ICON FUV Disk Column O/N2

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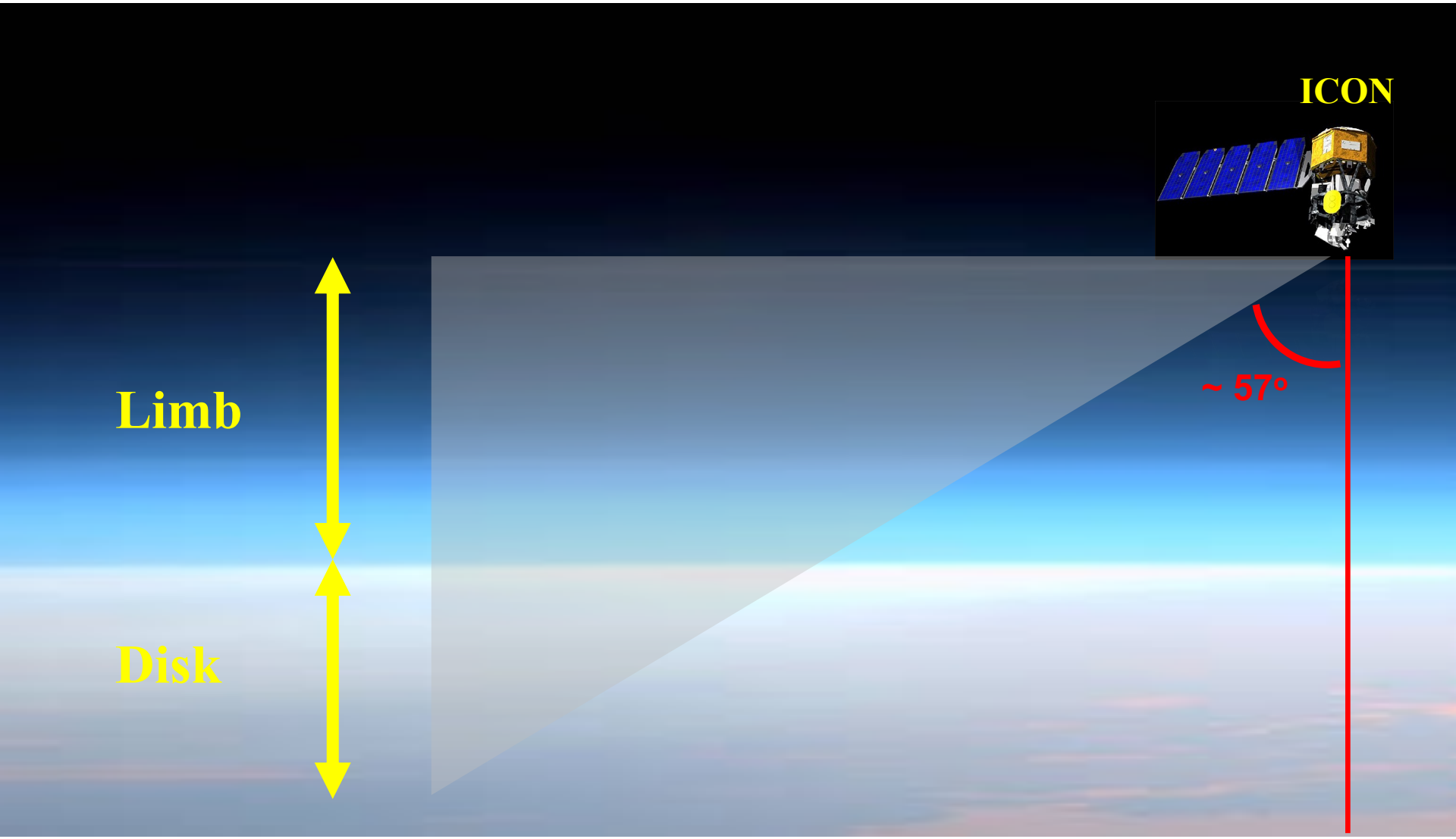
CEDAR ICON Data Tutorial Workshop

June 24, 2020

Topics

- Disk Column O/N_2 Retrieval
- ICON Disk Data Overview
- Summary
- Extras

Icon FUV Imaging



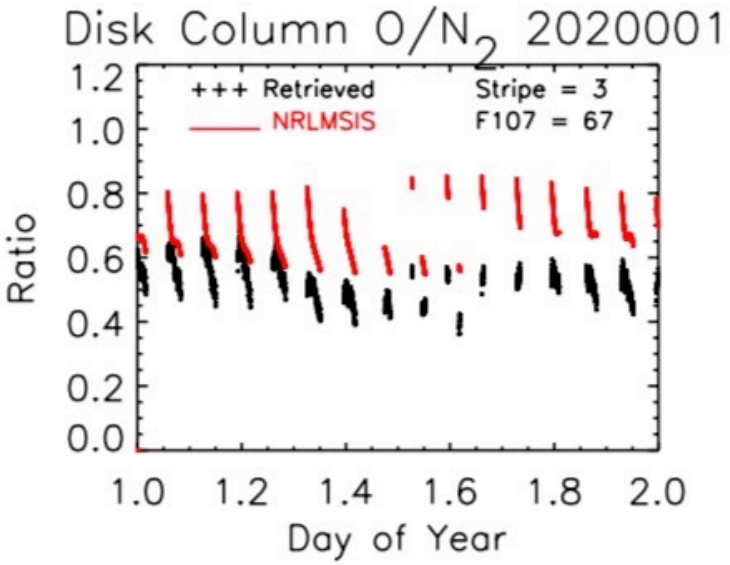
Disk column density ratio: $\Sigma O/N_2$

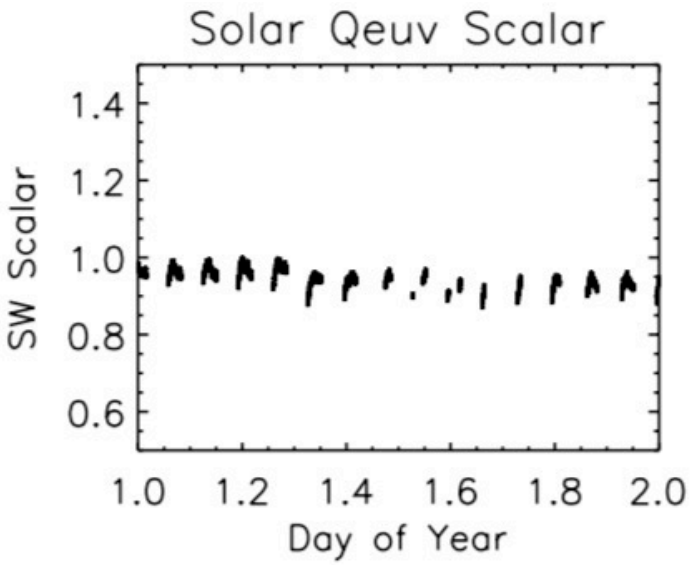
- **Why $\Sigma O/N_2$?**
  - Proportional to disk OI 135.6 nm / N_2 LBH band ratio
  - $\Sigma O/N_2$ responsive to thermospheric dynamics
  - Electron densities proportional to O/N_2
- **How to calculate $\Sigma O/N_2$ from model**
  - Integrate N_2 number density vertically downward to altitude where column density = 10^{17} cm^{-2}. Integrate O density above that altitude. Take ratio.
- **Symbolically**:

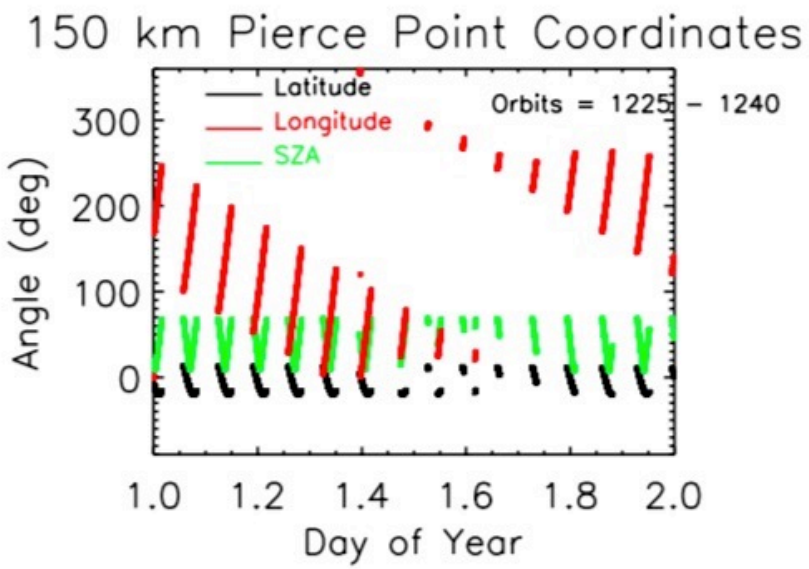
$$\sum \frac{O}{N_2} \equiv \frac{\int_{z_{17}}^{\infty} [O] dz}{\int_{z_{17}}^{\infty} [N_2] dz} = \frac{\int_0^{N_O} dN'_O}{\int_0^{N_{N_2}} dN'_{N_2}} = \frac{N_O}{10^{17} cm^{-2}}$$

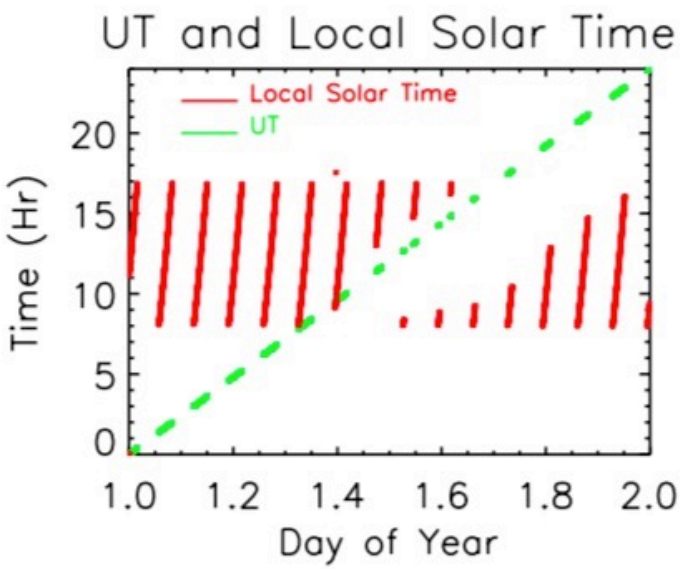
z_{17} = altitude where the N_2 vertical column density is $10^{17} cm^{-2}$

Disk Column O/N_2 Ratio







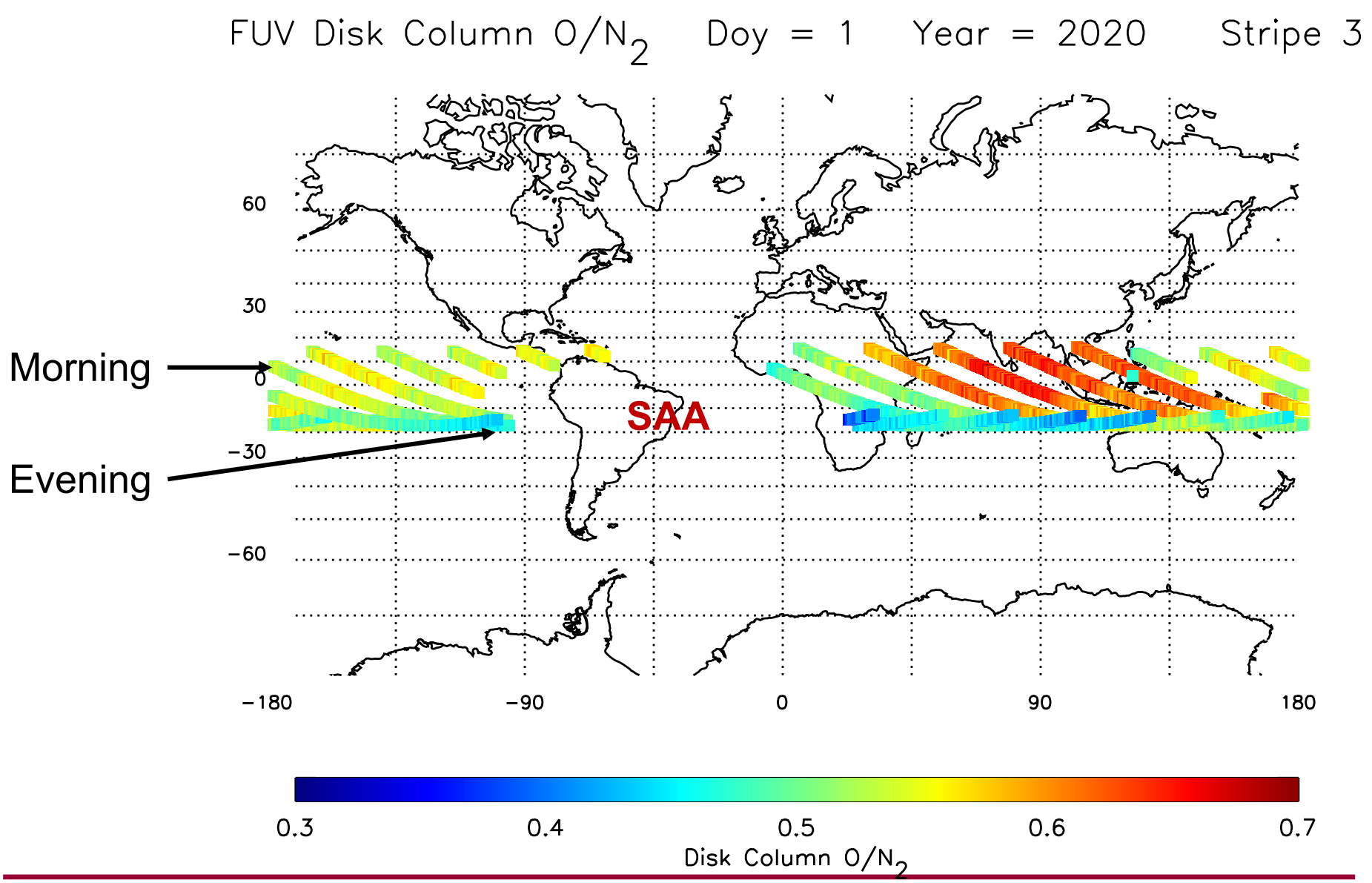


Comparison with NRLMSIS00

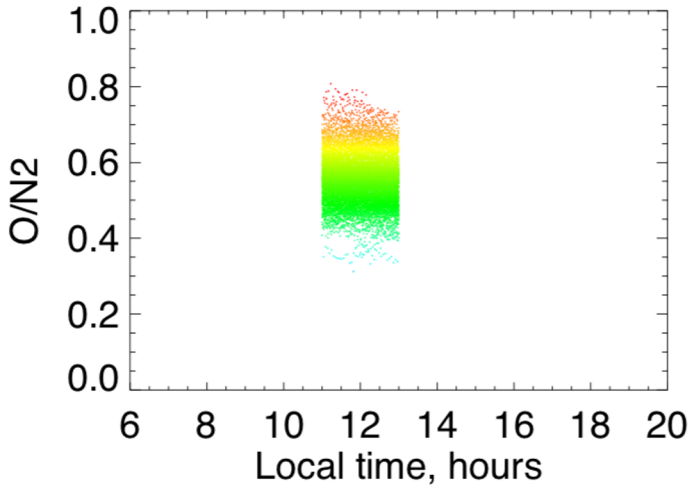
- **Median of $\Sigma O/N_2$ (MSIS) / $\Sigma O/N_2$ (ICON) = 0.80**
  - 5813 points on 1/1/20
  - F10 = 67.5

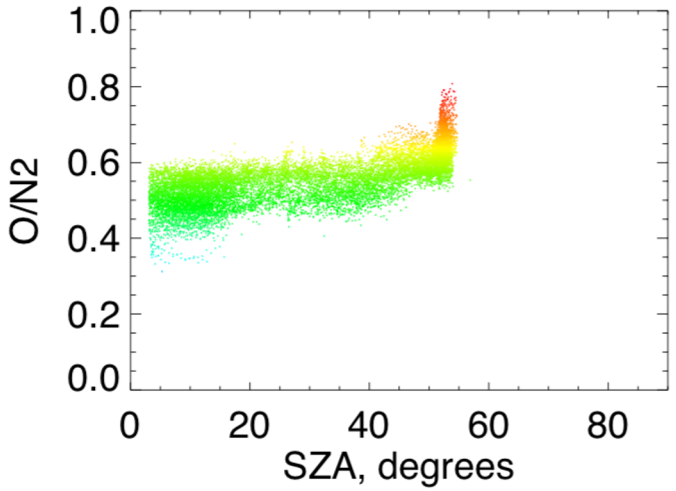
- **Median of $\Sigma O/N_2$ (MSIS) / $\Sigma O/N_2$ (GUVI) = 0.82**
  - Global UltraViolet Imager on TIMED satellite
  - Selected all observations where (65 < F10 < 70)
    - 1800+ data points
  - Mostly 2007

Disk Column O/N_2 Ratio

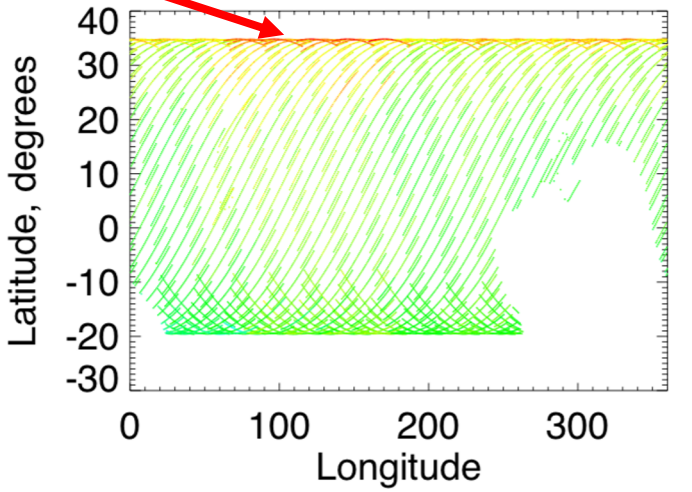


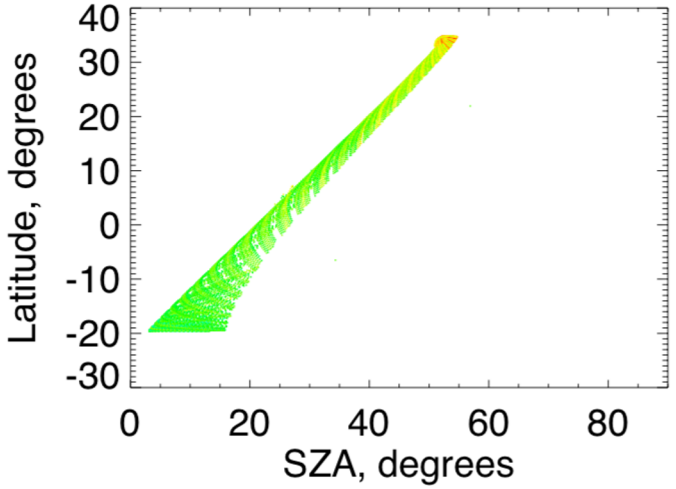
Looking near noon, January 2020



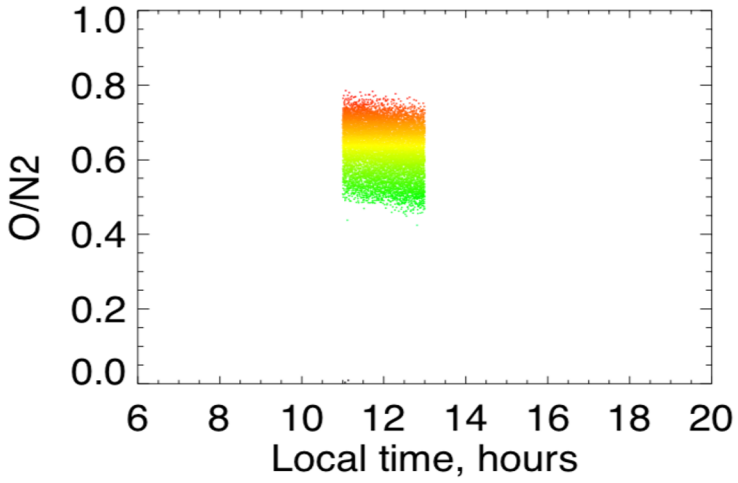


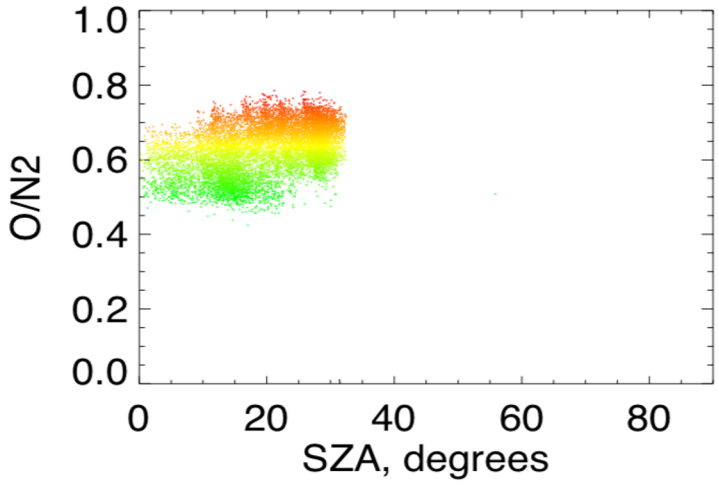
Higher ΣO/N_2 in Winter hemisphere



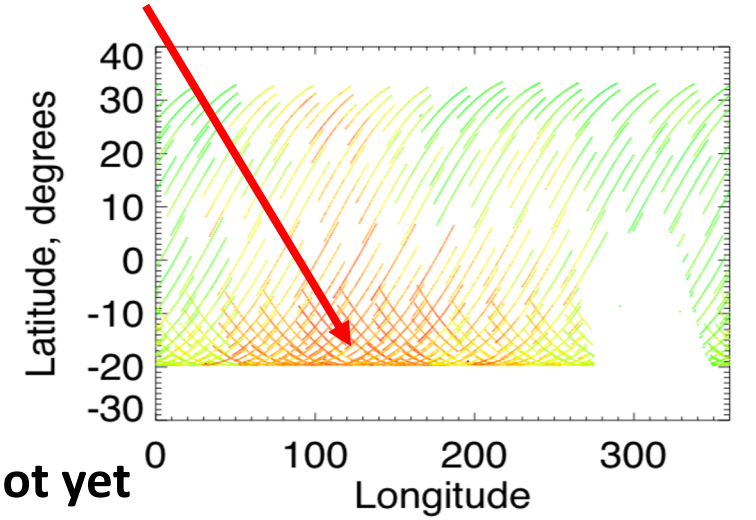


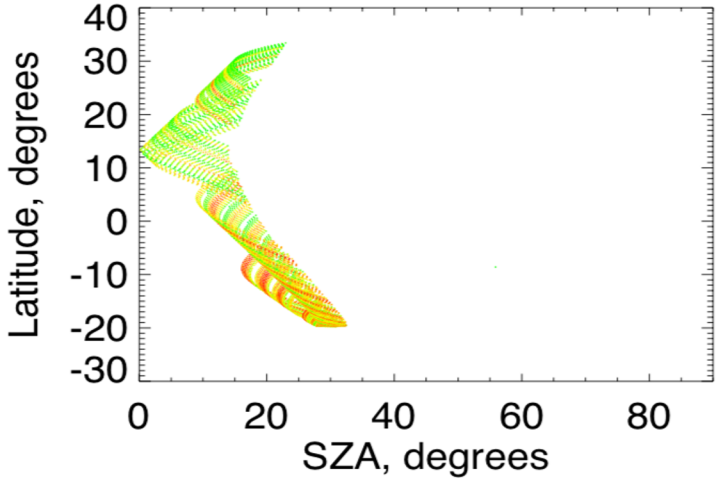
Looking near noon, April 2020





ΣO/N_2 higher in Southern Fall





Some data not yet processed

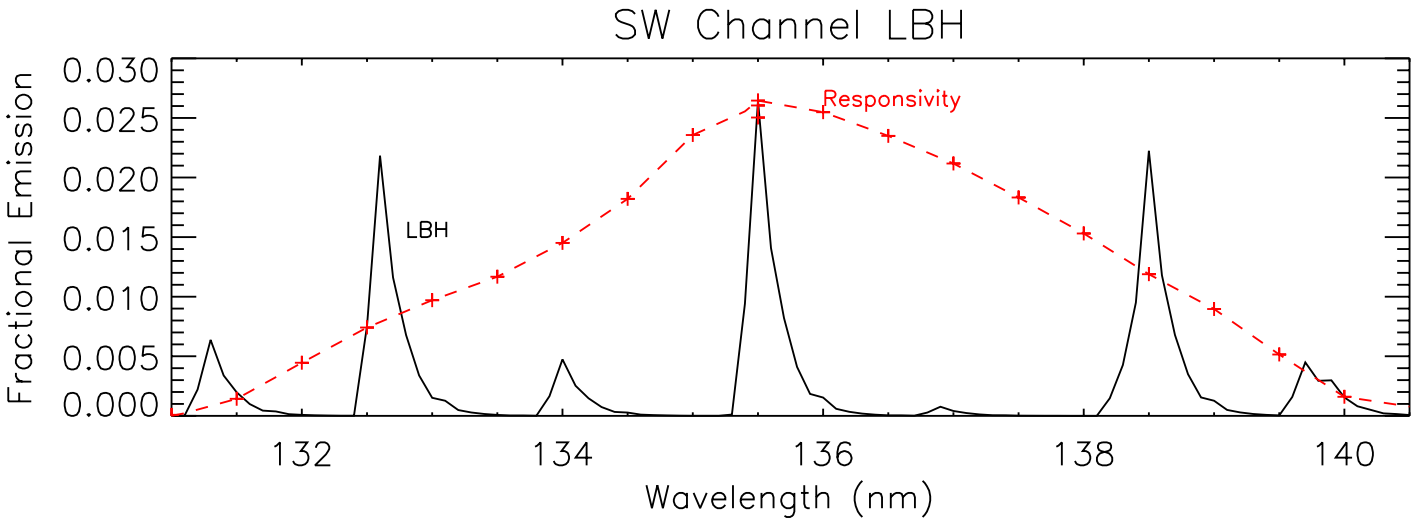
Summary

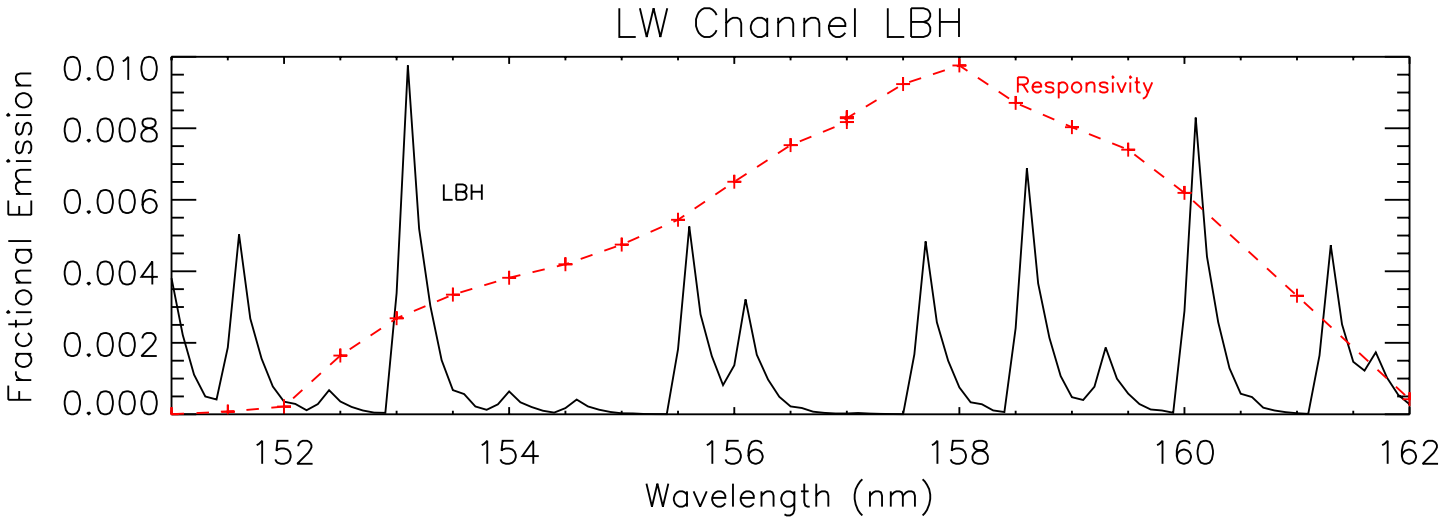
- ICON Disk $\Sigma O/N_2$ data quality is excellent
  - Data show seasonal variability
- $\Sigma O/N_2$ can be compared directly with models
  - Expect to see annual and semiannual oscillations, possibly tidal components
- ICON $\Sigma O/N_2$ typically lower than NRLMSIS00 by 20%
- Excellent agreement with GUVI at solar min
  - 13 years apart
- Limb data coming later

Extras

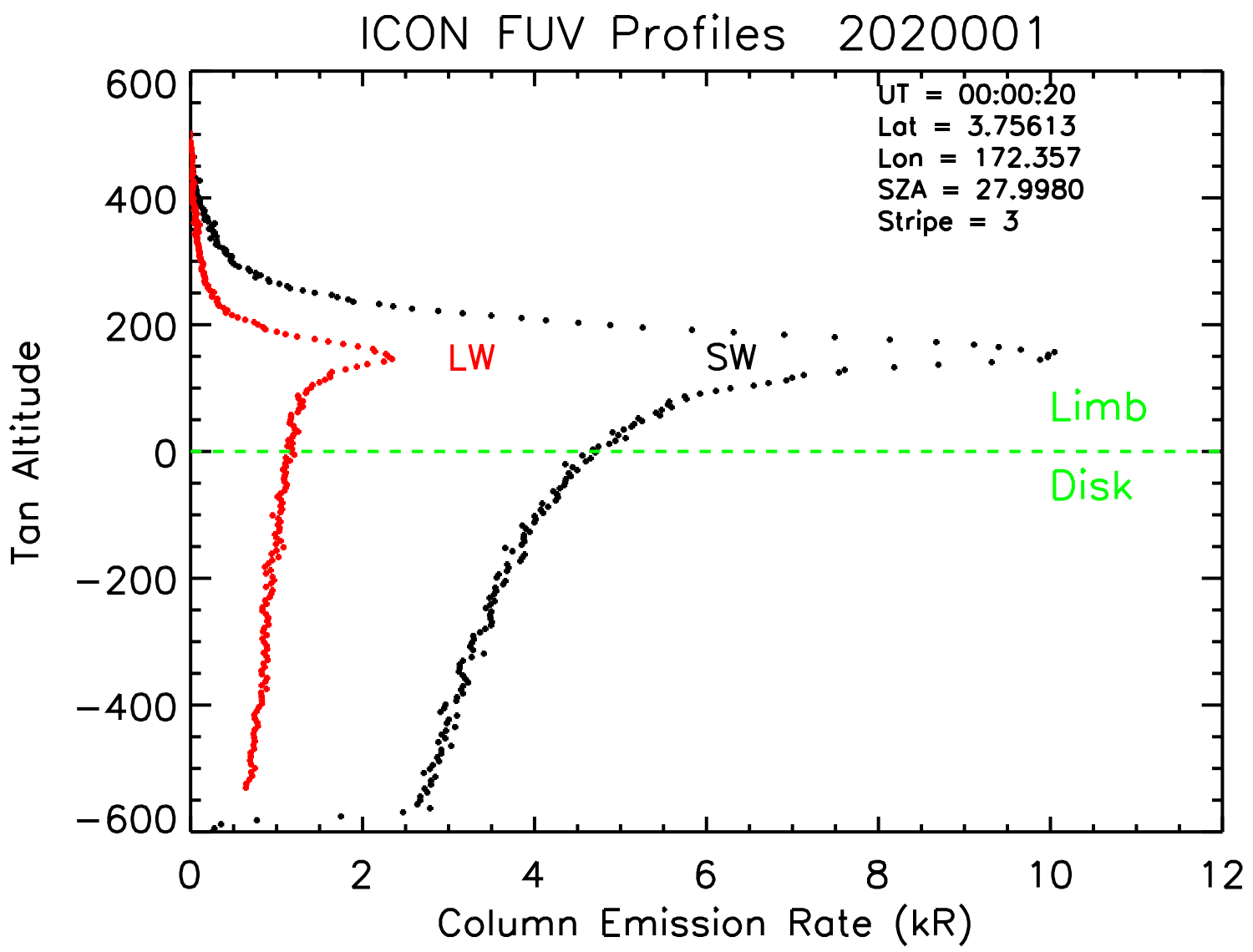
LBH emissions in SW and LW Channels

OI 135.6 nm not shown

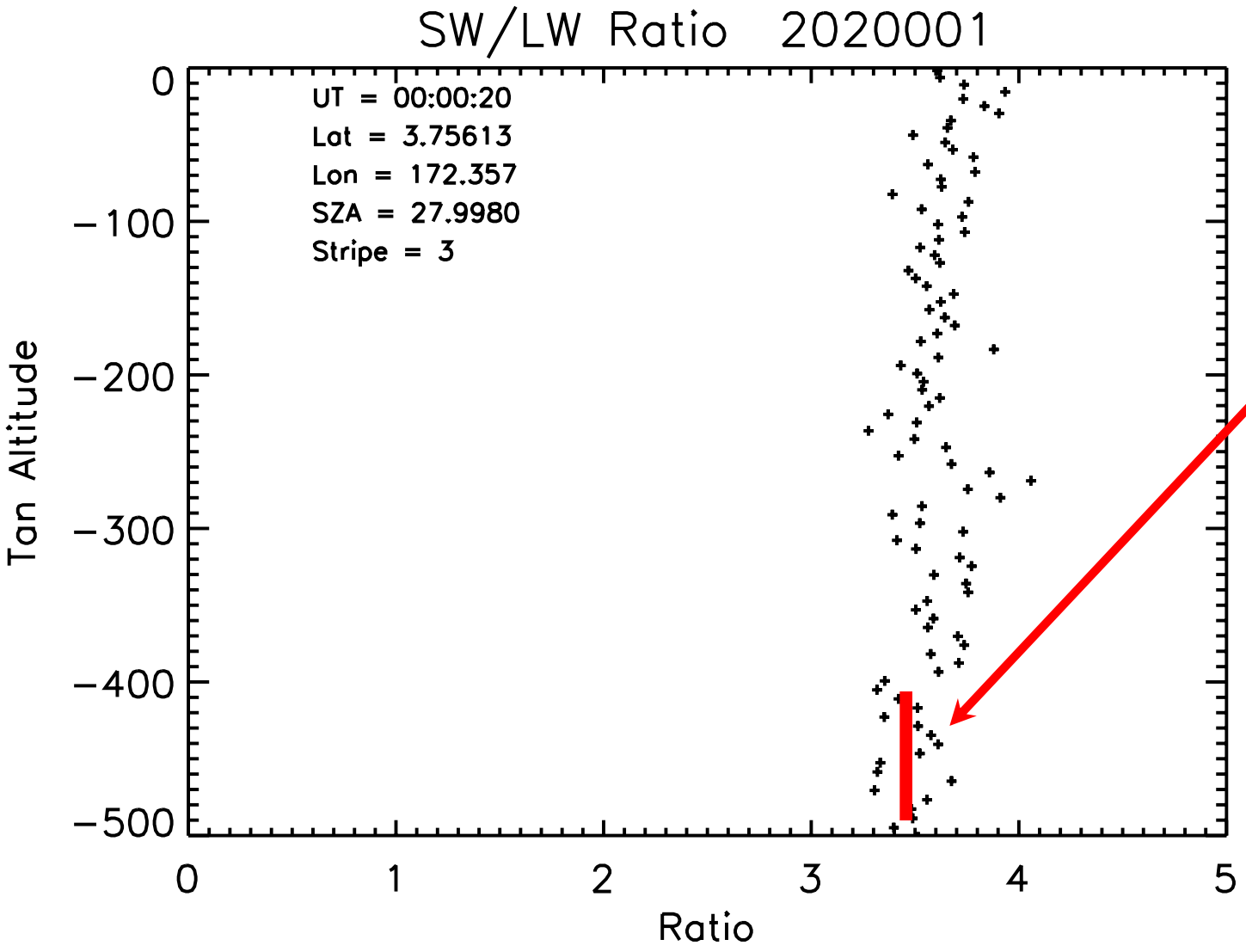




Typical ICON FUV Profiles



Disk SW/LW Ratio



Use mean for disk algorithm

Disk algorithm concept

- Developed by Strickland et al. [JGR, 100, 12,217, 1995]
- They showed that the ratio of column densities is proportional to the intensity ratio for viewing on the disk.

$$\frac{N(O)}{N(N_2)} \propto \frac{I_{135.6}}{I_{LBH}}$$

- Relationship varies with
  - Solar zenith angle
  - Angle from nadir (& sun)
  - Solar activity level

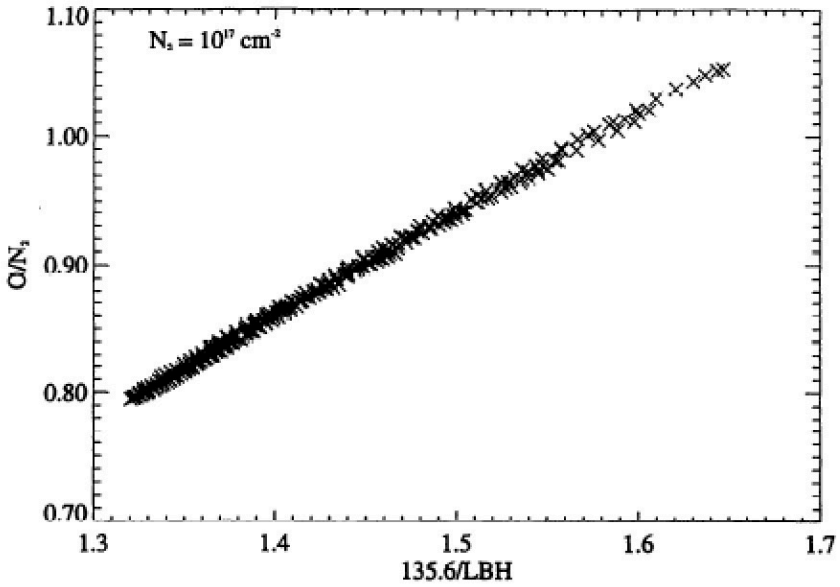
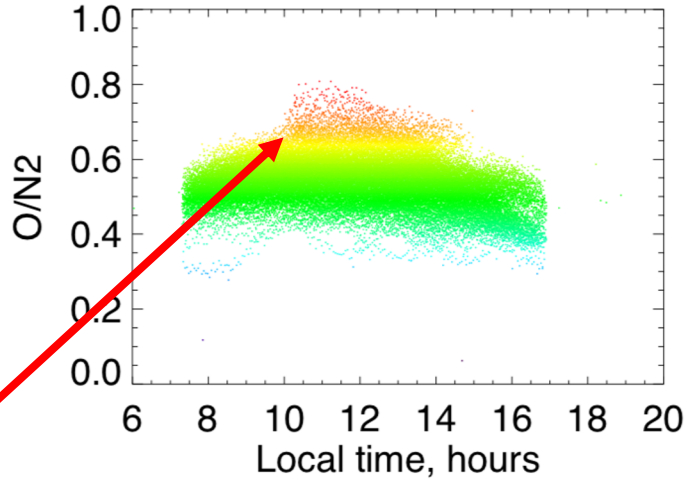
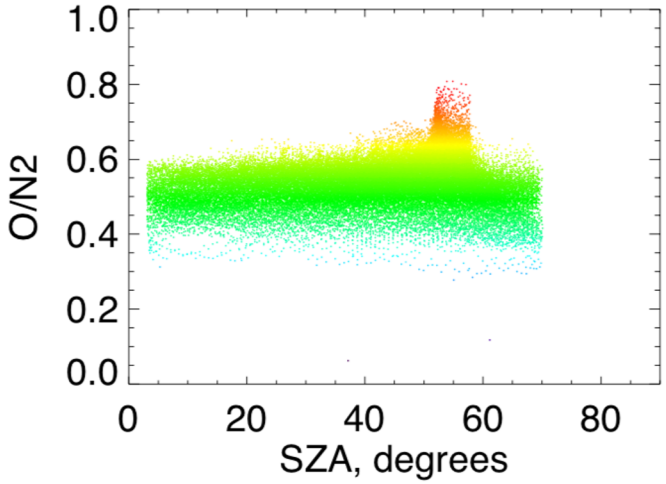


Figure 9. O/N_2 versus 135.6/LBH at an N_2 reference depth of 10^{17} cm^{-2} for the 324 unscaled TIGCM atmospheres. The results show that a nearly proportional relationship exists with uncertainty consistent with that shown in Figure 7b.

Detailed look at January 2020–all data





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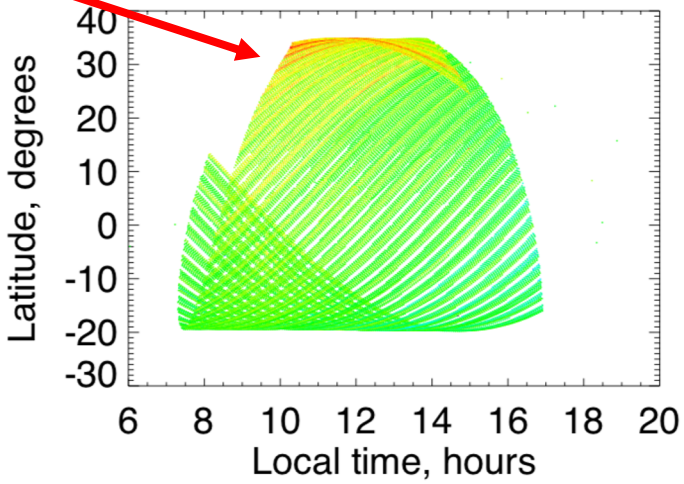
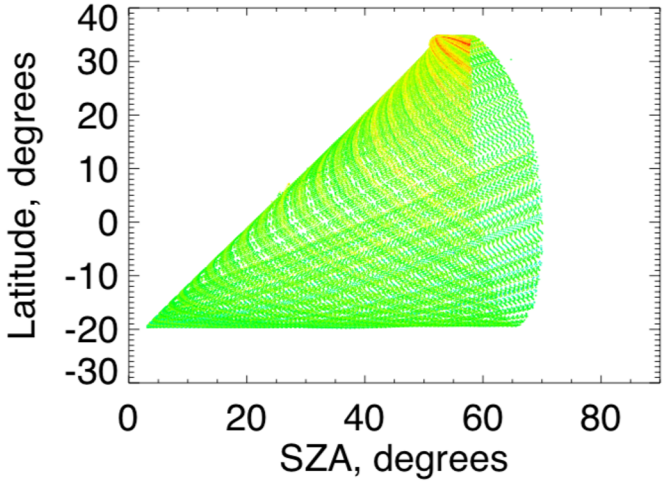
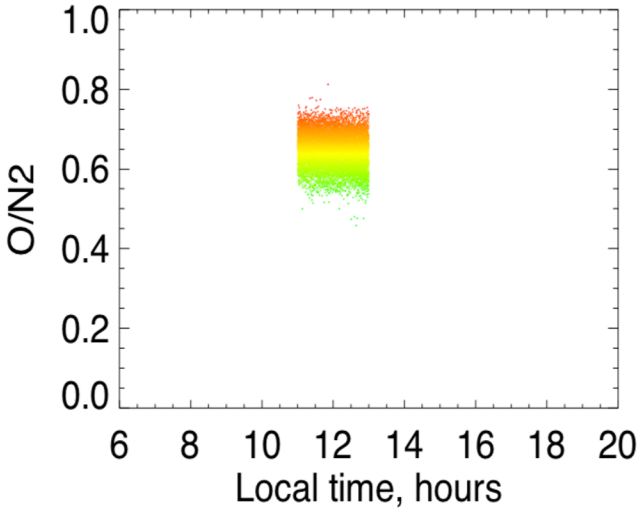
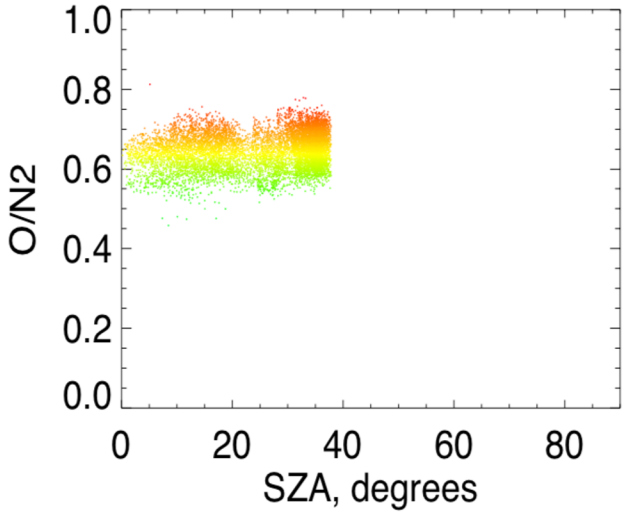


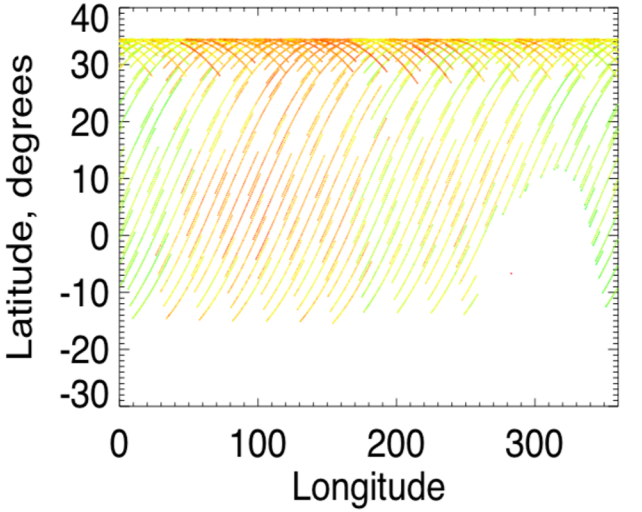


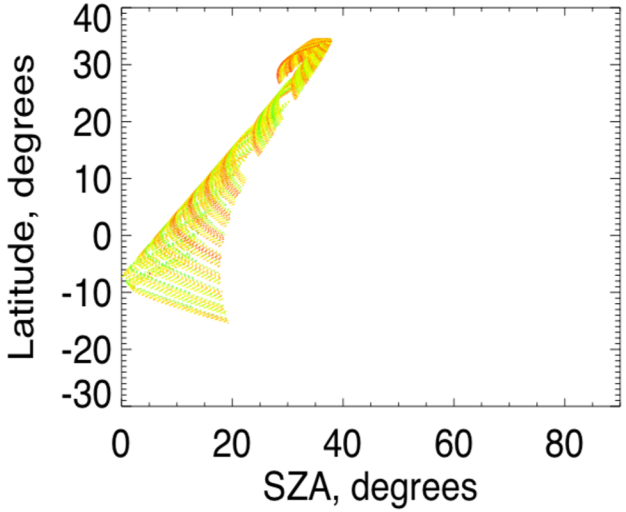
Looking near noon, March 2020





ΣO/N2 more uniform w. latitude





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