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Plasmasphere contribution to "total electron content"

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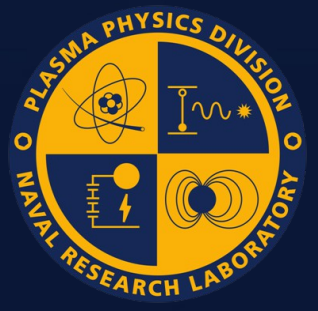

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"Total electron content"

NRL PPD

TEC (total electron content) is vertically-integrated density; 1 TECU = $10^{16}/m^2$.

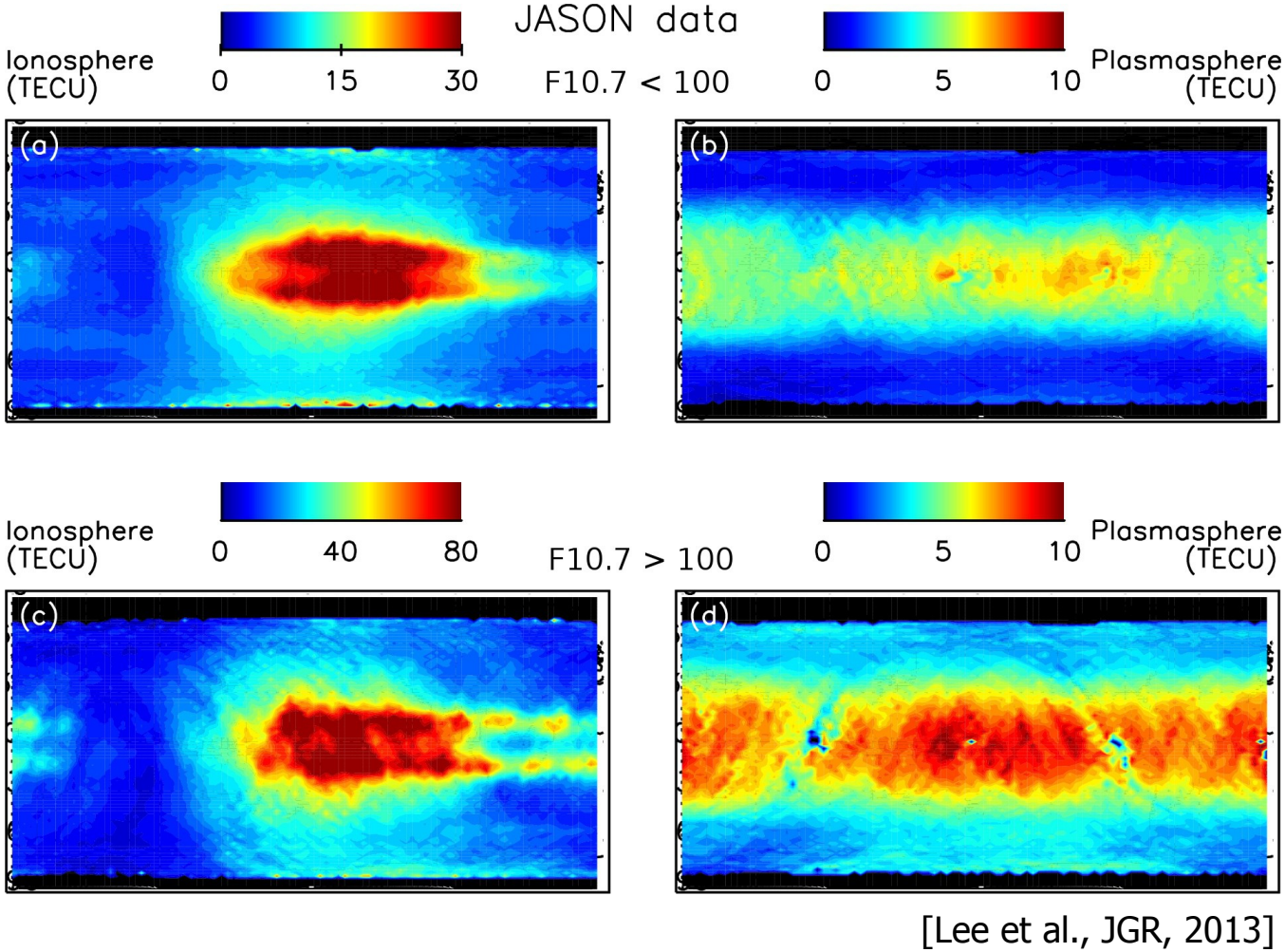
TEC is not the number of electrons over a square meter.

pTEC can be defined as the TEC contribution between JASON altitude (1340 km) and GPS altitude (20,200 km).

pTEC is stronger at solar maximum [Lee et al., 2013; Shim et al 2017].

During solar maximum, the atmosphere expands, slowing refilling of the plasmasphere, leading to the "plasmasphere electron content paradox" [Krall & Huba, 2016].

TEC = iTEC + pTEC



[Lee et al., JGR, 2013]

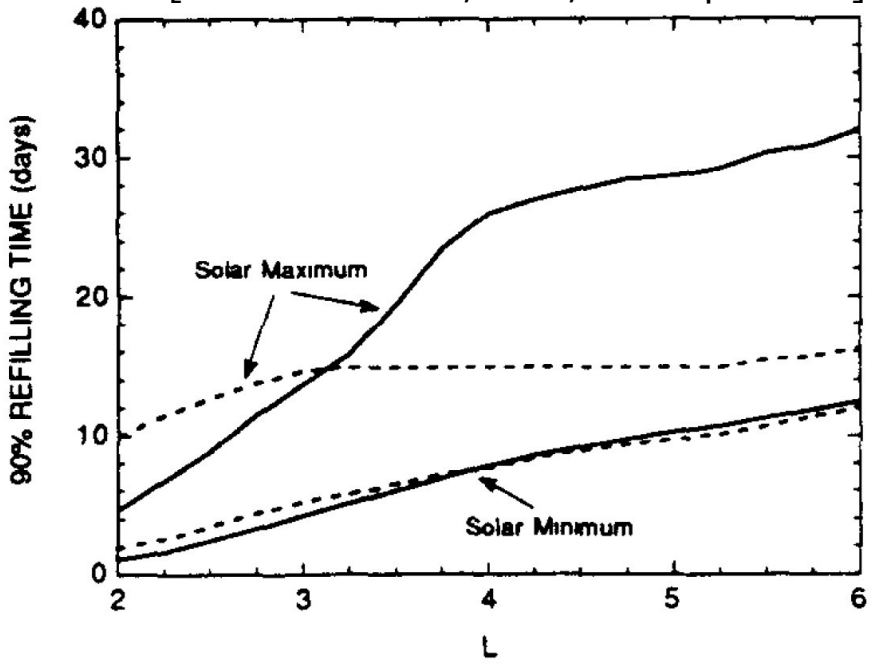
pTEC and iTEC data courtesy of H.-B. Lee

F10.7 is EUV index (80, 160 for solar min, max)

Measured pTEC result based on data from 2002-2009.

Refilling rates lower at solar max

[Rasmussen et al., 1993, Plan. Space Sci.]



It is well-known that post-storm plasmasphere refilling rates fall with solar activity.

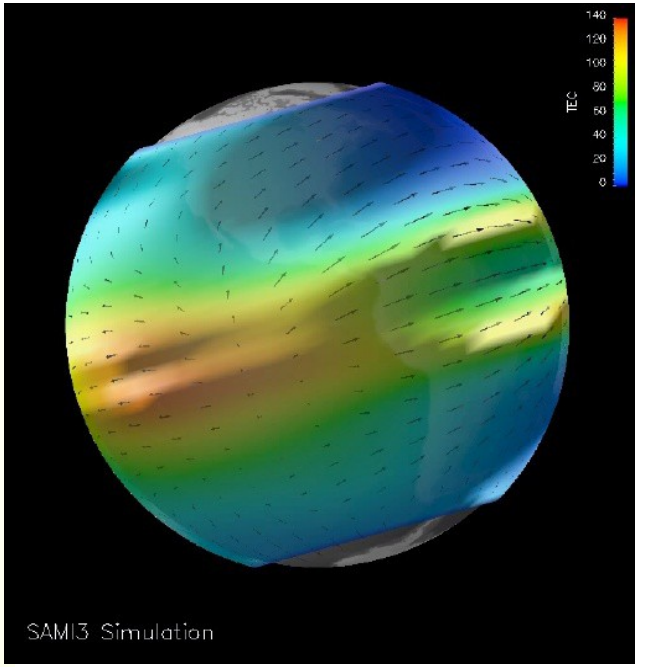
Refilling times are longer at solar maximum.

The paradox is that refilling rates fall with increasing solar activity while pTEC increases with increasing solar activity.

NRL SAMI3 Ionosphere/Plasmasphere Model

NRL PPD

- Magnetic field: ~~IGRF-like~~ Non-tilted dipole
- Interhemispheric
- Nonorthogonal, nonuniform fixed grid
- Seven (7) ion species (all ions are equal): H^+, He^+, N^+, O^+, N_2^+, NO^+, and O_2^+
  - Solve continuity and momentum for all 7 species
  - Solve temperature for H^+, He^+, O^+, and e^-
- Plasma motion
  - $\mathbf{E} \times \mathbf{B}$ drift perpendicular to **B**
  - Ion inertia included parallel to **B**
- Neutral species: NRLMSISE00 and ~~HWM93~~ HWM14
- Chemistry: 21 reactions + recombination
- Photoionization: Daytime (EUVAC) and nighttime

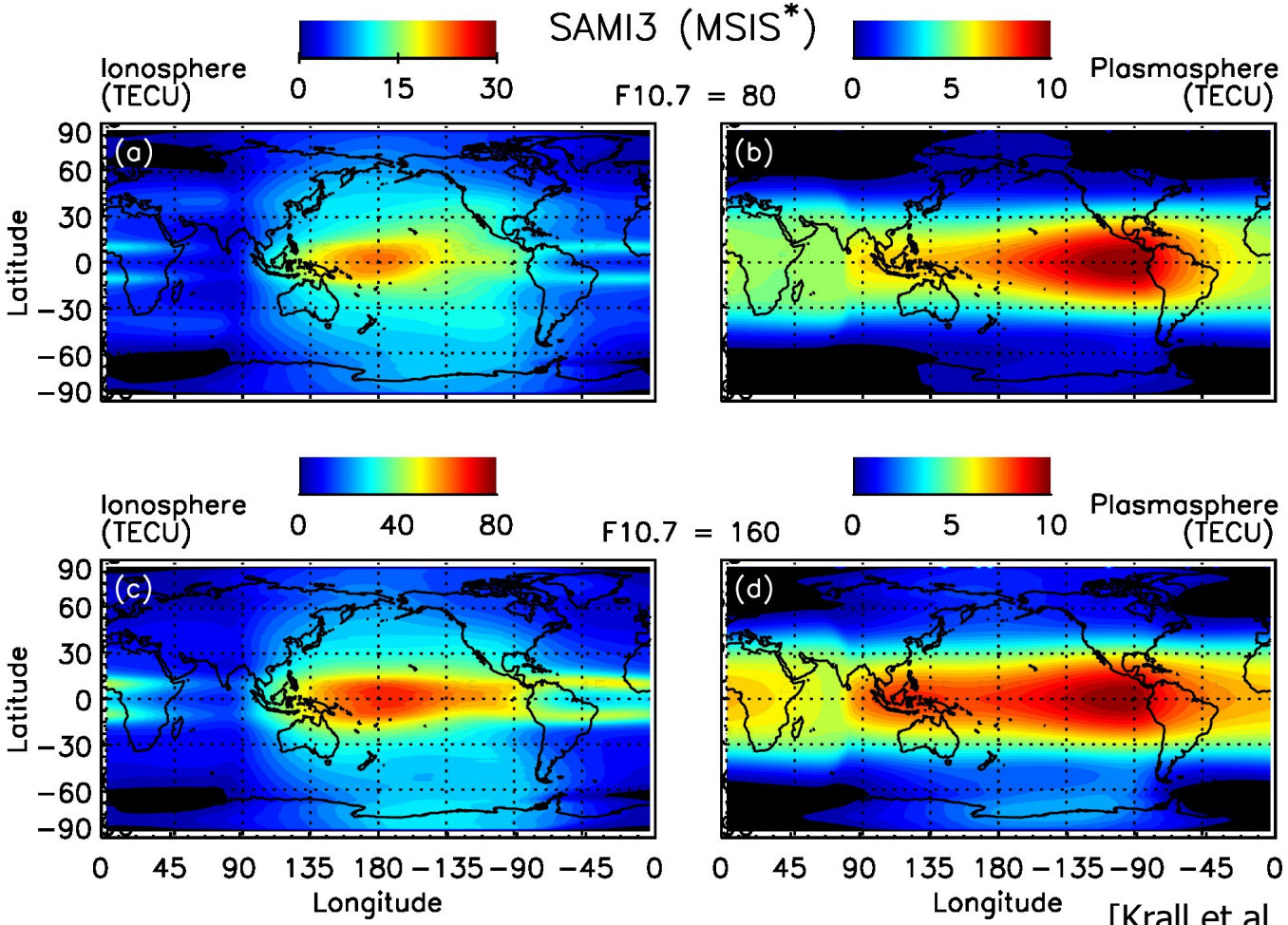


SAMI3 is coupled to a magnetosphere potential model and a thermosphere model.

[Huba et al., JGR, 2000; Huba and Joyce, GRL, 2010; Huba and Krall, GRL, 2013]

SAMI3/MSIS* agrees with observations

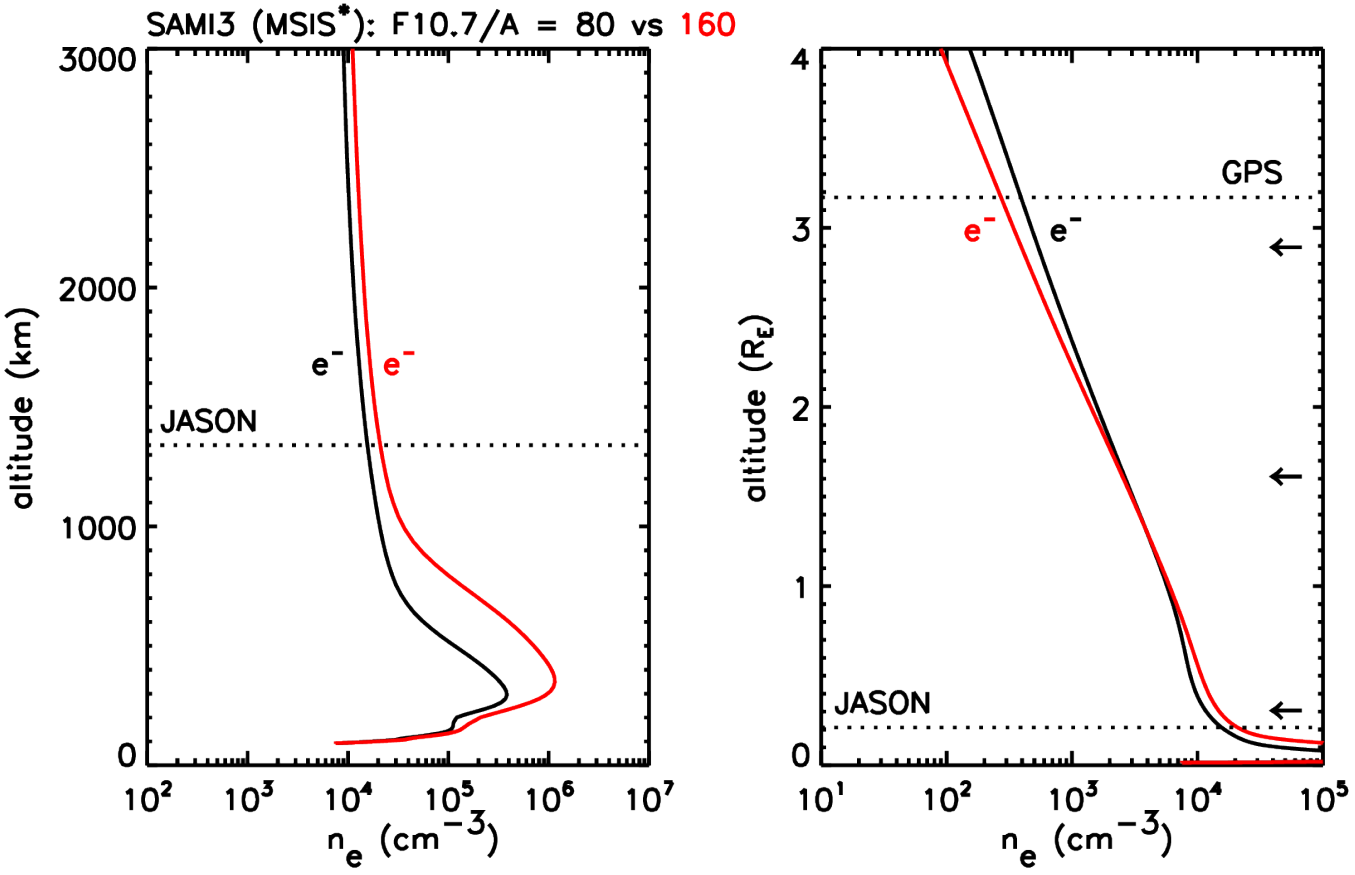
NRL PPD



[Krall et al., JGR, 2016]

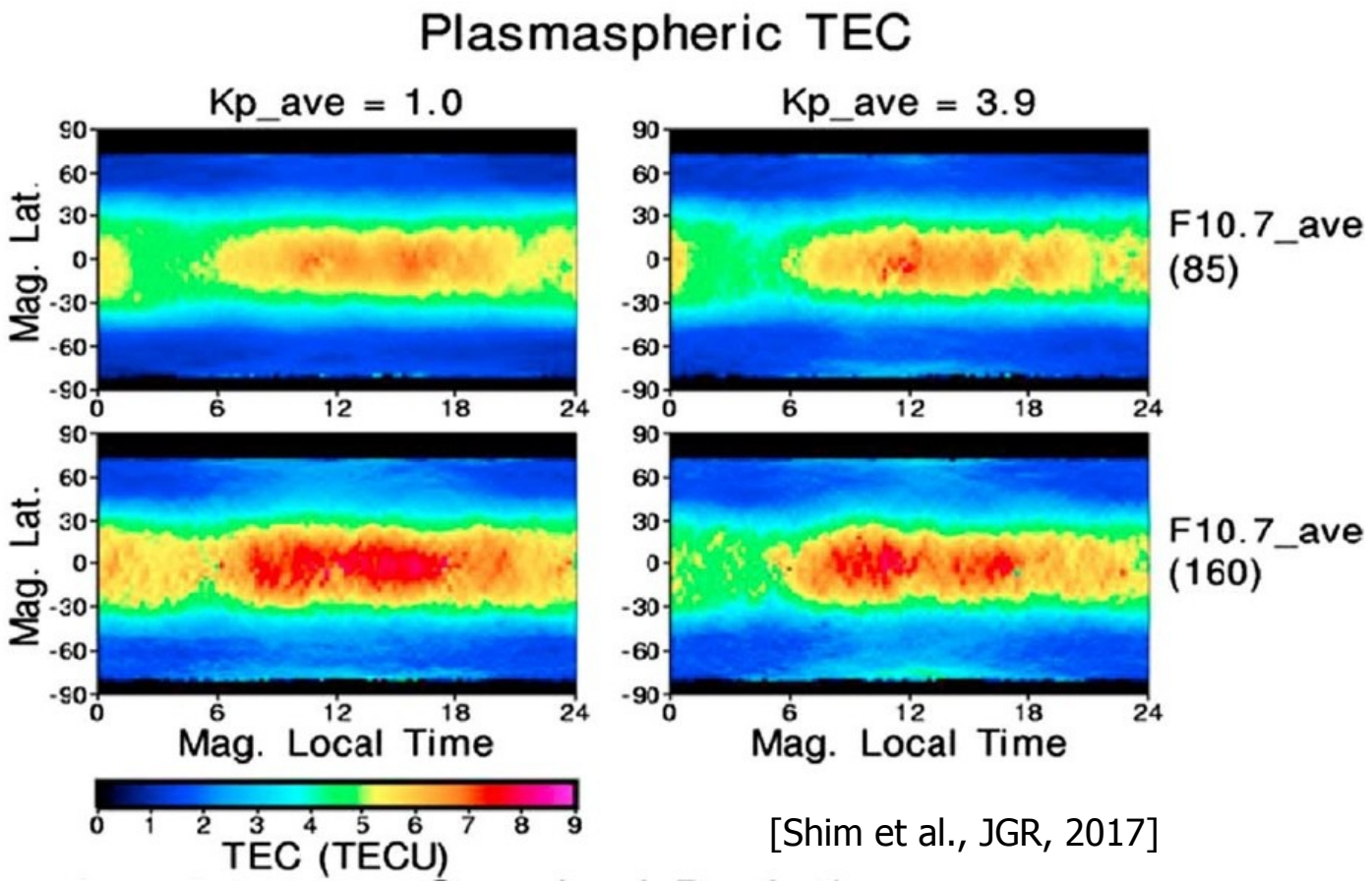
As in measurements, both TEC and pTEC increase with F10.7.

TEC measures near-Earth electrons



At solar max, O/O^+ collisions limit O^+ and H^+, reducing refilling. This effect can be seen a high altitudes.

pTEC isn't strongly affected by storms

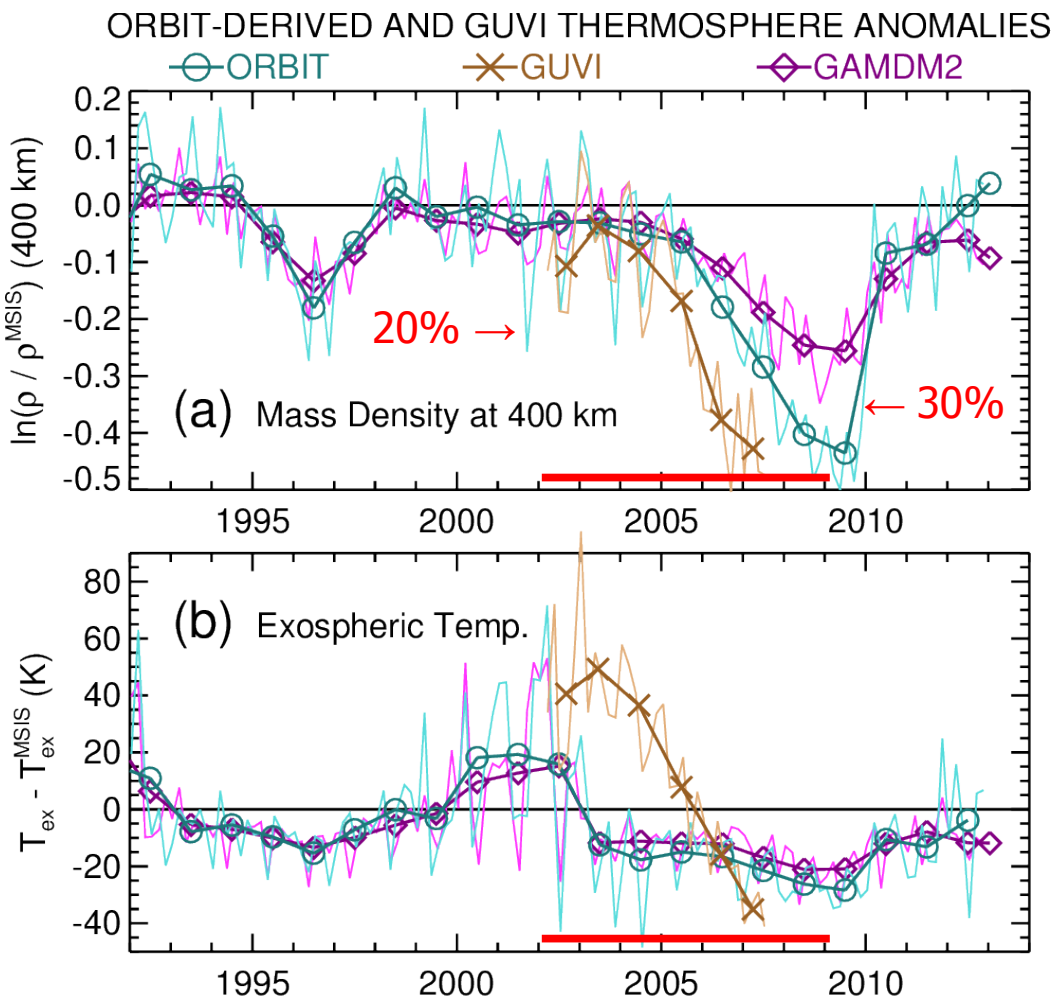


[Shim et al., JGR, 2017]

Related to the fact that pTEC isn't strongly affected by the refilling rate, it is also not strongly affected by storms.

pTEC is sensitive to the atmosphere

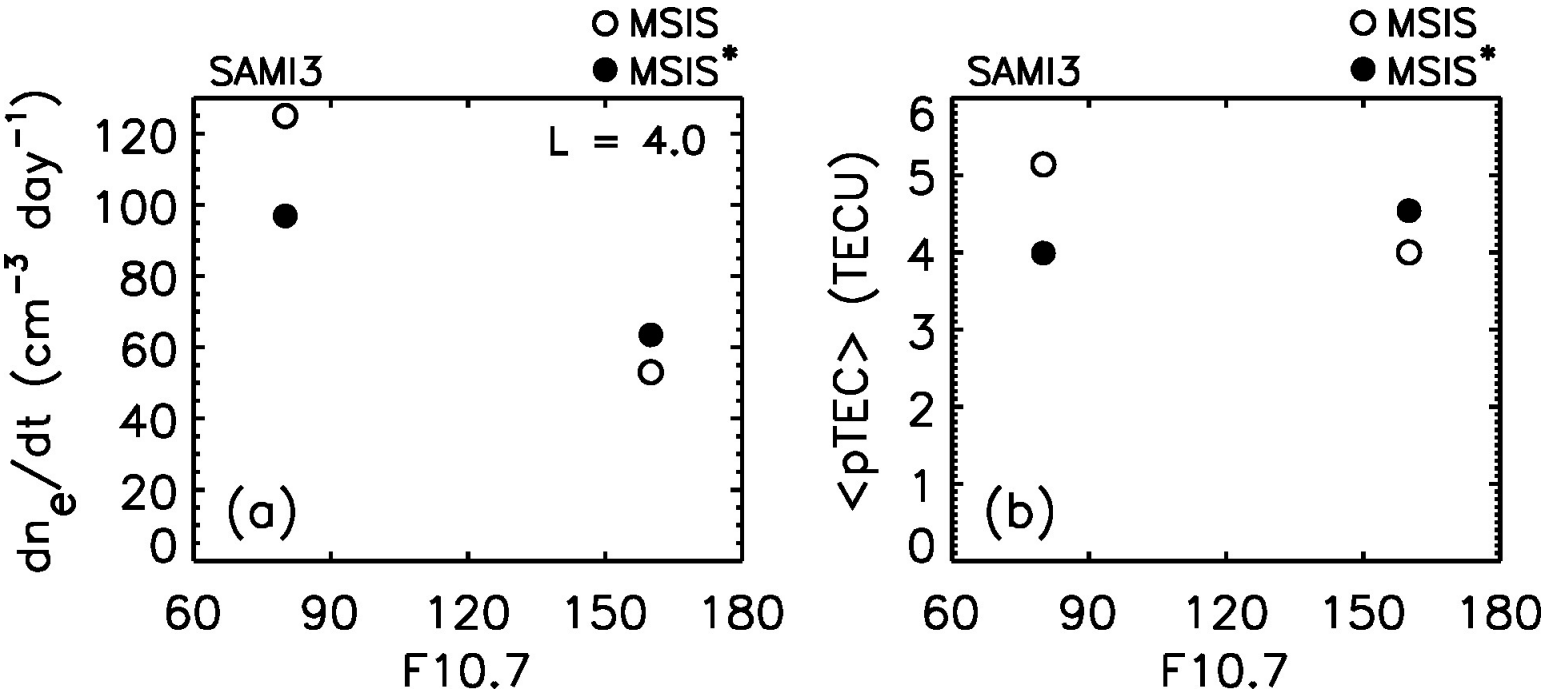
[Emmert et al., JGR, 2014]



Measured density variations of 20% are common.

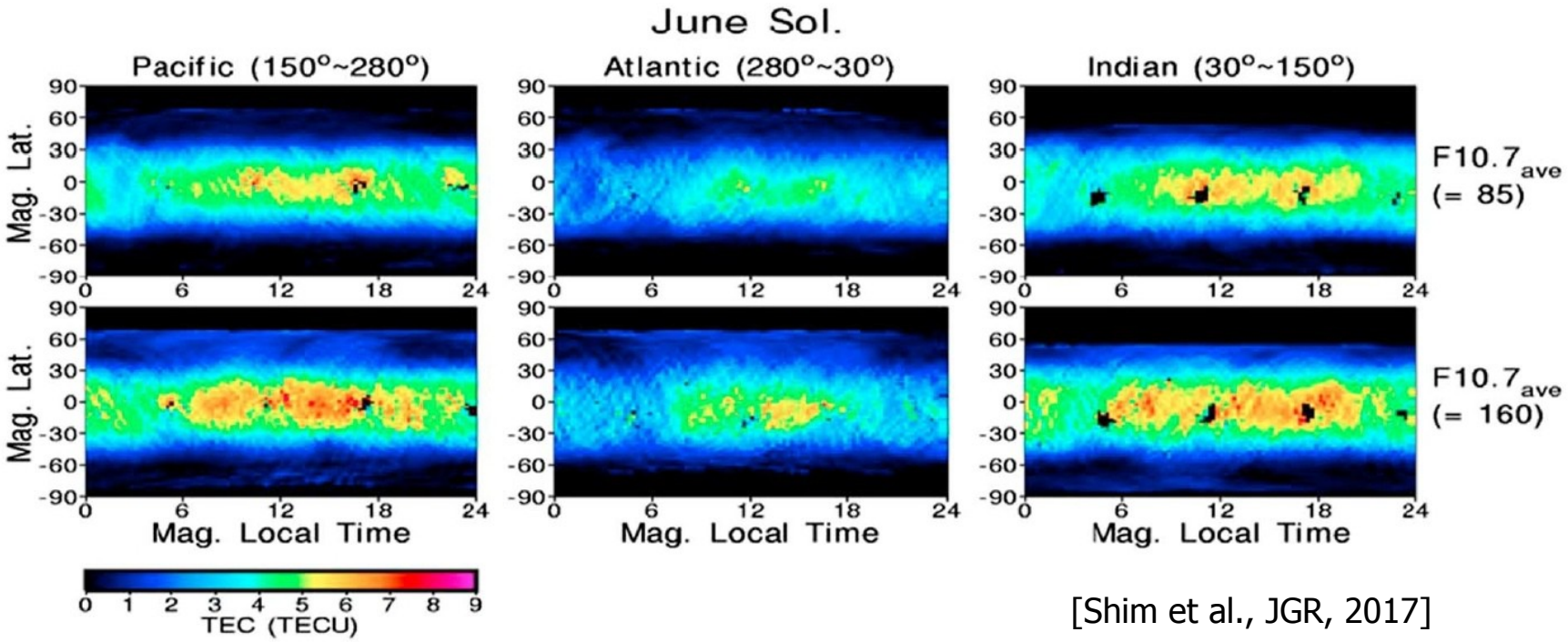
Fine lines are 61-day averages (Yaw cycle).

SAMI3/MSIS* reproduces the paradox



SAMI3 with the MSIS* modified atmosphere (black dots) reproduces the paradox: refilling rates fall vs F10.7 while pTEC increases vs F10.7.

PTEC does show variation with longitude



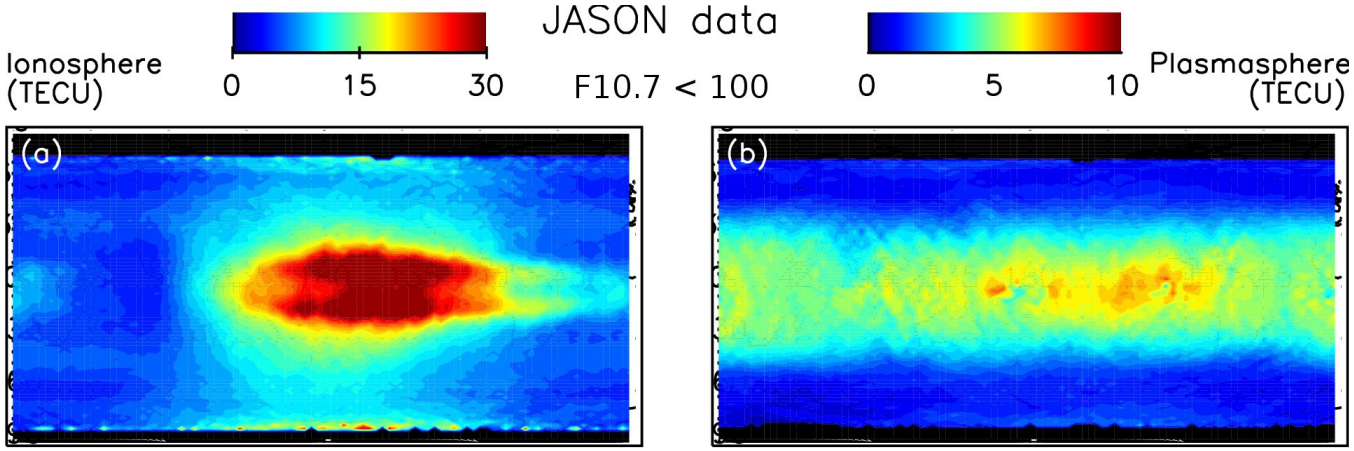
[Shim et al., JGR, 2017]

pTEC is insensitive to the solar cycle

pTEC commonly contributes 5-10 TECU to TEC.

pTEC is sensitive to atmosphere in a way that reduces its variation with solar cycle.

At night, pTEC can exceed TEC.



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