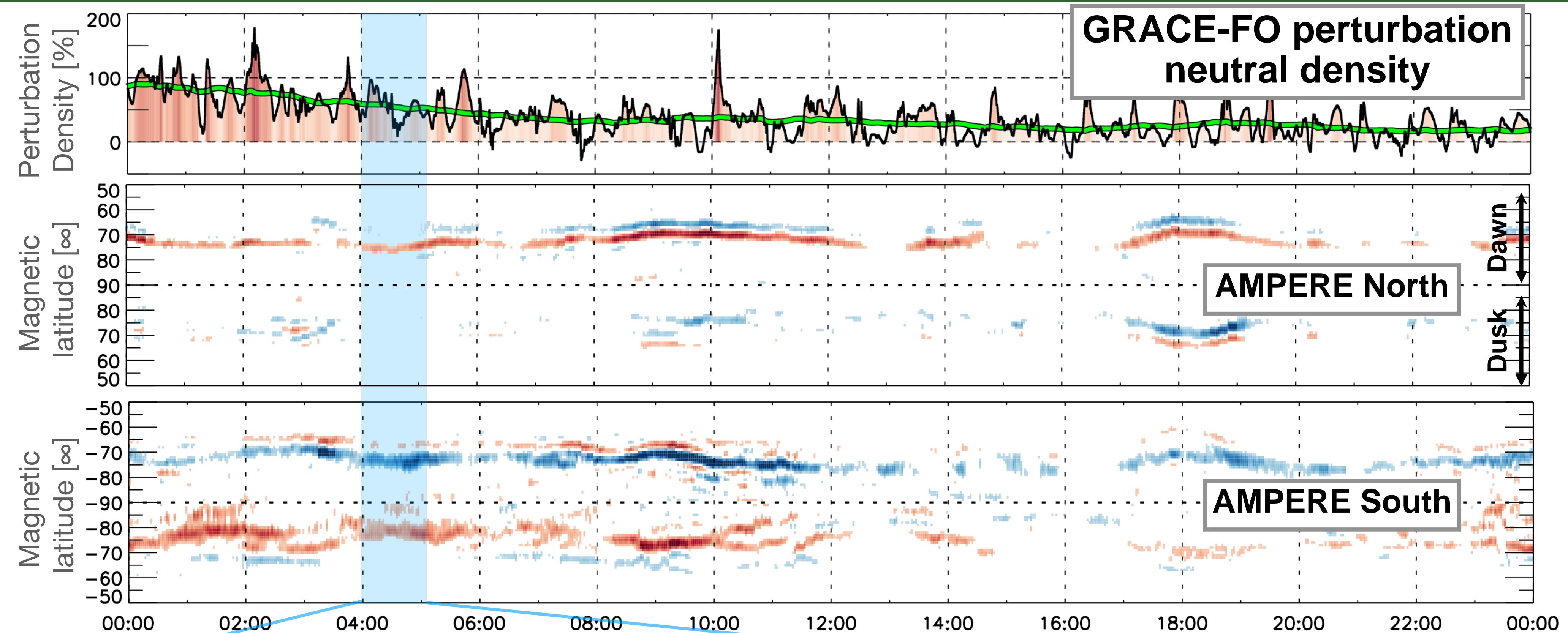
2nd storm hits and  
increases the density again

FACs are more symmetric  
between hemispheres



# The role of the ionosphere

Two days after launch - 2022/02/05



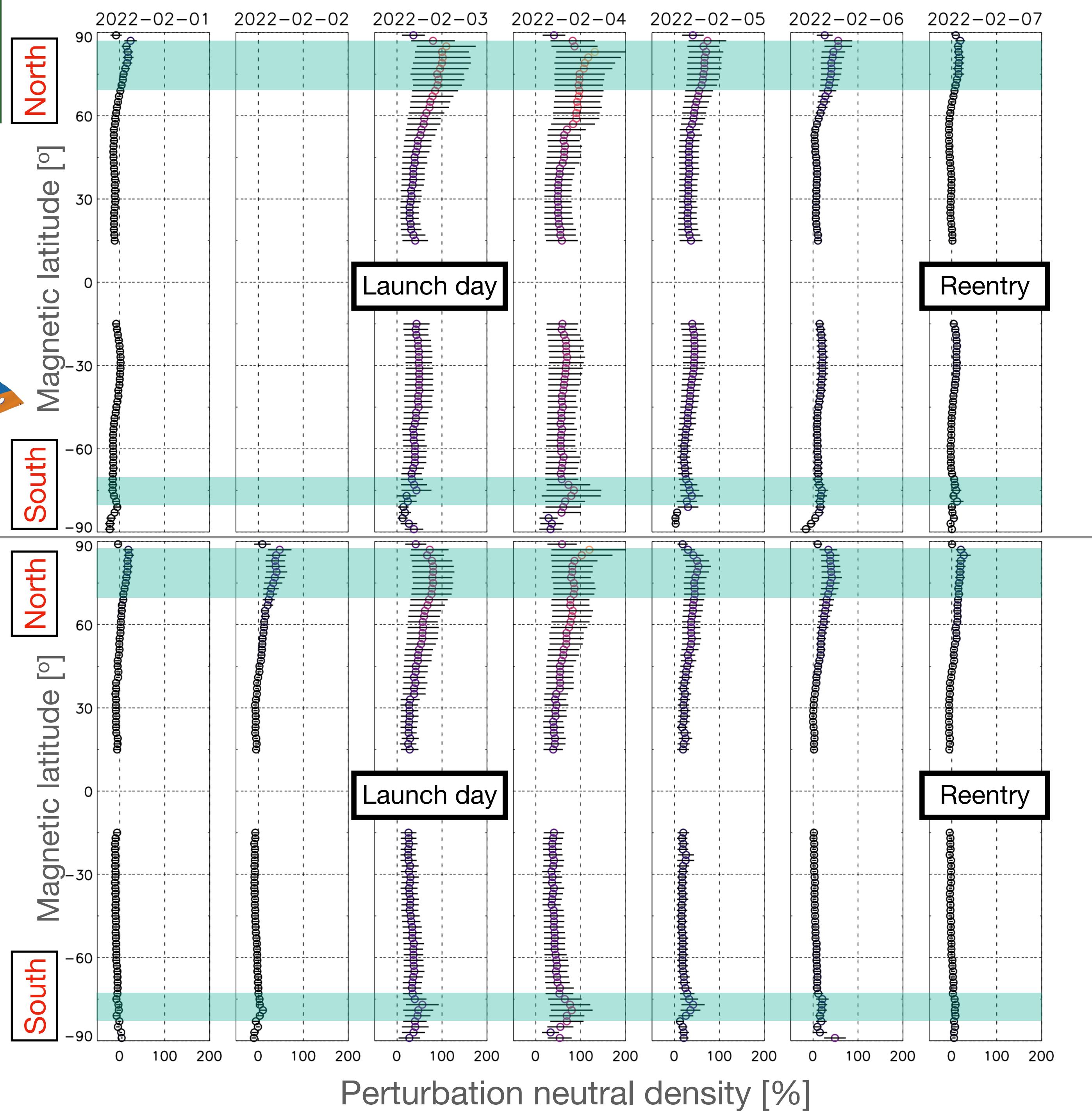
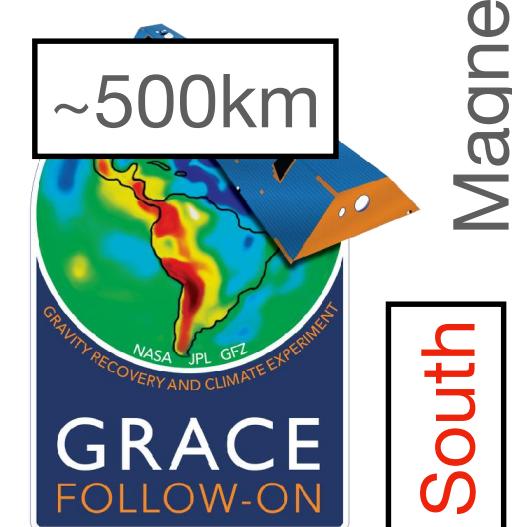
Density takes a day to  
recover after M-I  
forcing stops

# Bonus: Mean latitude profiles

**Mean perturbation  
density latitude profiles**

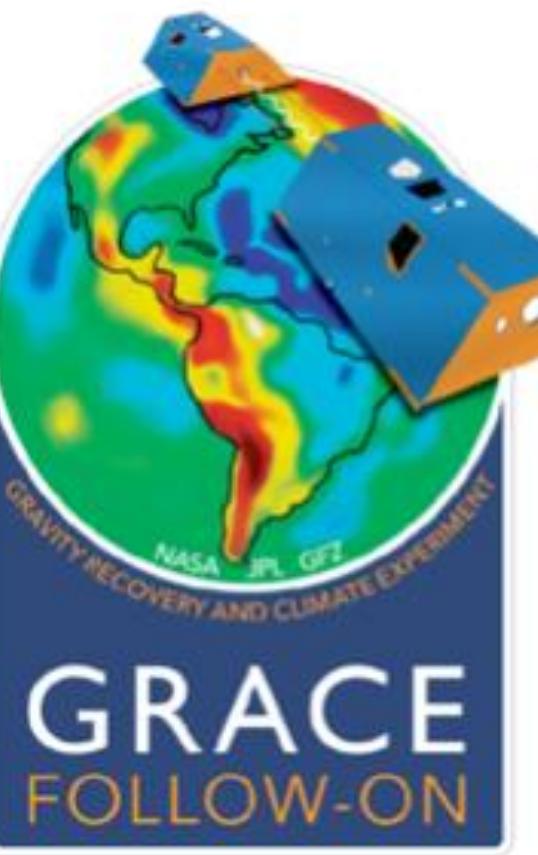
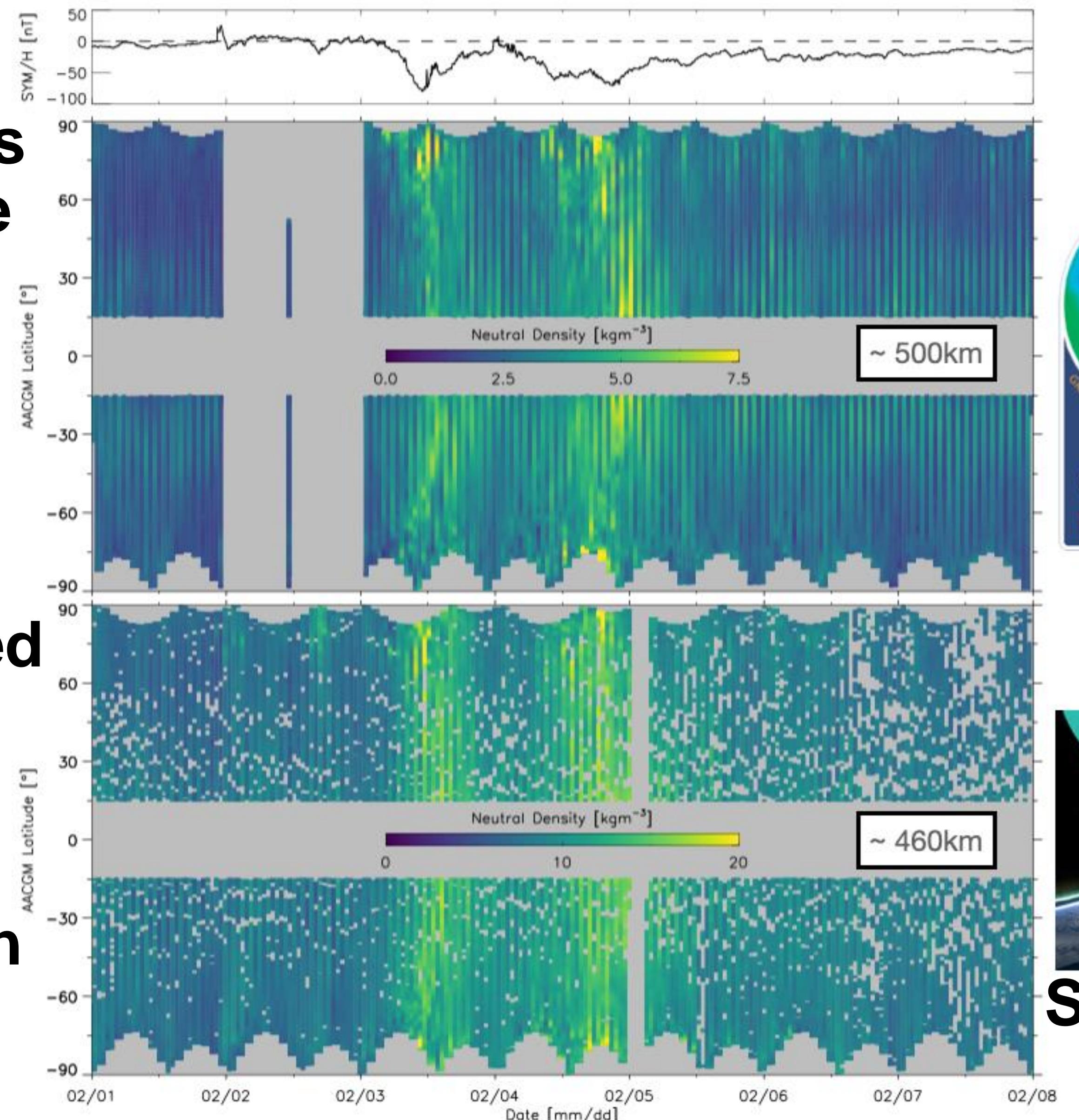
**Enhancements  
consistently higher in  
the northern cusp - due  
to FAC asymmetries?**

**High latitude  
perturbations still  
apparent two days after  
2nd storm**



# Summary

- Thermospheric neutral densities and magnetosphere-ionosphere field-aligned currents are examined for the Starlink destruction event
- When M-I forcing stops, the thermosphere remains perturbed for days afterwards
- Significant hemispheric asymmetries exist between both densities and FACs



**Swarm-C**

# Summary

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### The 2022 Starlink Geomagnetic Storms: Global Thermospheric Response to a High-Latitude Ionospheric Driver

D. D. Billett , K. Sartipzadeh, M. F. Ivarsen, E. Iorfida, E. Doornbos, E. C. Kalafatoglu Eyiguler, K. Pandey, K. A. McWilliams

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