TITAN'S IONOSPHERIC CONDUCTIVITIES, RELOADED

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MOTIVATION

- Charged dust impacts Pedersen & Hall conductivities:
  - on Earth (Muralikrishna & Kulkarni 2006)
  - in Enceladus plume (Simon+ 2011, Yaroshenko & Lühr 2016)
  - on Saturn (Shebanits+ 2020)
- Titan's ionosphere – large dusty plasma dataset
- Dust has not been included before 
  - also prev. study (Rosenqvist+ 2009) used a model for neutrals

DATA

- Cassini Dataset ~13 years: full solar cycle, almost ½ Titan year
  - RPWS/LP: plasma charge densities, electron temperatures
  - INMS: neutral densities and ion (neutral) temperatures
  - MAG: |magnetic field|
- Caveats
  - "soup" of species, no full spectra past 2012 – must average
  - dust charging non-trivial – must simplify (spoiler: $-1q_e$)

METHOD

density

charge

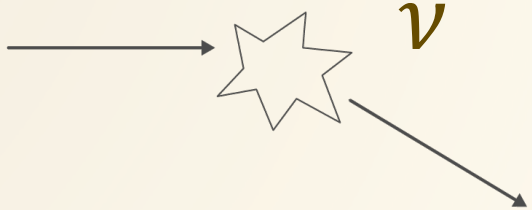
momentum transfer

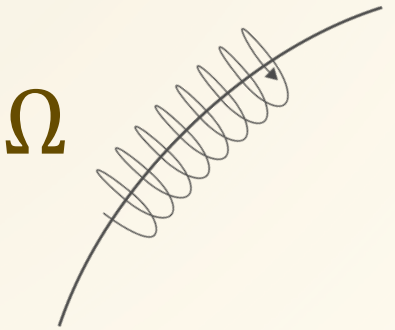
mass

gyrofrequency

$$\sigma_P = \sum_s n \frac{q^2}{m} \frac{\nu}{\nu^2 + \Omega^2}$$

$$\sigma_H = \sum_s n \frac{q^2}{m} \frac{\pm\Omega}{\nu^2 + \Omega^2}$$





Schunk & Nagy 2009

METHOD

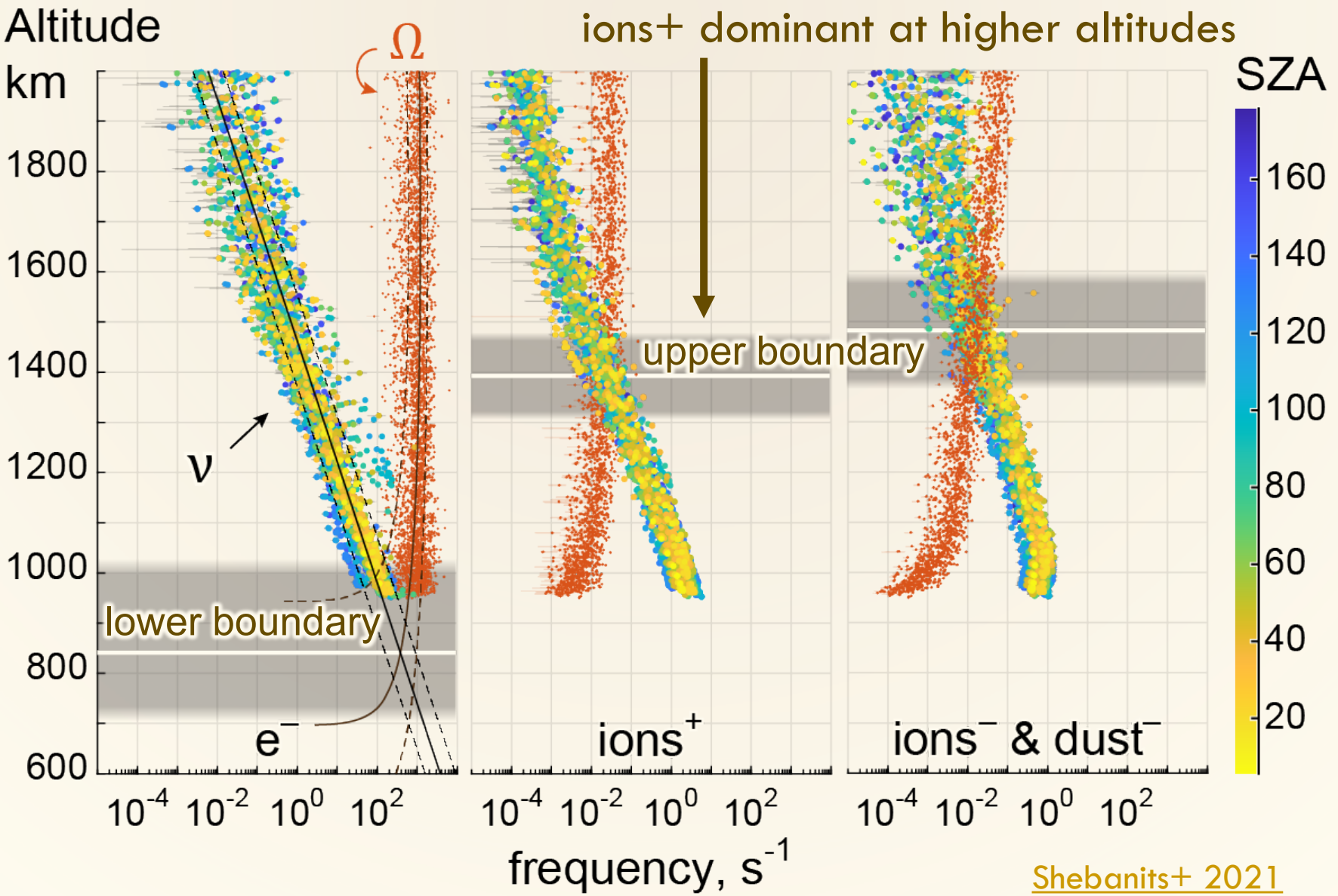
$$\sigma_P = \sigma_{P,e} + \sigma_{P,i} + \sigma_{P,d}$$

"heavy electron"

$$\sigma_H = \sigma_{H,e} - \sigma_{H,i} + \sigma_{H,d}$$

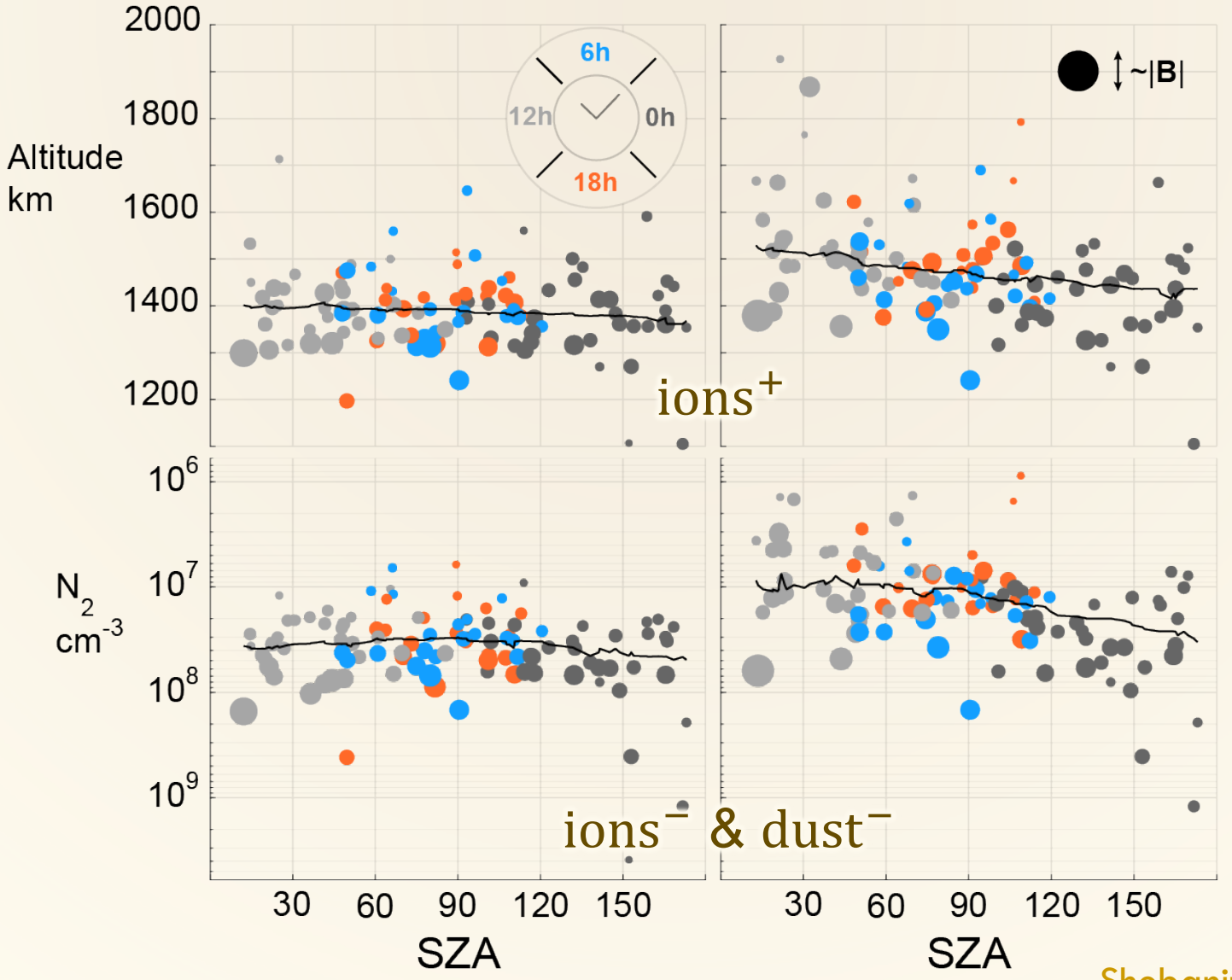
can make $\sigma_H < 0$!

CONDUCTIVE LAYER



Shebanits+ 2021

CONDUCTIVE LAYER: UPPER BOUNDARY TRENDS



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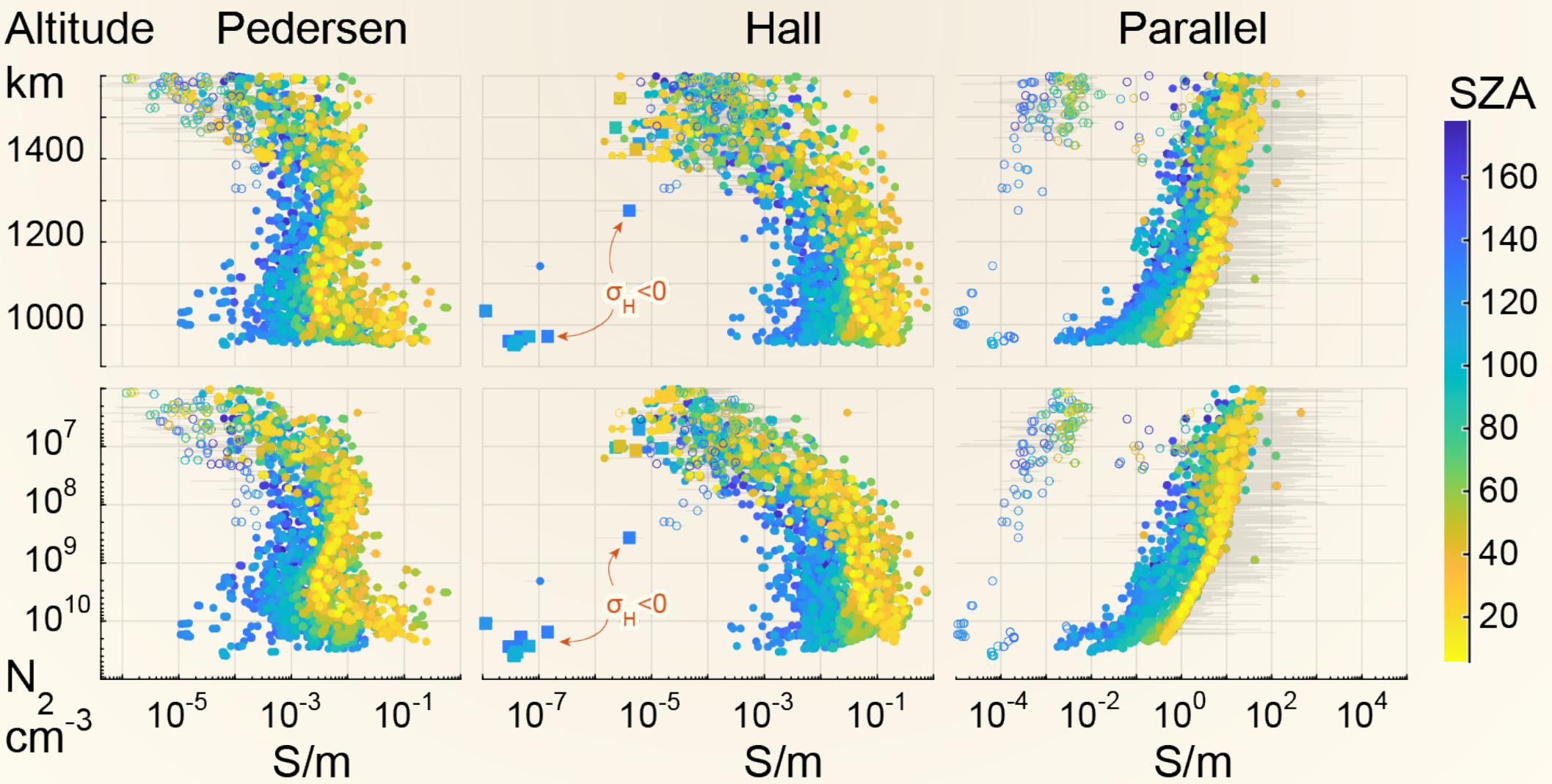
CONDUCTIVITIES



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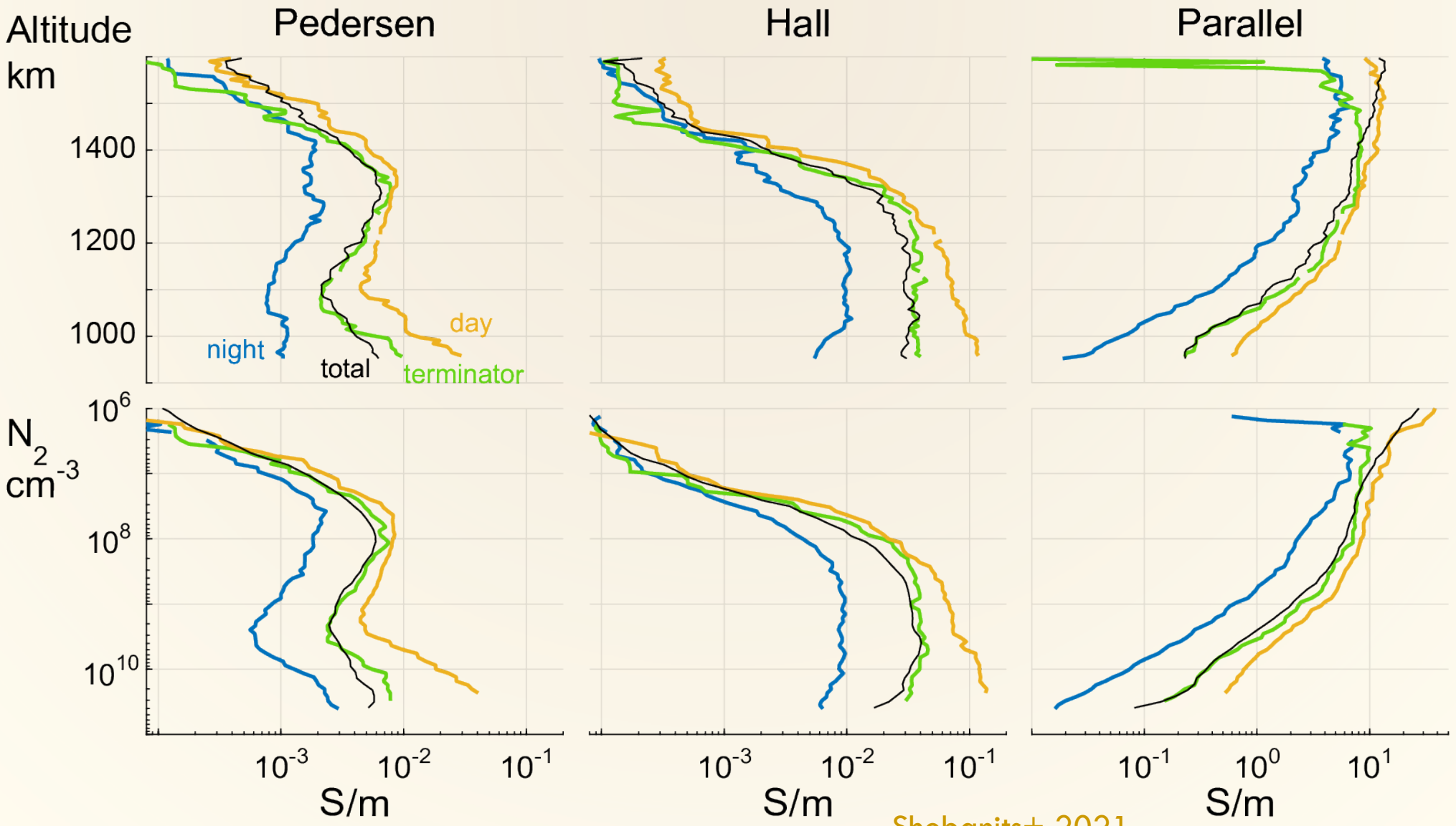
THE BIG PICTURE – MEDIANS



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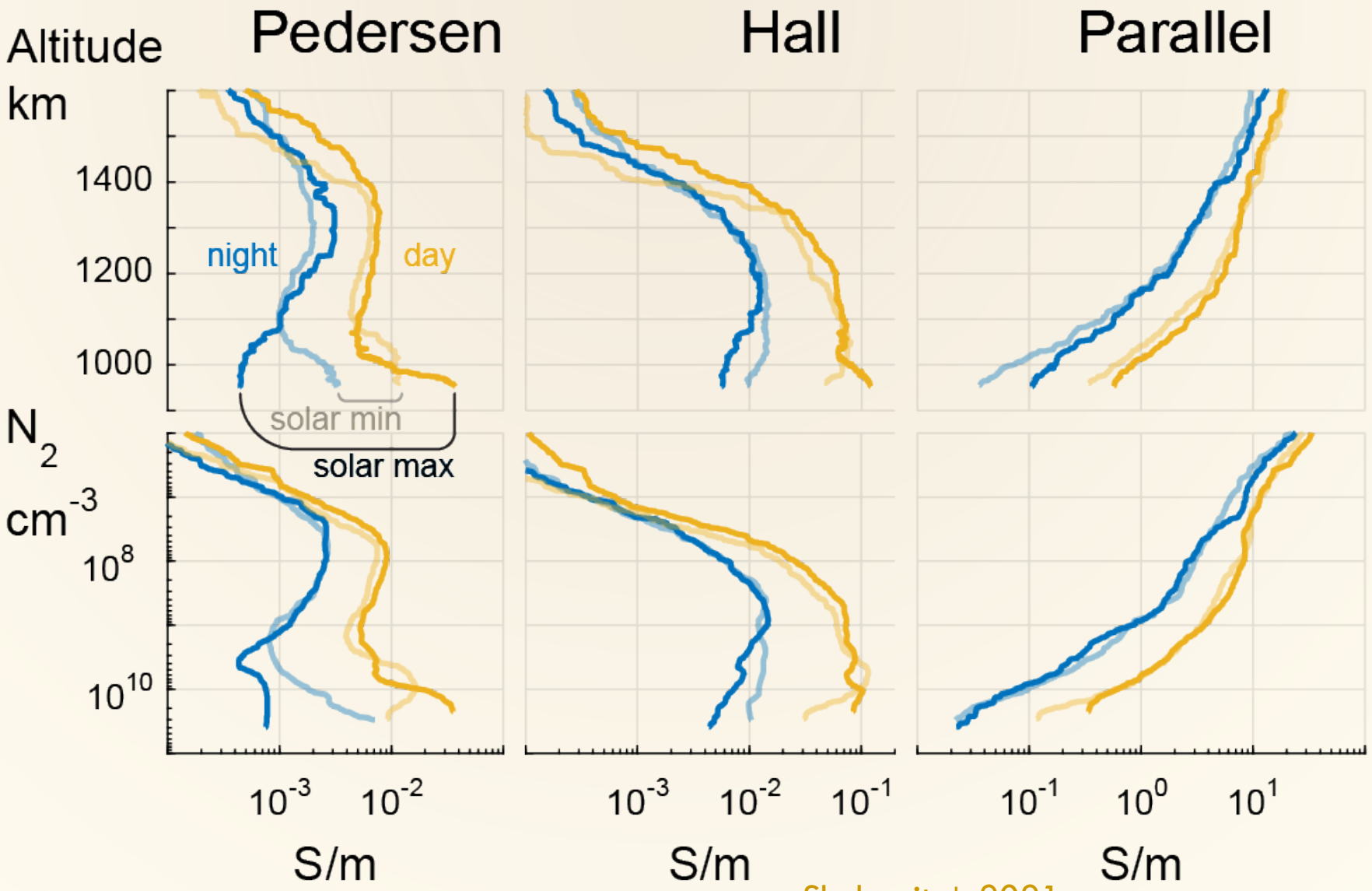
THE BIG PICTURE – SOLAR CYCLE



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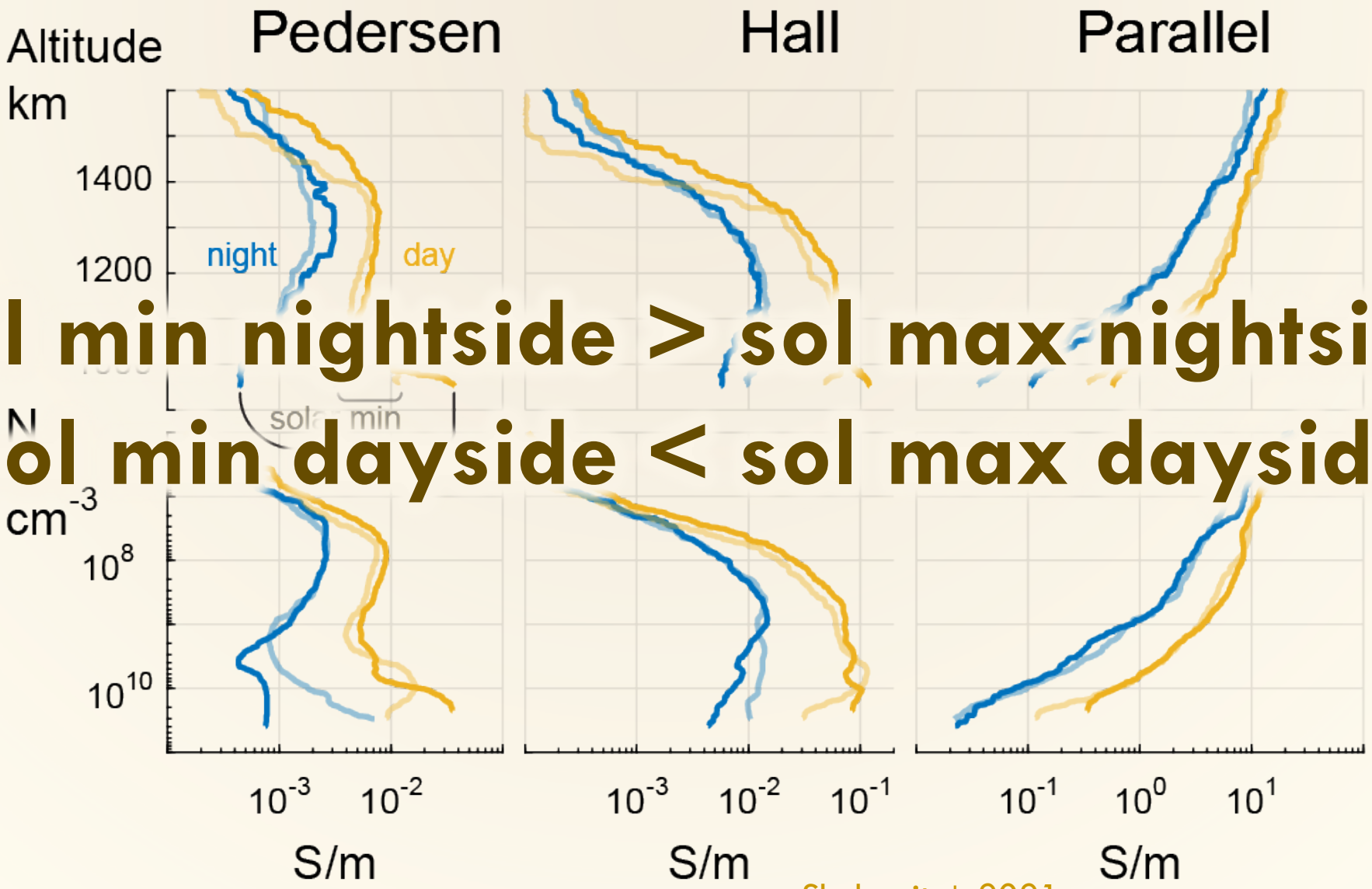
THE BIG PICTURE – SOLAR CYCLE



sol min nightside > sol max nightside

sol min dayside < sol max dayside

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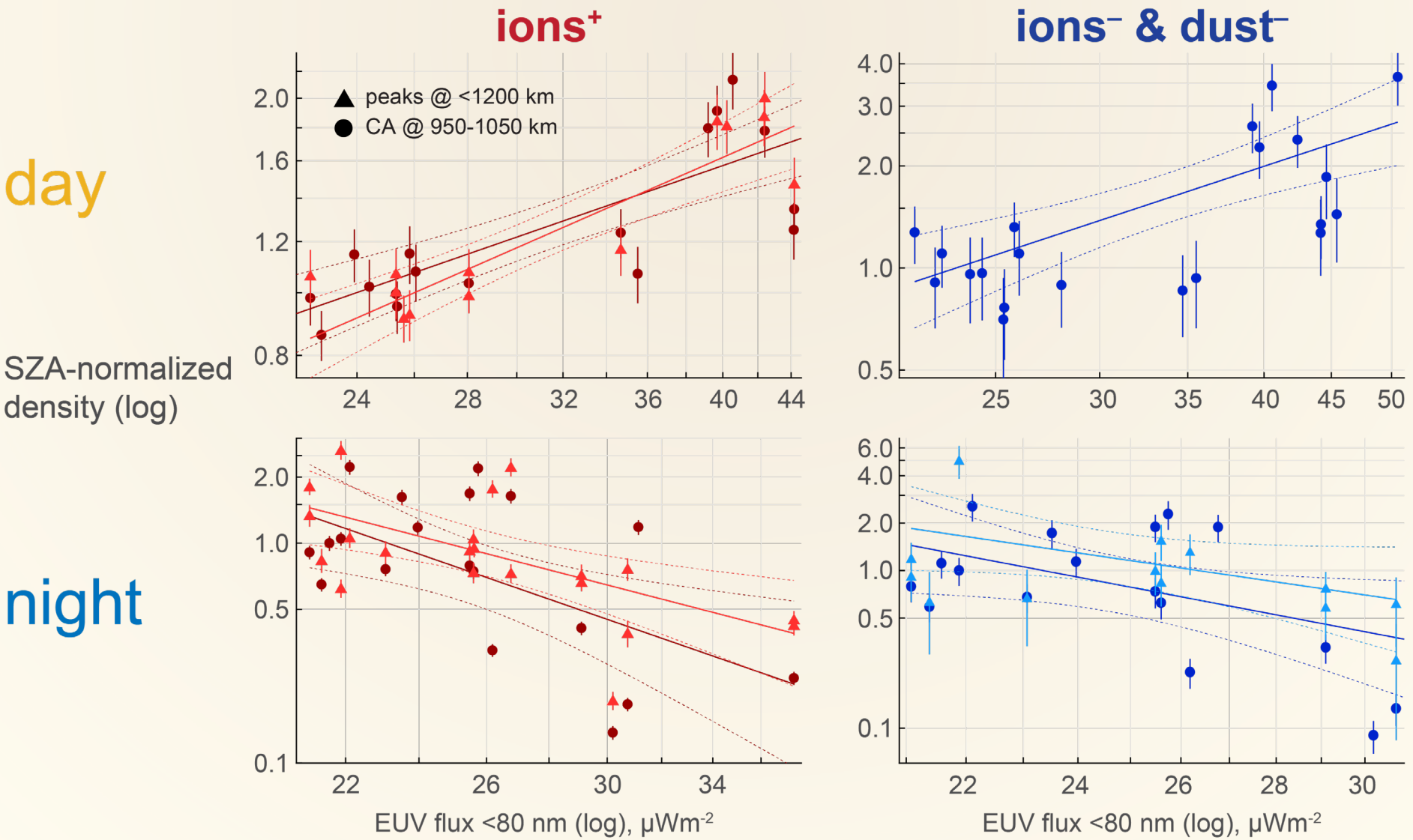
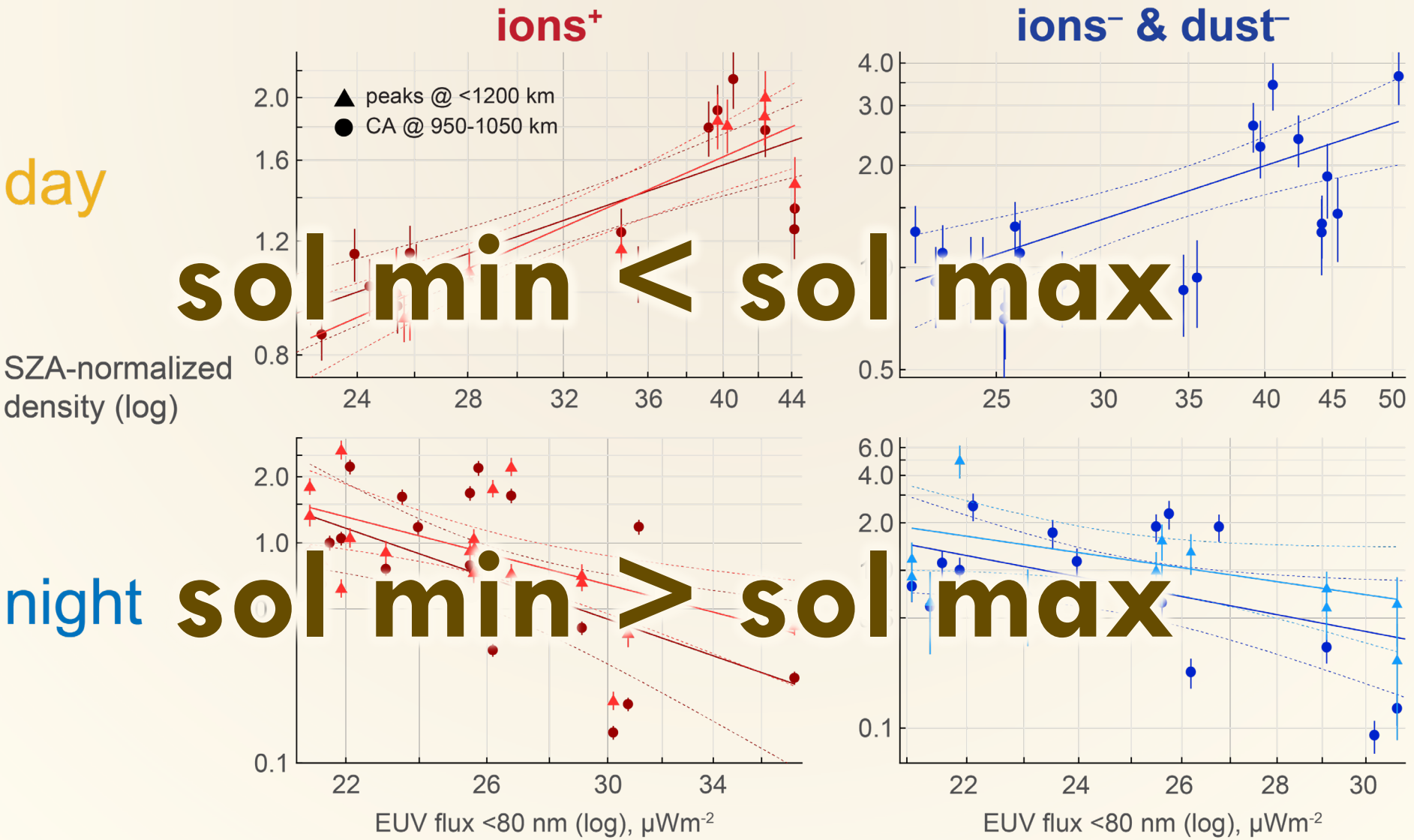
SOLAR CYCLE HEAVY$^{\pm}$ TRENDS



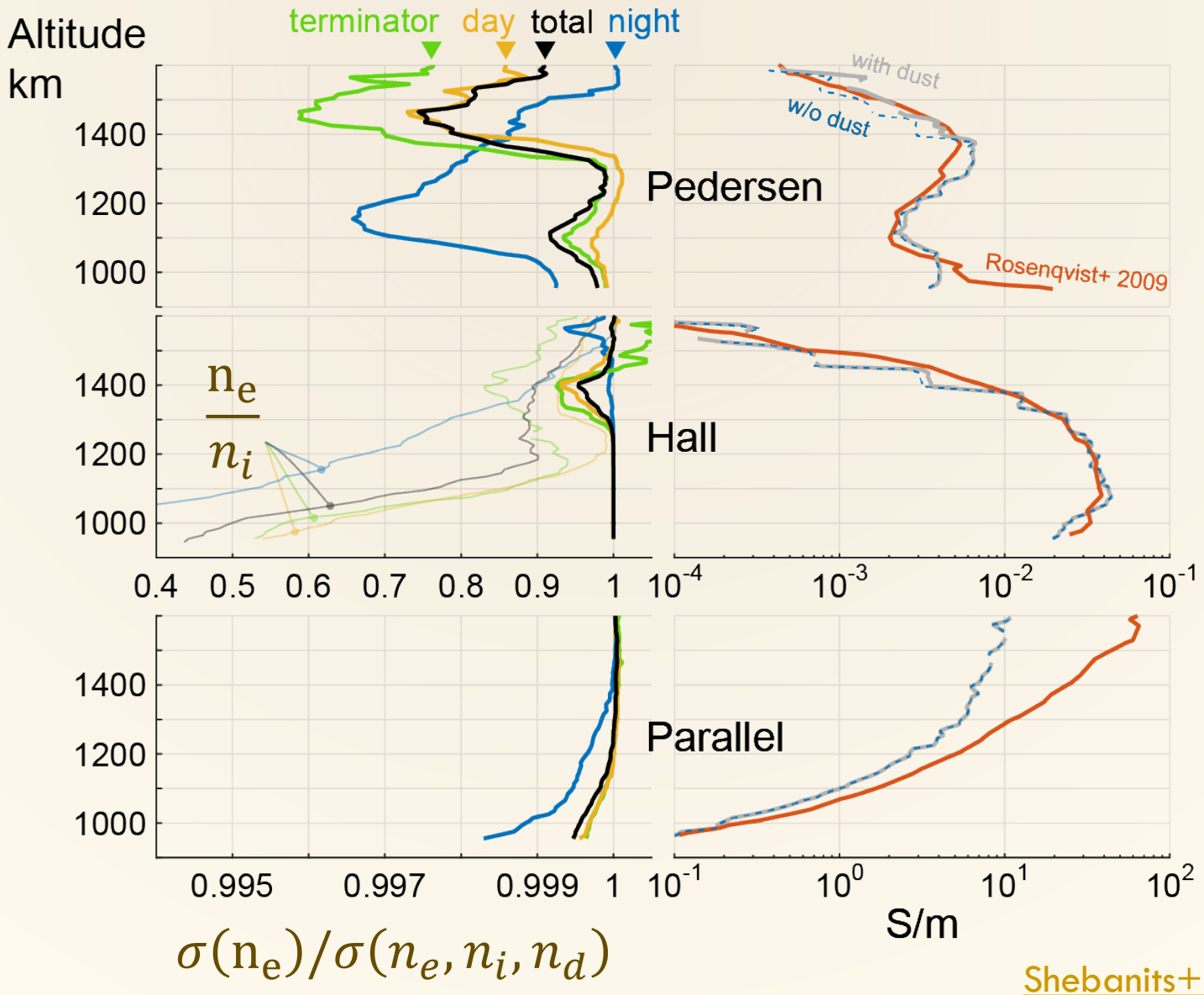
Shebanits+ 2017

SOLAR CYCLE HEAVY$^{\pm}$ TRENDS



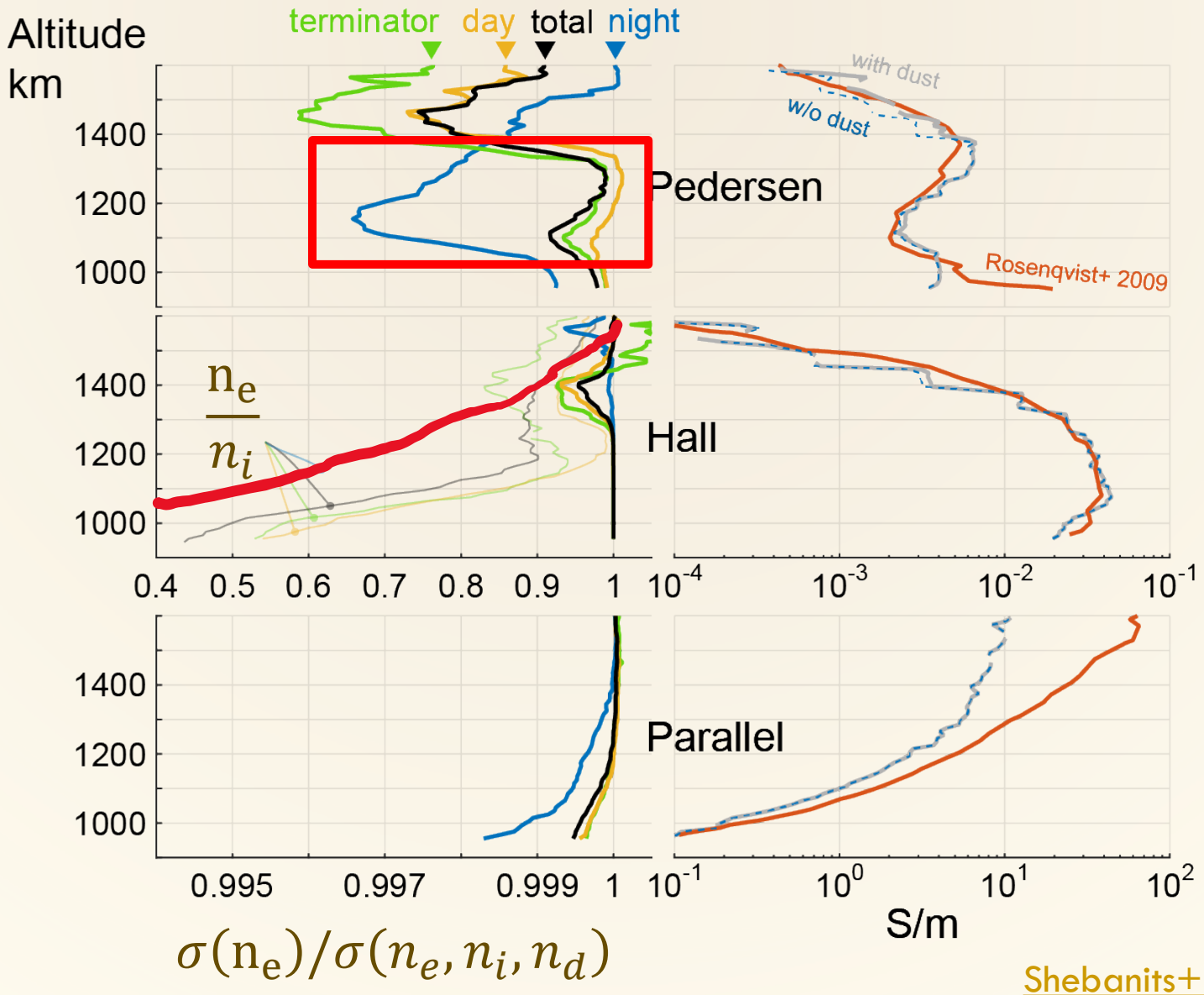
Shebanits+ 2017

TO DUST OR NOT TO DUST



Shebanits+ 2021

TO DUST OR NOT TO DUST



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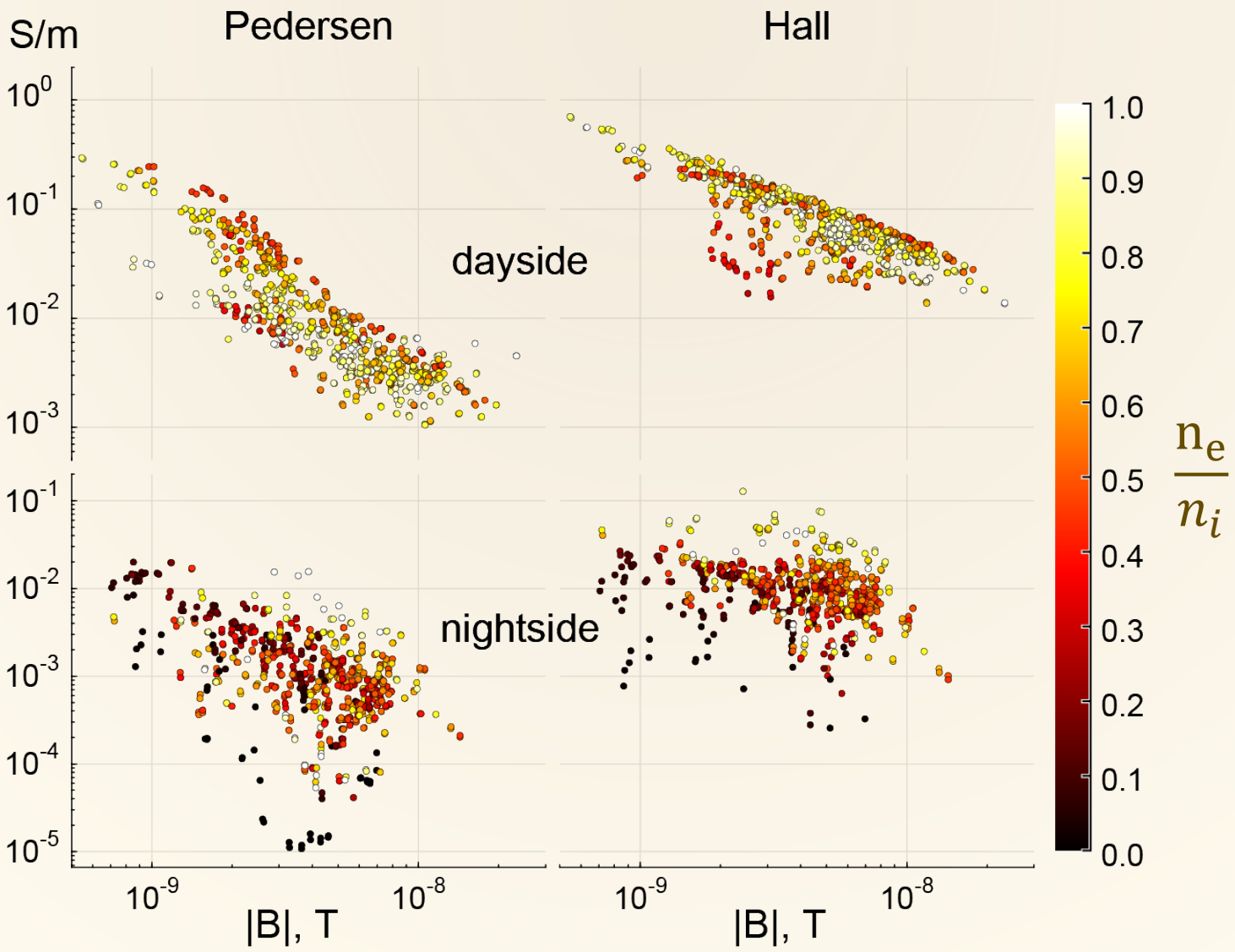
LOW ALTITUDE TRENDS (<1200 KM)



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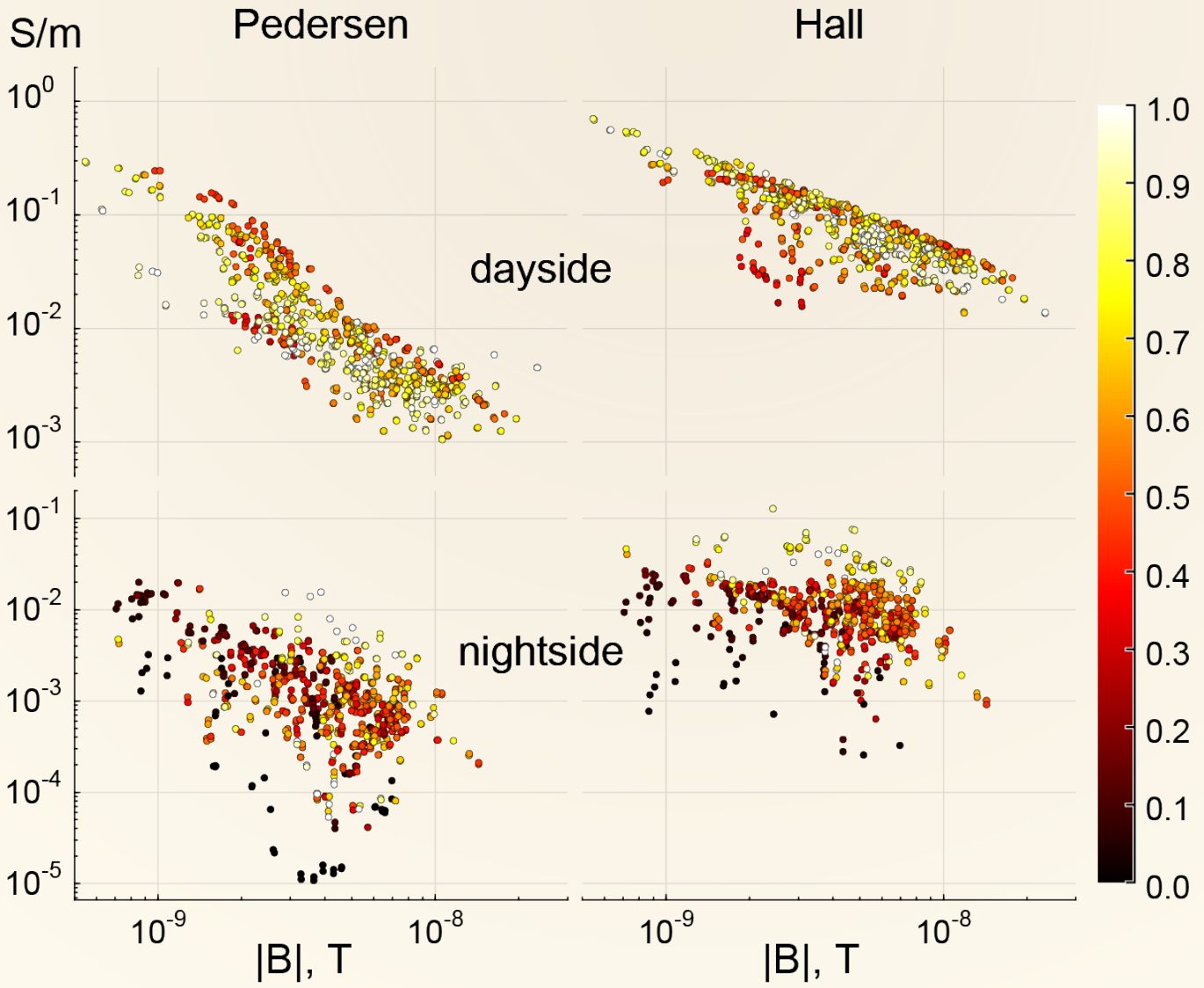
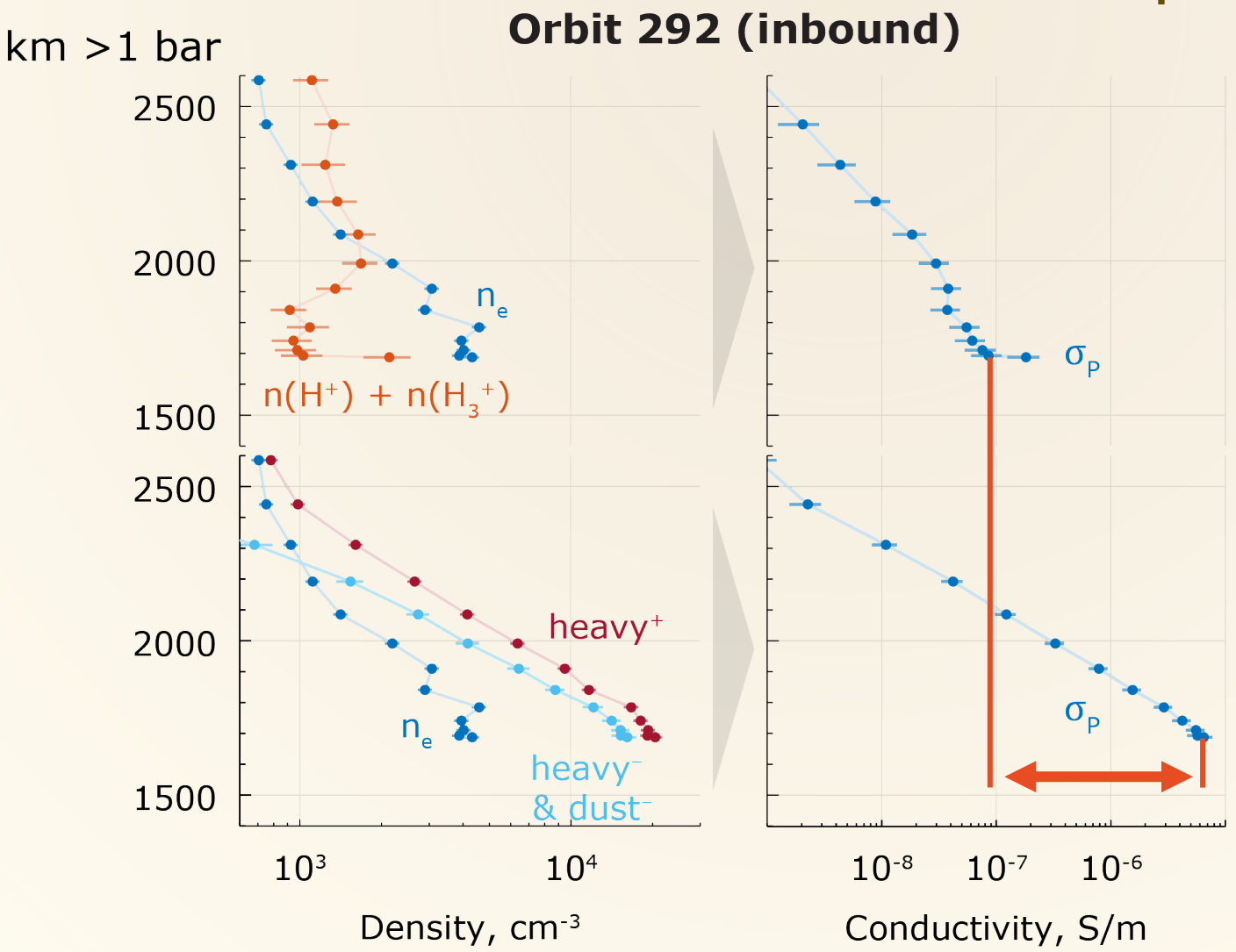


the lower, the more dusty

Shebanits+ 2021

COMPARE WITH SATURN

$|B| \sim 17000\ nT$



no dust

with dust

Shebanits+ 2020

SUMMARY

- Positive ions govern Pedersen & Hall > 1000 km
- Hall dominates $1000 - 1400$ km
- Dust influence $\leq 35\%$ night, $3 - 7\%$ day/terminator
  - most impact on Pedersen at $1100 - 1400$ km
  - Hall & Parallel mostly unaffected, $\boldsymbol{B}$ too weak!

  …except signs of reverse Hall effect < 950 km
- day $\sigma \sim 10 \times$ night σ

  solar max vs solar min: day $\sigma \downarrow$ night $\sigma \uparrow$
- $|\boldsymbol{B}|$ influences Pedersen more than dust (at least > 900 km)
- Secondary (!) Pedersen layer possible < 1100 km **IF significant** $|\boldsymbol{B}|$