# Validation of MLS OH measurements with FTUVS total OH column measurements at Table Mountain (TMF), California

Shuhui Wang, Herbert M. Pickett, Thomas J. Pongetti, Changsub Shim, Qinbin Li, and Stanley P. Sander

*Jet Propulsion Laboratory, California Institute of Technology*

Ross Cheung and Yuk L. Yung

*Division of Geological and Planetary Sciences, California Institute of Technology*

Timothy Canty, Ross J. Salawitch

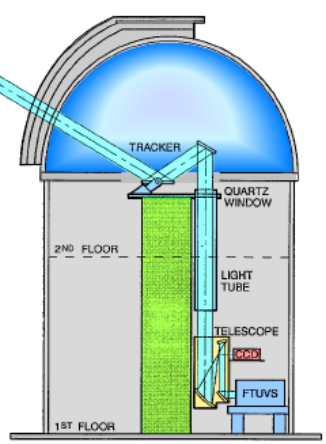
*Department of Atmospheric & Oceanic Science / Department of Chemistry & Biochemistry, University of Maryland, College Park*

# Introduction

- Earlier OH validation studies show good agreement between MLS and other observations/models in Sep.*[Pickett et al, 2006]*
- This work is the first comparison of space- and ground-based OH measurements over seasonal / inter-annual time scale.
- MLS measures OH down to ~ 21.5 hPa, which covers near 90% of the total OH abundance in the atmosphere.
- To compare data from MLS and TMF, OH residual in the lower atmosphere is estimated with GEOS-Chem.

TMF - Fourier Transform Ultra-Violet Spectrometer
Total OH column abundance

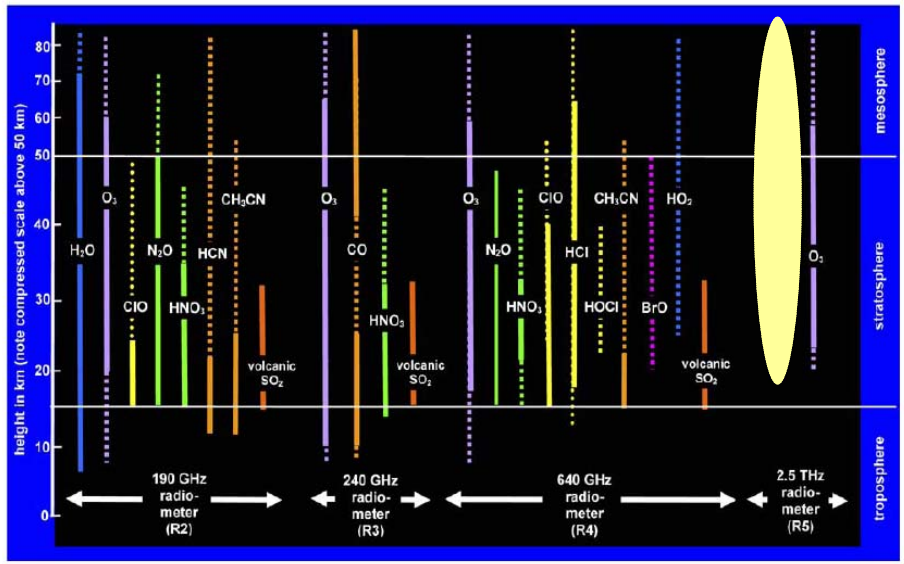
View of the building which houses the FTUVS instrument at JPL's Table Mountain Facility at 7500 ft. elevation near Wrightwood, California.




Layout of the FTUVS facility showing the tracker (heliostat), telescope and FTUVS interferometer.

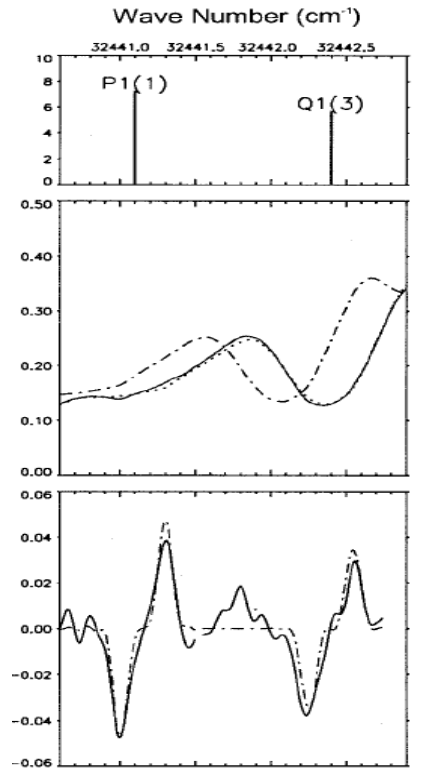
*[Cageao et al, 2001]*

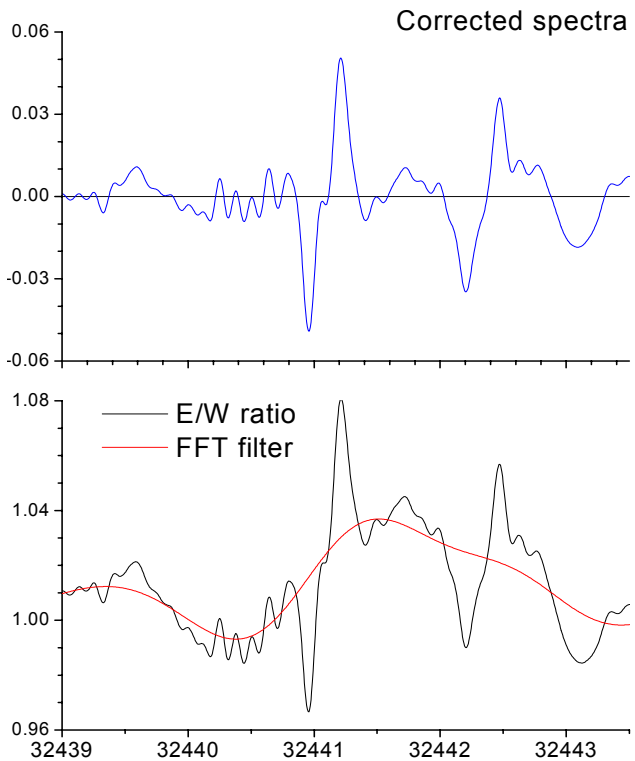
Aura – Microwave Limb Sounder
Partial OH column

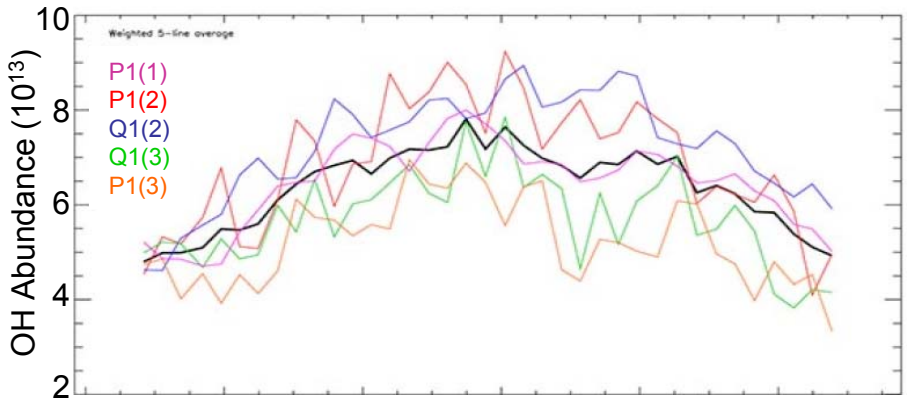


# TMF OH column retrieval

- Removal of solar Fraunhofer lines by matching and ratioing E and W spectra
- Solar background correction by FFT smoothing
- Nano-window fit for each OH line
- Weighted average OH abundance based on SNR *[Cheung et al, 2007]*

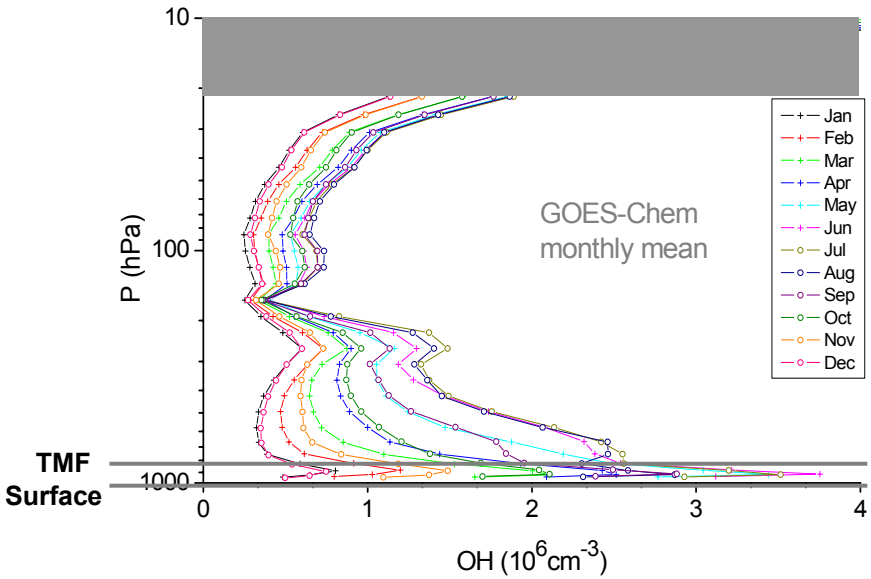


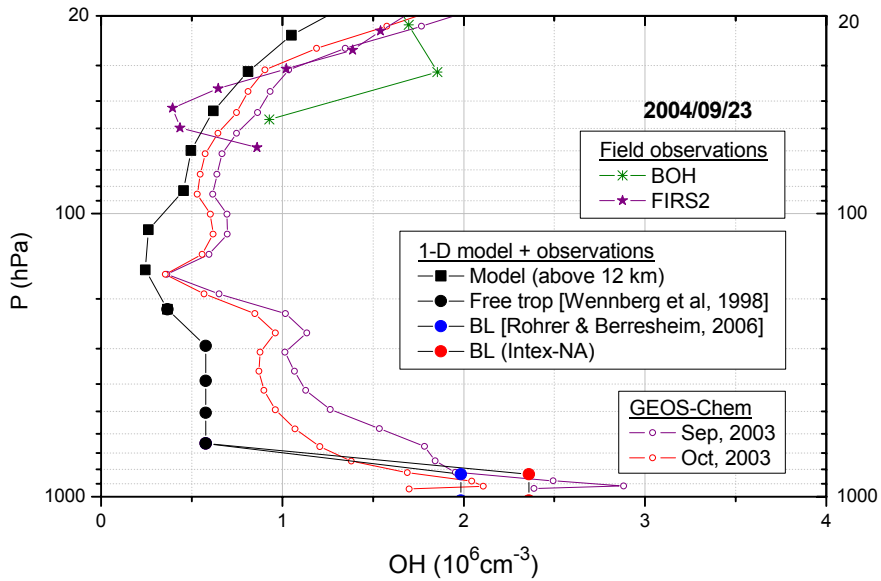



# OH residual in lower atmosphere

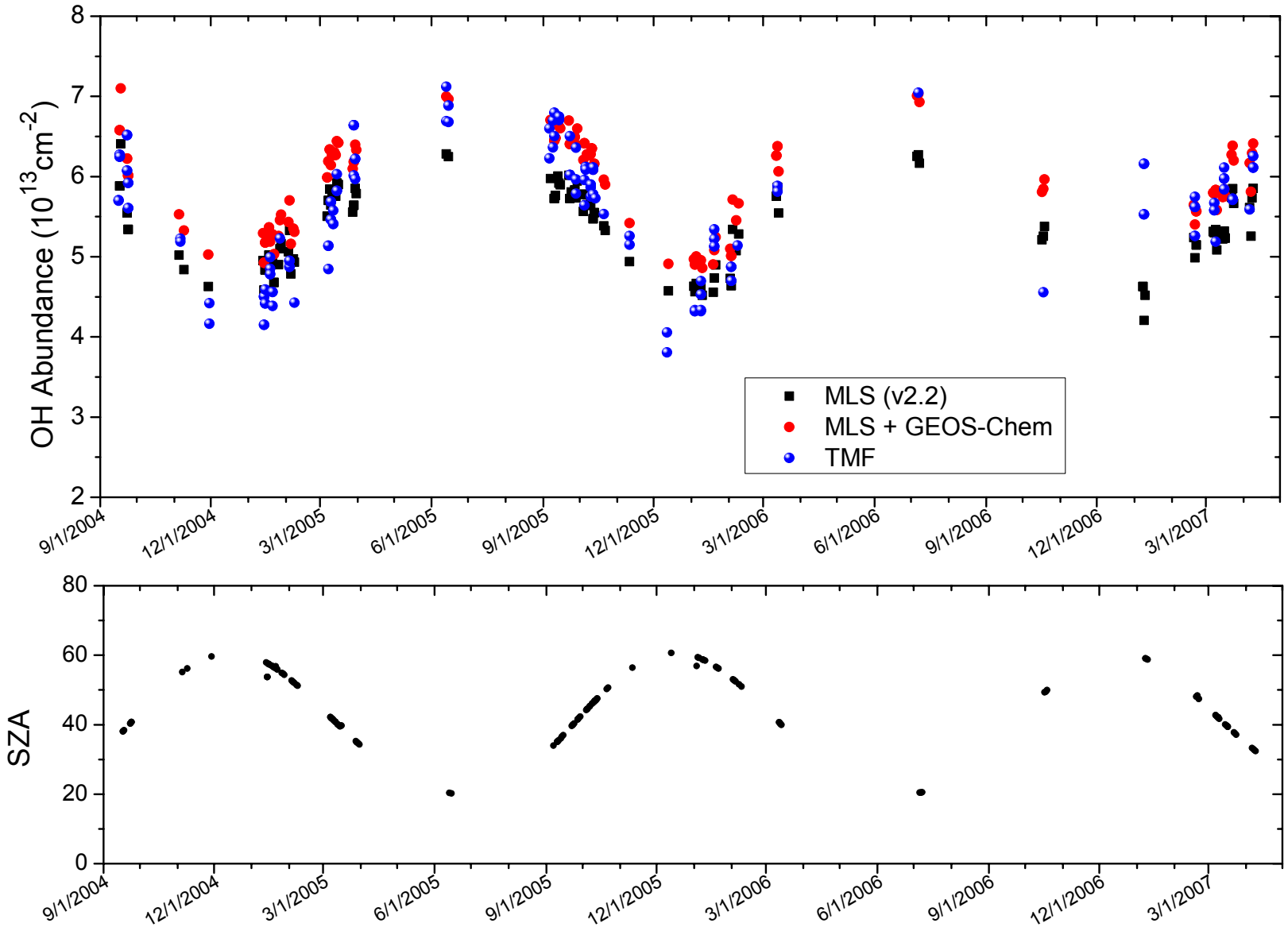
- Estimation based on GEOS-Chem 2003 monthly mean OH profiles and OH diurnal variation from observations/model *[Salawitch et al, 1994]*



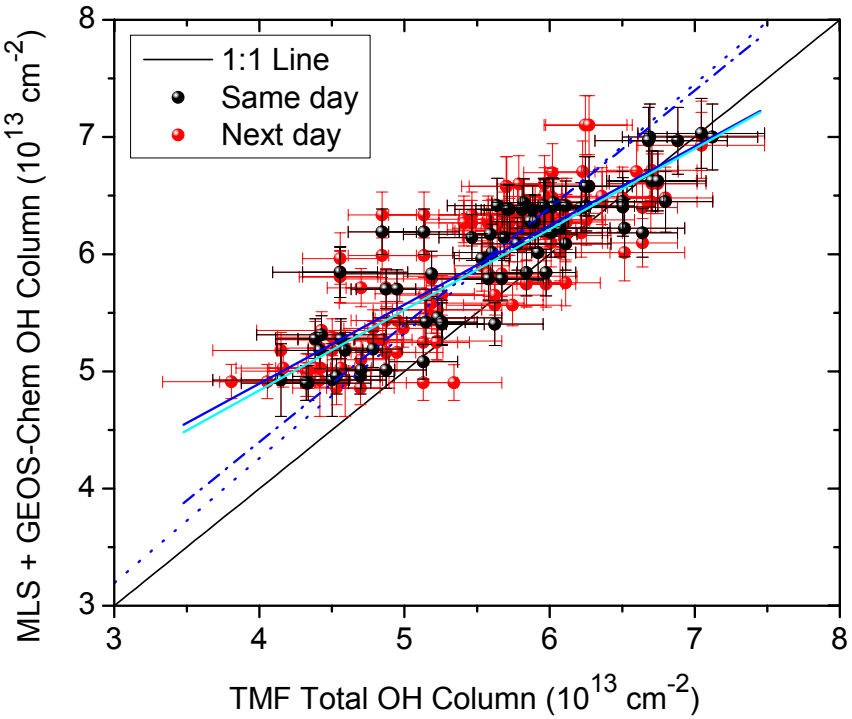




- GEOS-Chem monthly mean results are compare with field observations and results from 1-D HOx model for four seasons.
- To justify the interpolation from monthly mean, a newer version GEOS-Chem with hourly time resolution is applied to calculated OH at satellite overpass time during selected months. The majority of the calculated results agree with the interpolated results within 30%.
- The uncertainty in this estimation contributes less than 4% to the total OH column.

# Overview of the measurements

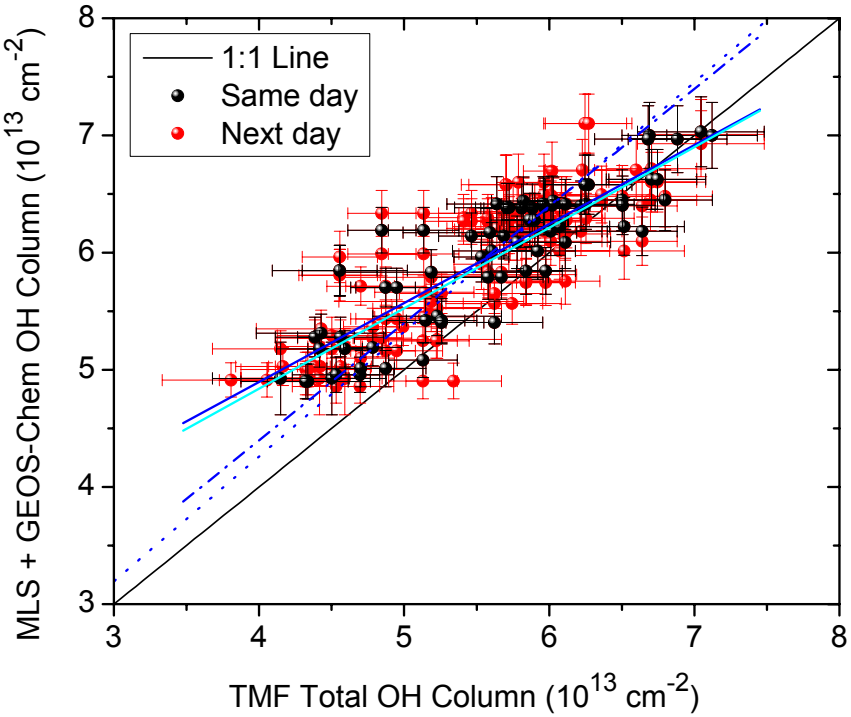


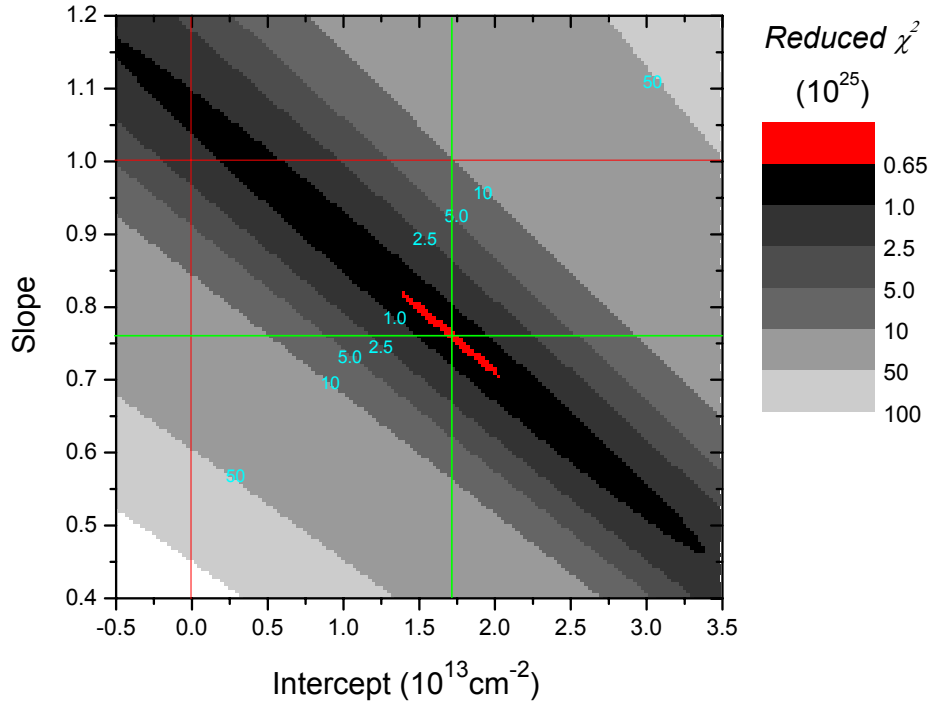
# Linear correlation of OH columns
# MLS + GEOS-Chem vs. TMF



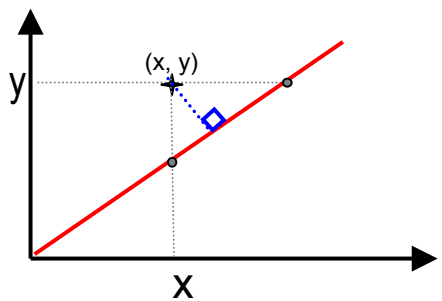

| Linear Fit | | Slope | Intercept ($10^{13}$) | R |
|---|---|---|---|---|
| **No error Weighted** | **Fit through 0** | 1.065±0.005 | 0 | 0.854 |
| | **Fit with unity slope** | 1 | 0.40 ±0.03 | 0.854 |
| | **Standard fit** | 0.673 ±0.029 | 2.20 ±0.16 | 0.854 |
| **Standard fit with y errors weighted** | | 0.686 ±0.019 | 2.09 ±0.10 | 0.850 |

# Linear correlation of OH columns
# MLS + GEOS-Chem vs. TMF

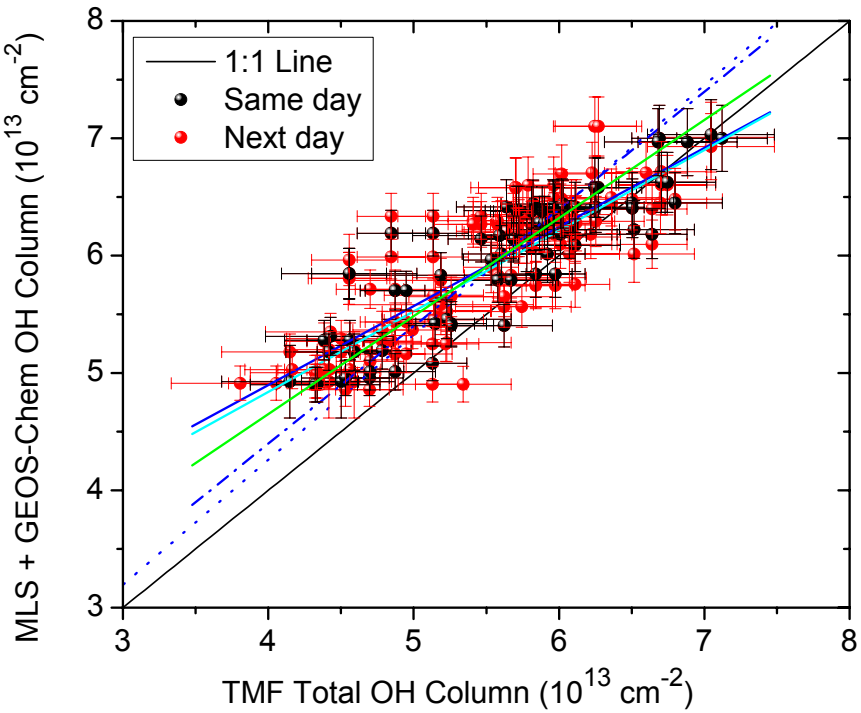


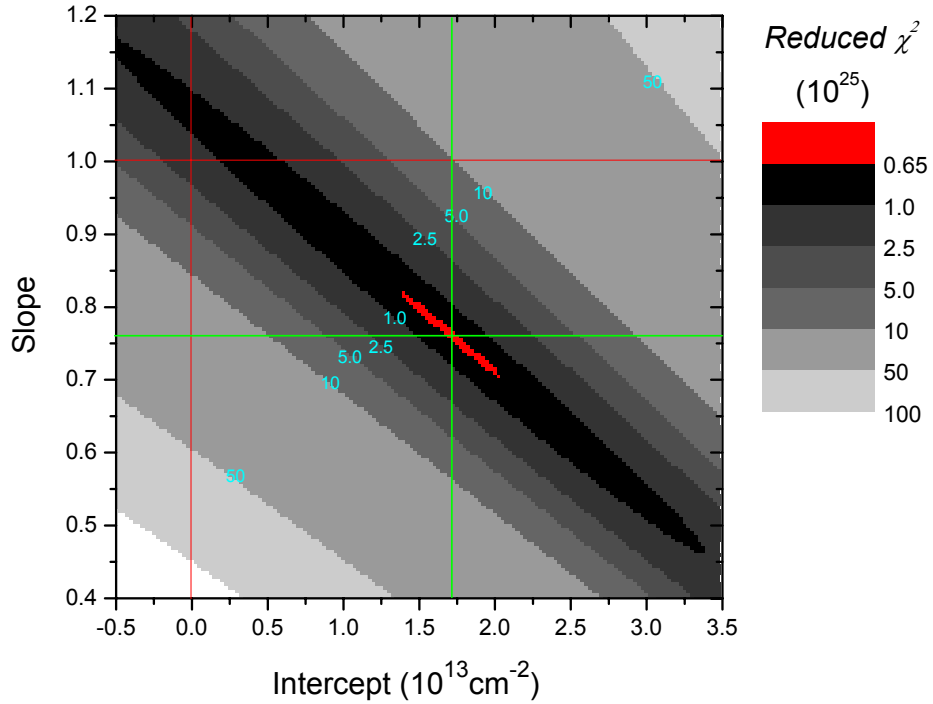




| Linear Fit | | Slope | Intercept ($10^{13}$) | R |
|---|---|---|---|---|
| No error Weighted | Fit through 0 | 1.065±0.005 | 0 | 0.854 |
| | Fit with unity slope | 1 | 0.40 ±0.03 | 0.854 |
| | Standard fit | 0.673 ±0.029 | 2.20 ±0.16 | 0.854 |
| Standard fit with y errors weighted | | 0.686 ±0.019 | 2.09 ±0.10 | 0.850 |

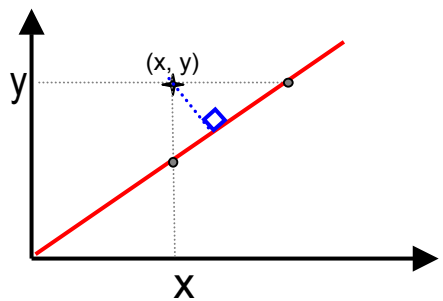


# Linear correlation of OH columns
# MLS + GEOS-Chem vs. TMF

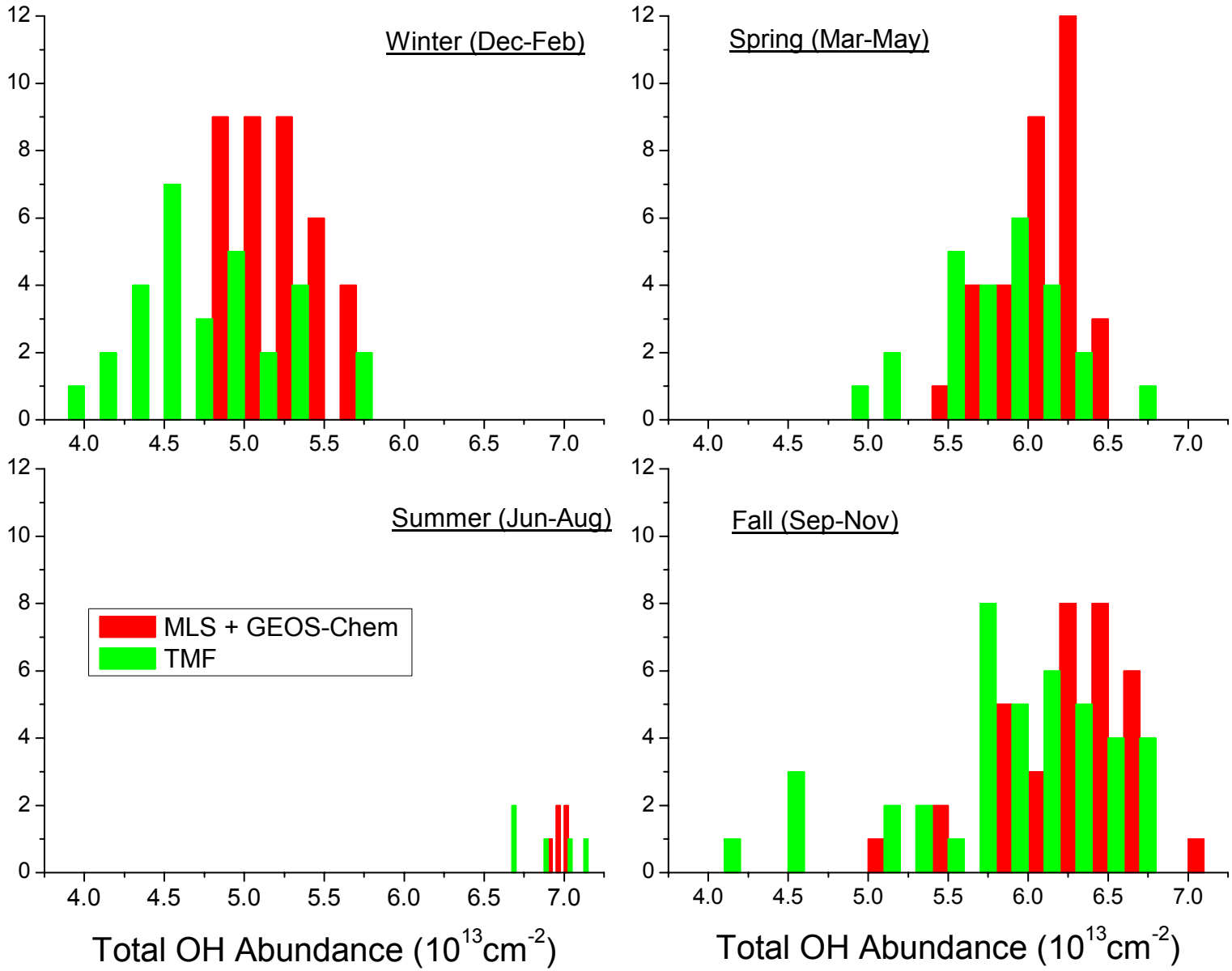


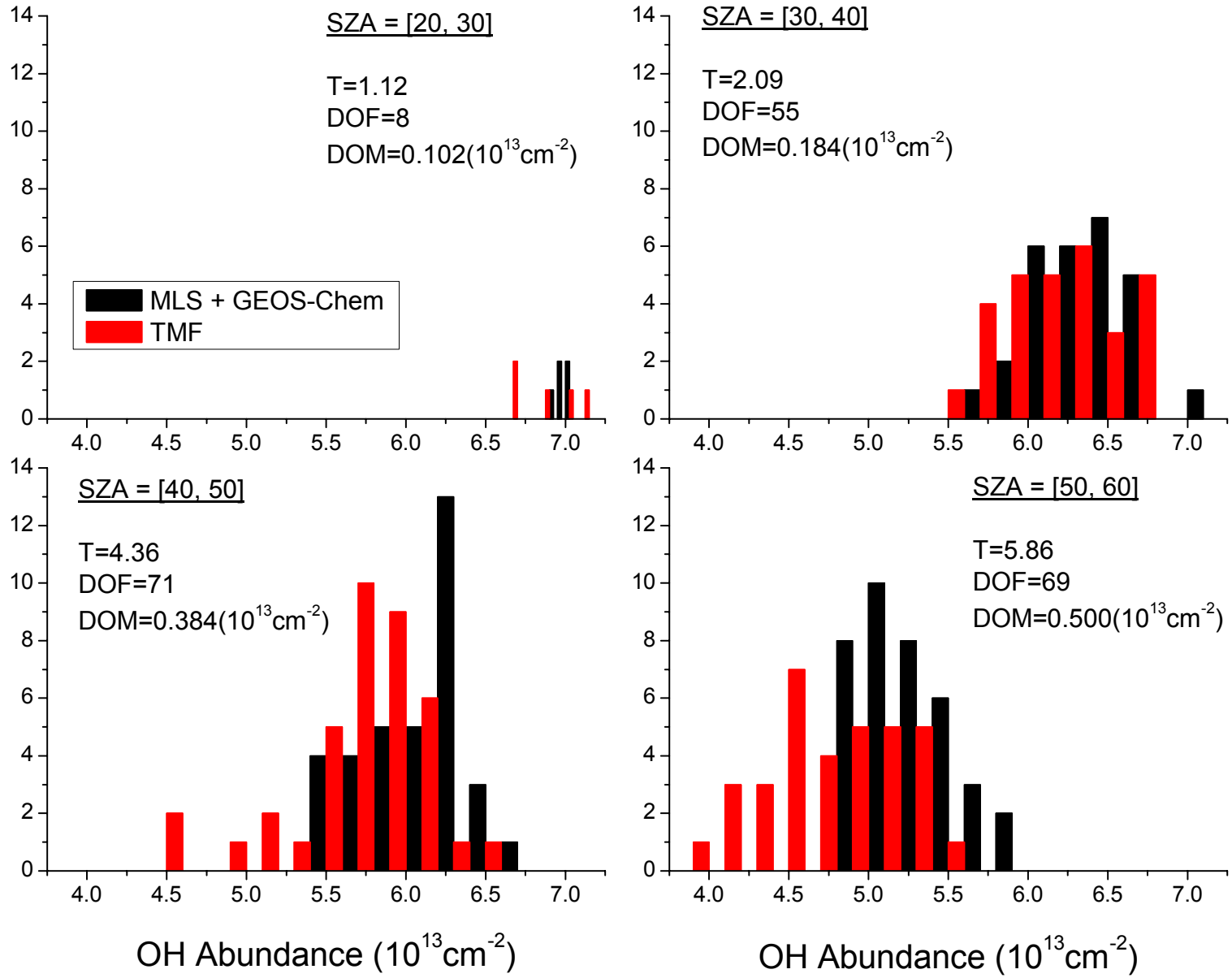

| Linear Fit | | Slope | Intercept ($10^{13}$) | R |
|---|---|---|---|---|
| No error Weighted | Fit through 0 | 1.065±0.005 | 0 | 0.854 |
| | Fit with unity slope | 1 | 0.40 ±0.03 | 0.854 |
| | Standard fit | 0.673 ±0.029 | 2.20 ±0.16 | 0.854 |
| Standard fit with y errors weighted | | 0.686 ±0.019 | 2.09 ±0.10 | 0.850 |
| Orthogonal fit with x and y errors weighted | | 0.835 ±0.185 | 1.308 ±0.003 | 0.855 |



# Seasonal histograms



# SZA histograms / T-tests



# Summary

• This is the first seasonal and inter-annual comparison of OH measurements from space and the ground-level.

• In general, the total OH columns from MLS + GEOS-Chem and TMF agree, especially during high OH seasons (small SZAs). A linear correlation through zero shows a remarkable agreement within 6.5%.

• Detailed statistical investigations, however, show differences during low OH seasons (large SZAs), suggesting a weaker seasonal variation in MLS measurements than TMF measurements and a possible offset.

• The summer time data are too sparse, which may bias the linear fit. More data during summer will be available as the MLS reprocessing goes.

• Further investigations, with focus on data at large SZAs, are required to understand the disagreement between these measurements.

## Acknowledgements

• We appreciate the help from Alyn Lambert in the orthogonal linear fit with x and y errors.

## References

• *Cageao, R.P., J.F. Blavier, J.P. McGuire, et al., High-resolution Fourier-transform ultraviolet-visible spectrometer for the measurement of atmospheric trace species: Application to OH, Appl. Opt., 40, 2024 – 2030*

• *Cheung, R., K.F. Li, S. Wang, et al., An improved method for retrieving hydroxyl radical (OH) abundances from ultraviolet spectra, to be submitted to Appl. Opt., 2007*

• *Pickett, H.M., B.J. Drouin, T. Canty, et al., Validation of Aura MLS HOx measurements with remote-sensing balloon instruments, Geophys. Res. Lett., 33, L01808, 2006*

• *Rohrer, F. and H. Berresheim, Strong correlation between levels of tropospheric hydroxyl radicals and solar ultraviolet radiation. Nature, 442, doi:10.1038, 2006*

• *Salawitch, R.J., S.C. Wofsy, P.O. Wennberg, et al., The diurnal variation of hydrogen, nitrogen, and chlorine radicals: implications for the heterogeneous production of HNO2, Geophys. Res. Lett., 21(23), 2551 – 2554, 1994*

• *Wennberg, P.O., T.F. Hanisco, L. Jaegle, et al., Hydrogen radicals, nitrogen radicals, and the production of O3 in the upper troposphere, Science, 279(49), dio:10.1126, 1998*