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Effects of 6300 Å Airglow Altitude Variations

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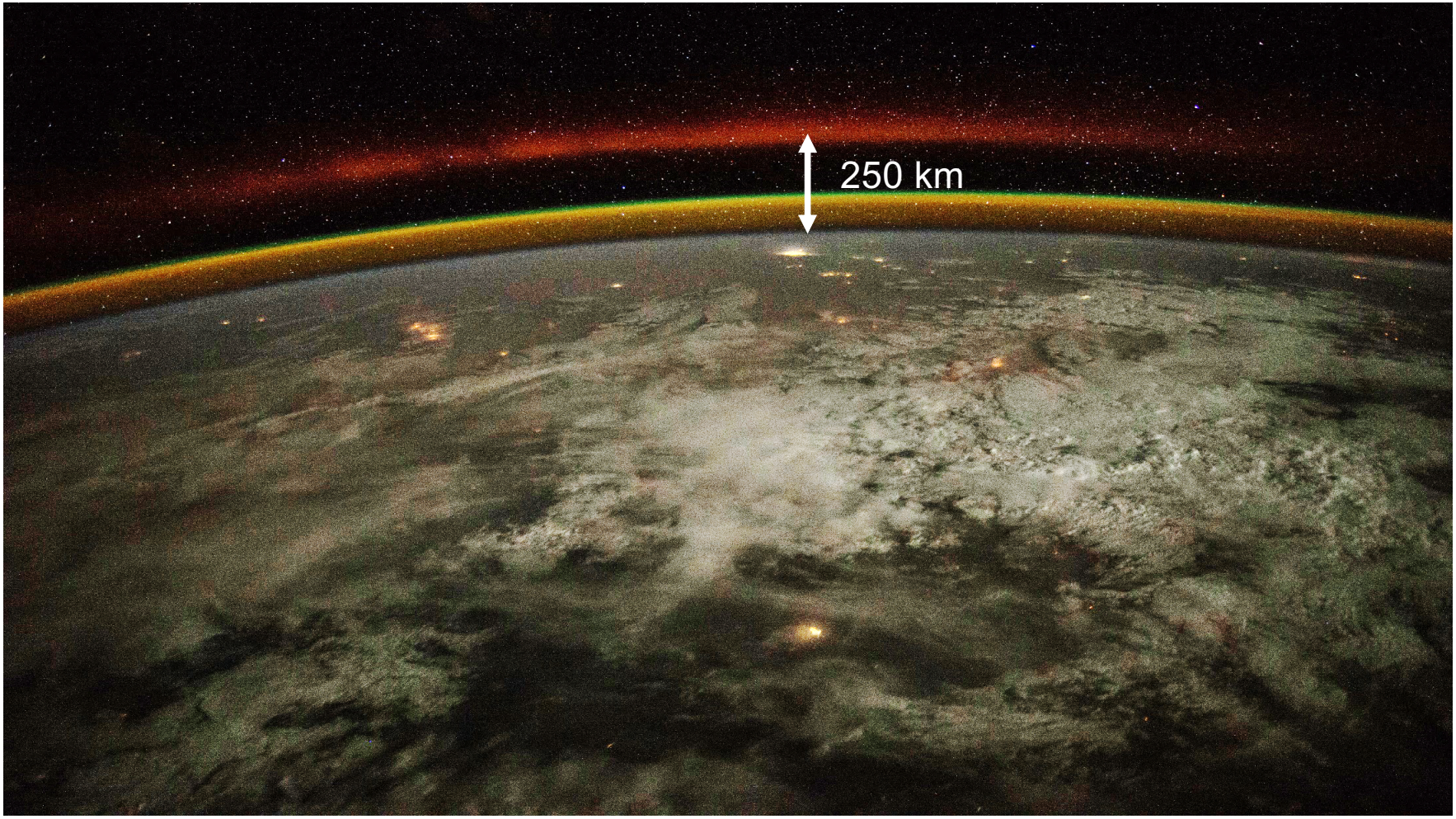
6300 Å Airglow Altitude: 250 km?

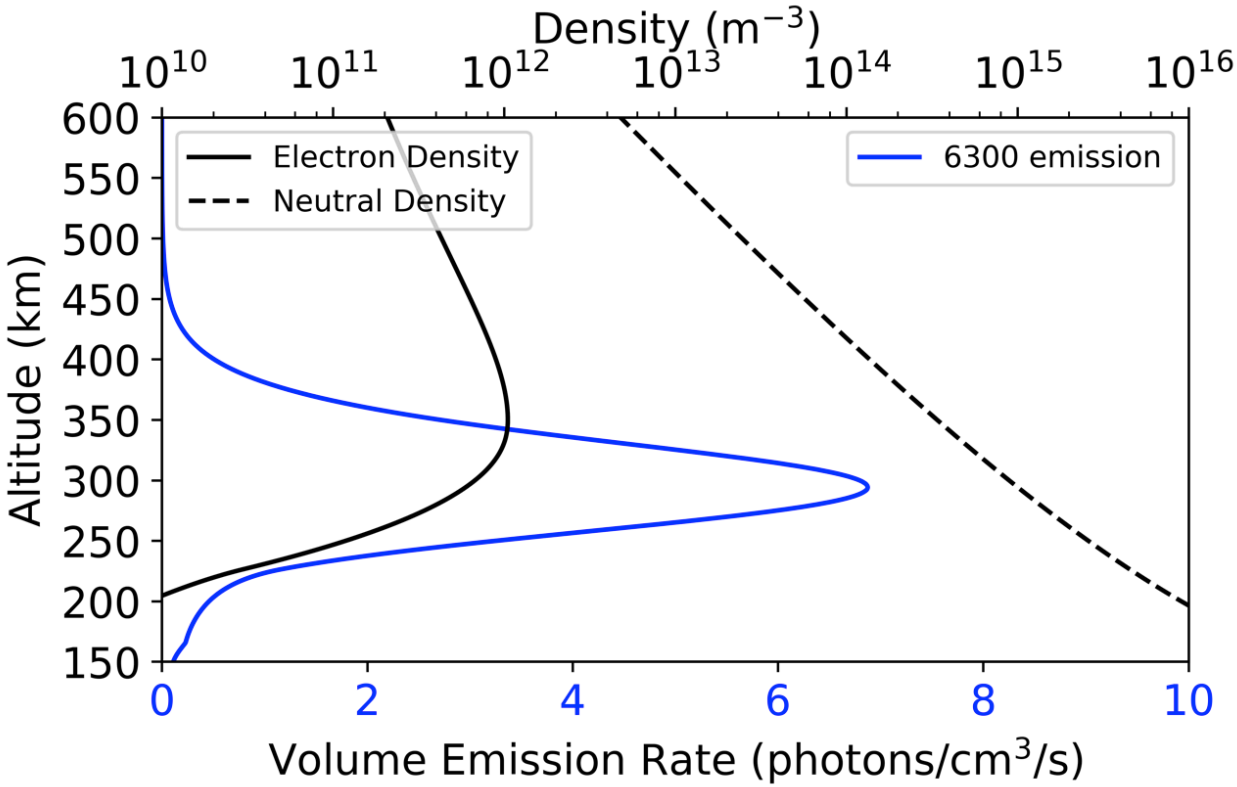


Earth Science and Remote Sensing Unit, NASA Johnson Space Center, ISS043-E-3310

Determining Airglow Altitude

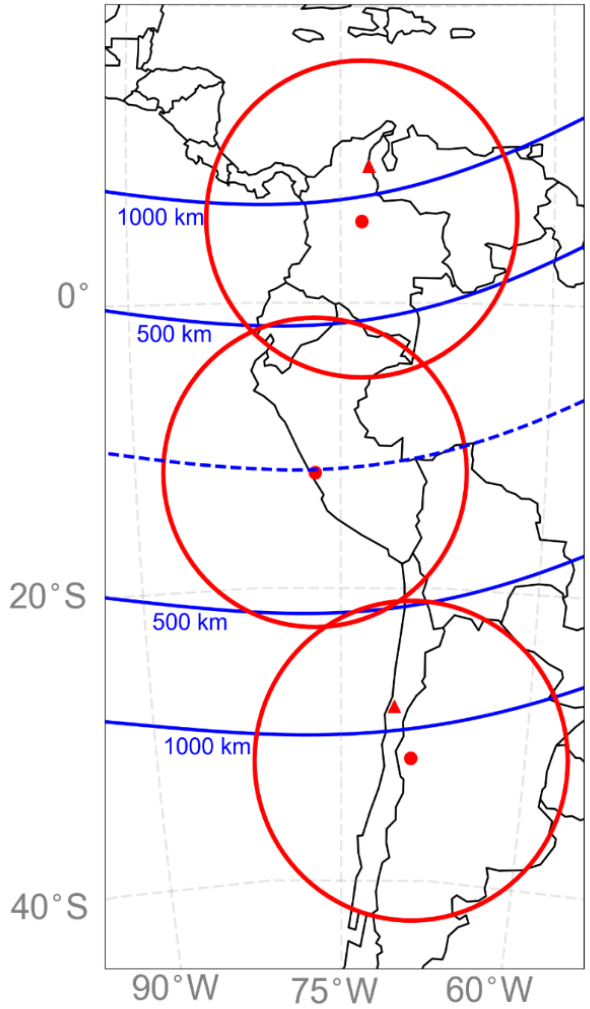
- $O^+ + O_2 \rightarrow O_2^+ + O$
- $O_2^+ + e^- \rightarrow O + O^*$
- $O^* \rightarrow O + 6300$ Å

- Peak emission is usually about 50 km below F peak
- Emission is proportional to electron density and height
- **Measurements of the background neutrals, ions, and electrons are needed to fully compute the emission profile**



- Integrated gives rayleighs
- 1 R =10^6 photons/cm^2/s

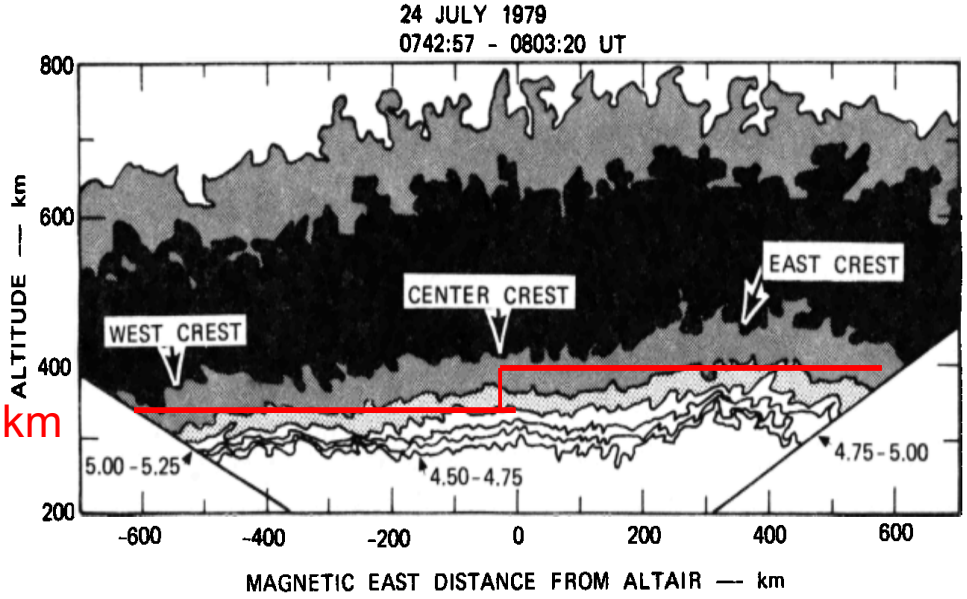
All-sky imager field of view



- All-sky imager (ASI) fields of view can cover a diameter of about 2000 km
- Fabry-Perot Interferometers often measure the ionosphere in a region with a diameter of about 500 km
- These fields of view can cover regions with significant geomagnetic and geographic variation
- ASIs used for ESF observations are often located near the magnetic equator and the equatorial ionization crests

Are the ionosphere and thermosphere constant at these scales?

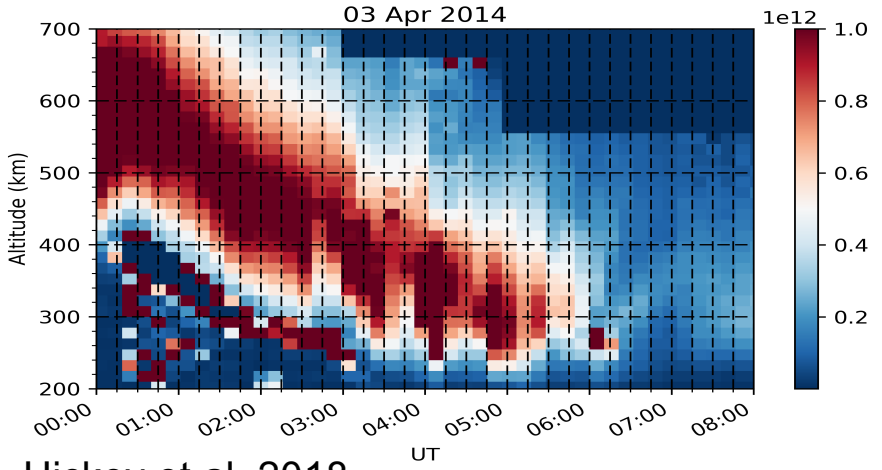
- Lack of measurements to determine variability on these scales
- Empirical models do not capture variation at this scale
  - Grid size limitations
  - Lack of measurements



~ 50 km

Tsunoda and White, 1981

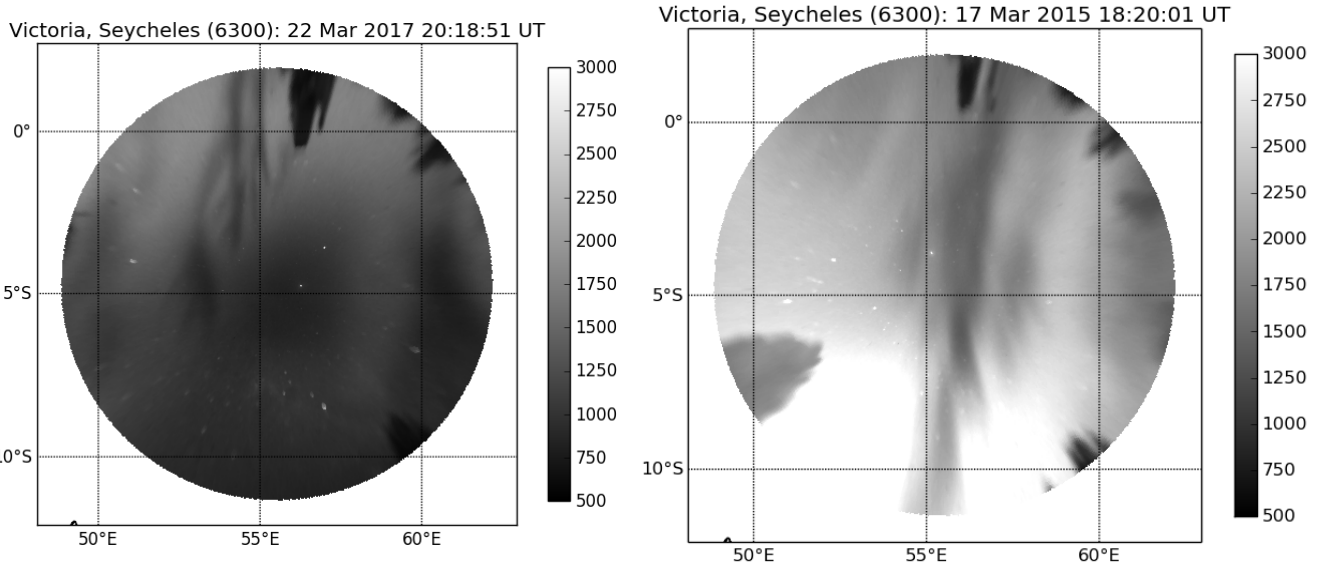
- Large altitude variation with time at the magnetic equator due to the prereversal enhancement



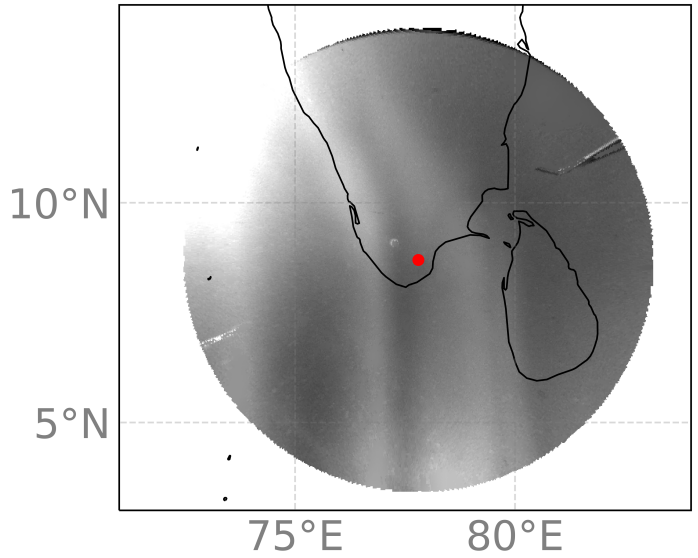
Hickey et al. 2018

Evidence of possible altitude variations

- Brightness variations
  - Hard to separate from other effects such as electron density variations

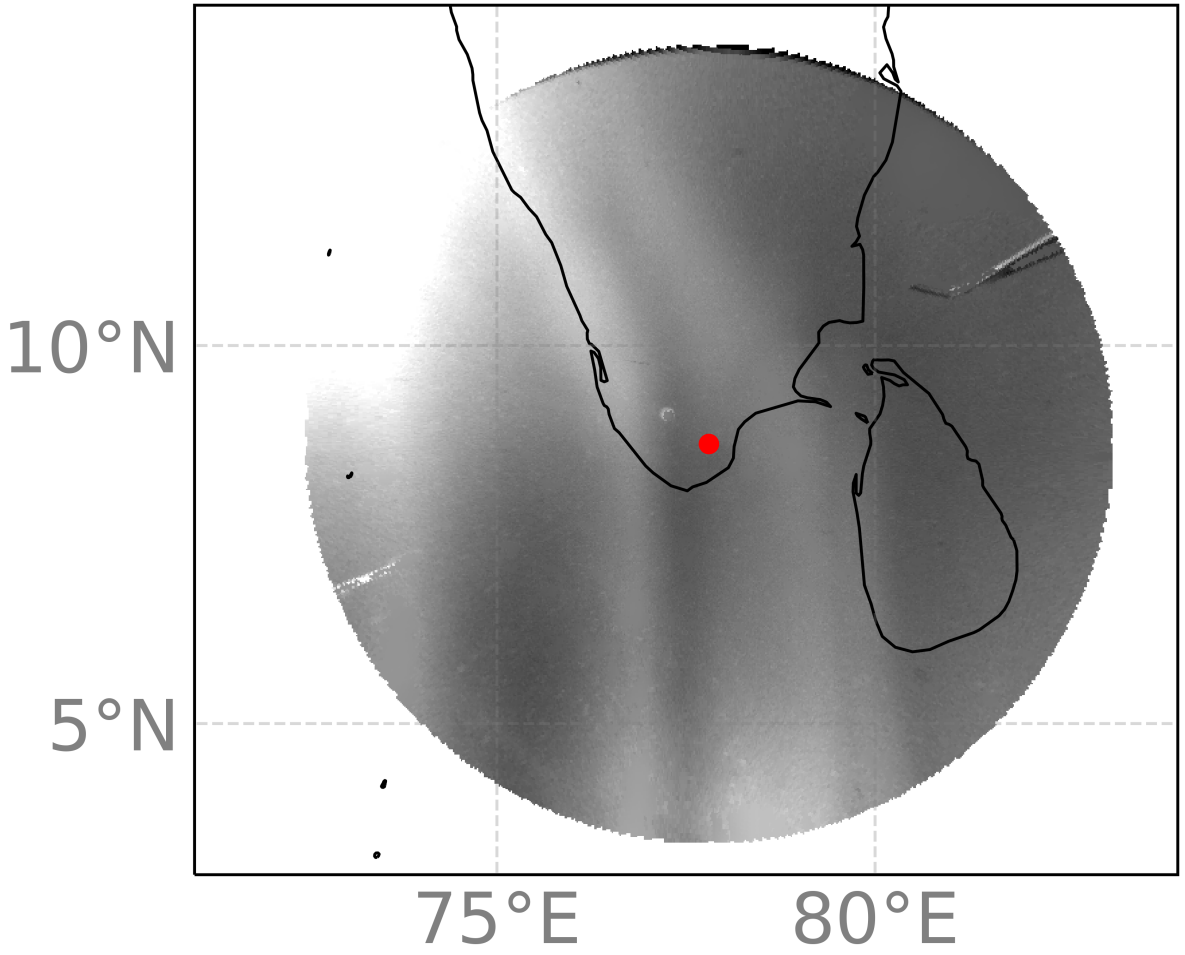


- Features that are not conjugate



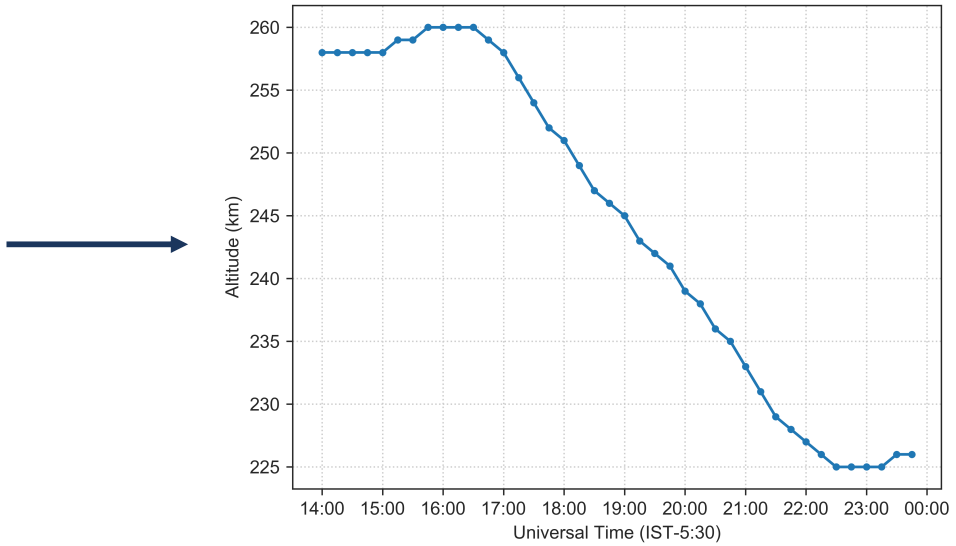
India ASI Case Study

- Sau et al. 2017 showed airglow depletions that are asymmetric with regards to the magnetic equator
- We propose that this asymmetry is due to a variation in airglow altitude across the image

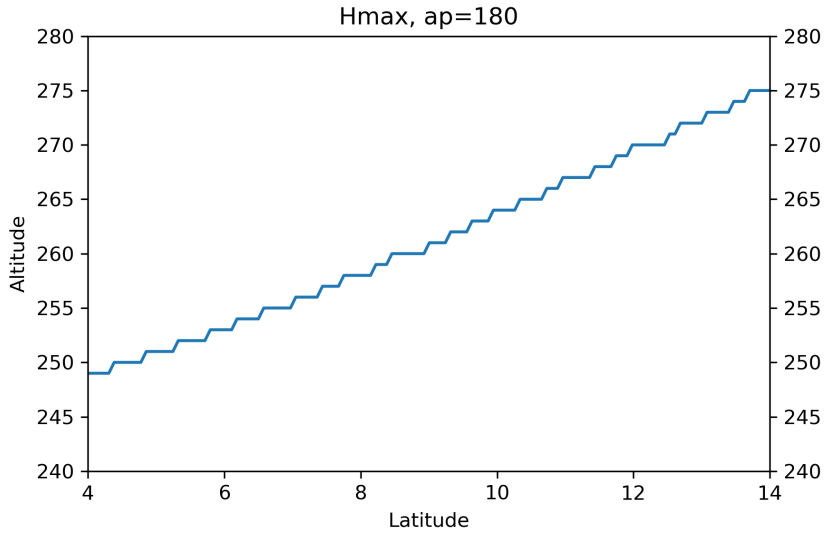


India ASI Case Study

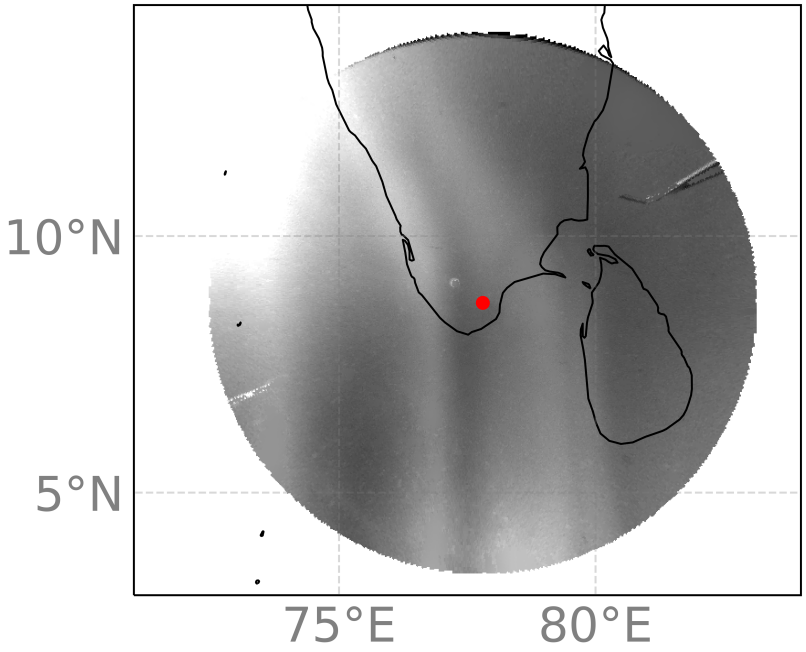
- Airglow calculations from empirical models show altitude variation throughout the night but not much in across the image

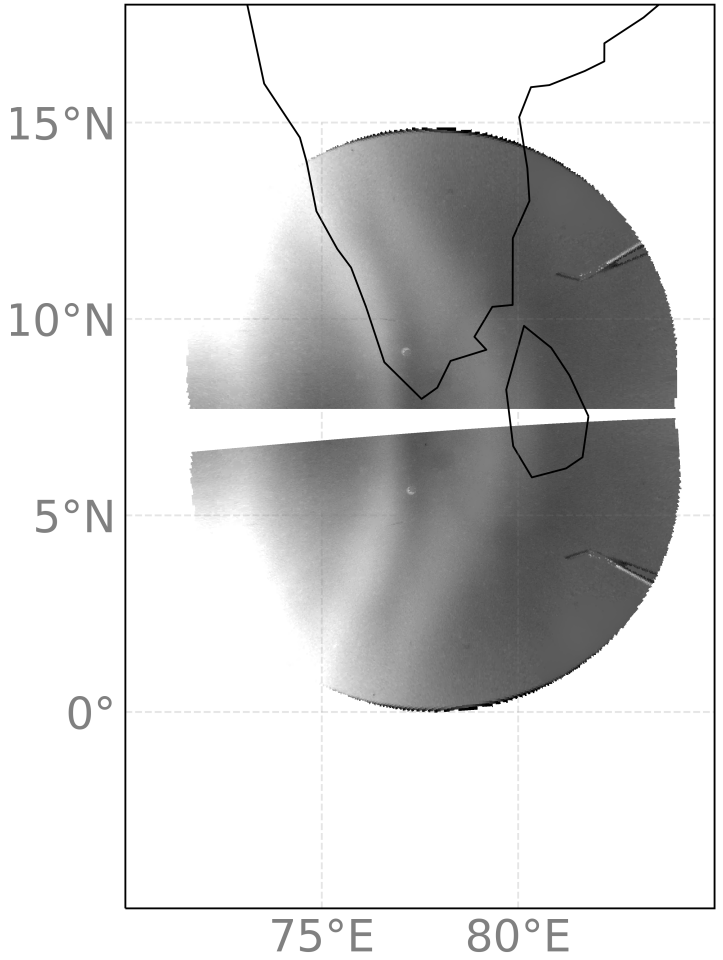


- SAMI2 results indicate that a variation in altitude of 25 km could occur on this night
- Altitude variation is 10 km larger during geomagnetically active time



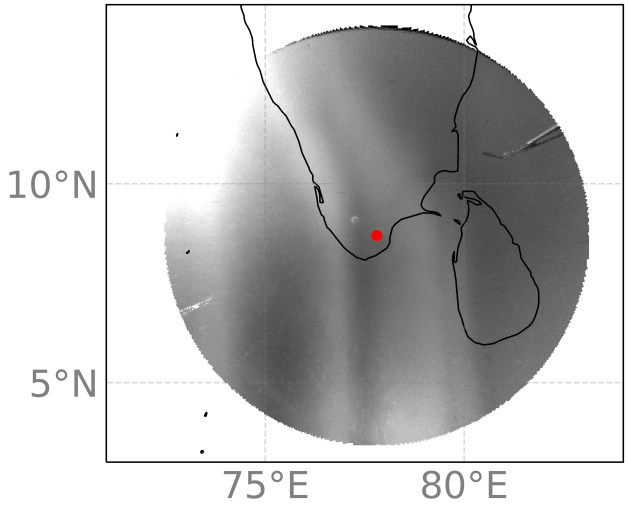
Impact of Airglow Altitude Variation

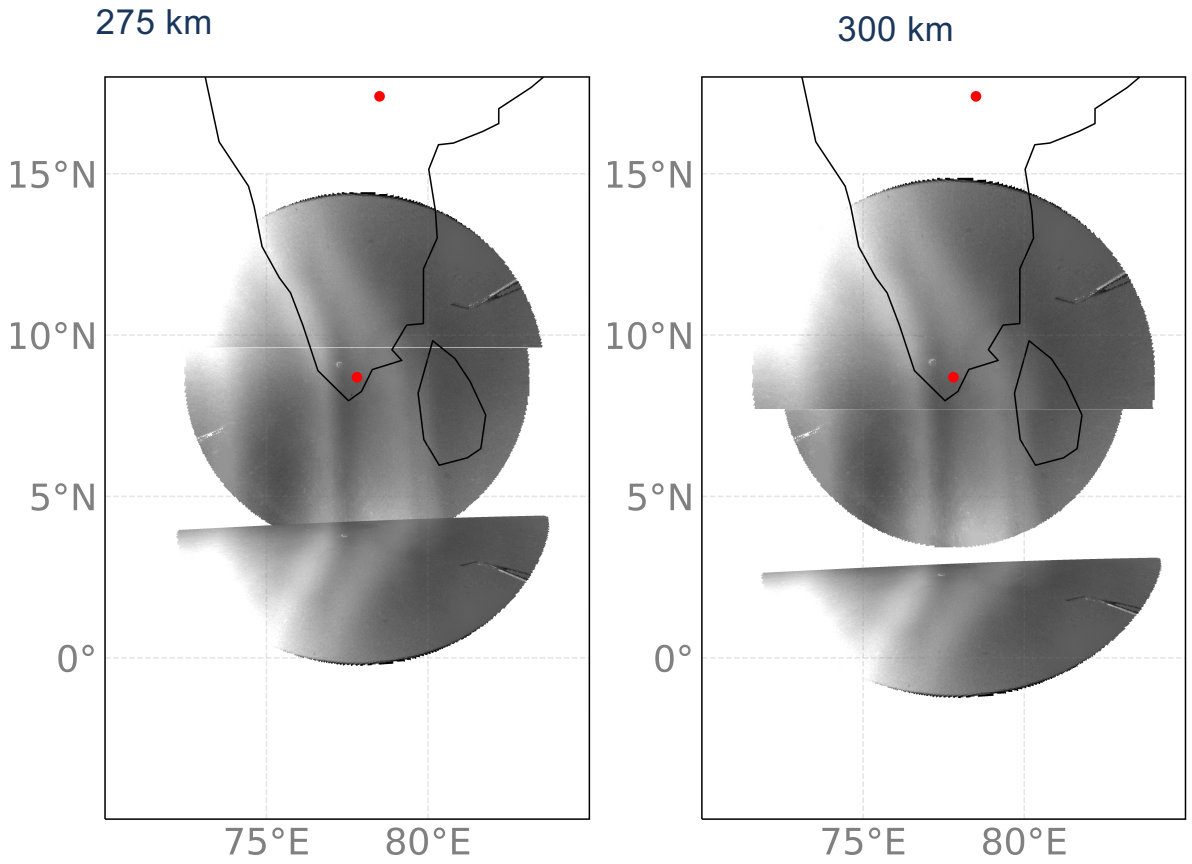




- These results show the original image (left) and what happens when the northern half of the image is mapped along field lines to the southern half (right)
- This is what would be expected if the features were conjugate

Impact of Airglow Altitude Variation



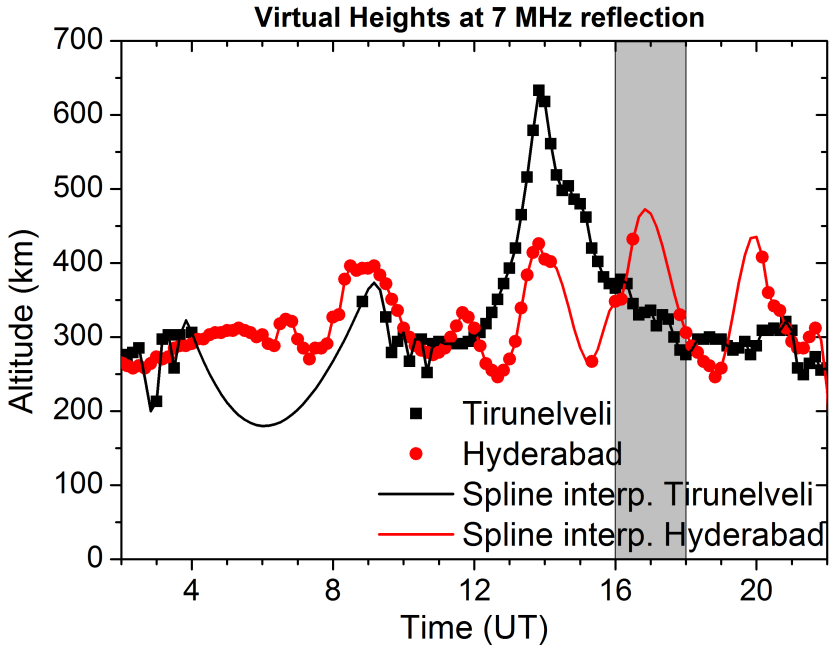


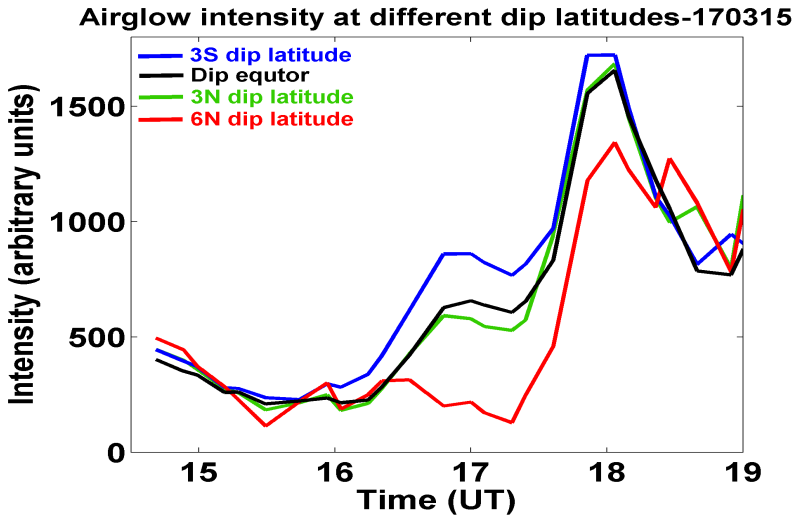
- For these images, the northern half is unwarped at a higher altitude and mapped along field lines and projected in the southern half, along with the original image at 250 km

- This shows that an altitude variation can account for the asymmetry

Evidence for the Variation

- Nearby ionosondes provide evidence for a variation in altitude
- Ionosondes and ISRs can help to a determine airglow altitude
- Airglow intensity also shows weaker airglow to the north





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Summary

- 6300 Å airglow altitudes are often assumed to be 250 km at all times and at all locations
- Deviations from this assumed altitude can affect the interpretation of results
- Variation throughout the night is common and variation within an image is possible
- We have shown a case where non-conjugate features lead us to believe there is a significant variation in airglow altitude within the image
- Accounting for this variation:
  - Local measurements from ionosondes, ISRs, GPS, and satellites
  - Running empirical and physics based models

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