Raman Lidar Observations of Water Vapor Mixing Ratio Turbulence Profiles in the Convective Boundary Layer

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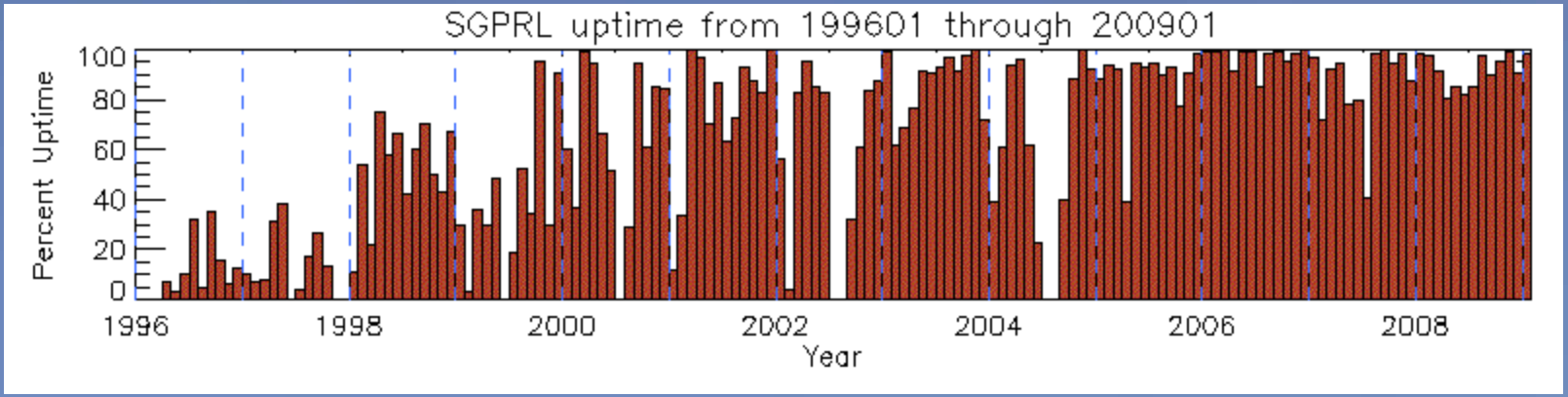
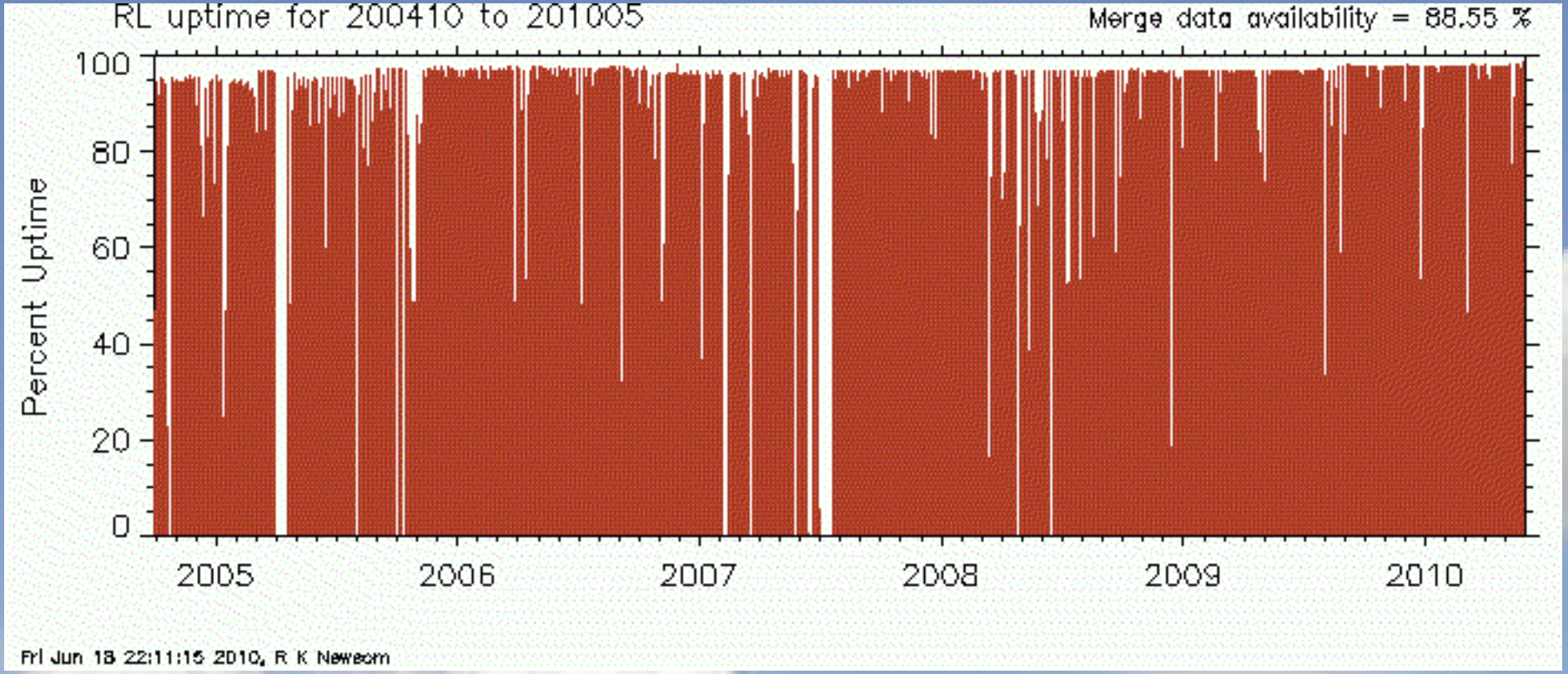
SGP Raman Lidar

- System is Operated 24/7/365
- First deployed in 1996
- Major upgrade in Sep 2004
  - 10-s data since Feb 2005

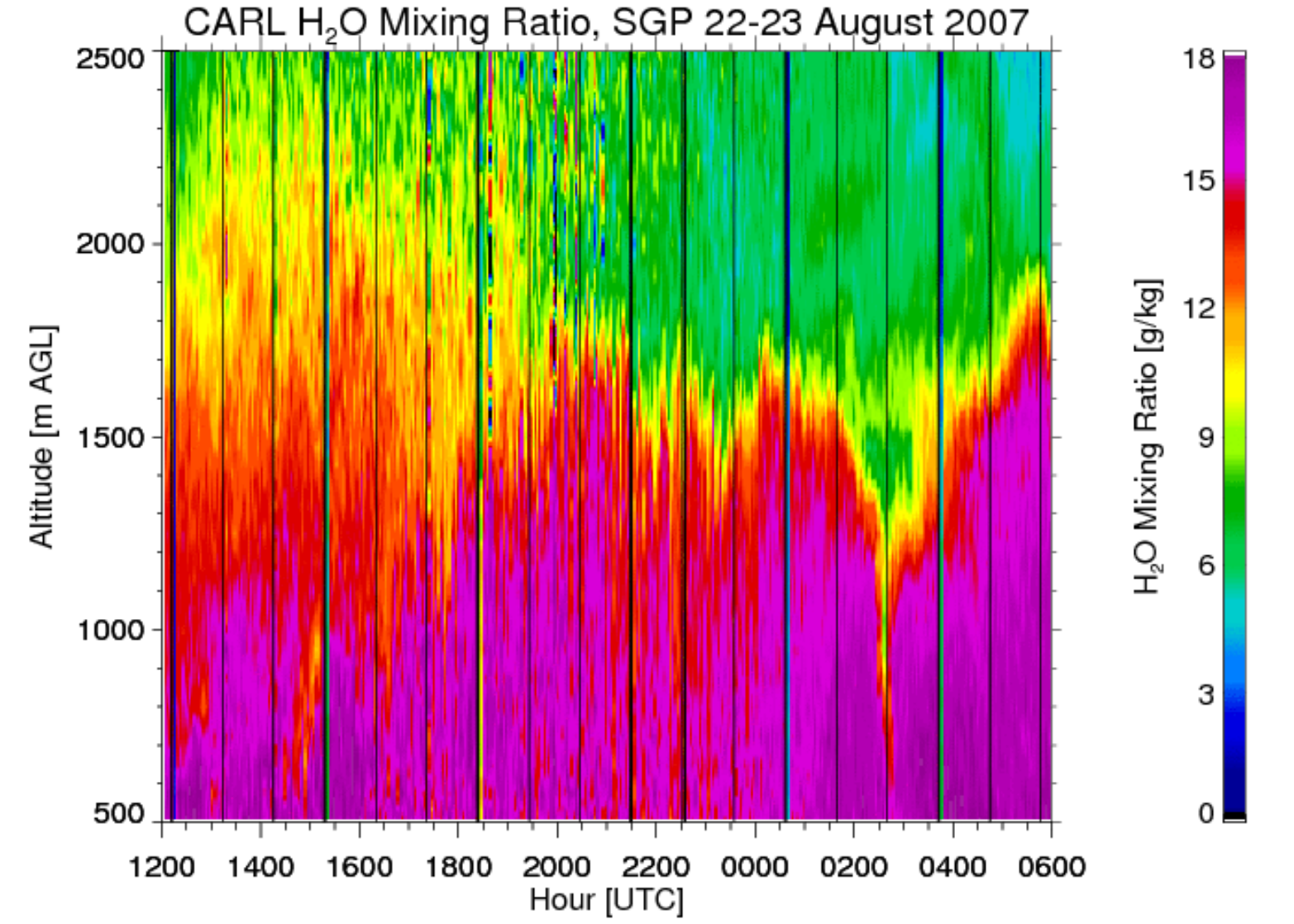
SGP Raman Lidar Uptime





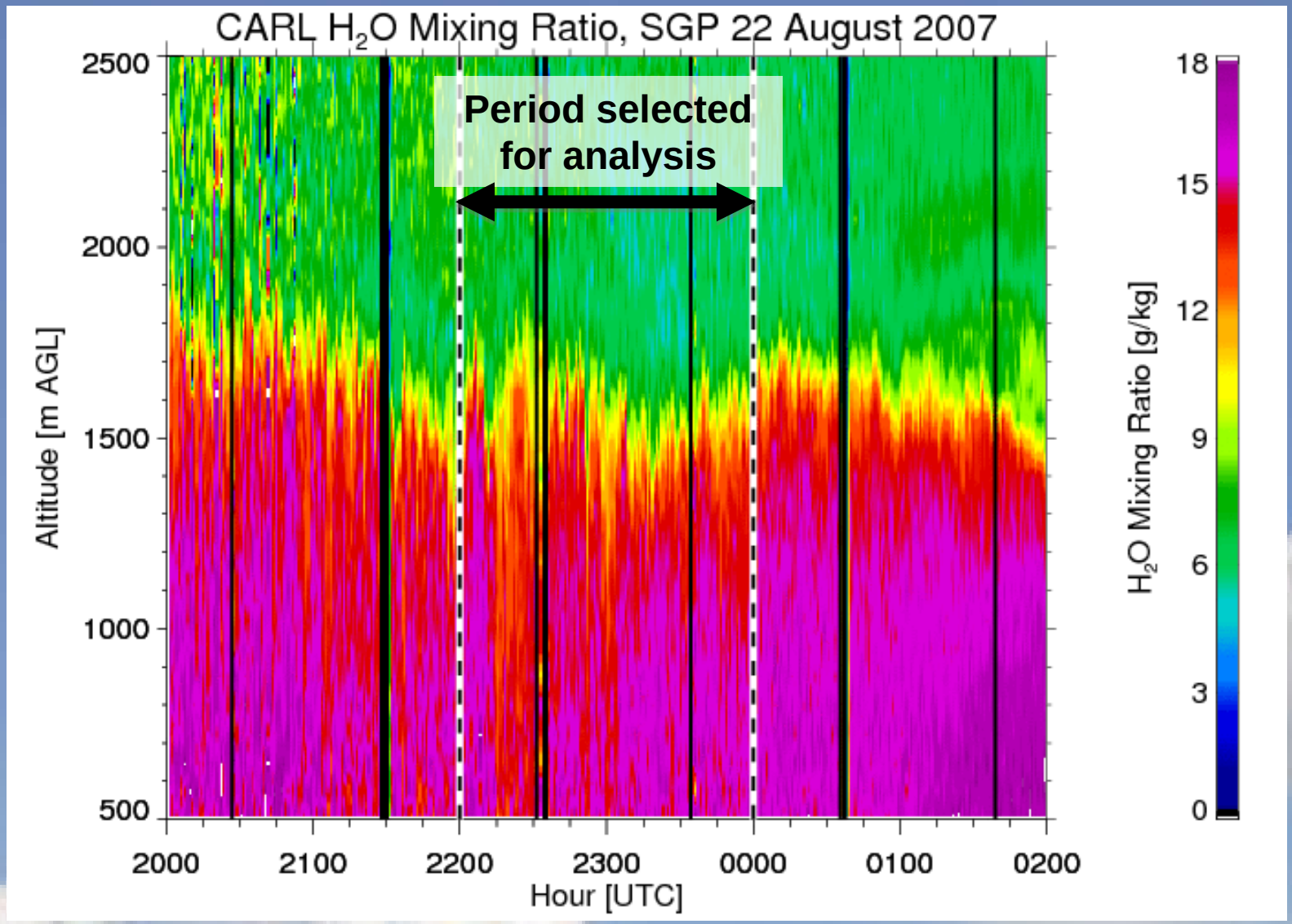
Example Time-Height Cross-Section

10-s, 75-m resolution



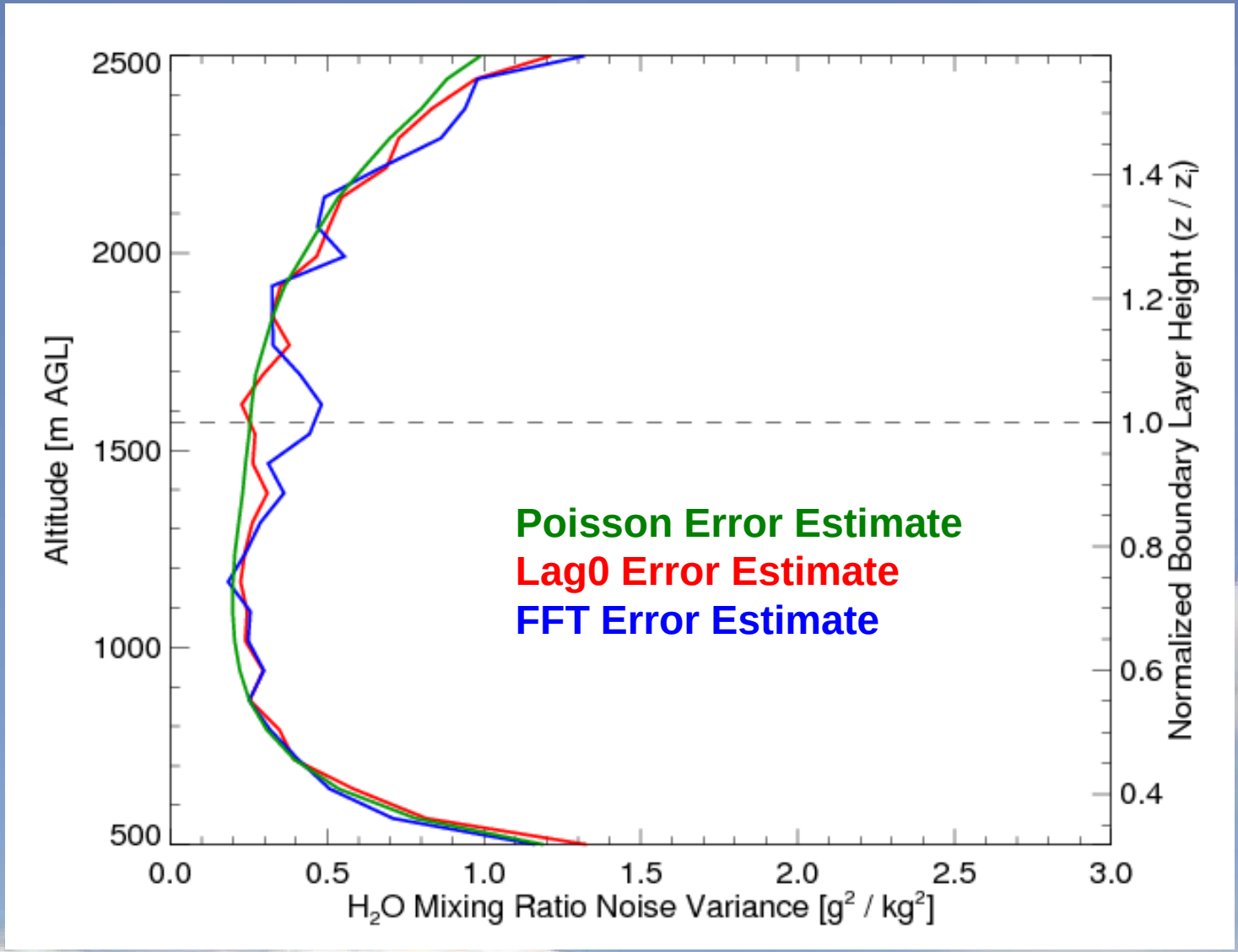
Example Time-Height Cross-Section

10-s, 75-m resolution (zoomed view)



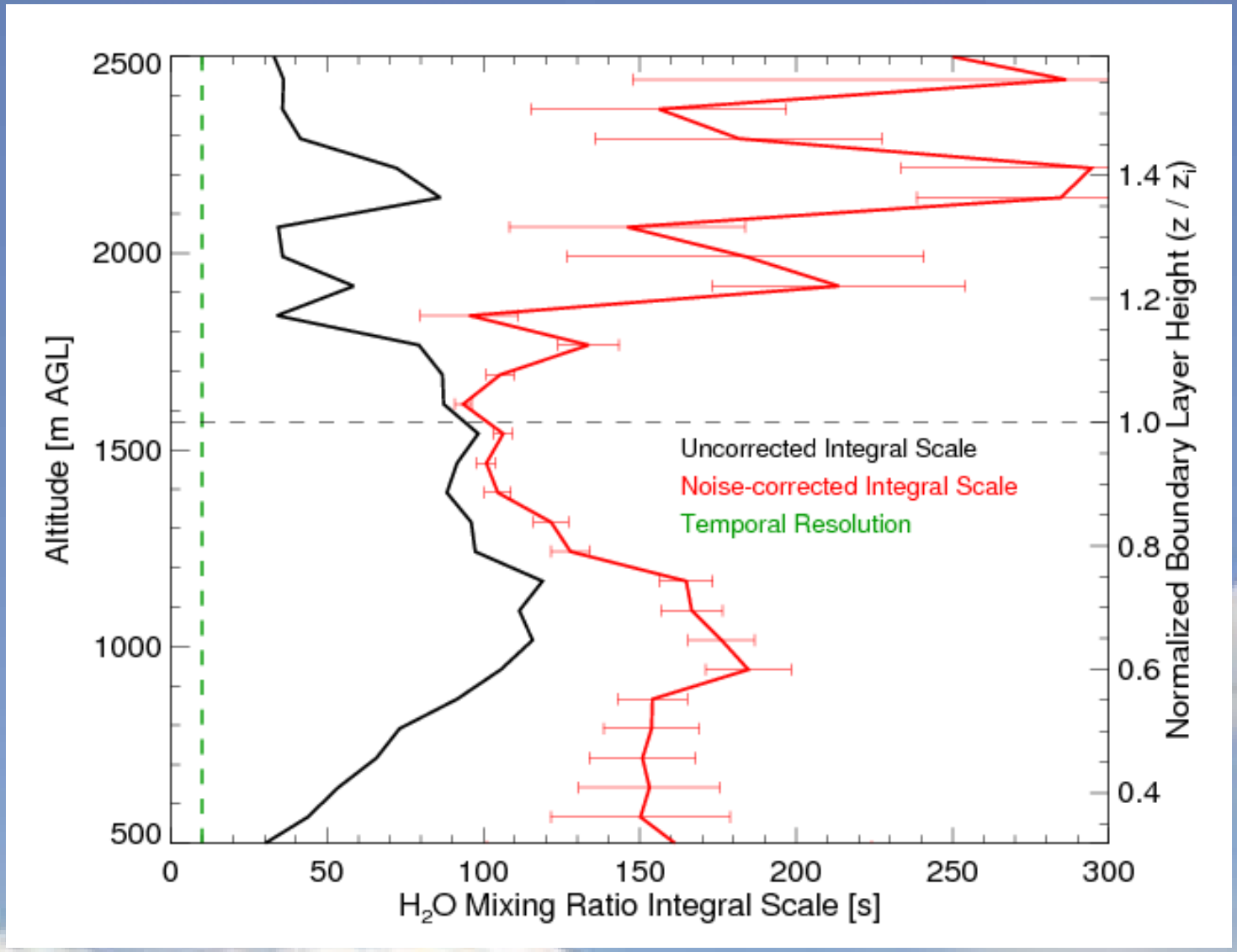
Instrument Noise Characteristics

22 Aug 2007 from 2200-2400 UTC



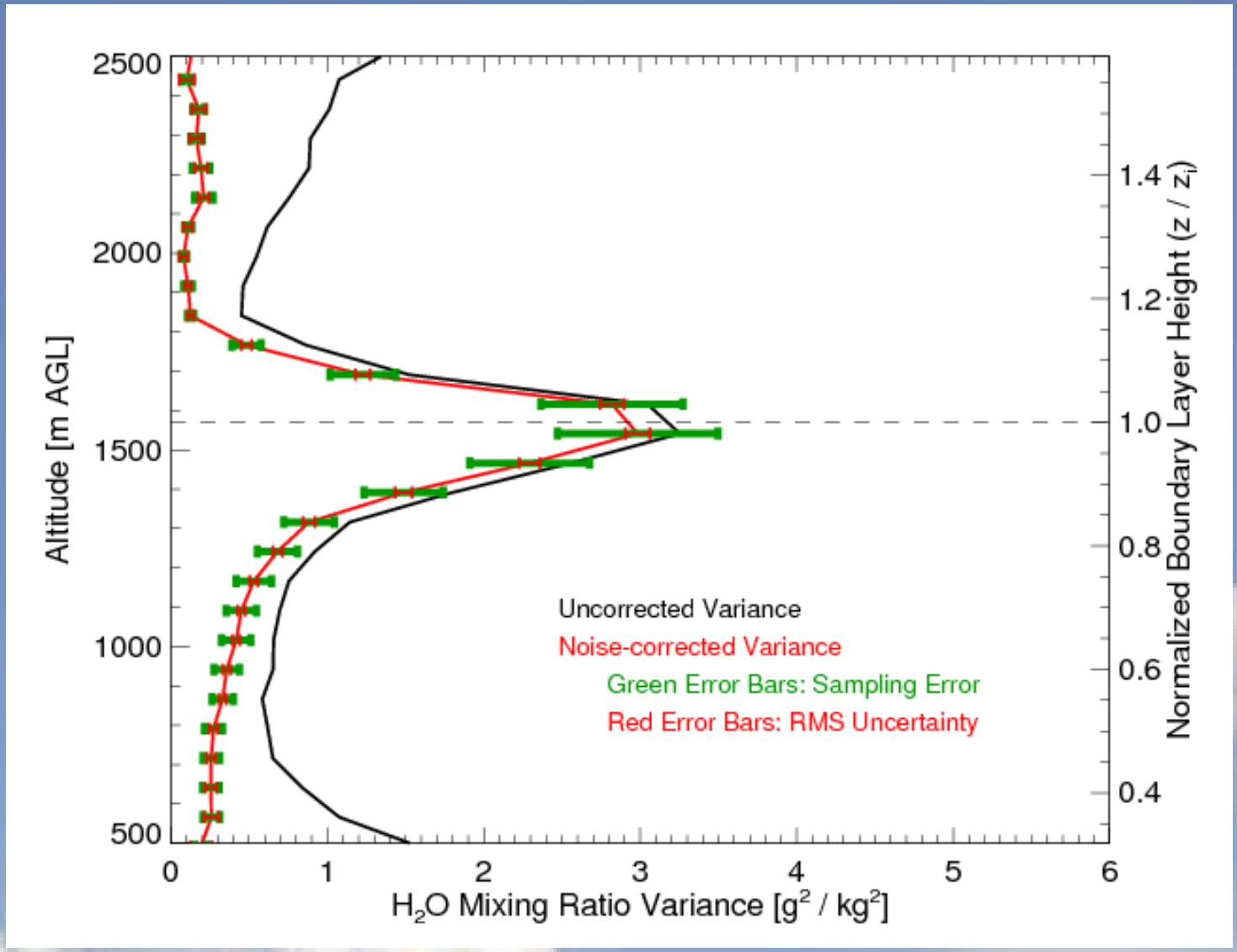
Integral Scale Profile

22 Aug 2007 from 2200-2400 UTC



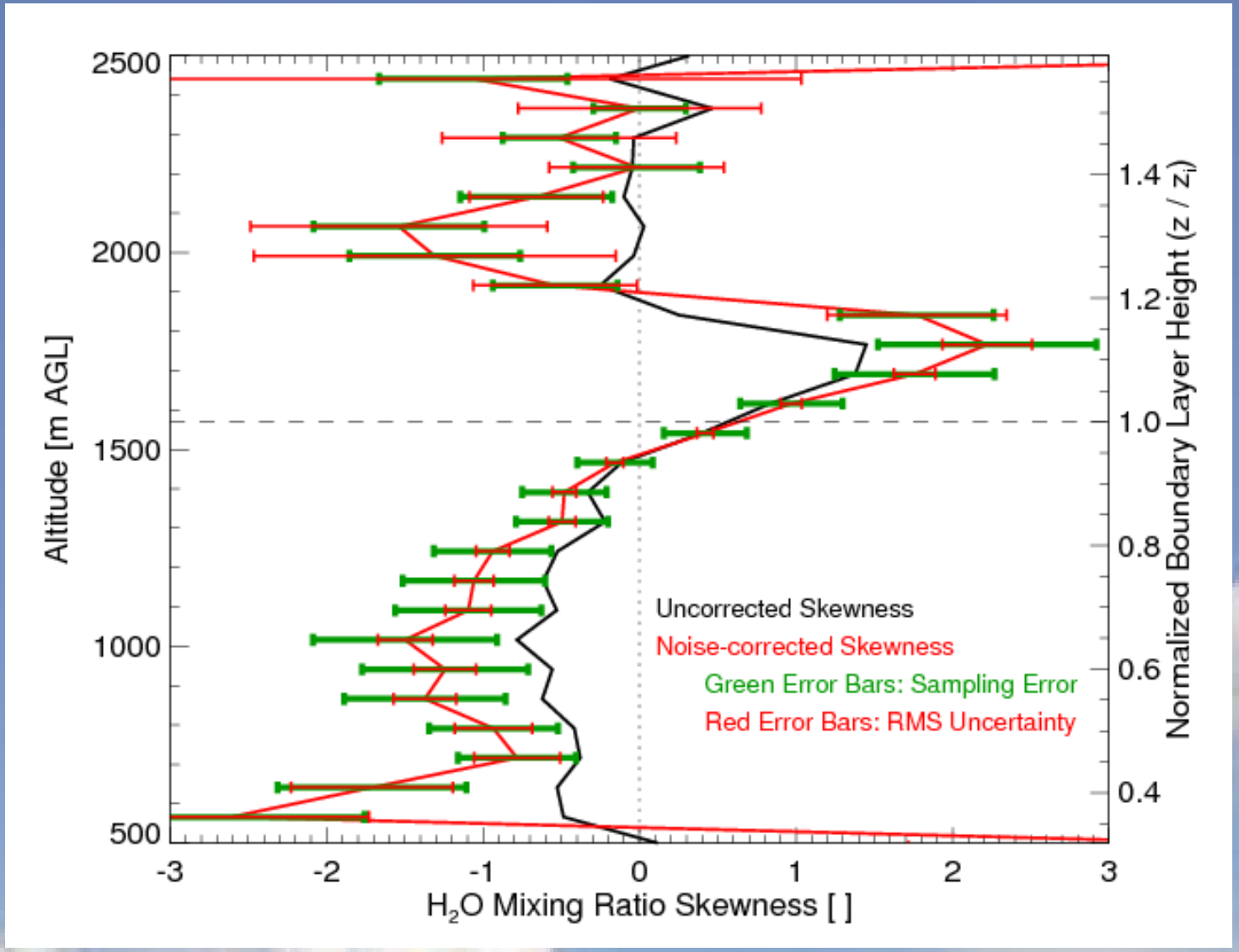
Atmospheric H_2O Variance Profile

22 Aug 2007 from 2200-2400 UTC



Atmospheric H_2O Skewness Profile

22 Aug 2007 from 2200-2400 UTC



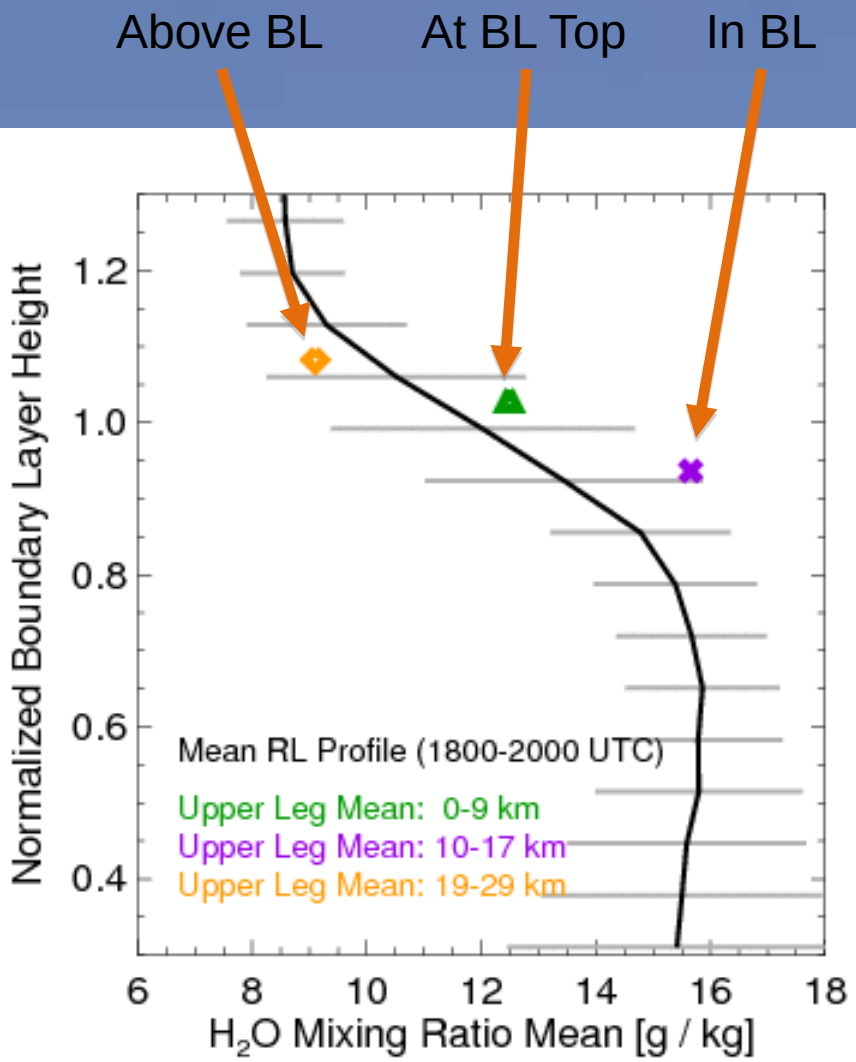
Comparison With Aircraft Observations

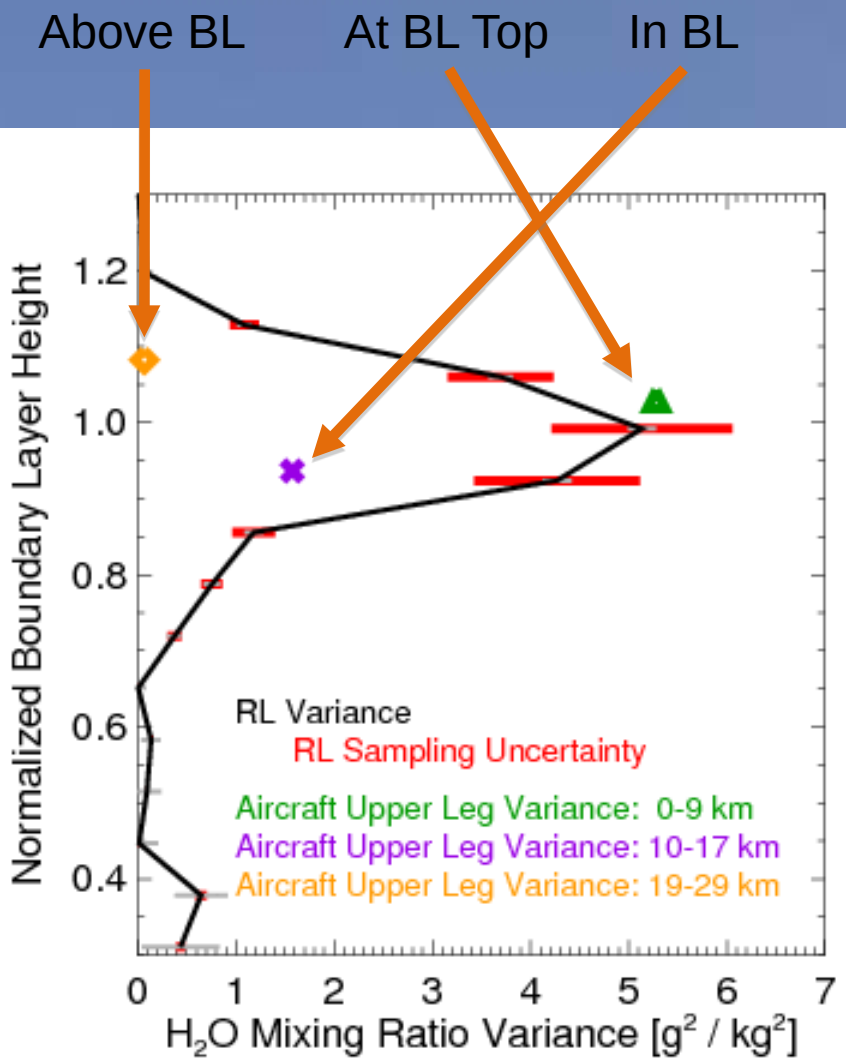
The CIRPAS Twin Otter

Twin Otter carried a diode laser hygrometer operating at 90 Hz during RACORO Field Campaign (Jan-Jun 2009)

Mean and Variance Normalized Profiles

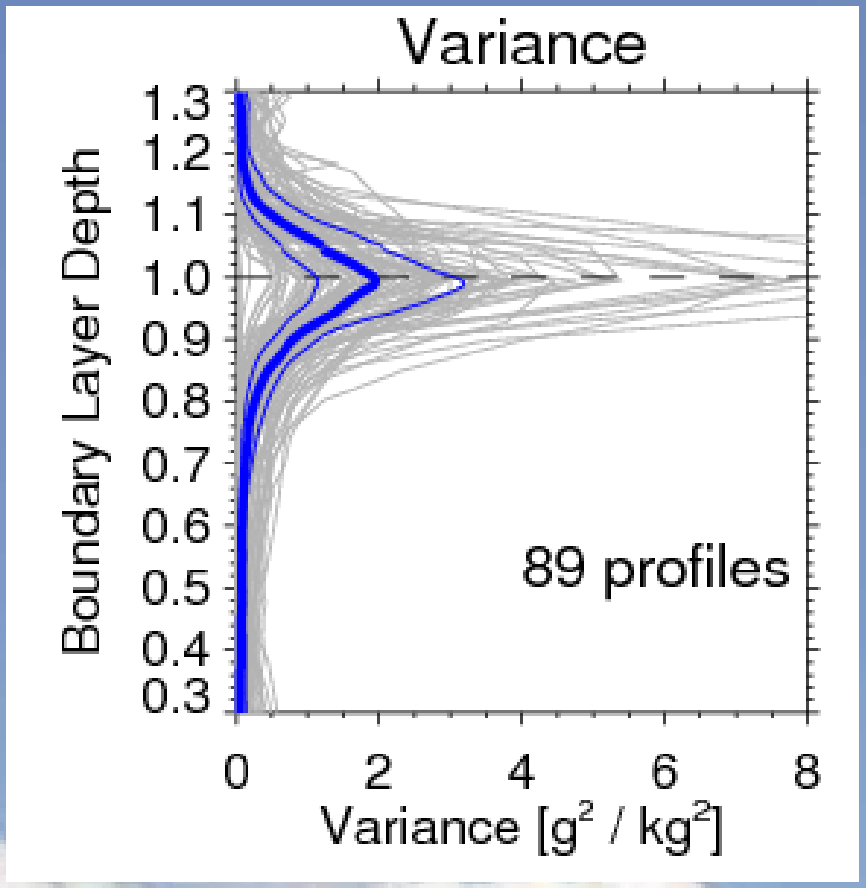
15 June 2009





How Does Variance and Skewness Vary?

- Cases will well-mixed daytime BLs from 2005 – 2009
- Only cases where $\sigma^2_{BLtop,instr} < 0.5 * \sigma^2_{BLtop,total}$



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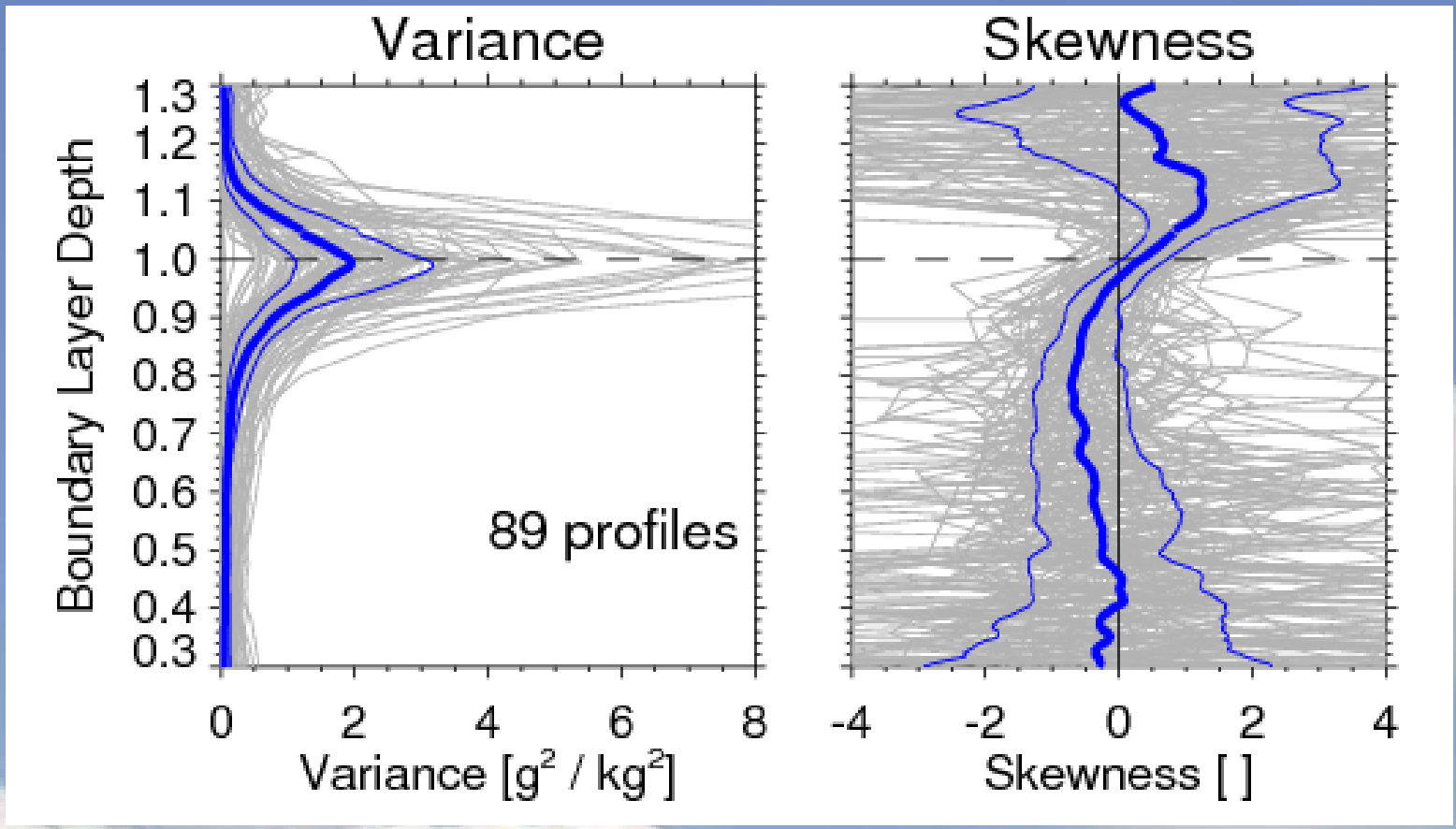
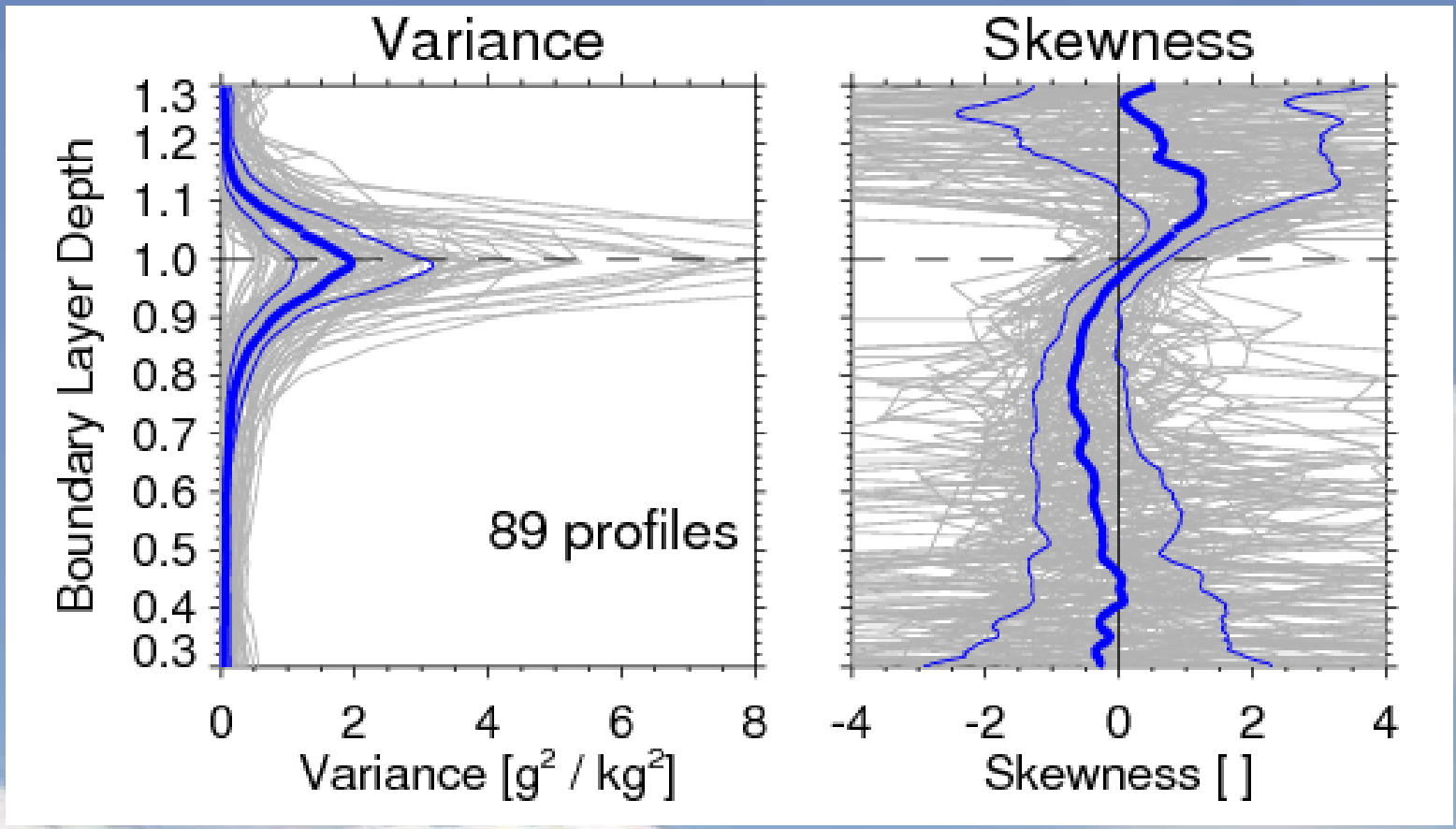


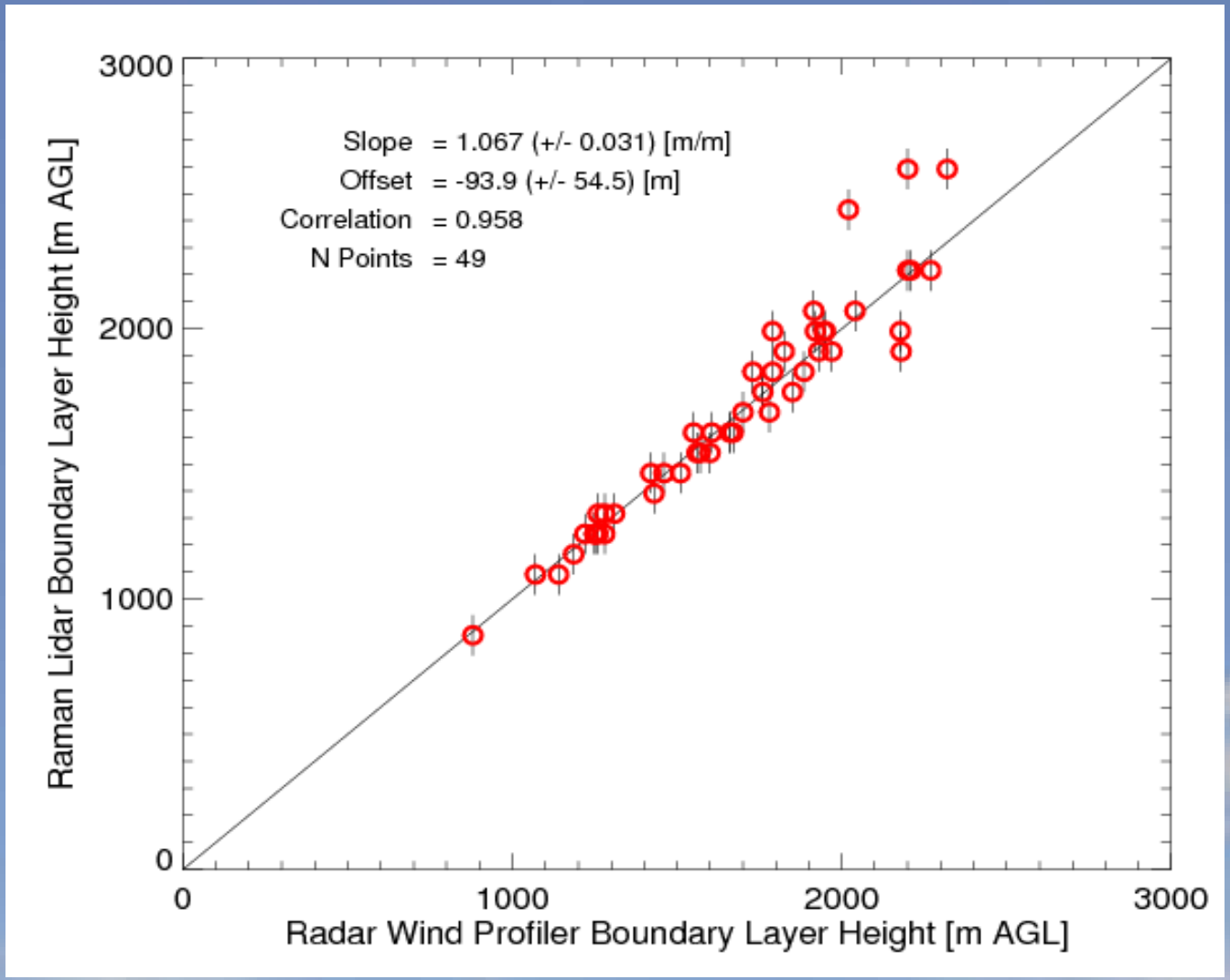
How Does Variance and Skewness Vary?

- Cases will well-mixed daytime BLs from 2005 – 2009
- Only cases where $\sigma^2_{BLtop,instr} < 0.5 * \sigma^2_{BLtop,total}$
- No significant correlations found with w_*, q_*, or h…



Comparison of BL Heights

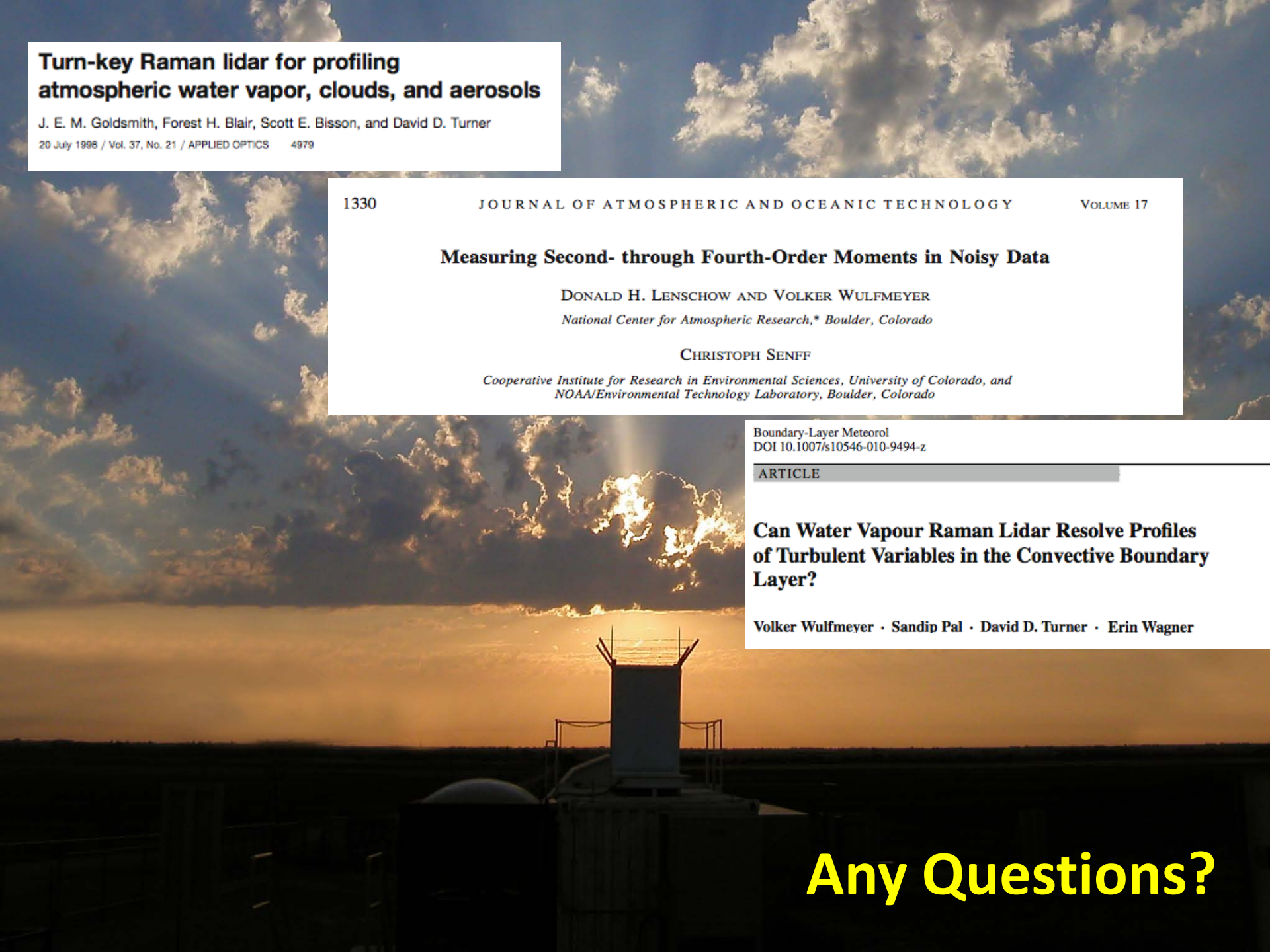
Raman Lidar vs. Radar Wind Profiler (915 MHz)



RWP data courtesy of Dr. Rich Coulter

Summary

- ARM Raman Lidar at the ARM Site in Oklahoma was upgraded in September 2004 to profile H_2O with 10-s, 7.5 m resolution
- Demonstrated that the noise level is low enough to be able to measure profiles of water vapor variance and skewness, as well as integral scale, in convective (and stationary) BLs
- Comparison with in-situ measurements of water vapor (using a DLH at 100 Hz) shows good agreement in variance with RL
- Large dataset with ~90 cases has been assembled using data from 2005-2009
  - Excellent agreement in BL heights with radar wind profiler
  - Variance at top of BL ranges from < 0.5 to over 10 g^2 / kg^2
  - Distribution of skewness narrows substantially for $0.9 < z/z_i < 1.05$
  - No significant correlations found (yet) with convective scales and these profiles



Turn-key Raman lidar for profiling atmospheric water vapor, clouds, and aerosols

J. E. M. Goldsmith, Forest H. Blair, Scott E. Bisson, and David D. Turner

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Measuring Second- through Fourth-Order Moments in Noisy Data

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Boundary-Layer Meteorol
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ARTICLE

Can Water Vapour Raman Lidar Resolve Profiles of Turbulent Variables in the Convective Boundary Layer?

Volker Wulfmeyer · Sandip Pal · David D. Turner · Erin Wagner

Any Questions?