Discoveries From the First Year of MLS OH Measurements

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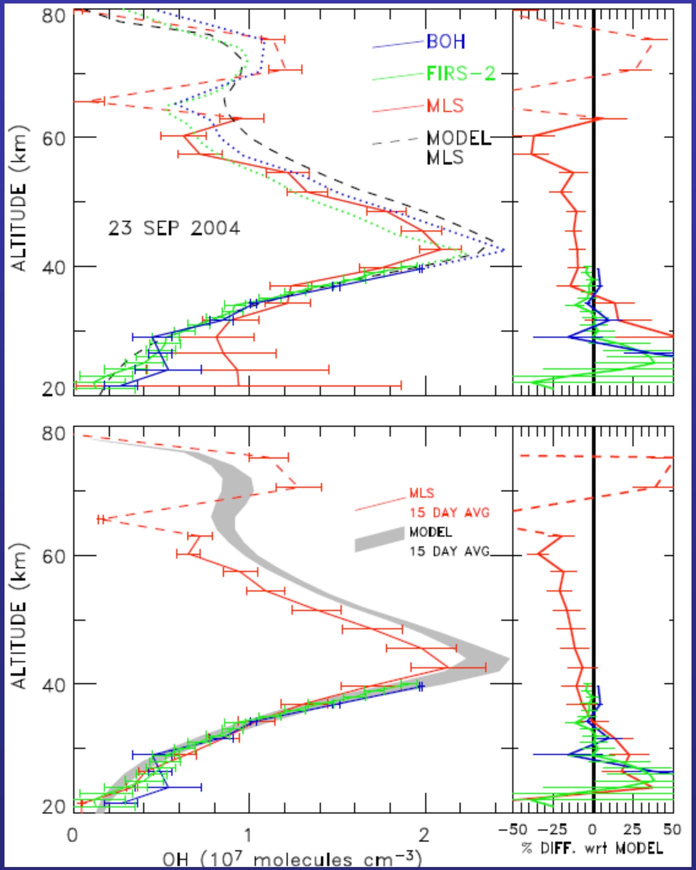
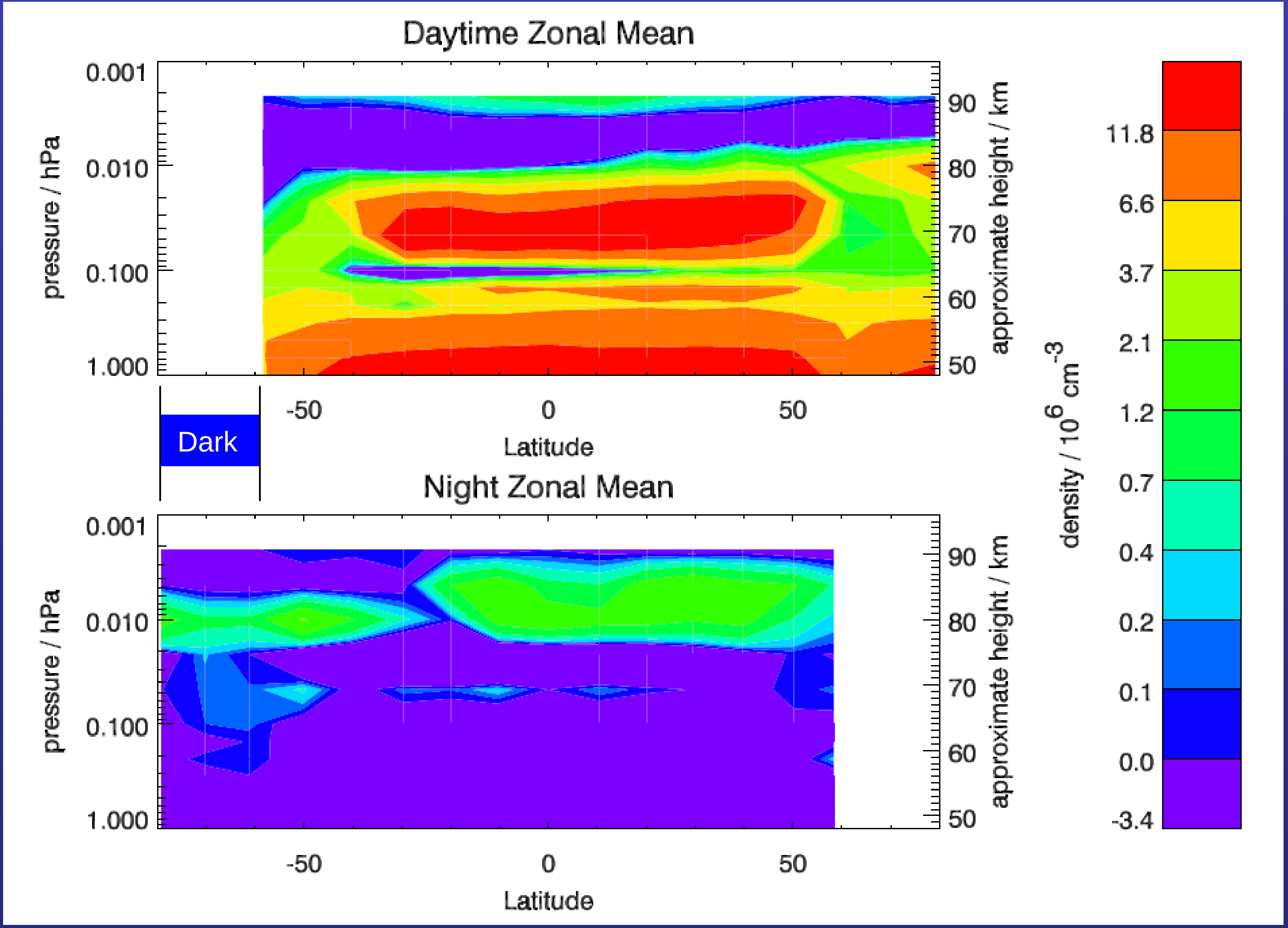
Previous Attraction

- Poster: Measured and Modeled HOx: Aura MLS, BOH, FIRS-2, and Ground-based Comparisons



- MLS average in upper panel is for latitude = [31.5, 36.5], longitude = [-122, -72], and LST = 13.5 hr
- BOH and FIRS-2 profiles are for closest LST and assume a profile shape above 40 km
  - Spectral profile is Doppler above 48 km
  - Measurements are still sensitive to the column above 40 km
- MLS average in lower panel is a zonal mean for latitude = [24, 44] and LST = 13.5 hr

Zonal Means for OH on June 22, 2005



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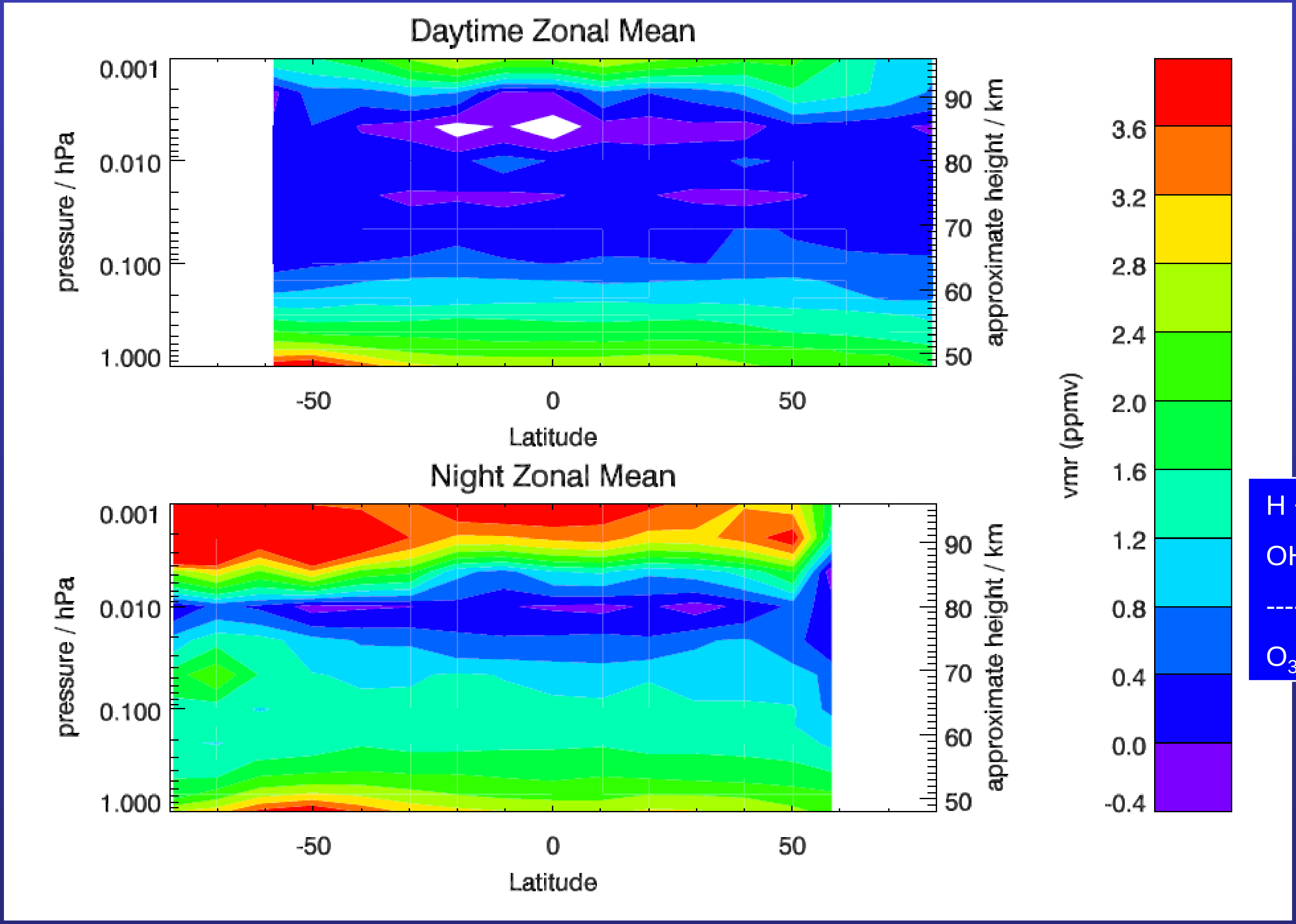
Zonal Means for O_3 on June 22, 2005



$H + O_3 \rightarrow OH^* + O_2$

$OH + O \rightarrow H + O_2$

$O_3 + O \rightarrow 2\,O_2$

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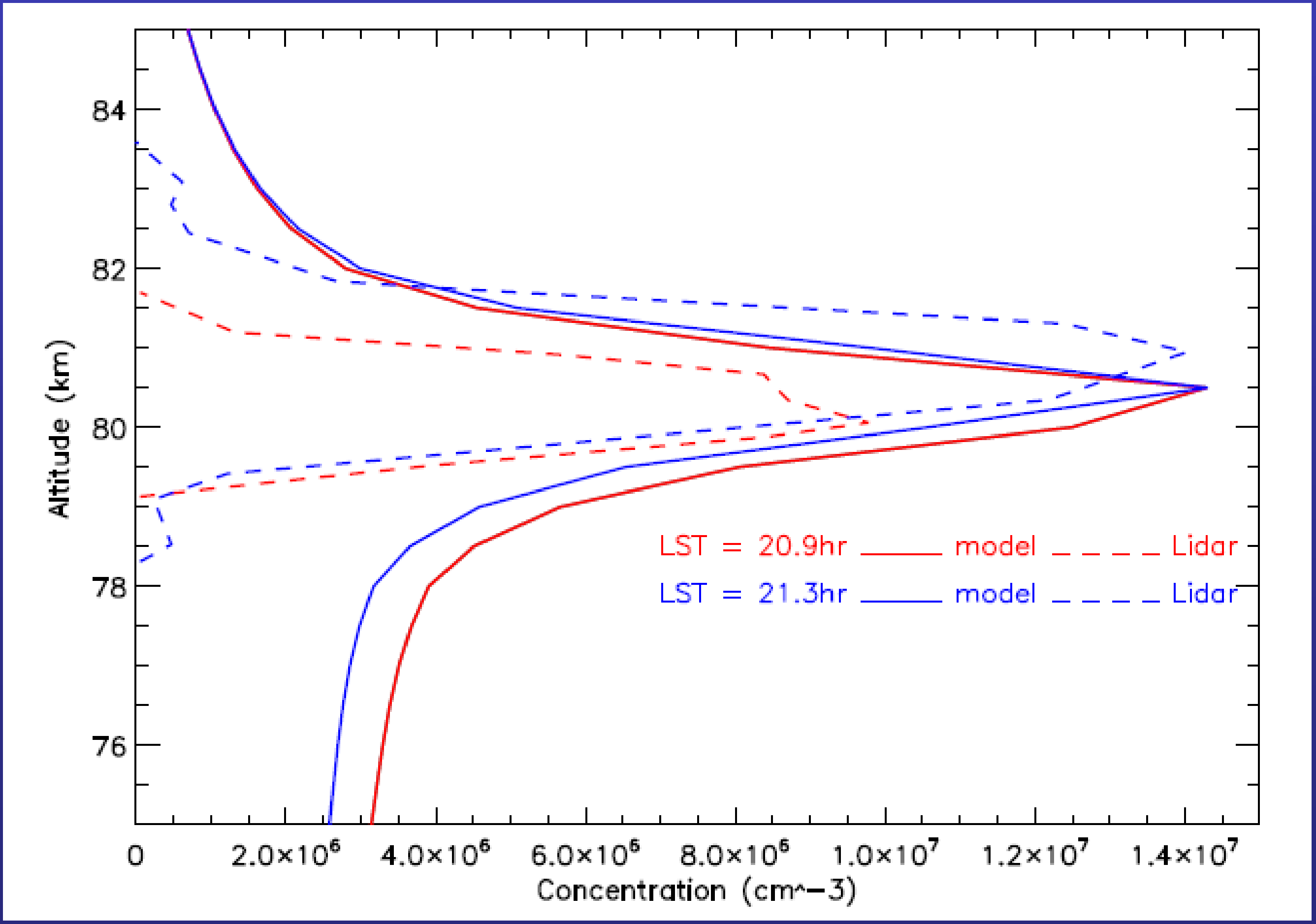
Model Simulation of Night OH LIDAR Observations



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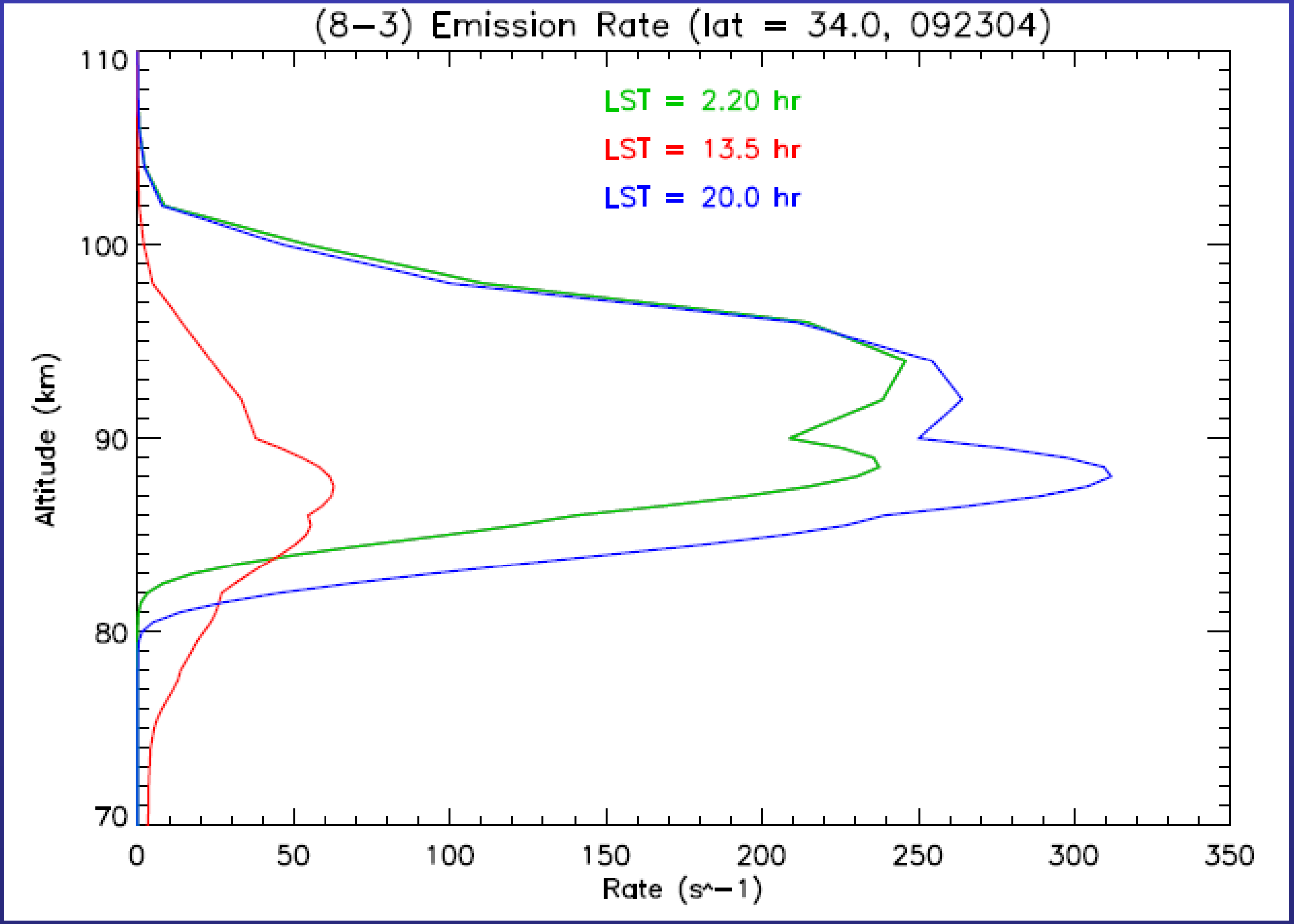
Modeled Meinel Emission of OH in Near-Infrared



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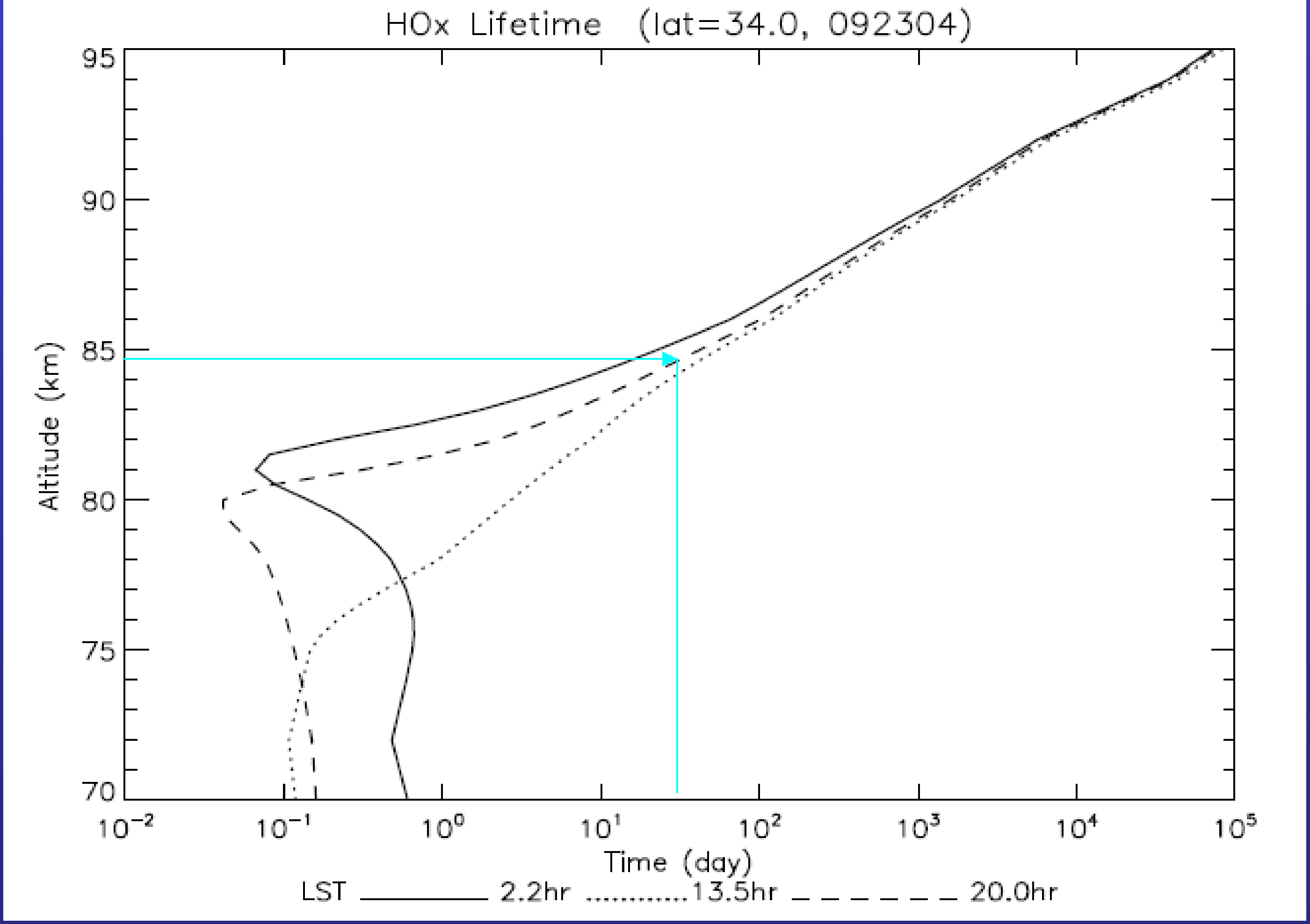

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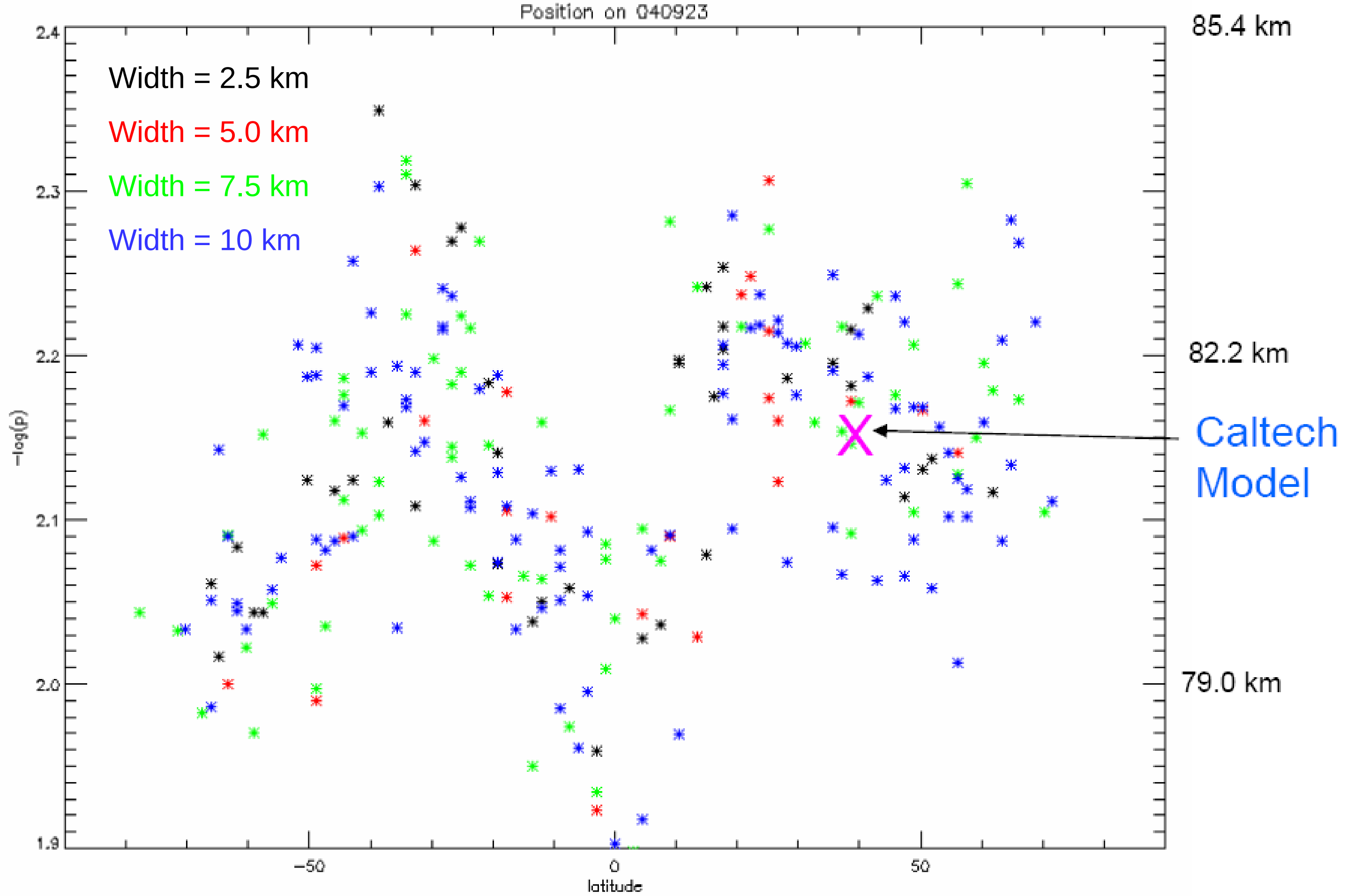
Night OH layer Position



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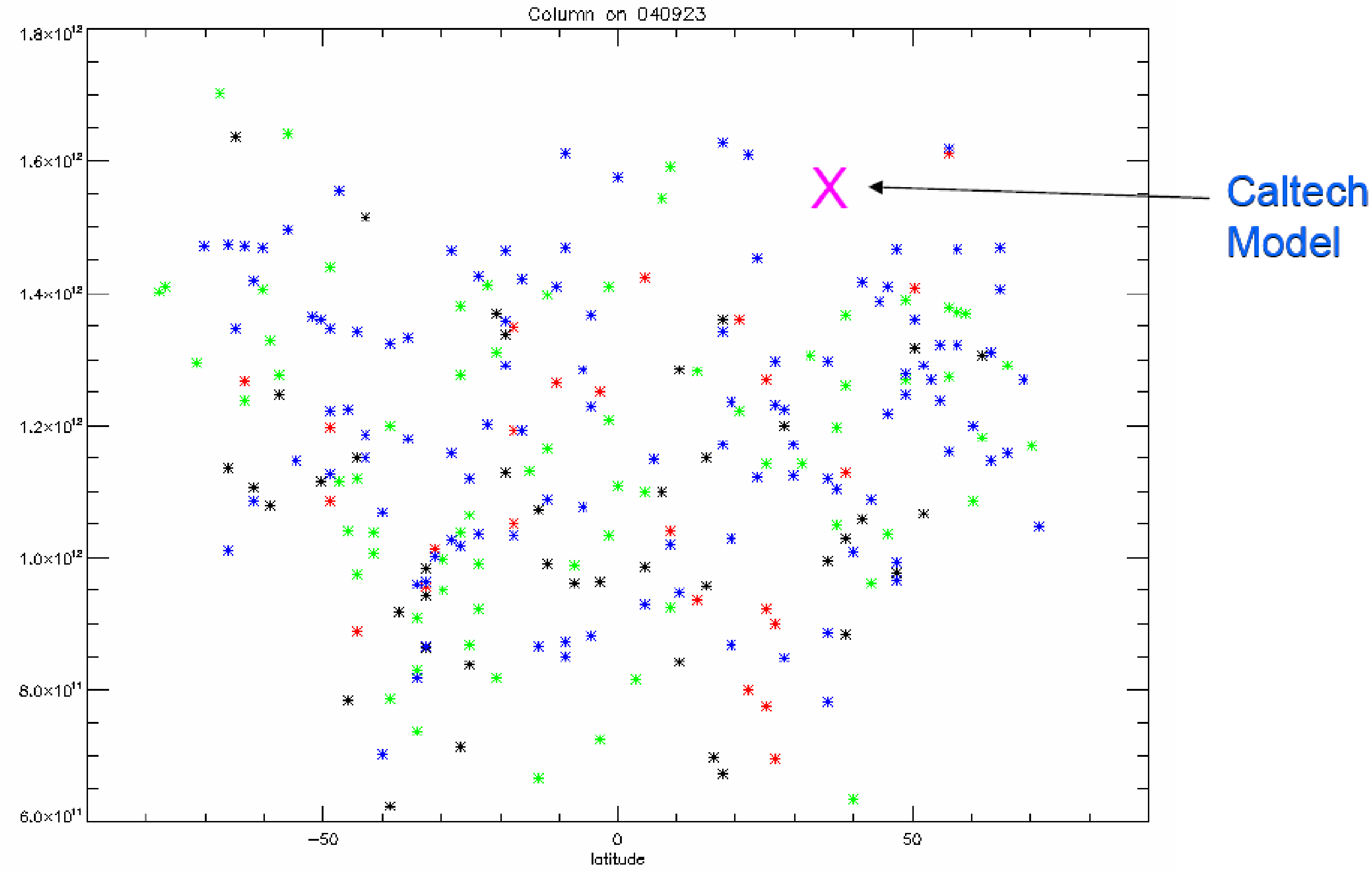
Night OH layer Column



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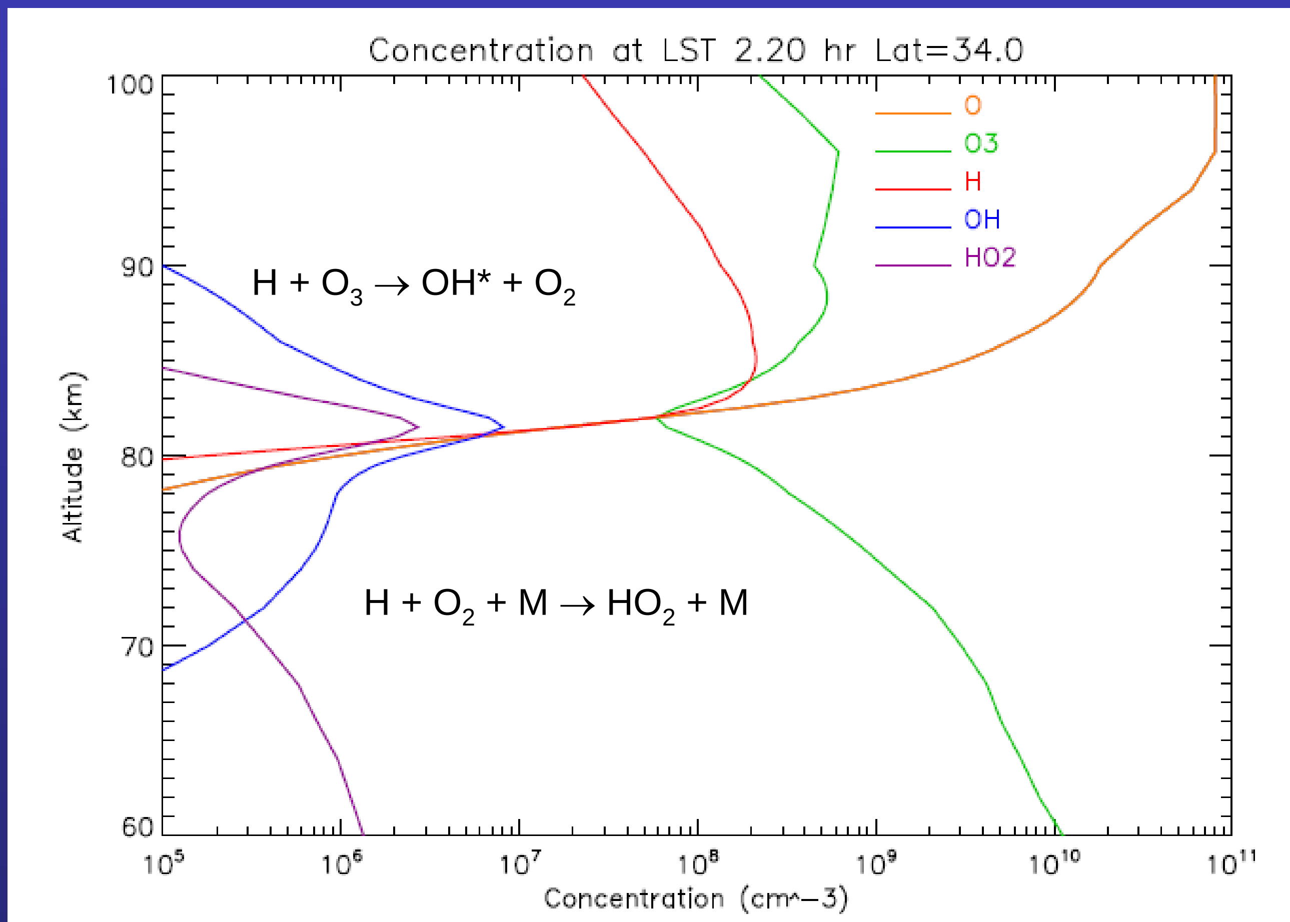
Modeled Radical Concentrations



Night OH Layer

- Layer at 82 km is associated with $H + O_3 \rightarrow OH(v) + O_2$ reaction
  - Ozone catalysis with H and OH leads to ozone minimum
- Caltech 1-D model has been modified to include spontaneous emission in Meinel bands and collisional quenching (using S. Adler-Golden rates)
  - Calculated chemical lifetime of HO_x is ~1day at 82 km but ~1 month at 87 km
  - Calculated width of level for OH(v=0) is 1.9 km at 81.5 km
    - LIDAR signal has similar width and altitude
  - Calculated emission height for Meinel bands is consistent with WINDII measurements of 87 km (width is ~10 km)
- MLS measurements show that the width, position, and area of the OH(v=0) layer is variable
- MLS measurements show that the layer persists in the dark pole near equinox and requires meridianal transport of H and O from solar-illuminated latitudes
  - Chemical lifetimes require the transport to take place above 87 km

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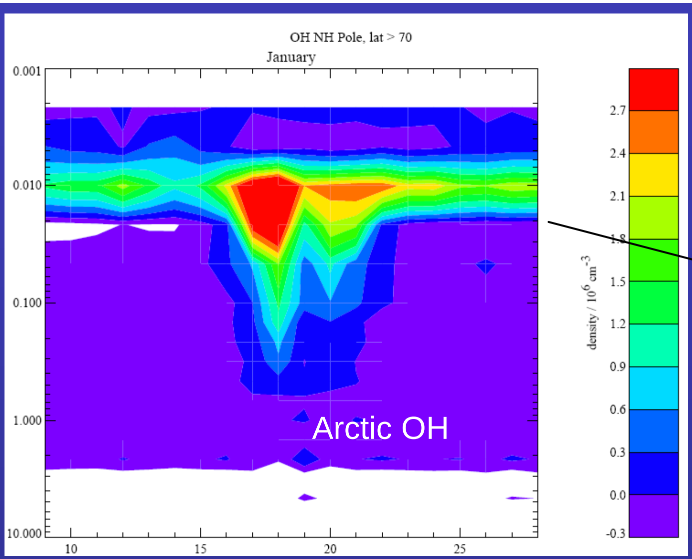

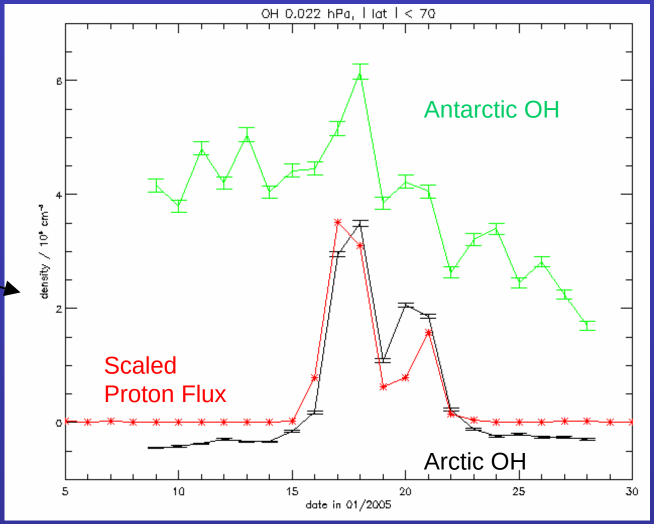

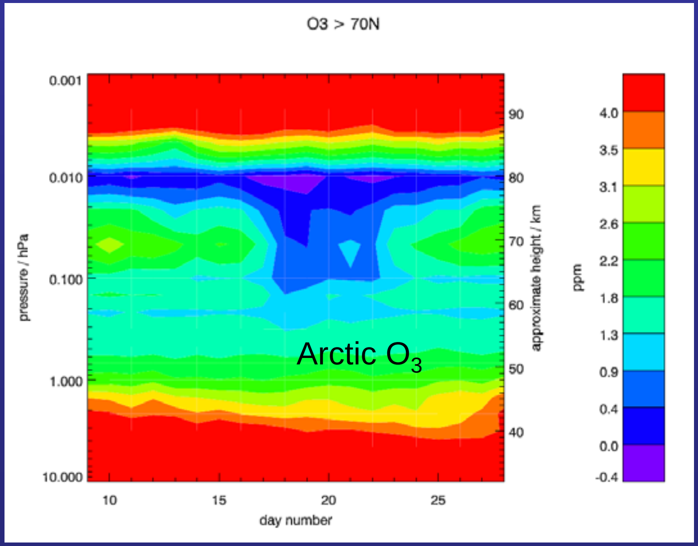

- A major Solar Proton Event occurred on 01/17/2005
- MLS detected an increase in mesospheric OH and a decrease of mesospheric O_3 in the Arctic polar night
  - Arctic results for OH and O_3 are shown to the left
  - Proton flux and OH response for the Arctic and Antarctic are shown above
- MLS also detected an increase in mesospheric OH in the Antarctic polar day
- No corresponding decrease in Antarctic O_3 was found because the background O_3 in the daylight Antarctic mesosphere is already very small
- Thanks to C. Jackman for suggesting the OH-Sun connection

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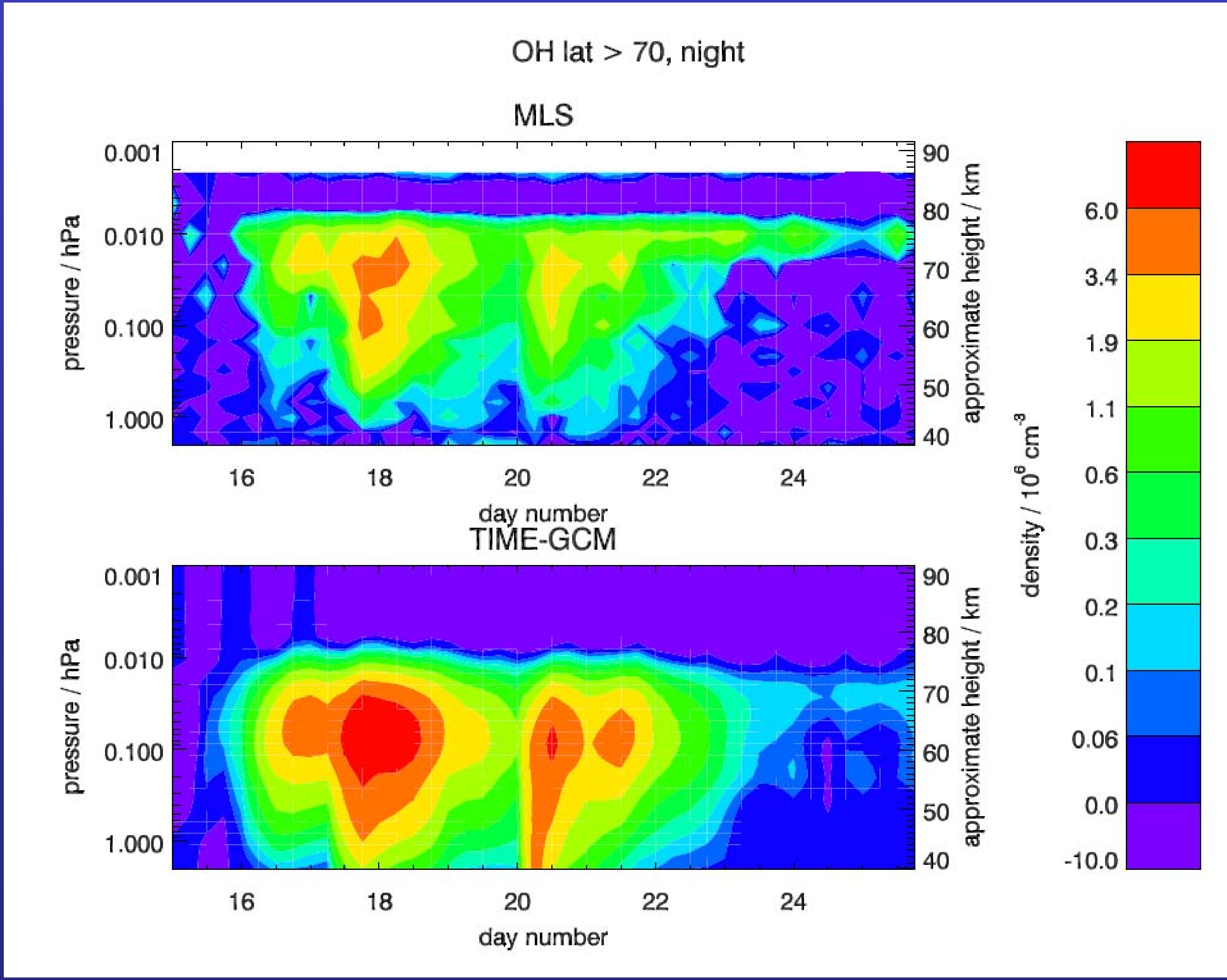

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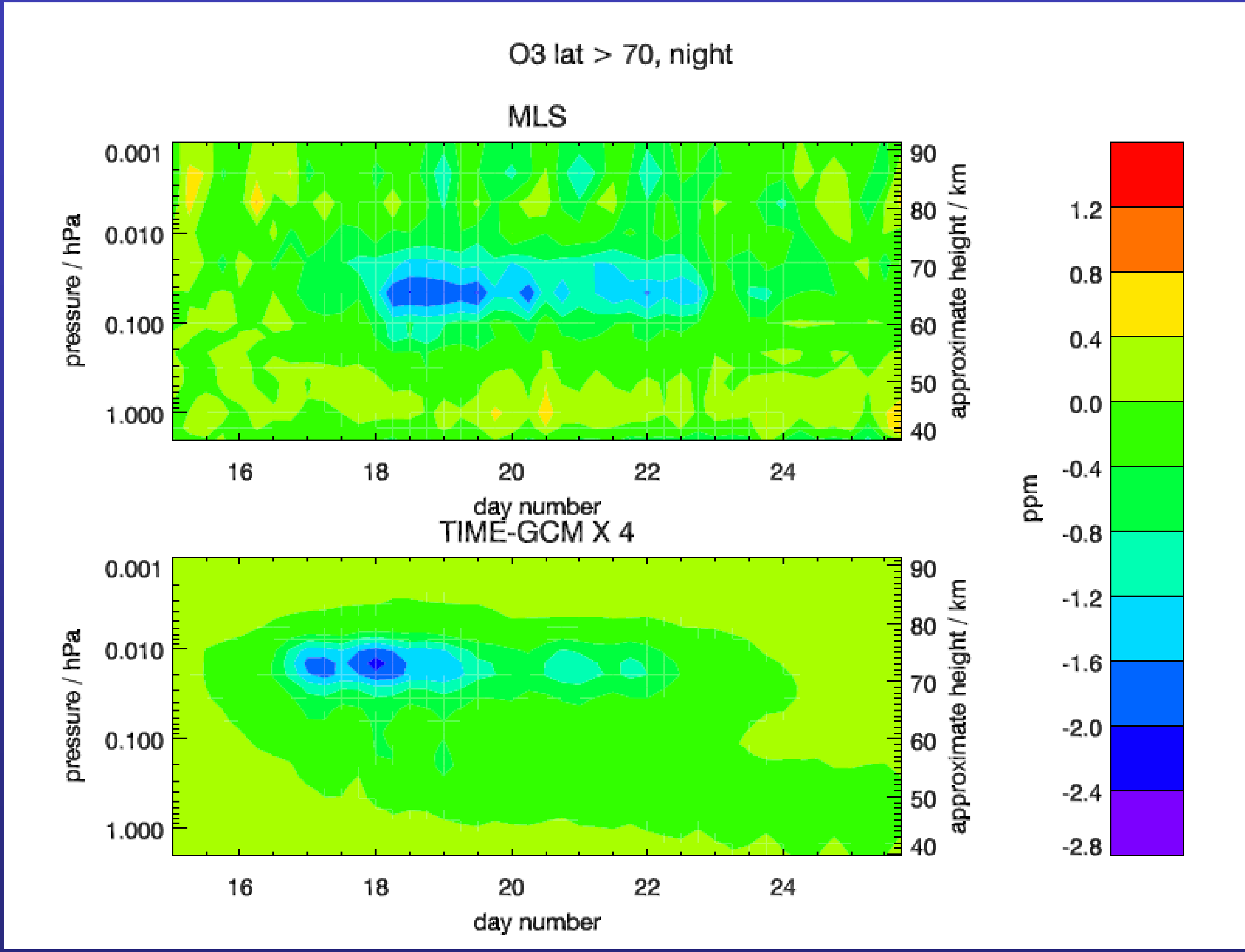
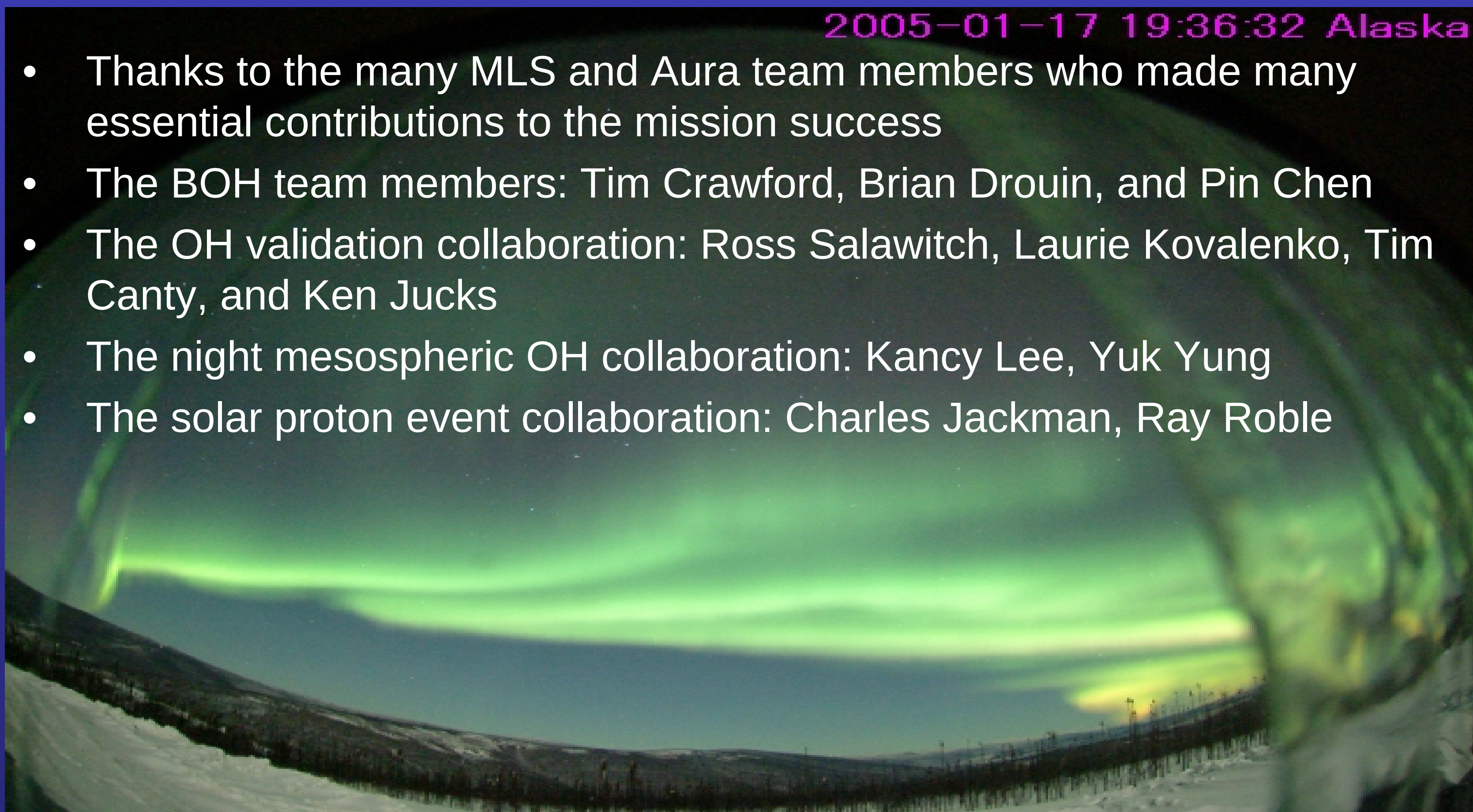


Conclusions

- Key results for MLS HO_x in the first year:
  - Have validated OH with both BOH and FIRS-2
  - Have validated HO_2 with FIRS-2
  - Have measured night OH near 82 km that is related for Meinel band emission in the near infrared and is responsible for a minimum in night O_3
  - Have seen OH produced from solar proton flares for the first time in 4 events
- MLS OH and HO_2 profile measurements are being made every 25 seconds, with 240 samples per orbit and 14.5 orbits per day virtually continuously.
  - Data set will allow comparison of HO_x with models with season from 83S to 83N latitude
  - Night observations of HO_x are possible and represent half of the data set
  - Other molecules measured by MLS (such as O_3, H_2O, HNO_3,..) share a common footprint

Acknowledgements



- Thanks to the many MLS and Aura team members who made many essential contributions to the mission success
- The BOH team members: Tim Crawford, Brian Drouin, and Pin Chen
- The OH validation collaboration: Ross Salawitch, Laurie Kovalenko, Tim Canty, and Ken Jucks
- The night mesospheric OH collaboration: Kancy Lee, Yuk Yung
- The solar proton event collaboration: Charles Jackman, Ray Roble