Variations of Thermospheric Composition in TIMED/GUVI Limb Measurements

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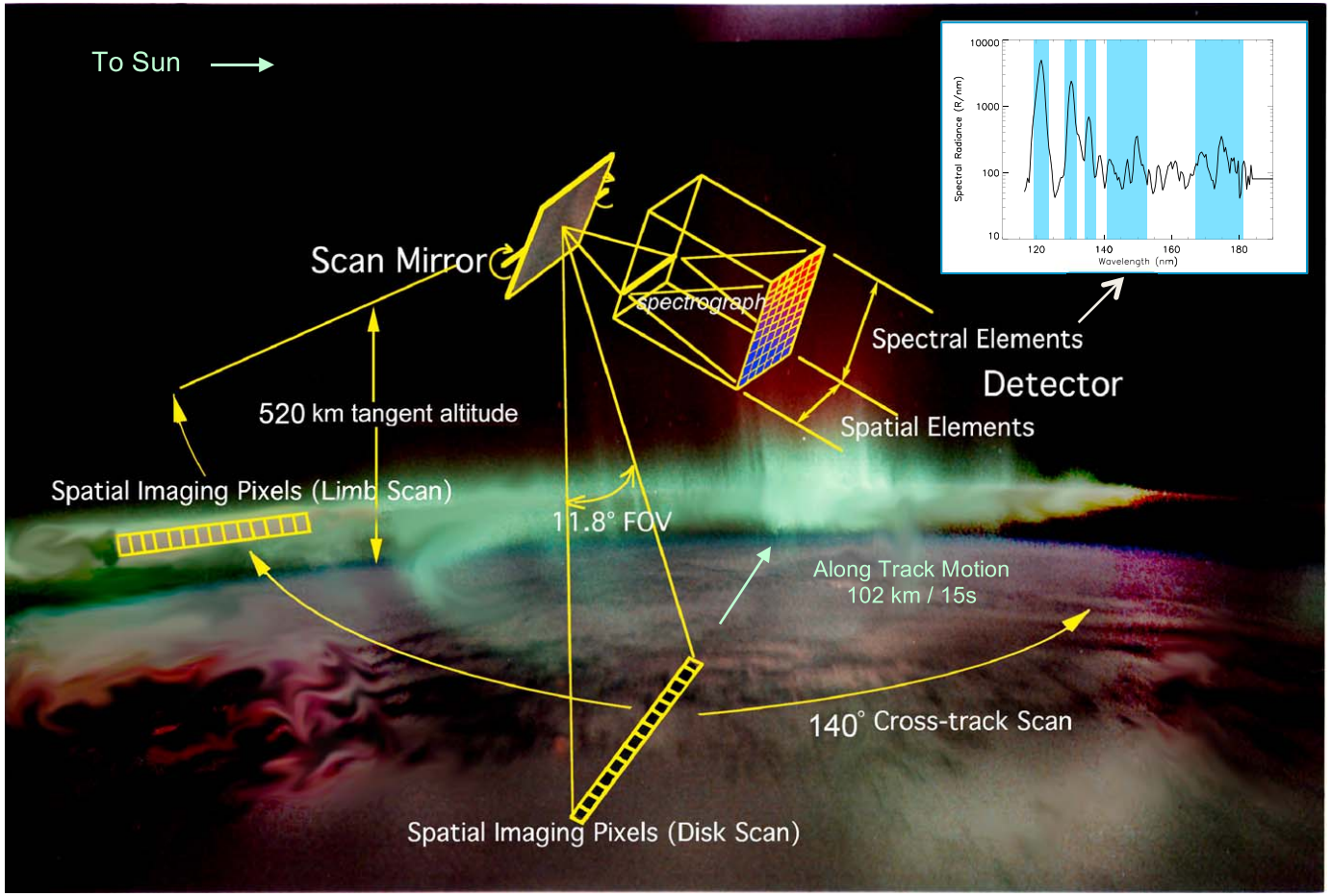
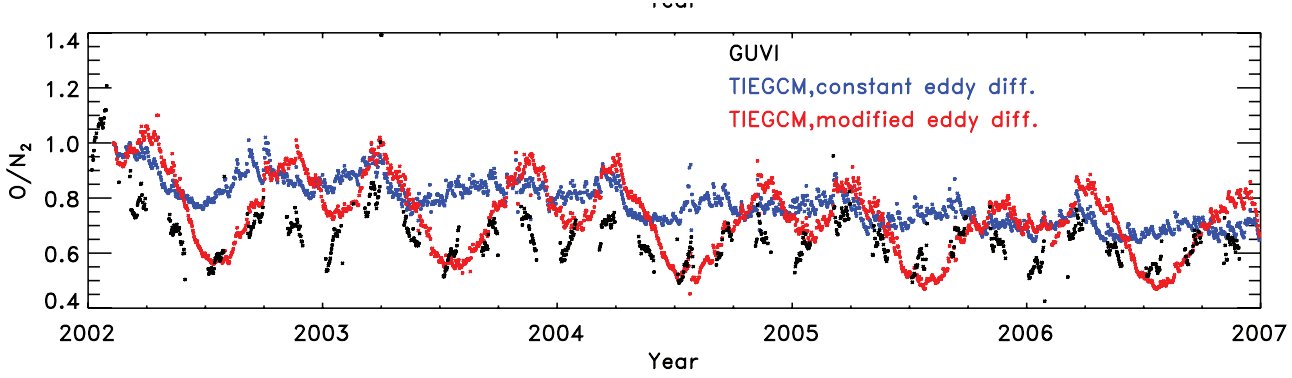
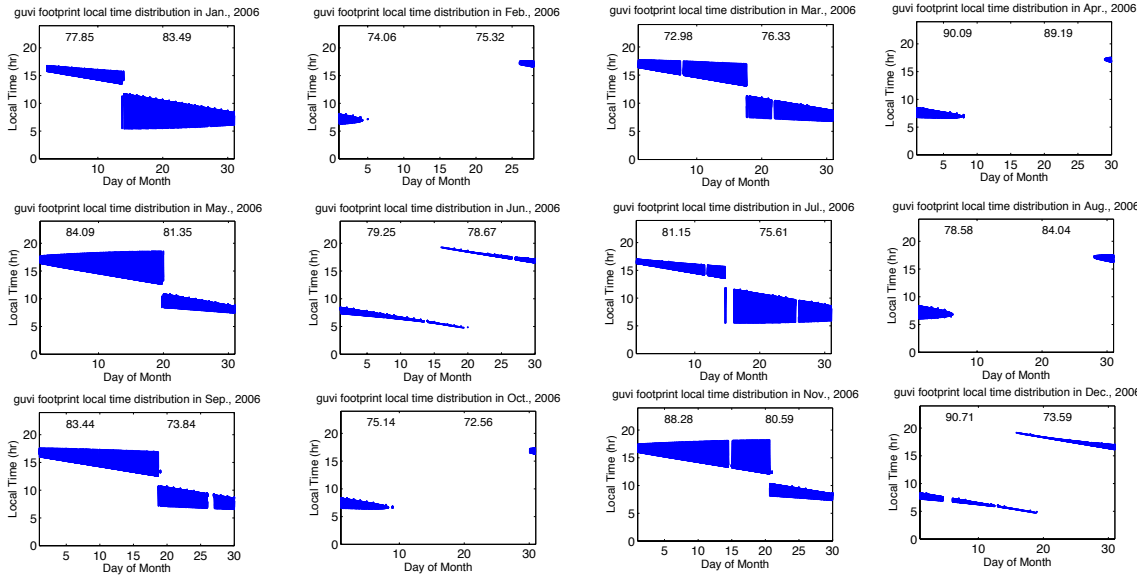


GUVI nadir and limb view schematics. The 14 spatial imaging pixels across the entrance slit each generate a spectrum on the detector focal plane. The scan mirror sweeps the slit across the limb and disc. There are 32 slit positions in a limb scan between approximately 510 and 110 km, and 159 samples on the disk, for a total of 191 angular slit positions in a complete cross-track scan [Meier et al., 2015].

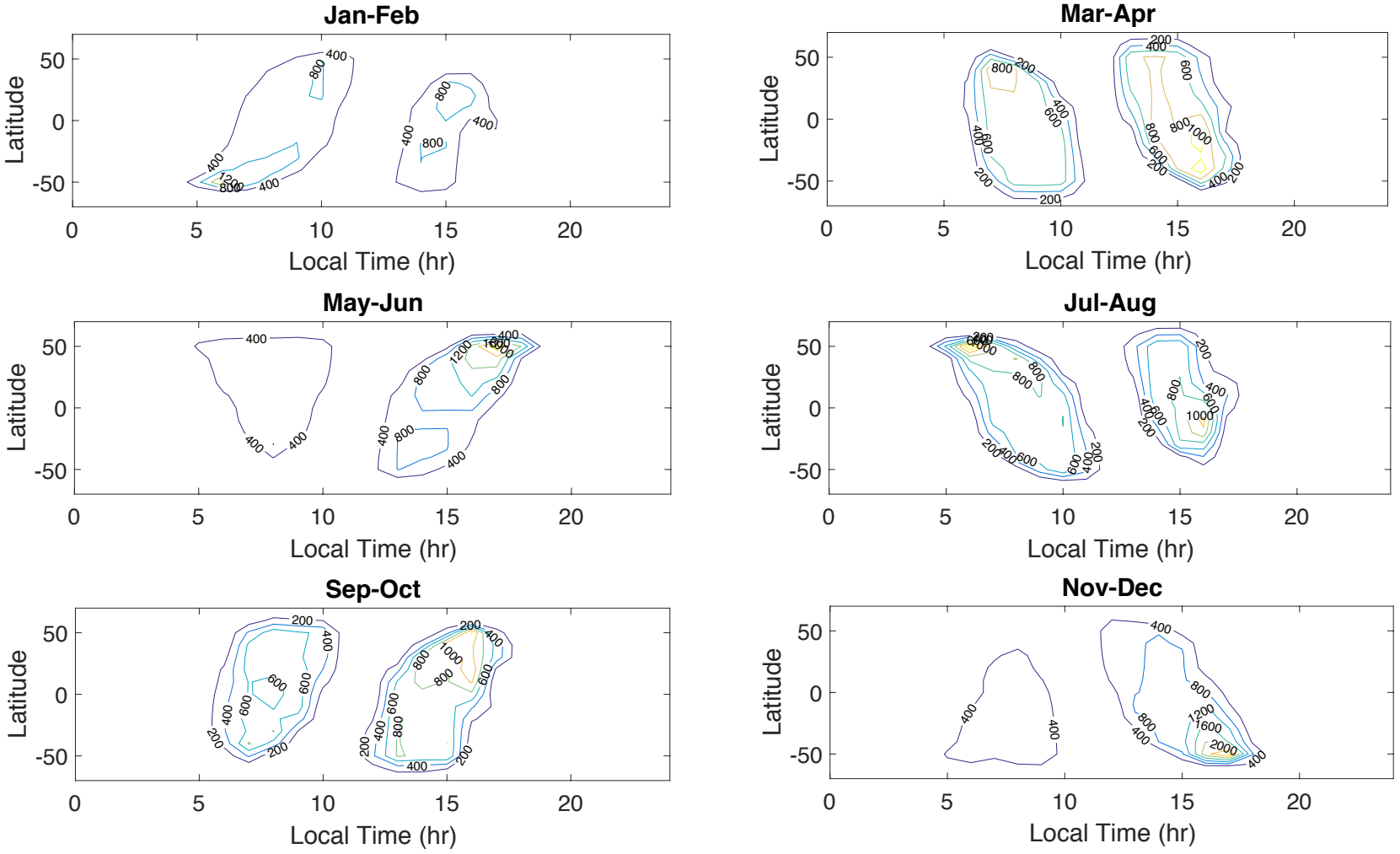
GUVI DISC O/N2 (Qian et al., 2009)



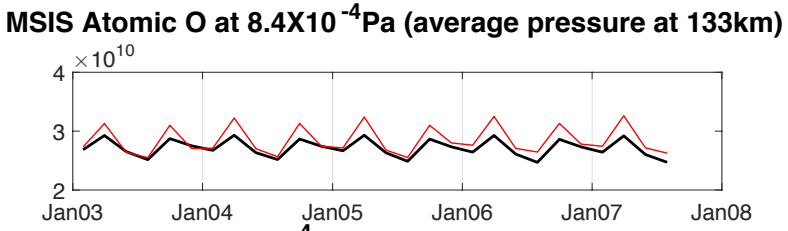
GUVI limb data (2002-2007) is daytime only

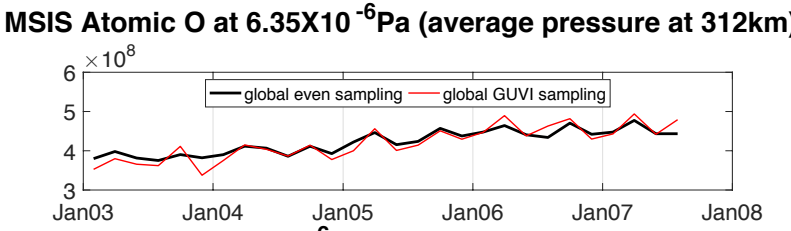


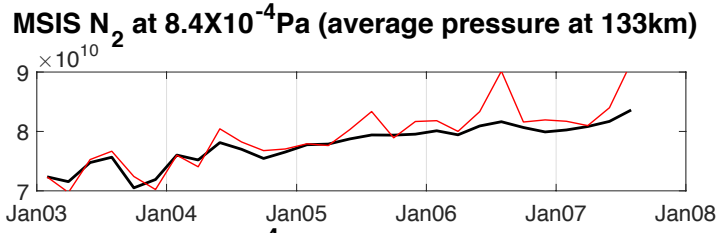
Data distribution vary from month to month

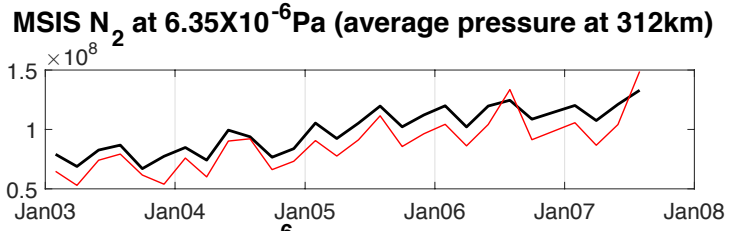


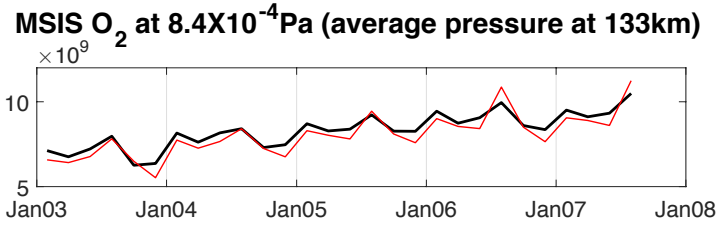
Impact of incomplete GUVI local time/latitude tested with MSIS global mean outputs
The sampling does not change the main patterns

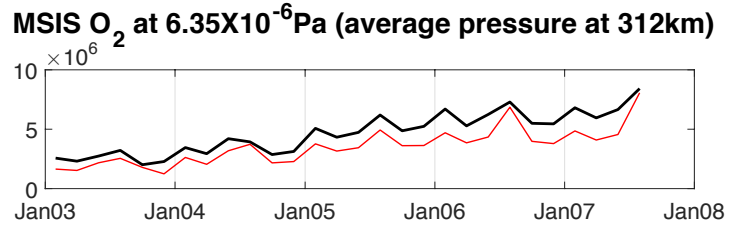


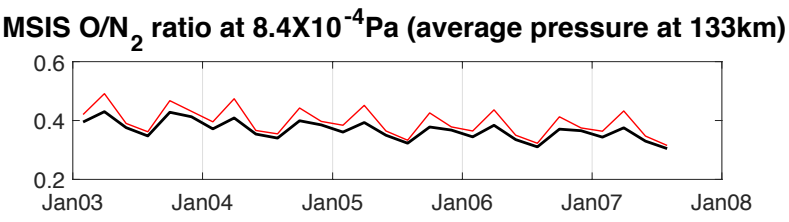


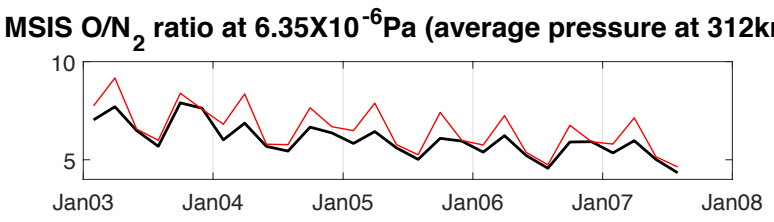






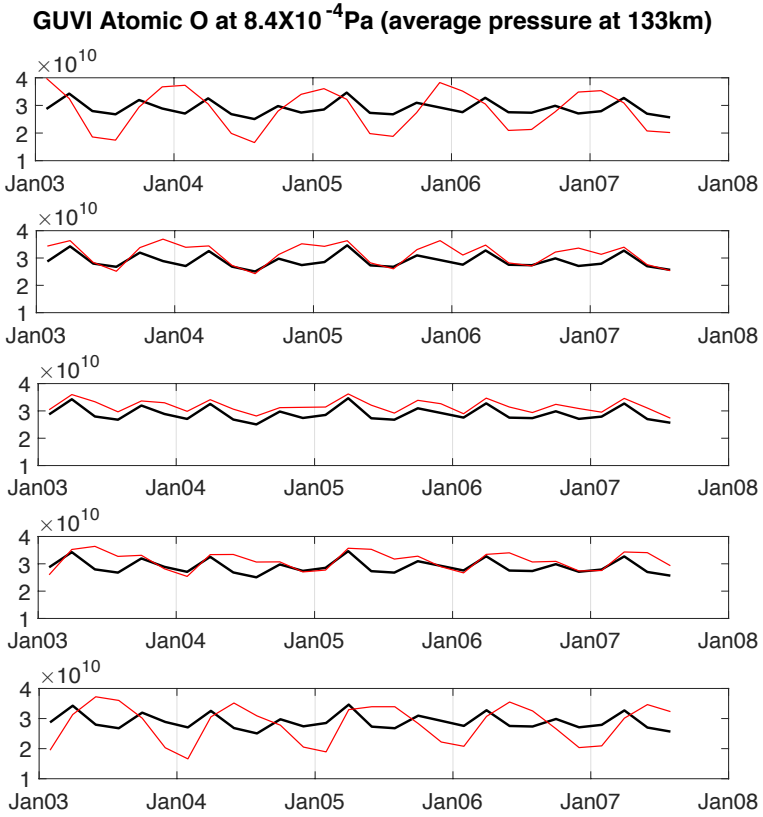


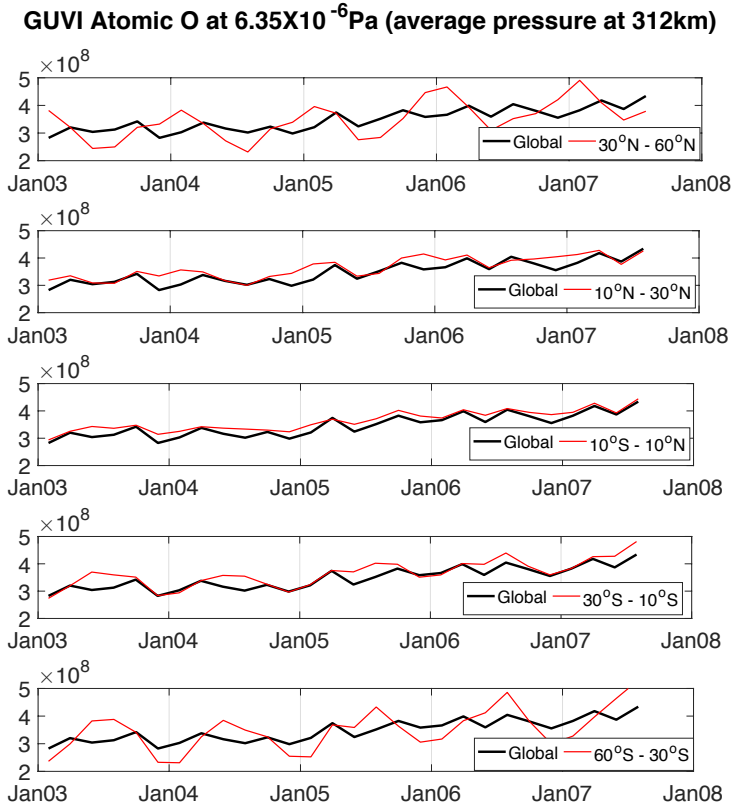




Black: even sampling; red: GUVI limb sampling

GUVI O in the lower thermosphere and upper thermosphere

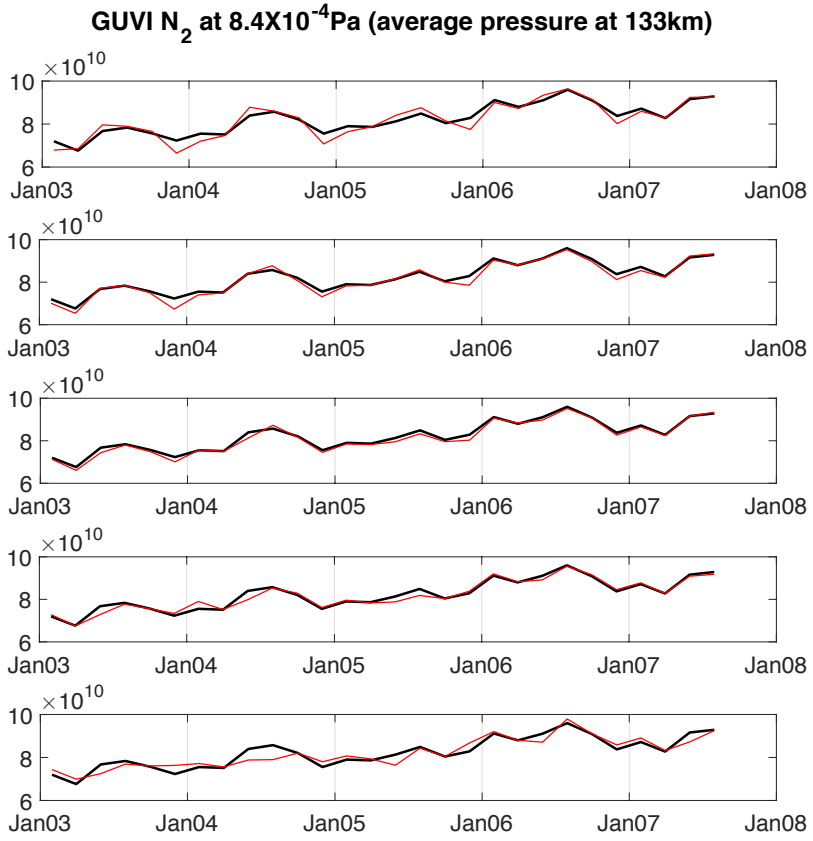


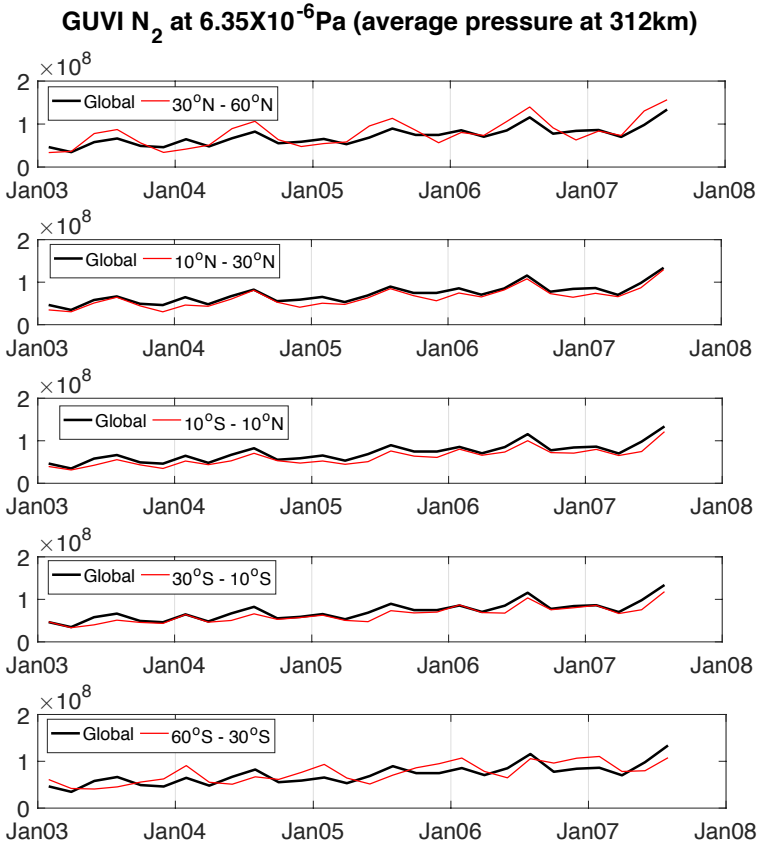


- At midlatitudes, the amplitude of annual variation decreases with solar cycle
- Semiannual variation is more important at low latitudes.
- No apparent O trend in the lower thermosphere
- Upper thermosphere O density increases with declining solar activity, following ideal gas law

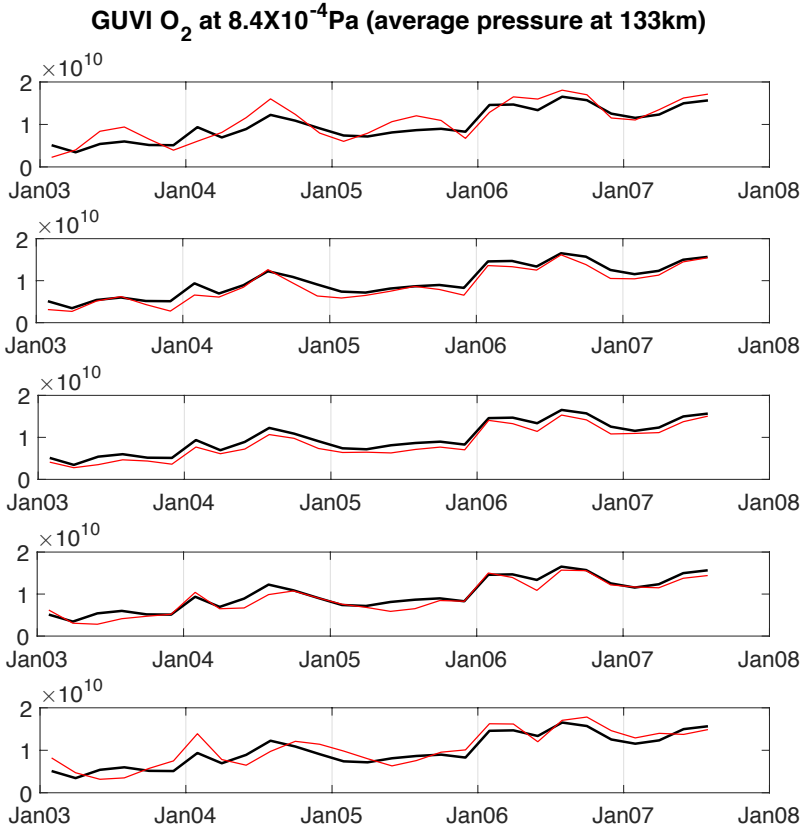
GUVI N2 in the lower thermosphere and upper thermosphere

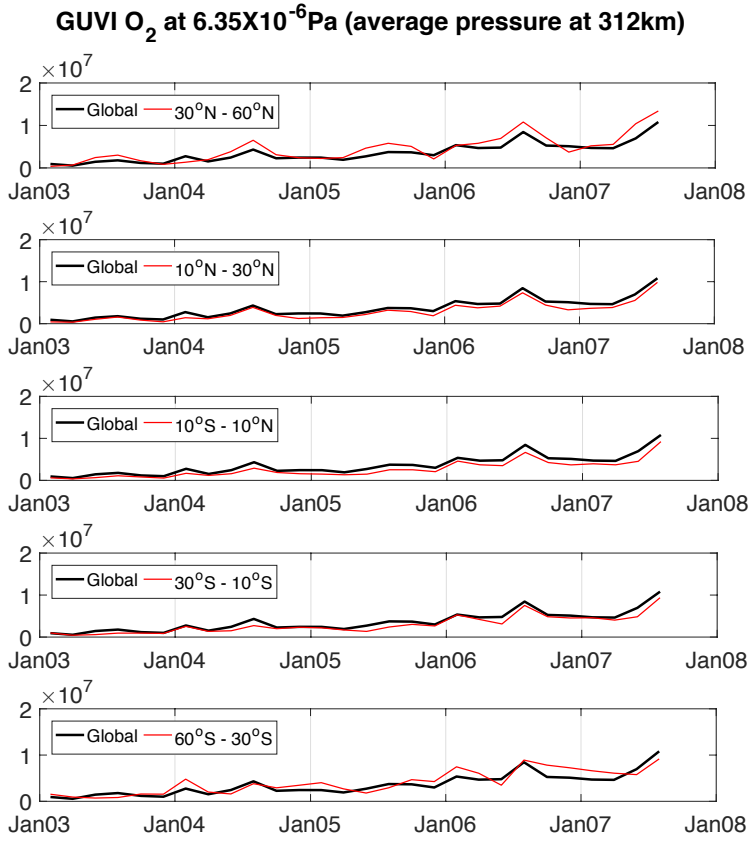
Both lower and upper thermosphere N2 density shows a negative correlation with solar cycle.



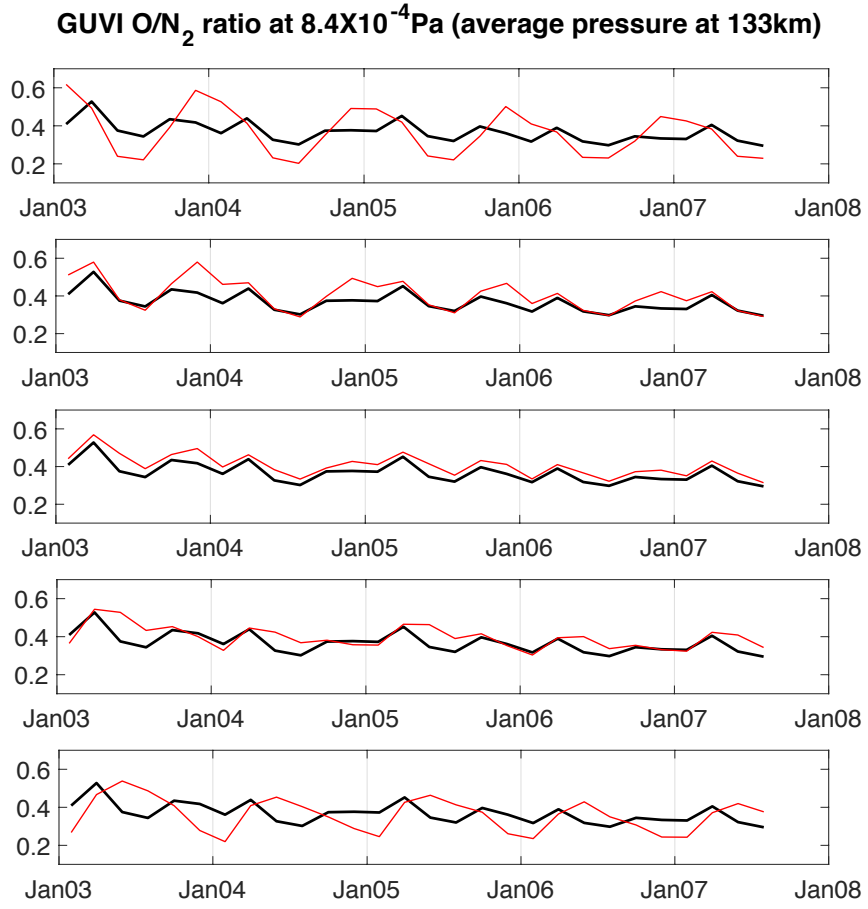


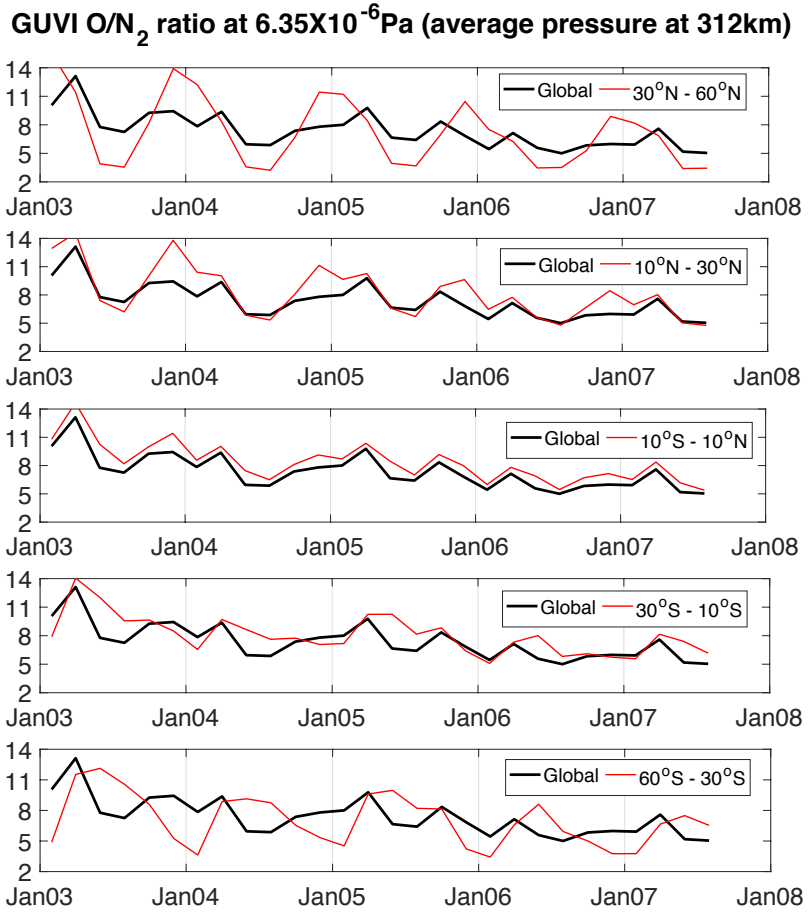
GUVI O2 in the lower thermosphere and upper thermosphere

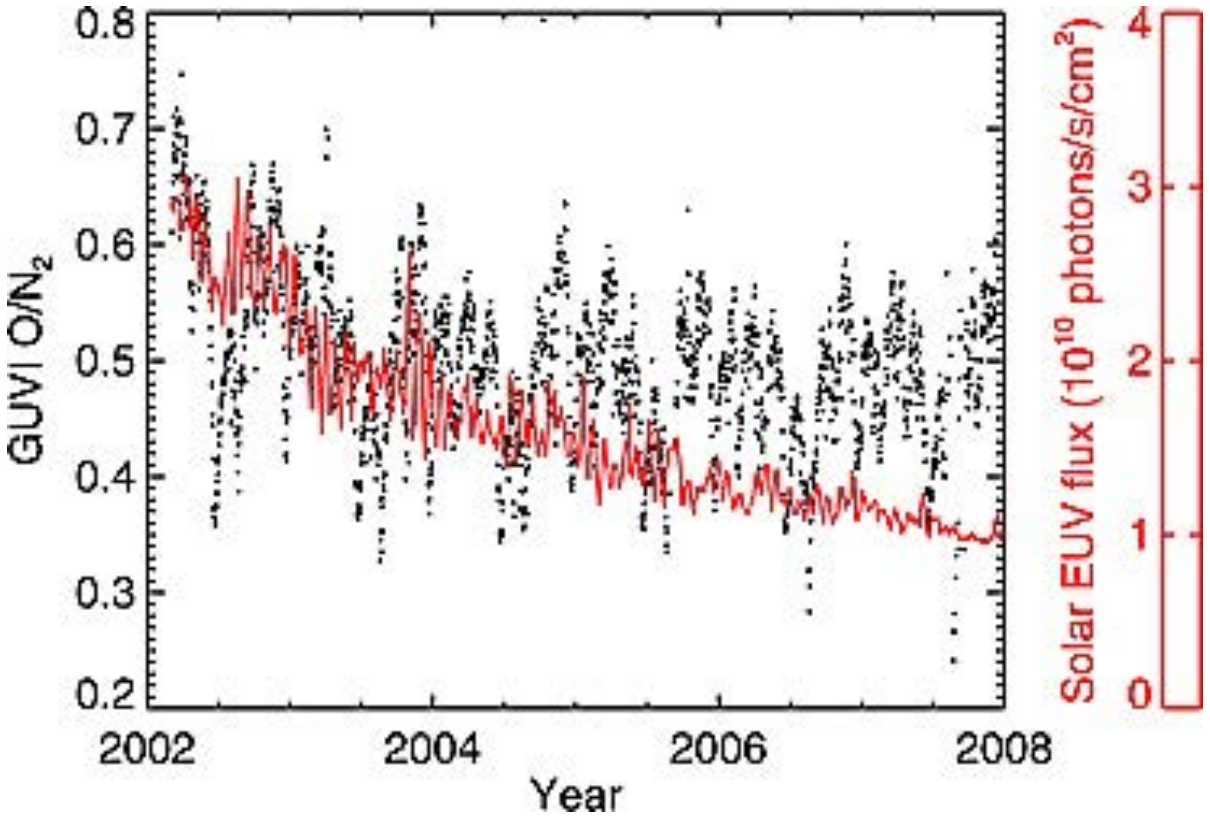




GUVI O/N2 in the lower thermosphere and upper thermosphere



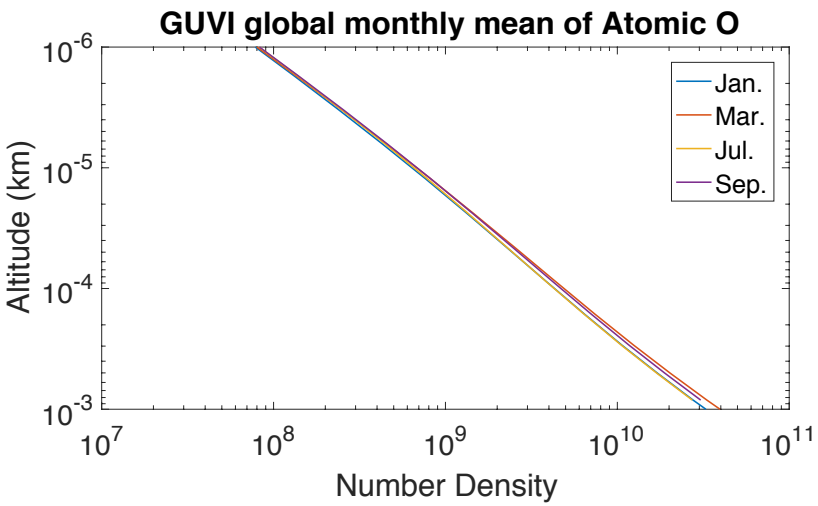


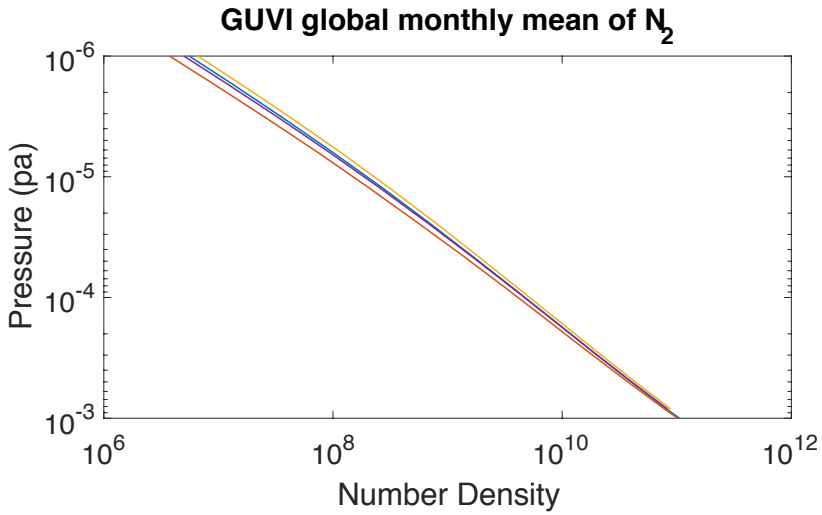


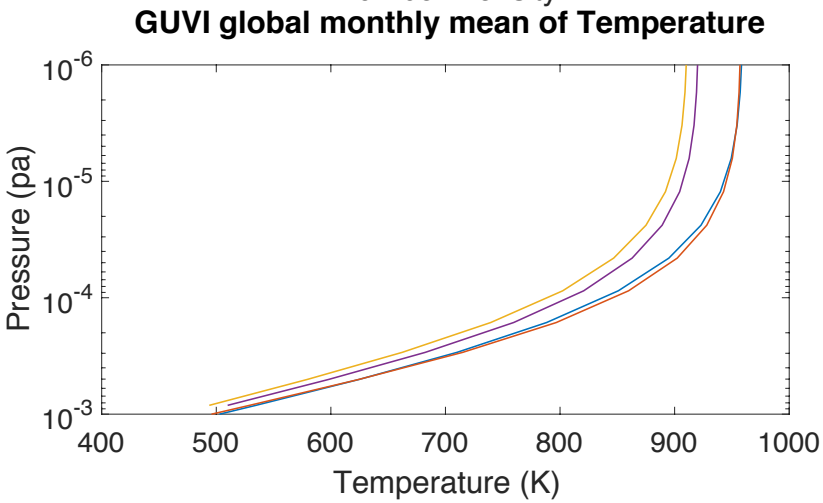
GUVI $\sum O/N_2$ variations from 2002 to 2008 (adapted from Zhang and Paxton [2011]).

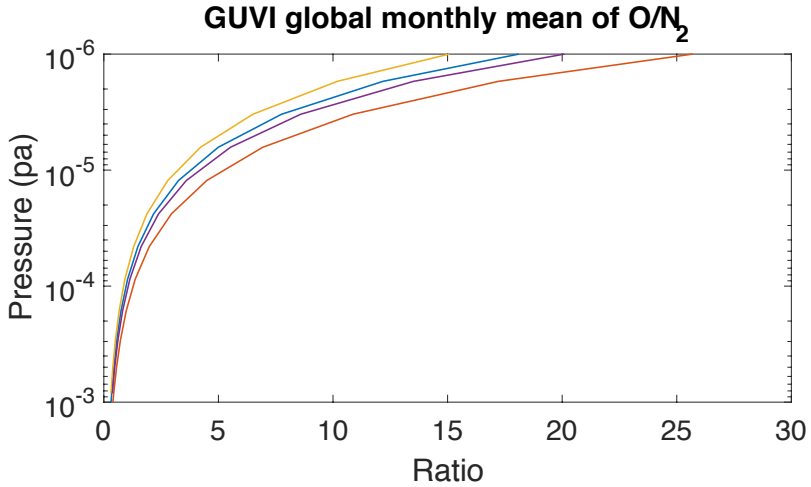
- O/N_2 in the upper thermosphere shows a strong annual variation with maximum in January and minimum in July, and the annual variation phases follow those in the lower thermosphere.
- The annual variation amplitude of O/N_2 is stronger near solar maximum than solar minimum, following the annual variation amplitude of O
- global O/N_2 decreases with the declining solar phase from 2003 to 2007. This can be explained by the species dependent vertical density gradients: heavy species change more than light species [Burns et al., 2015]. The decrease of N_2 density with solar flux at a constant pressure is larger than that in O. N_2 is heavier than O, thus responding stronger to varying temperature.

Vertical profiles of GUVI limb composition









Conclusions

- GUVI limb column composition data is a useful dataset. Could be available from ICON.
- O and O/N_2 in the lower thermosphere show a strong annual variation at mid latitudes and a clear semiannual variation at lower latitudes.
- global mean GUVI O/N_2 shows the well-known annual variation, with slightly larger values in January than in July, and a semiannual variation with O/N_2 greater during equinoxes than at the solstices.
- O and N_2 densities on fixed pressure levels in the upper thermosphere are anti-correlated with solar flux, and O/N_2 follows the solar cycle.