

# Ozone vertical distribution on Mars from SPICAM/MEX UV occultations

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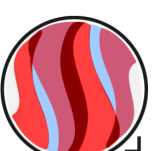
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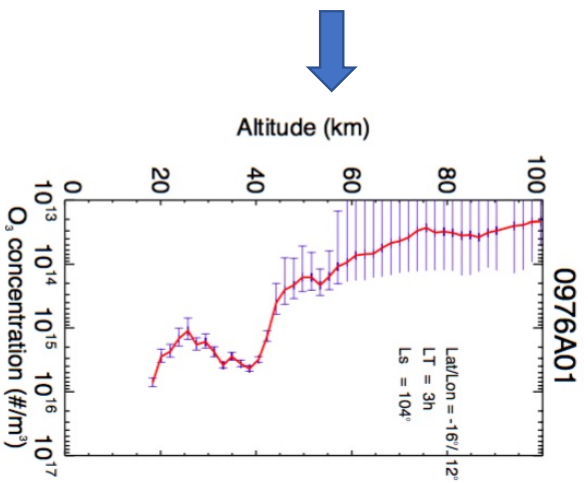
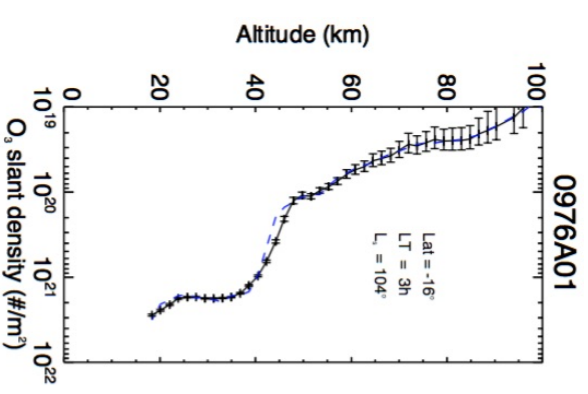
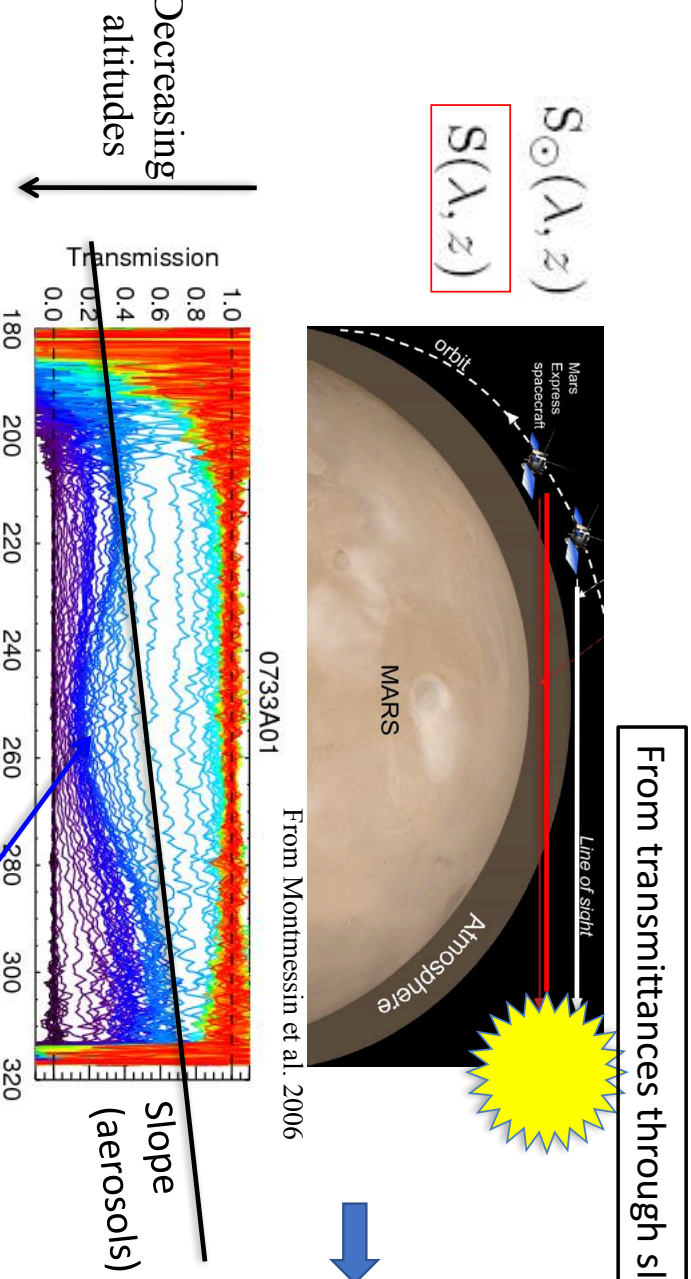


# SPICAM UV solar and stellar occultations: O<sub>3</sub>

- Previous analyses from stellar occultations: Lebonnois et al. 2006 and Montmessin&Lefèvre 2013
- Ozone vertical distribution climatology (MY 27-30)

$$S_{\odot}(\lambda, z)$$

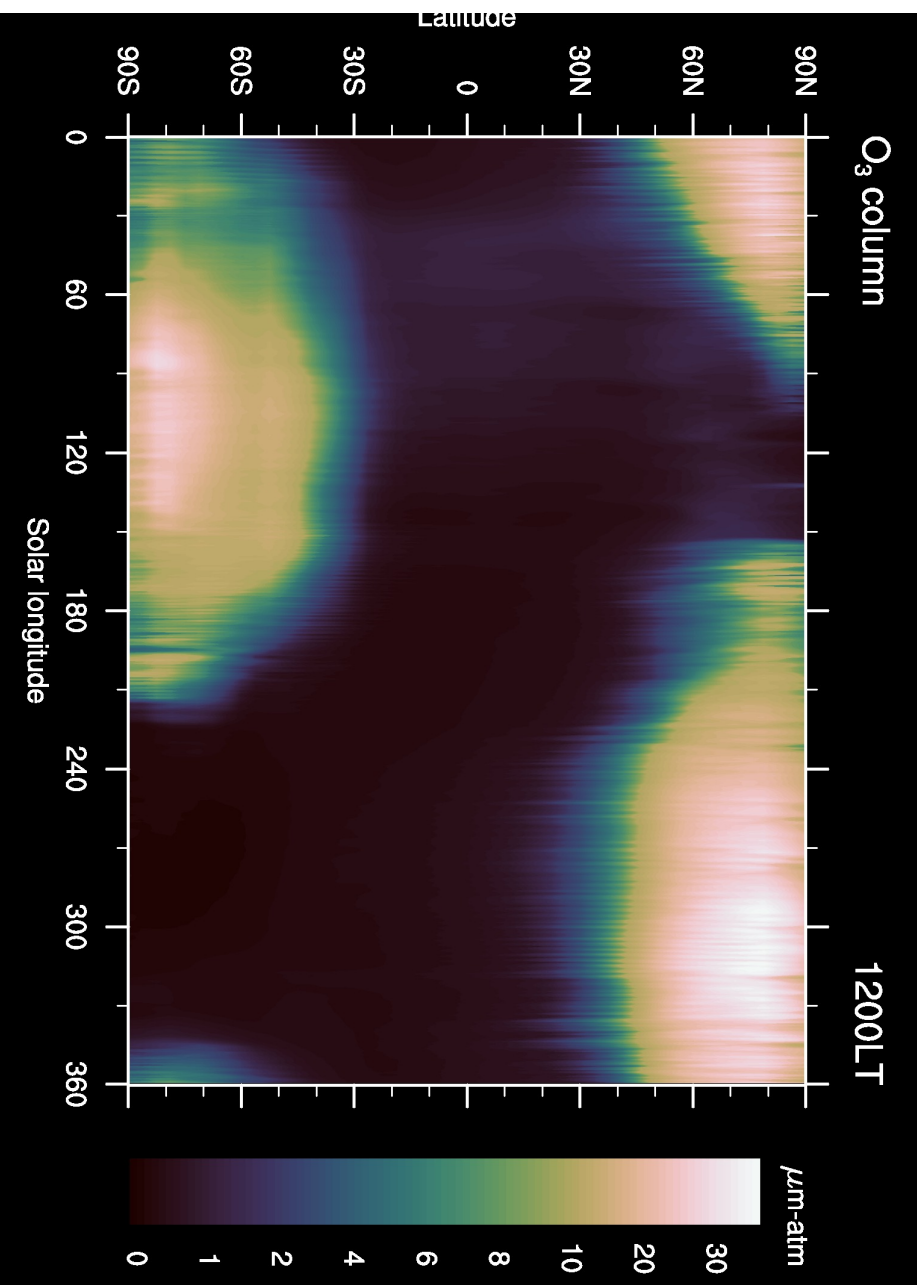
$$S(\lambda, z)$$



$$T(z, \lambda) = \frac{S(z, \lambda)}{S_{\odot}(\lambda)} = \exp(-\sigma_{\text{CO}_2}(\lambda)N_{\text{CO}_2} - \sigma_{\text{O}_3}(\lambda)N_{\text{O}_3} - \tau_{\text{aer}}(\lambda))$$

Spectral behaviour of aerosols  
 $(\tau_{\text{aer}}(\lambda) = \tau_0(\frac{\lambda_0}{\lambda})^\alpha)$

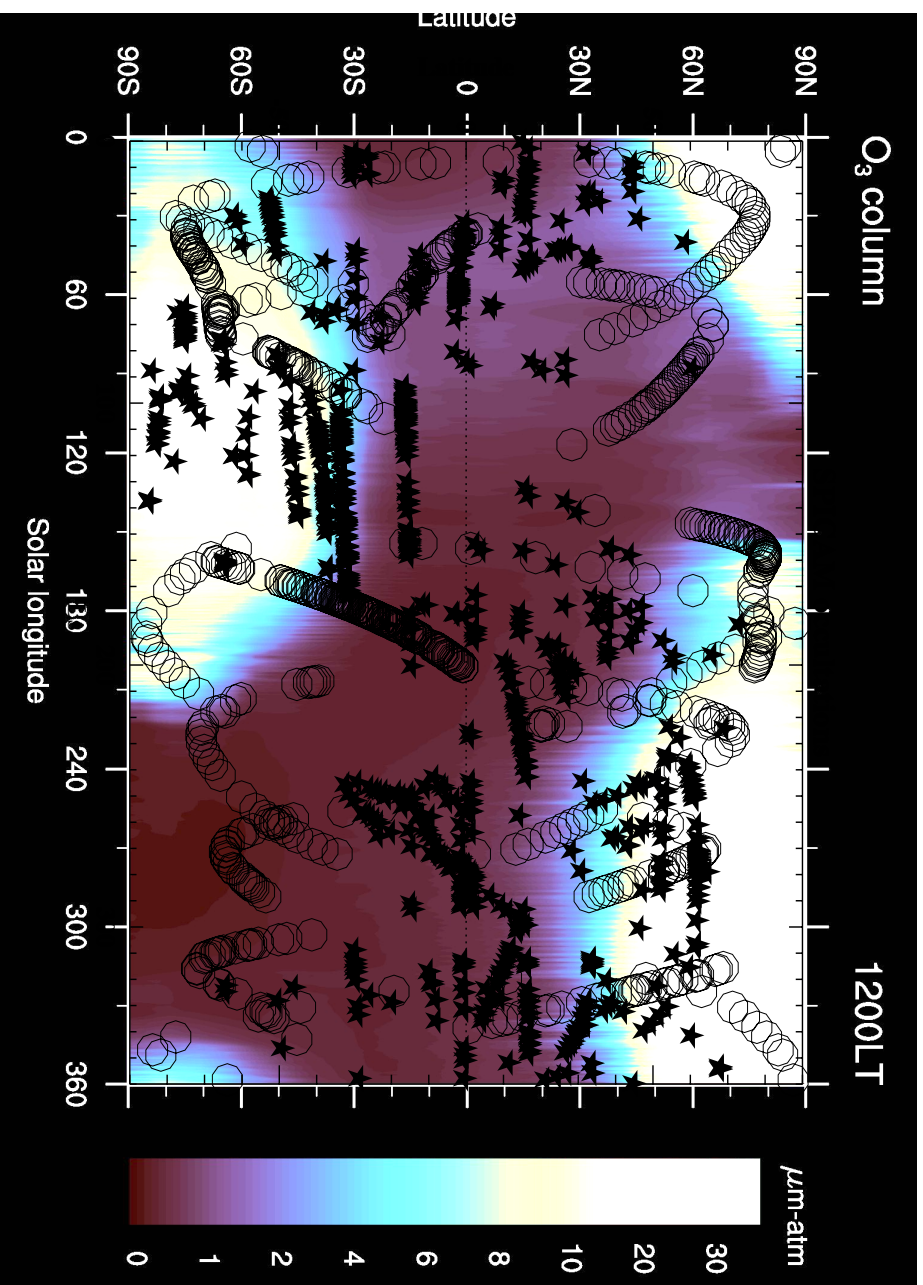
# Ozone climatology



- Modelled ozone column climatology
- Ozone concentrations locally controlled by water vapor distribution (anti-correlation)

(LMD Mars GCM, courtesy of Franck Lefèvre)

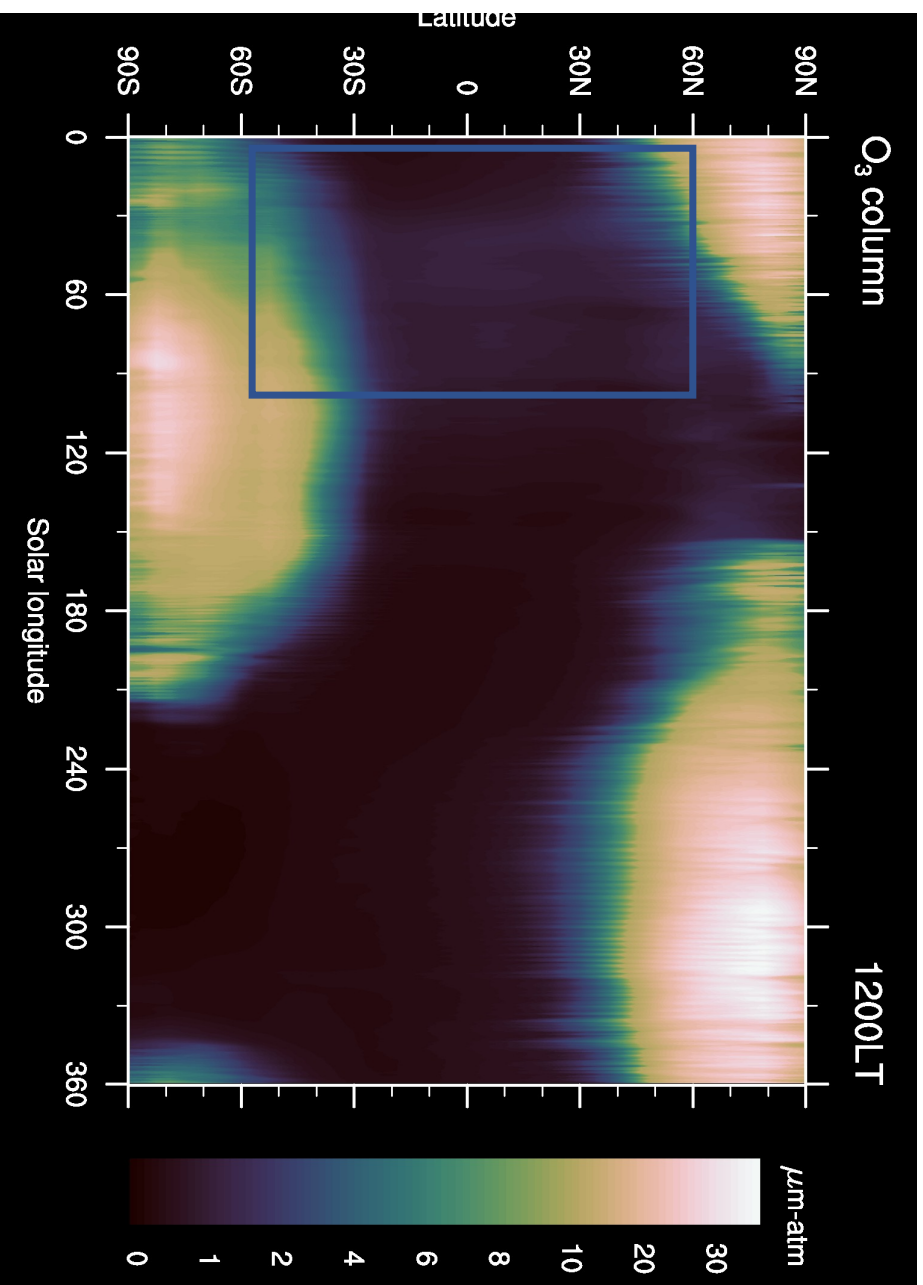
# Ozone climatology



- Modelled ozone column climatology + full SPICAM UV occultation coverage

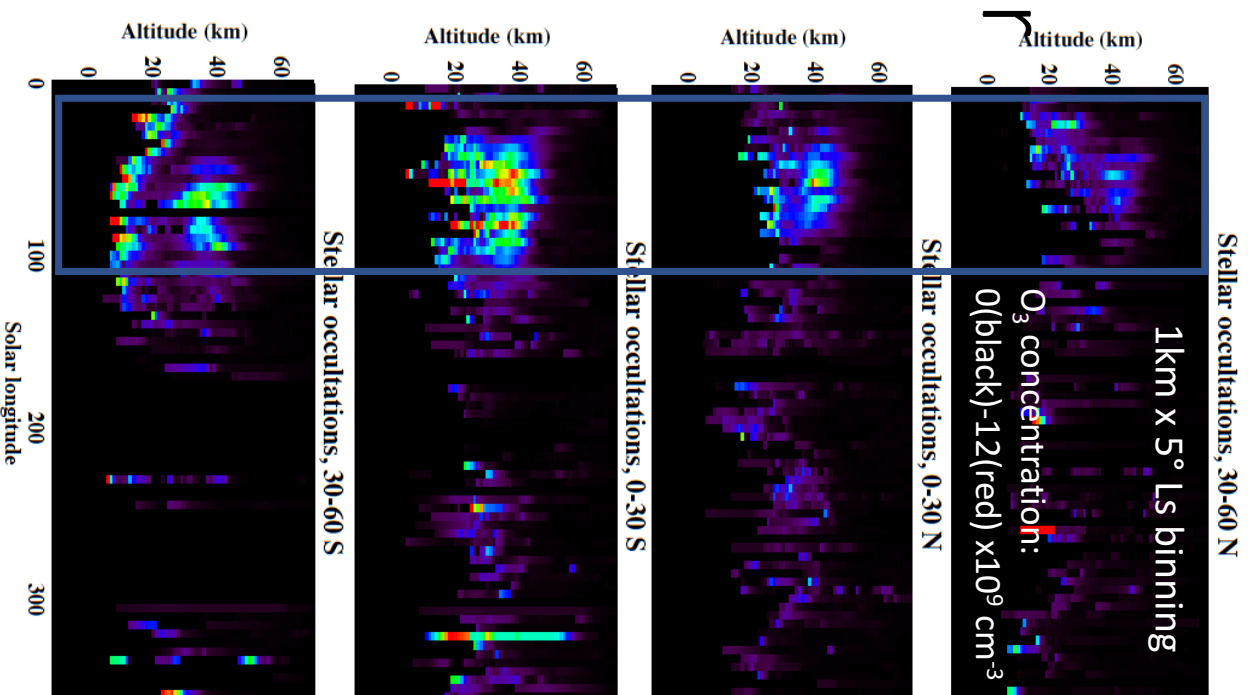
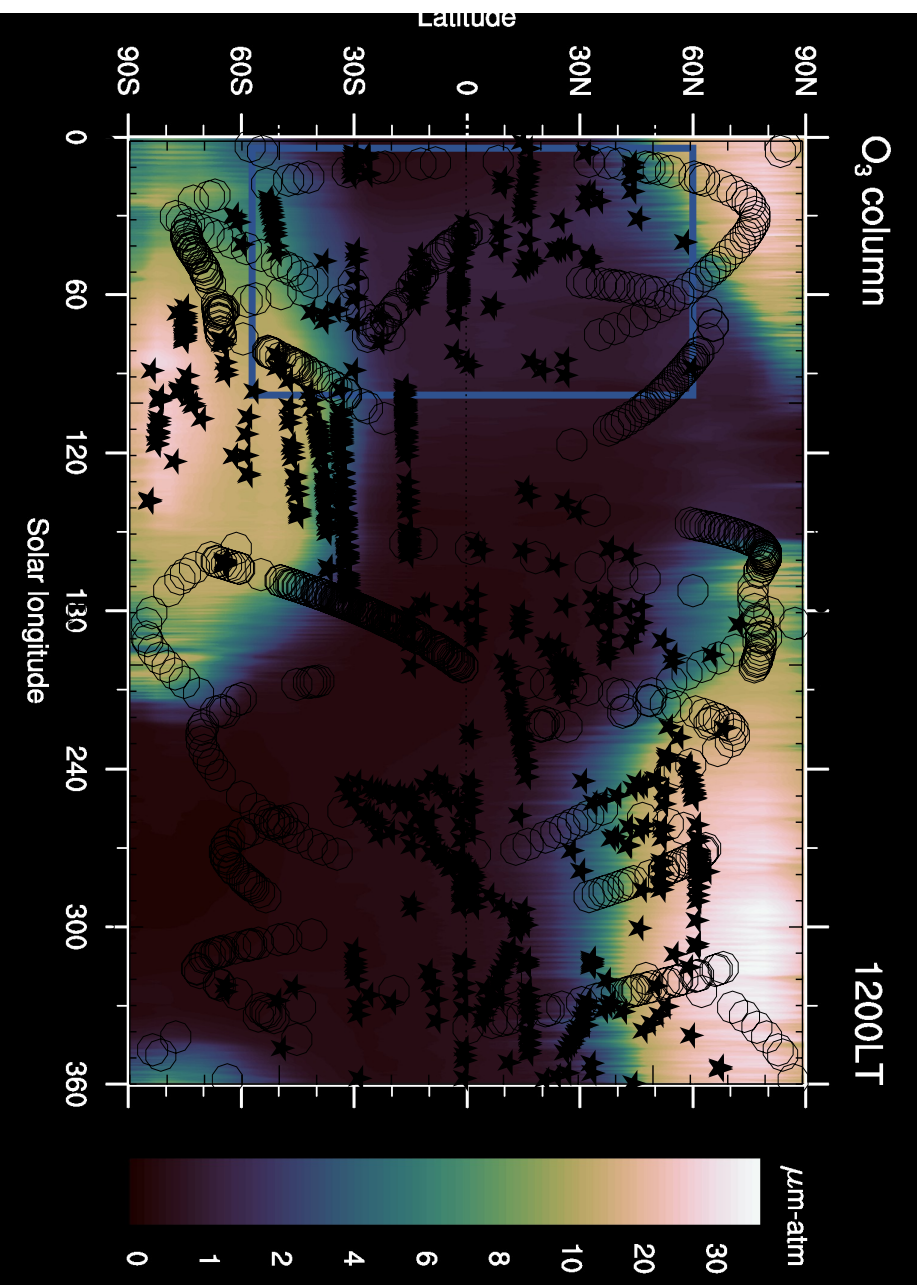
(LMD Mars GCM, courtesy of Franck Lefèvre)

# Ozone climatology: tropical & midlatitude ozone layer

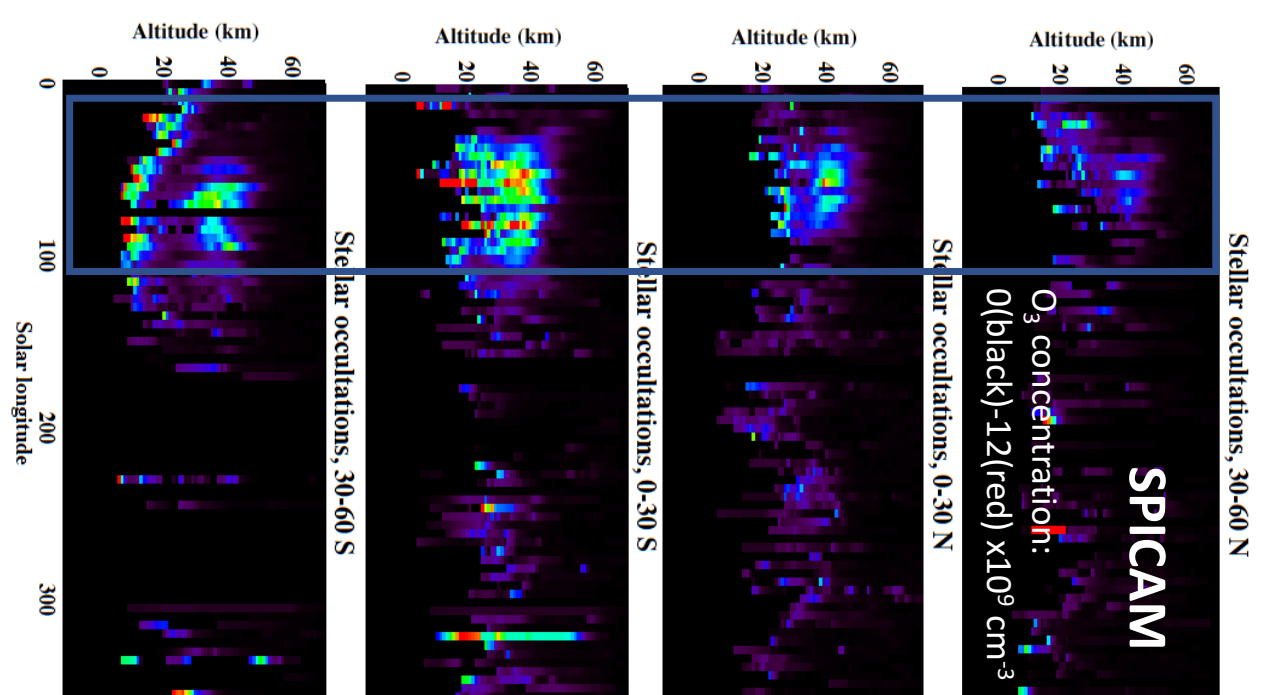
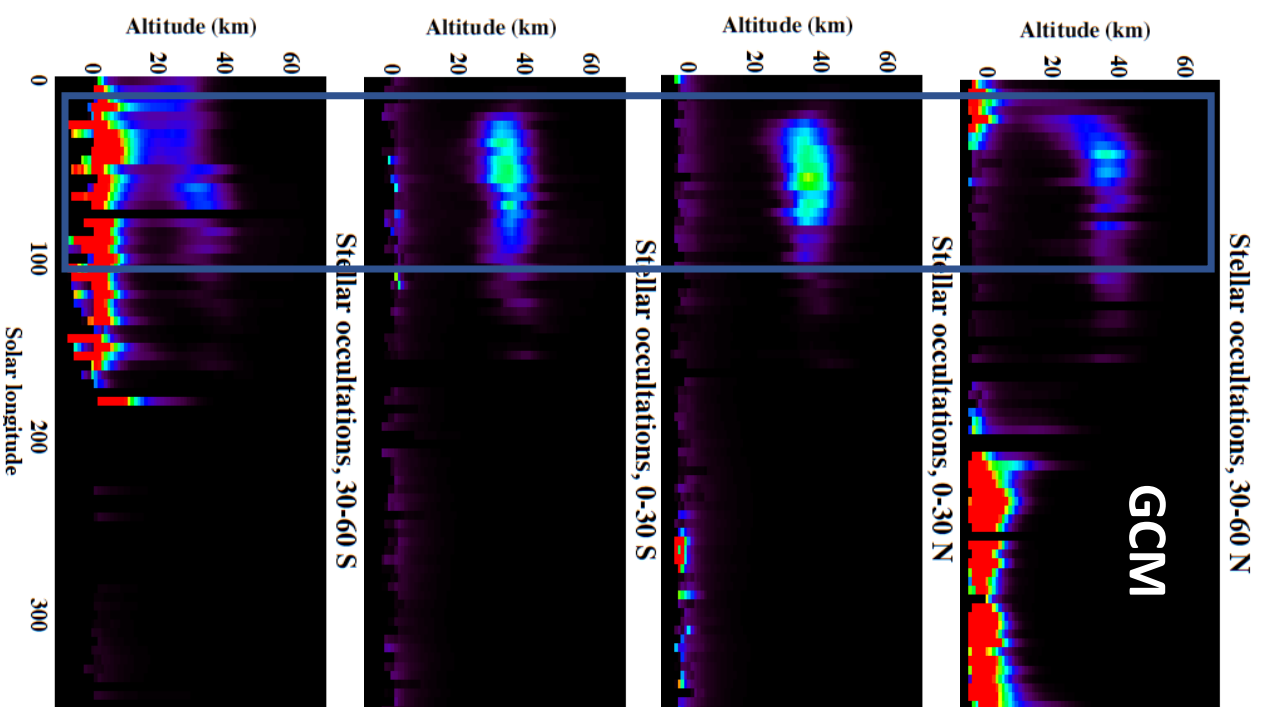


- Low and midlatitudes in spring:
  - Nighttime ozone layer around 30-40 km at aphelion related to low hygropause and confinement of water vapor (OH radicals) at lower altitudes
  - No ozone closer to perihelion season: rise of hygropause level and OH leading to destruction of ozone

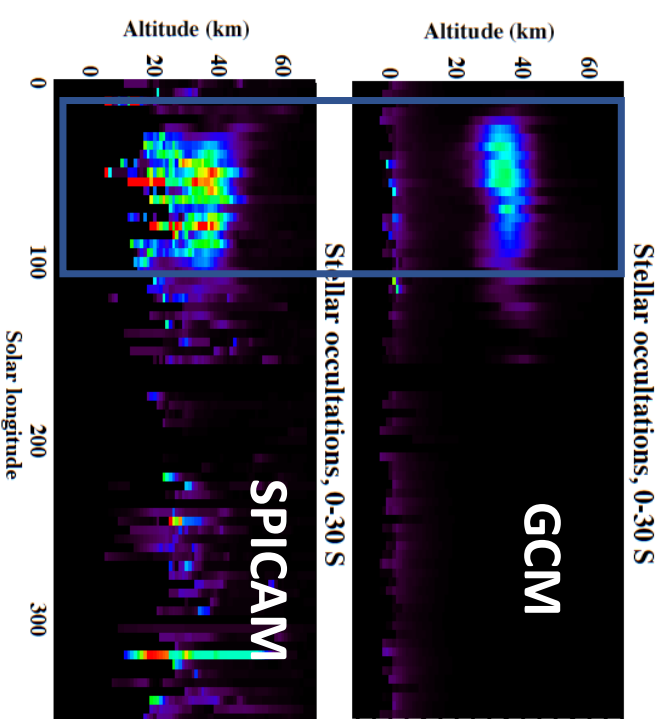
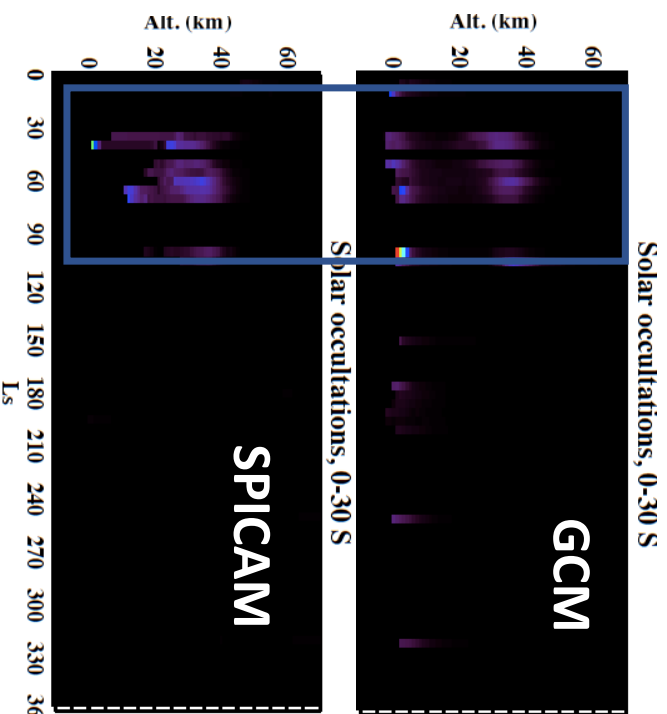
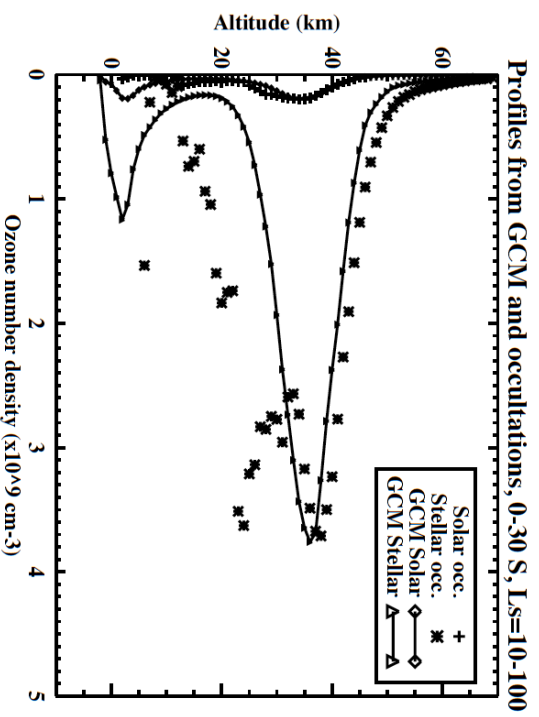
# Ozone climatology: tropical & midlatitude ozone layer



- Low and midlatitudes in spring:
  - Ozone layer around 30-40 km **well predicted by the GCM**
  - Small differences:
    - Structure
    - Max concentrations
    - Duration



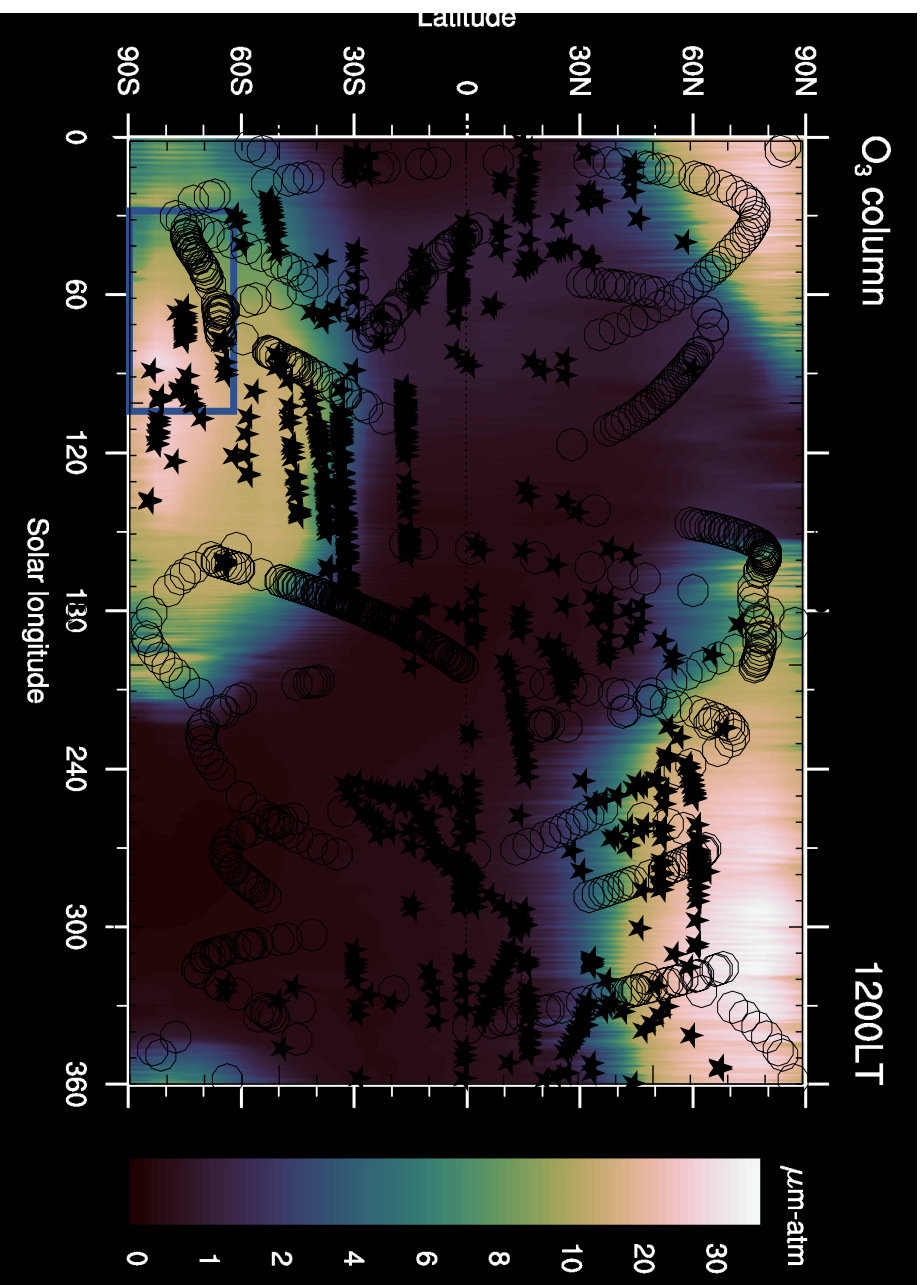
# Average profiles & layer diurnal variation (0-30°S)



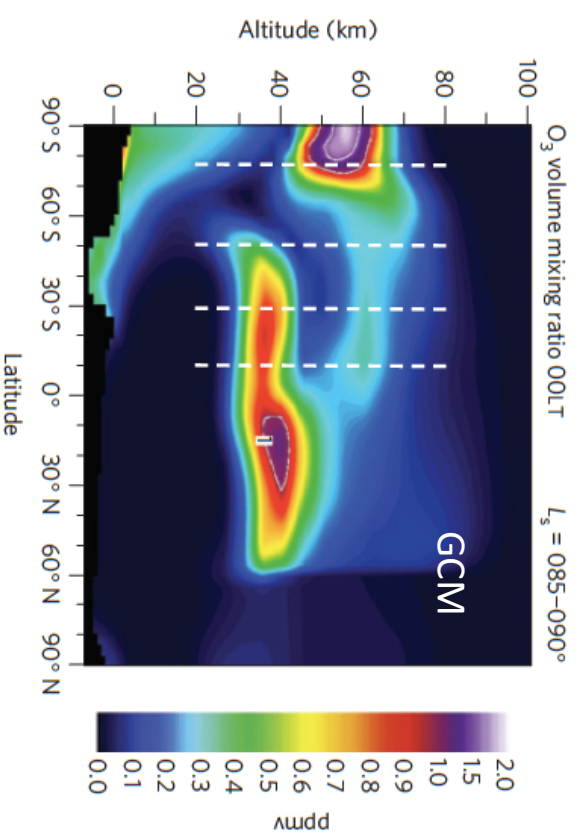
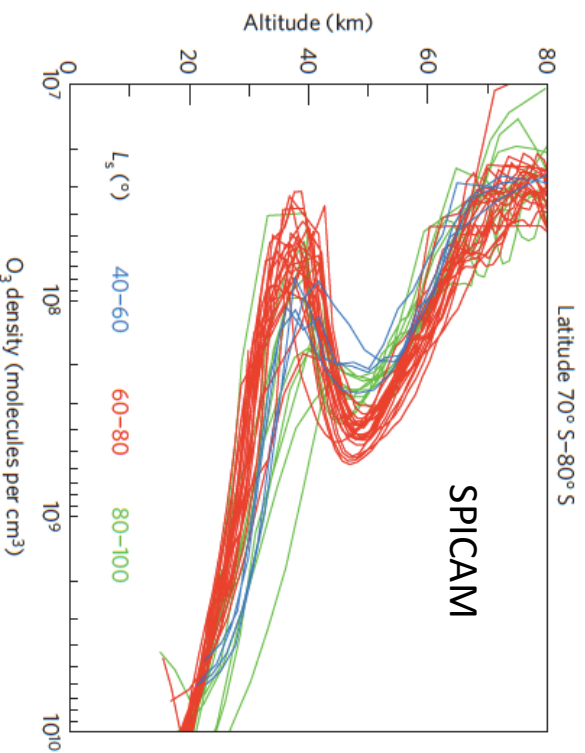
O<sub>3</sub> concentration:  
 0 (black) -12 (red)  $\times 10^9 \text{ cm}^{-3}$



# Ozone climatology: southern polar winter vortex

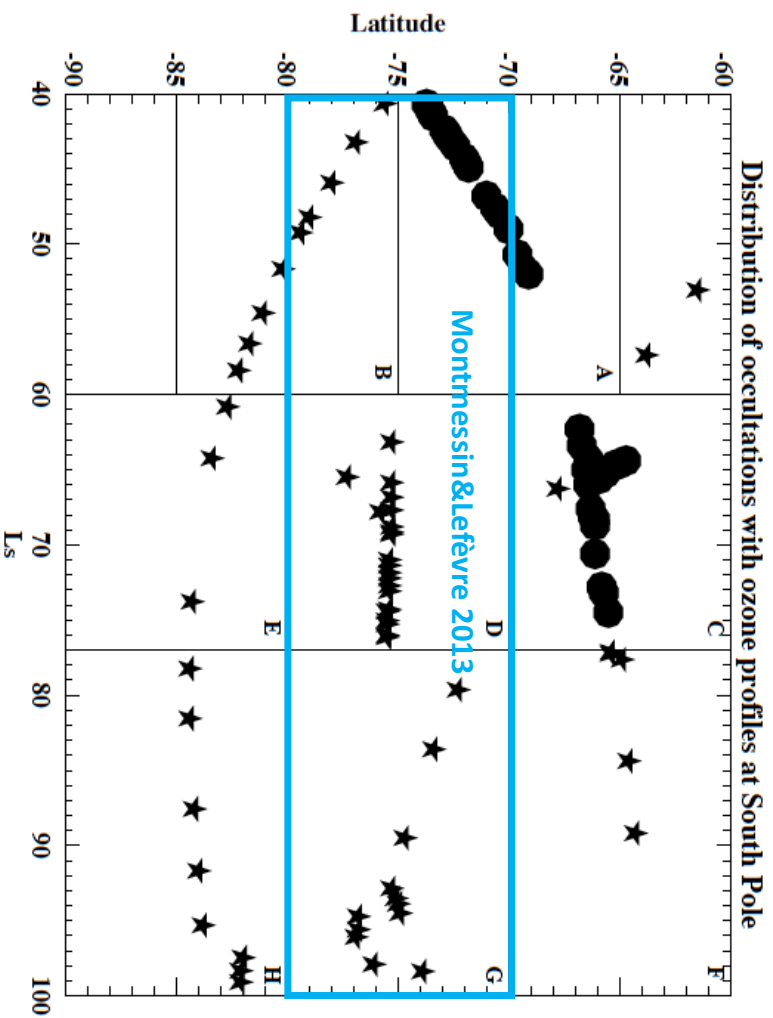


# SPICAM O<sub>3</sub>: SP Winter

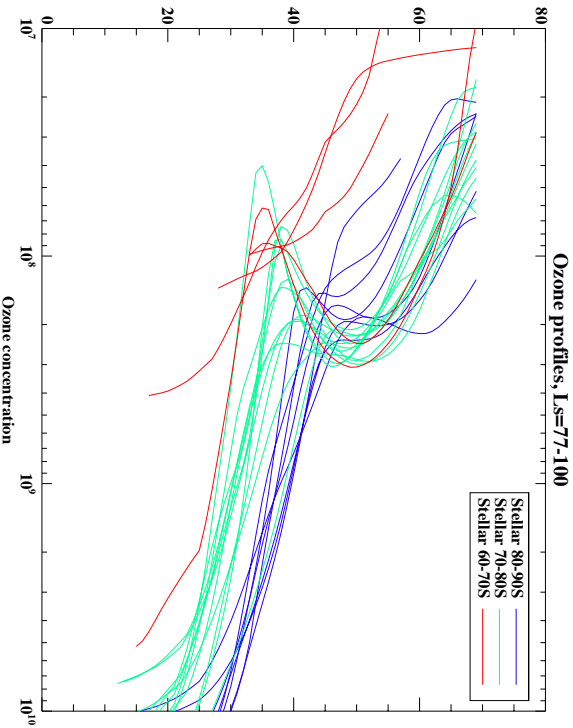
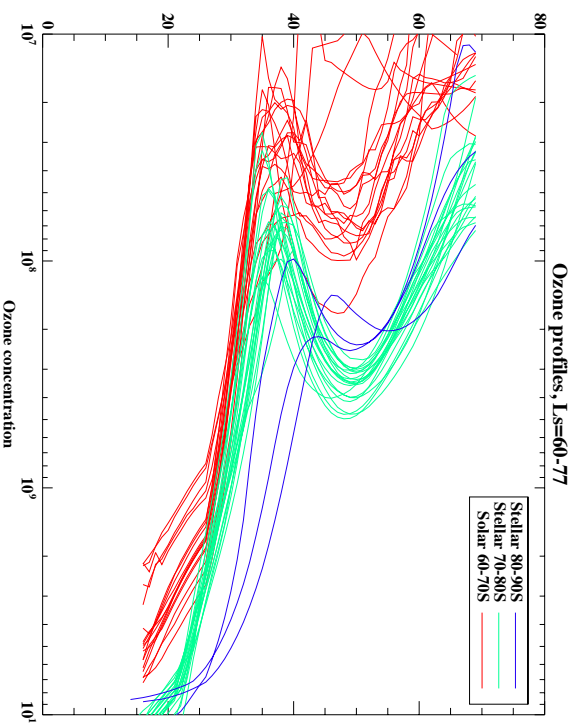
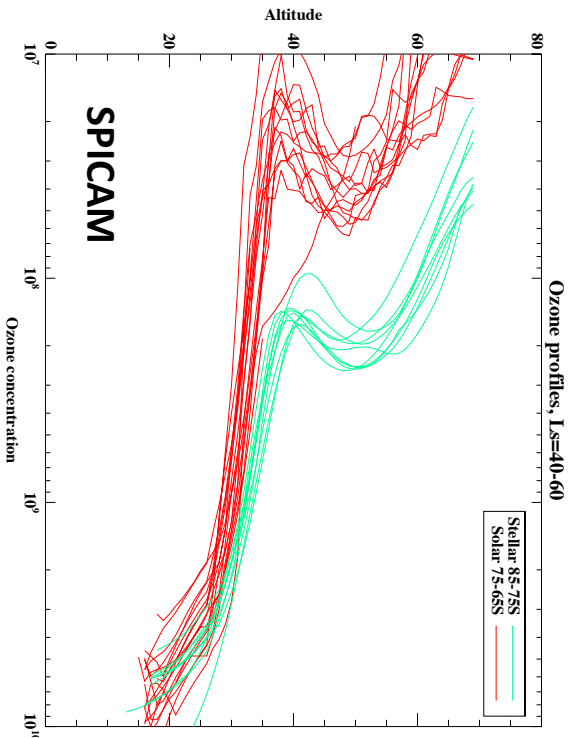


- Montmessin and Lefèvre 2013
- Transport-driven ozone layer within the South polar vortex (no equivalent in the Northern winter), latitudes 70-80°S, L<sub>s</sub>=40°-100°
- Result of the large-scale transport of oxygen-rich air from sunlit latitudes to the pole, where the oxygen atoms recombine to form ozone during the polar night

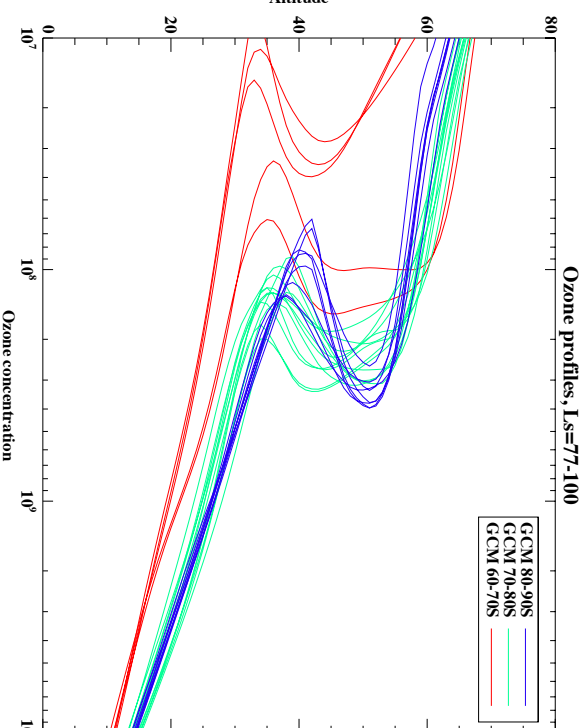
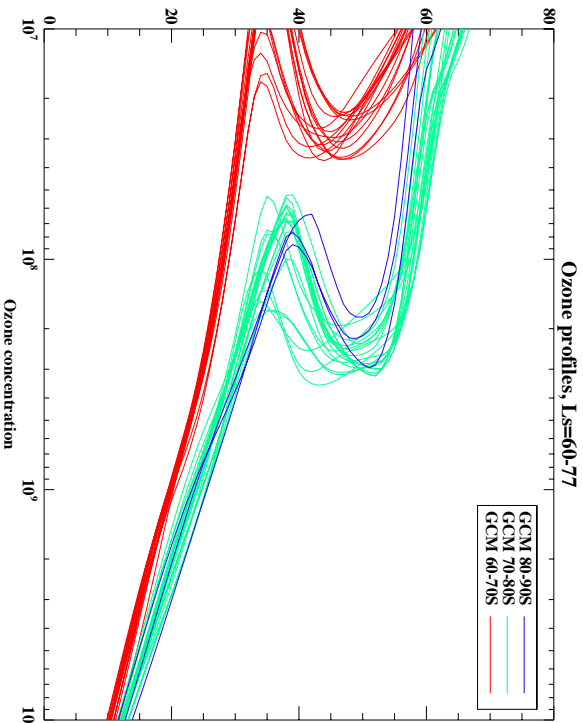
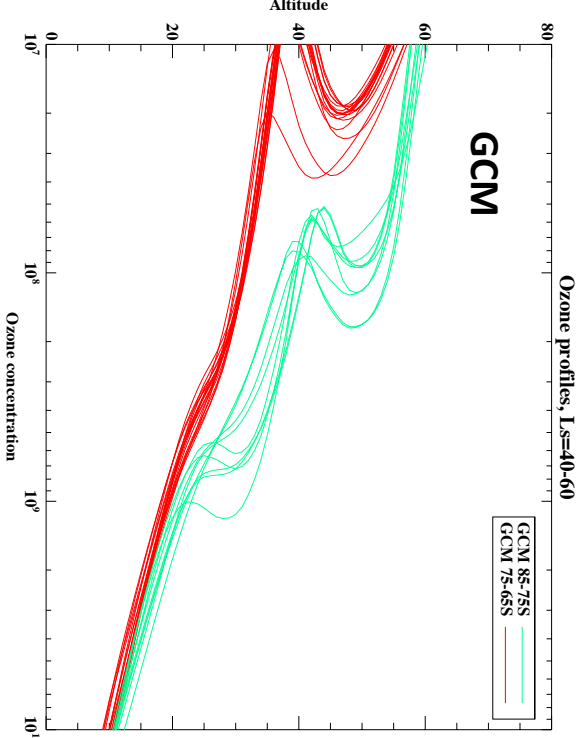
# SPICAM O<sub>3</sub>: SP Winter



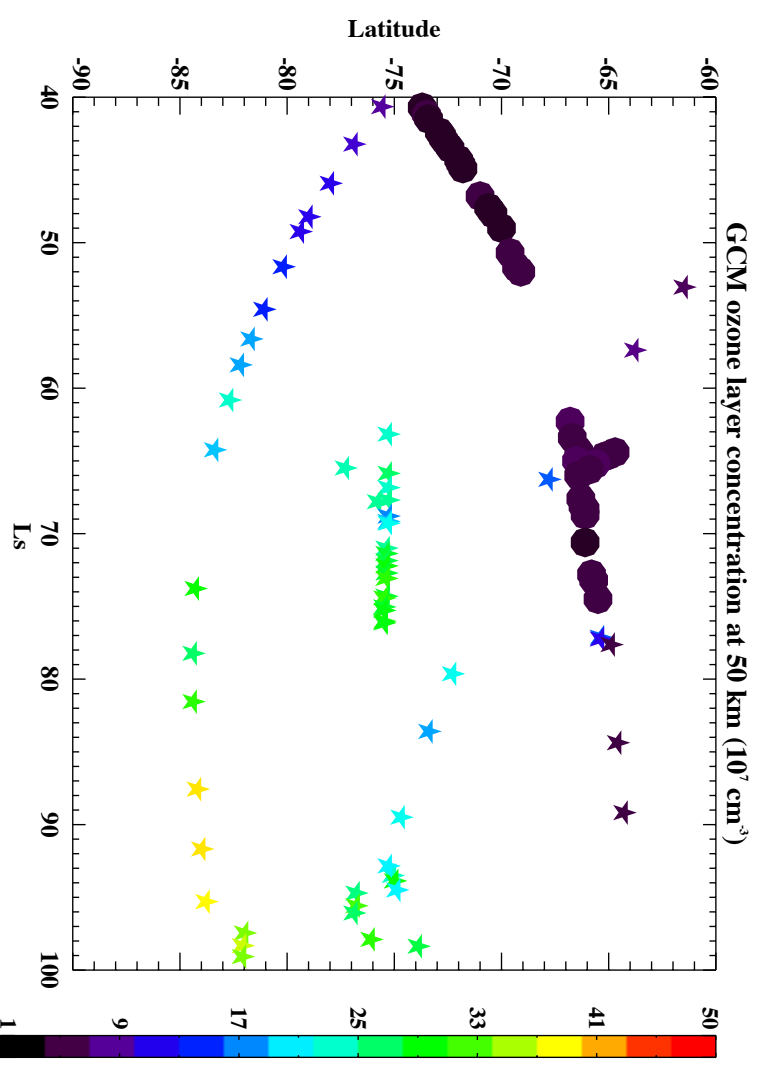
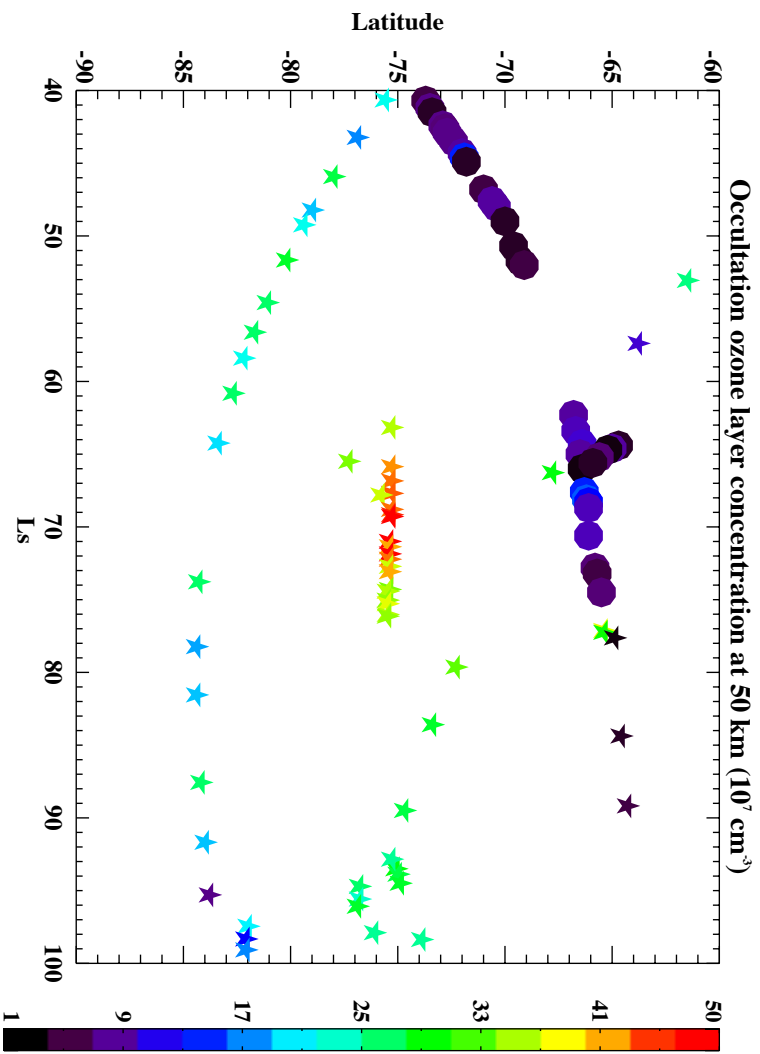
- Latitude-Ls coverage of all occultations
- Circles: solar occultations
- Stars: stellar occultations



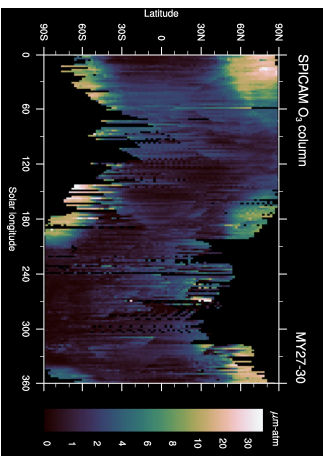
LS 40-60° 60-77° 77-100°



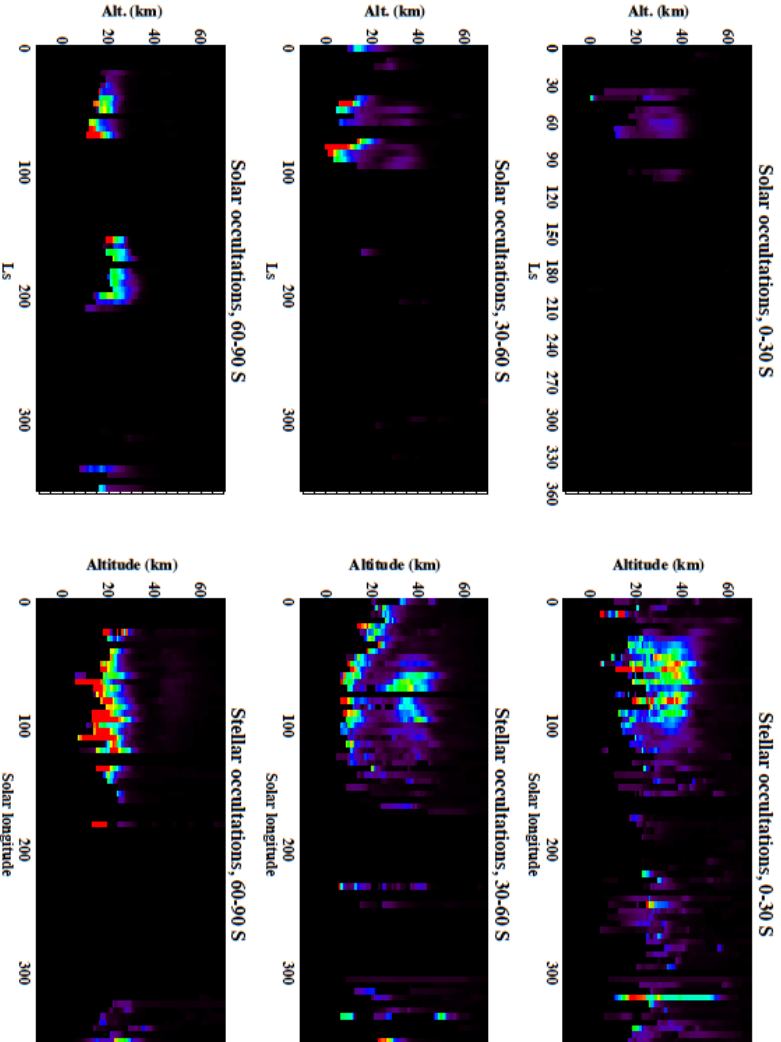
# SPICAM O<sub>3</sub>: SP Winter



- O<sub>3</sub> concentration @ 50 km (~max in previous profiles): Occultations vs. GCM



# SPICAM O<sub>3</sub>



- SPICAM UV solar and stellar occultations combined reveal the O<sub>3</sub> vertical distribution and its variations
  - A 3D picture of O<sub>3</sub> with SPICAM (nadir+occultations)
- SPICAM has probed the low and midlatitude O<sub>3</sub> layer and mapped the southern polar night O<sub>3</sub> layer throughout the polar vortex
- Good overall agreement with the GCM results
  - Next step: constrain the GCM with co-located O<sub>3</sub> and H<sub>2</sub>O profiles (SPICAM UV and IR)
- Keep in mind the strong horizontal gradients in solar occultations that should be accounted for in vertical inversion (Piccialli et al. talk)