

Validation of Aura MLS stratospheric water vapor measurements by the NOAA frost point hygrometer

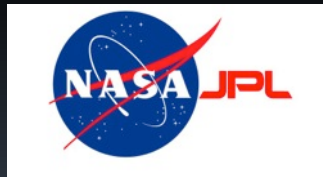
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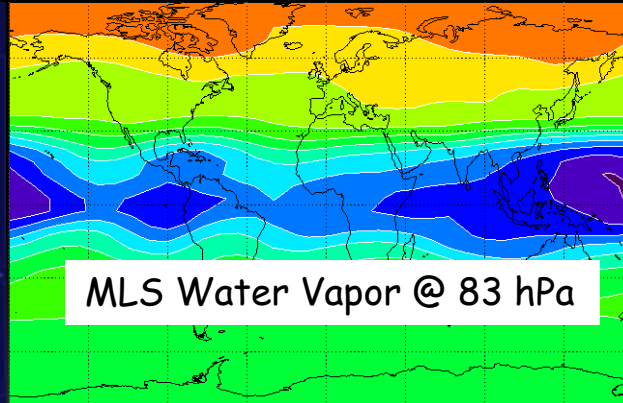
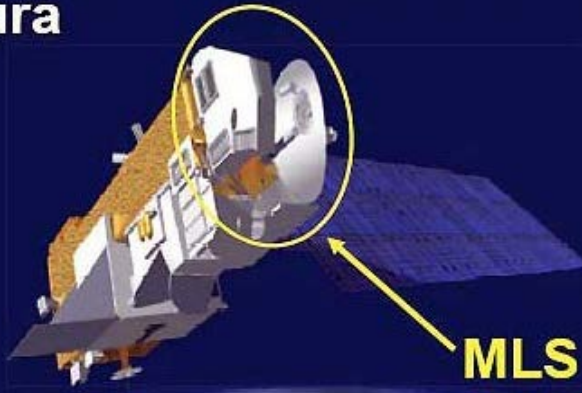
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The Instruments

Aura

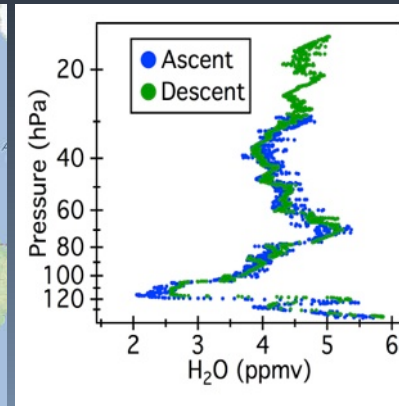
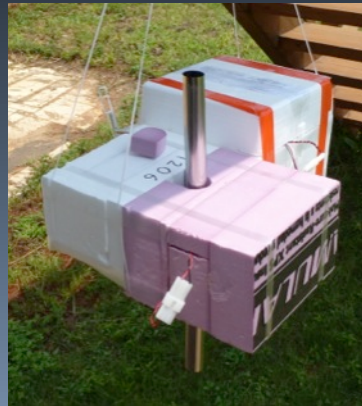


Aura MLS

Near-global coverage
~3500 profiles per day
316 hPa to well above 0.1 hPa
Low vertical resolution (~3 km)
Operational since August 2004

NOAA FPH

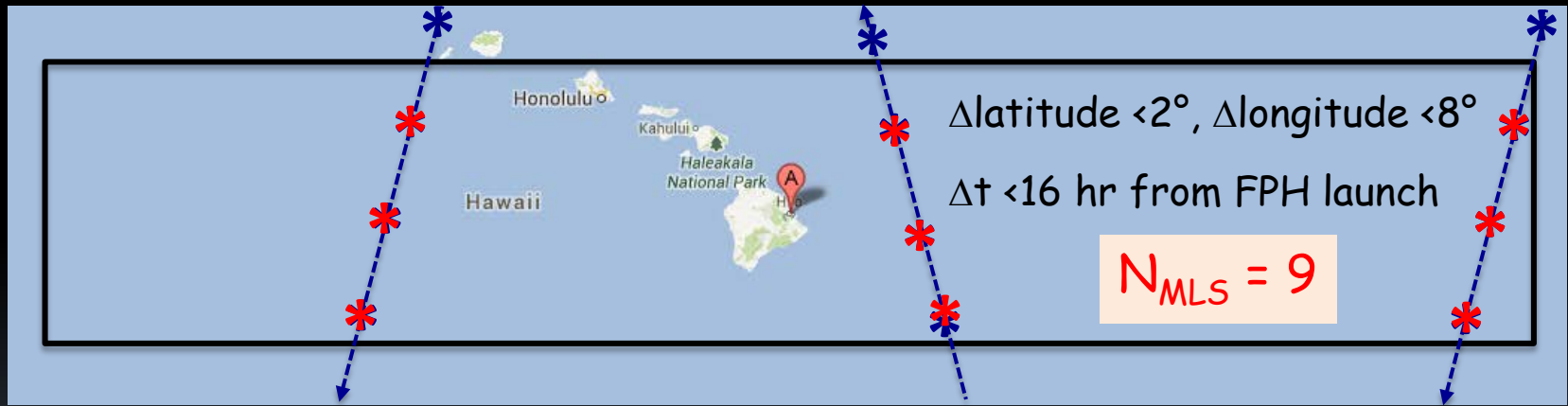
Three sites world-wide
Monthly vertical profiles
Surface to ~20 hPa
High resolution (5-10 m)



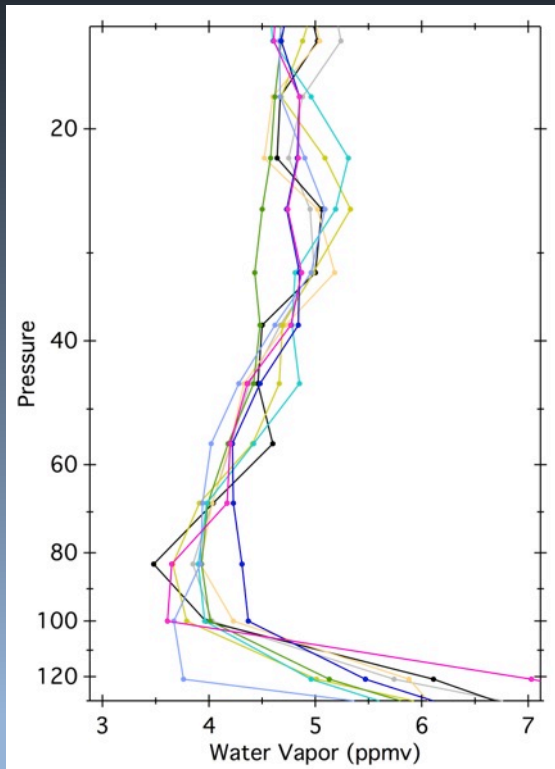
Boulder April 1980 ->
Hilo December 2010 ->
Lauder August 2004 ->

Period of Comparison: Aug 2004 - Dec 2012

Coincidence Criteria for MLS Overpasses of FPH Sites

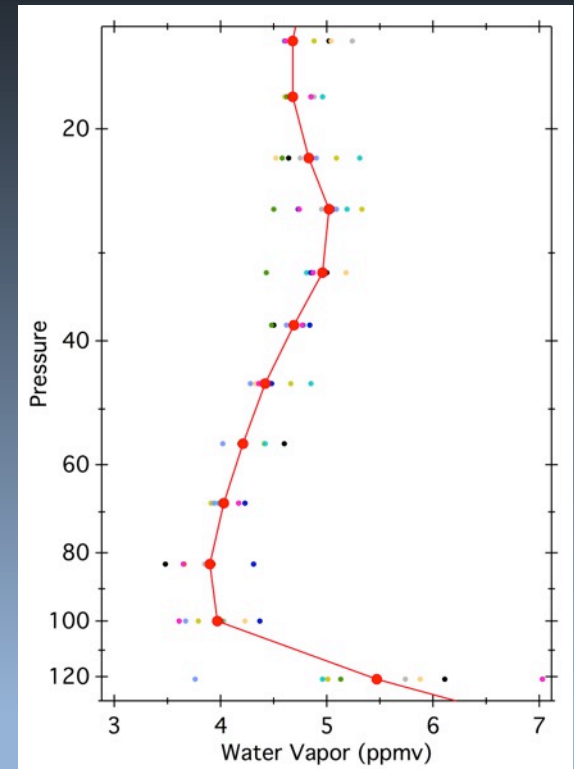


Coincident MLS Profiles



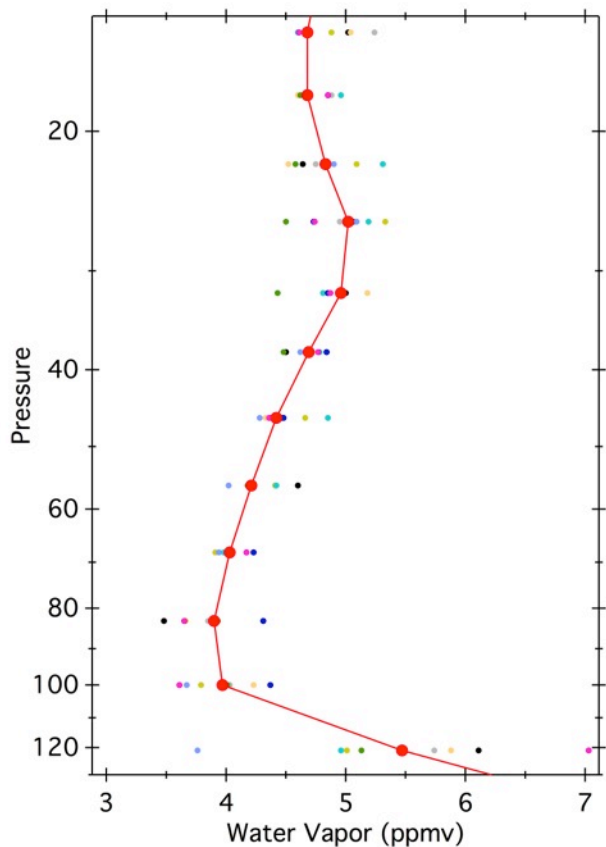
How to compare these 9 MLS profiles with one FPH profile?

Distill the 9 profiles into one MLS median profile

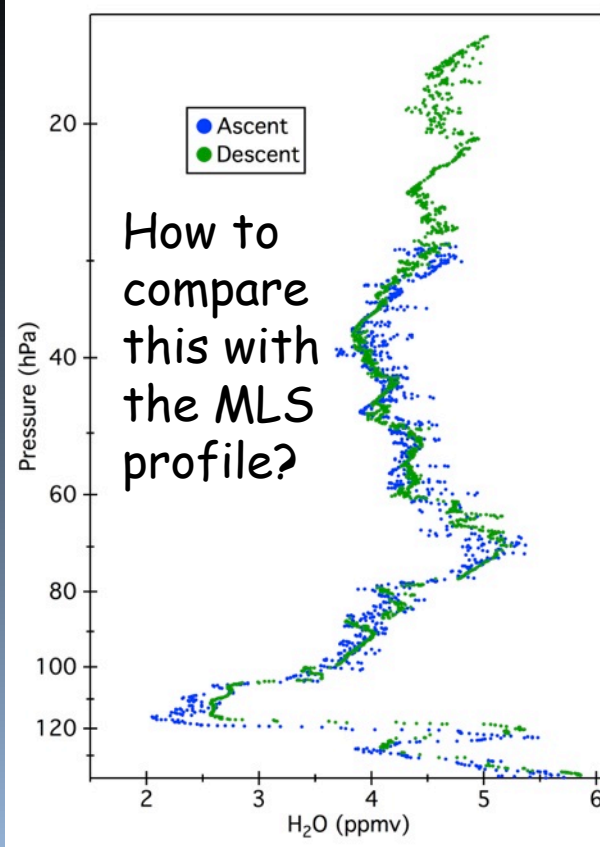


Comparing FPH Profiles with MLS Median Profiles

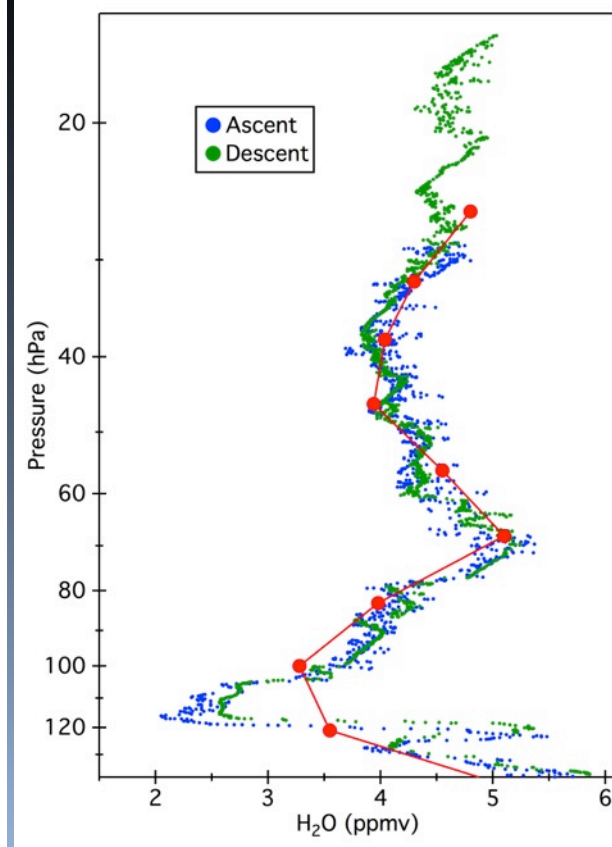
MLS Median Profile



FPH Profile
Resolution: 5-10 m



Convolve the FPH profile with the MLS averaging kernels



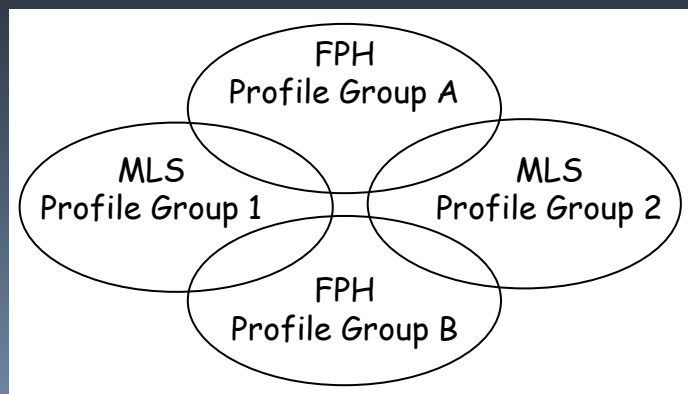
Creating Profile Comparison Groups

Convolved FPH Profile Groups A and B

*group B requires 95% coverage of FPH data before AK applied
this severely reduces FPH data availability at the highest altitudes*

MLS Coincident Profile Groups 1 and 2

group 2 employs slightly more relaxed spatial criteria but includes a matching criterion for Equivalent Latitude



FPH-MLS Difference Groups

A1

A2 laxest criteria; largest Diff Group

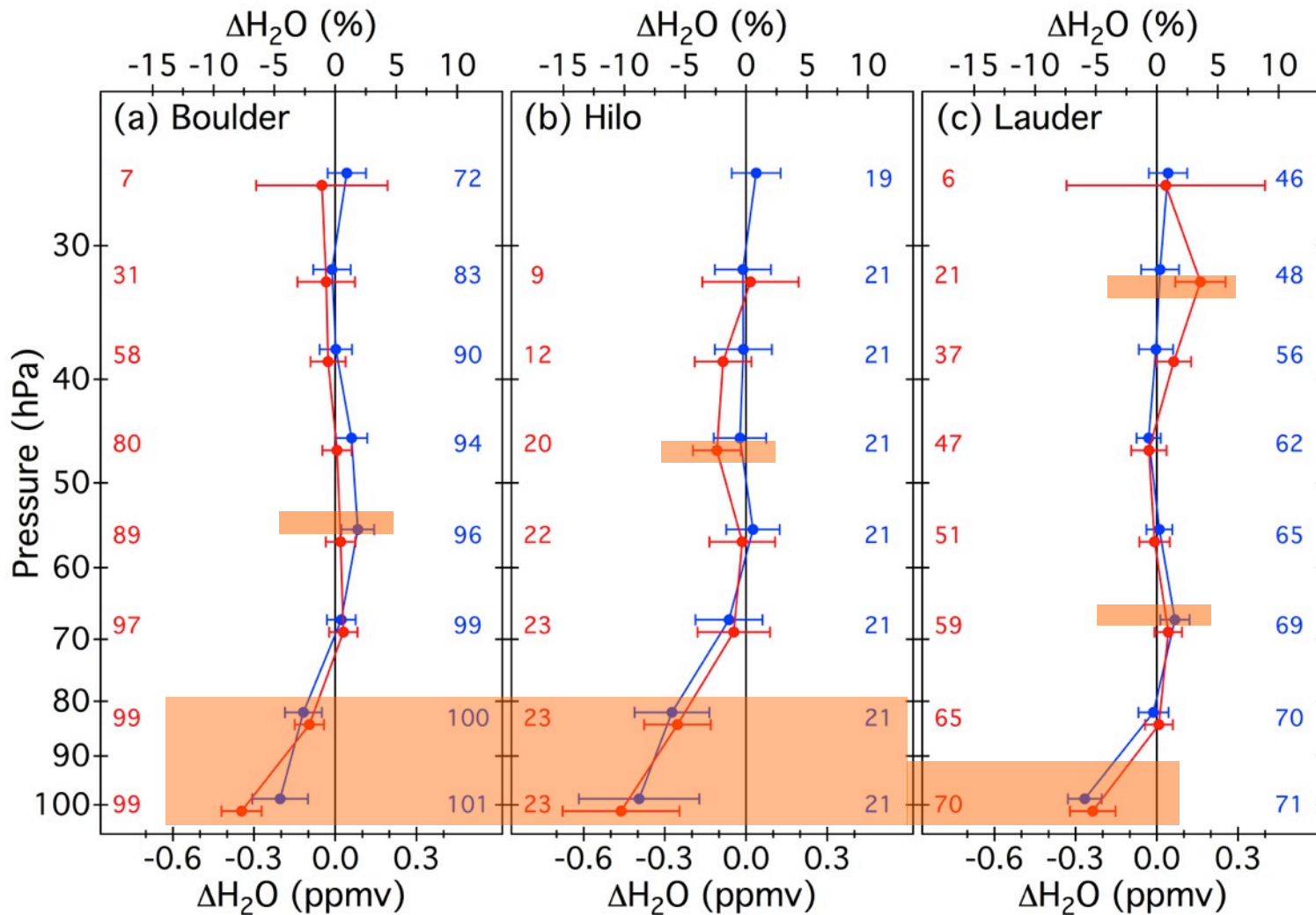
B1 strictest criteria; smallest Diff Group

B2

Site	Total FPH Flights	Coincident Profile Group 1 FPH Flights	Coincident Profile Group 1 MLS Profiles	Coincident Profile Group 2 FPH Flights	Coincident Profile Group 2 MLS Profiles
Boulder	135	115	634	130	1294
Hilo	24	23	105	23	193
Lauder	97	96	352	95	929

Evaluation of FPH-MLS Biases

FPH-MLS: **Group B1** **Group A2**



0.03 ppmv
0.8%

-0.19 ppmv

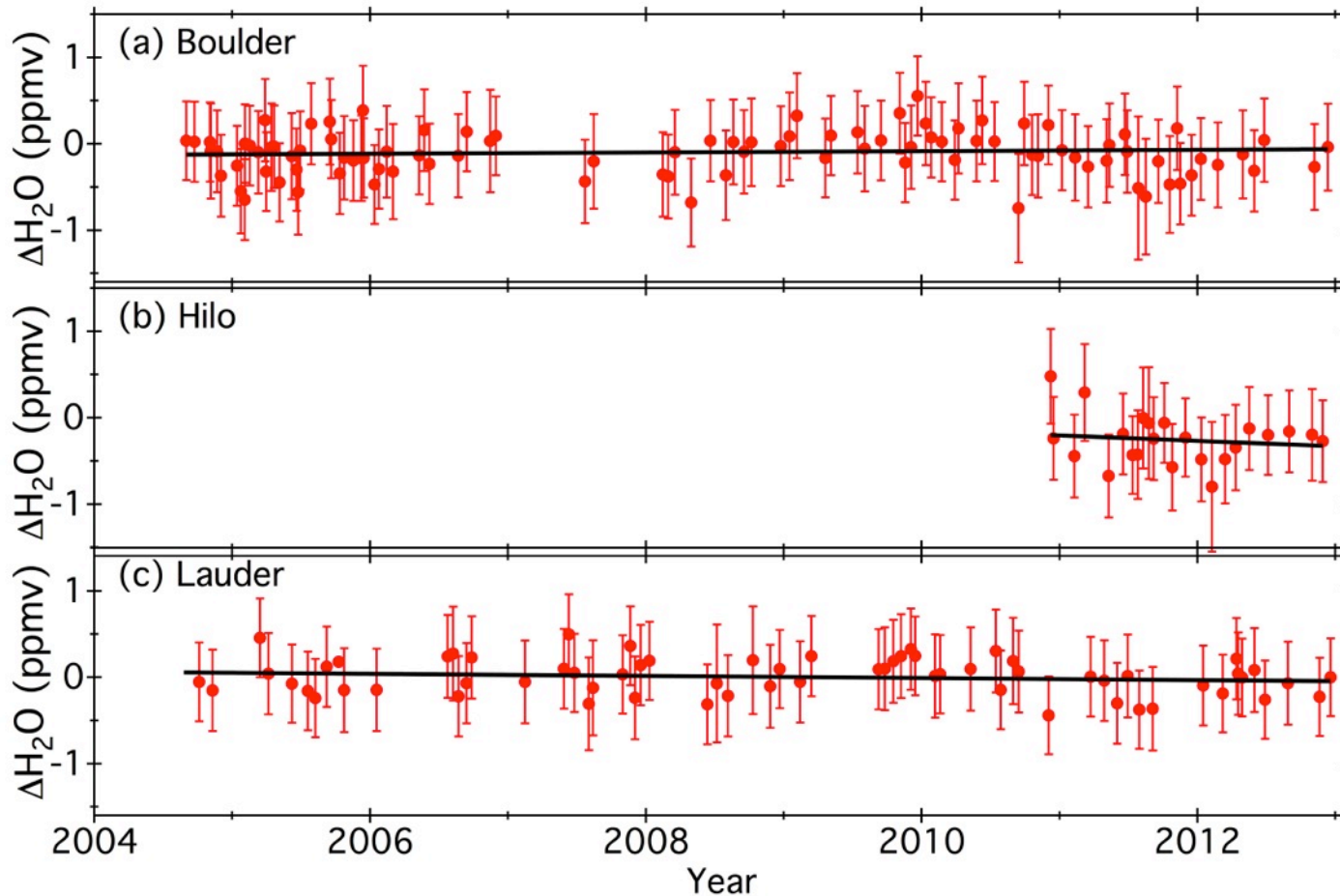
-0.32 ppmv

Mean differences \pm 95% confidence intervals

Evaluation of Temporal Trends in FPH-MLS

Slope \pm 95% CI
ppmv yr⁻¹
(% yr⁻¹)

FPH-MLS: **Group B1 at 83 hPa**



0.01 ± 0.04
($0.2 \pm 0.8\%$)

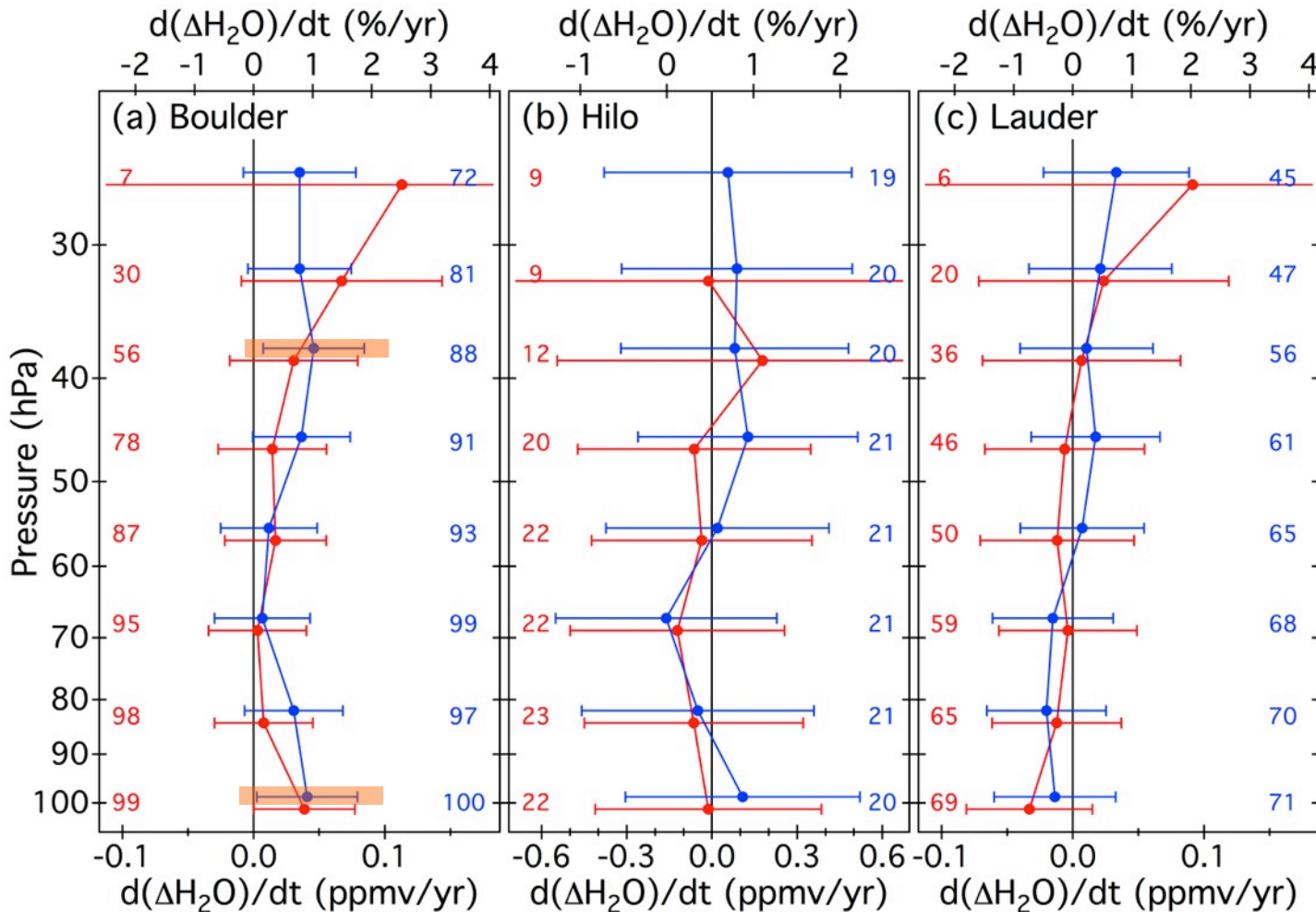
-0.06 ± 0.39
($-1.4 \pm 8.6\%$)

-0.01 ± 0.05
($-0.3 \pm 1.1\%$)

Weighted Linear Regression Analyses

Regression Slopes for FPH-MLS

FPH-MLS: **Group B1** **Group A2**

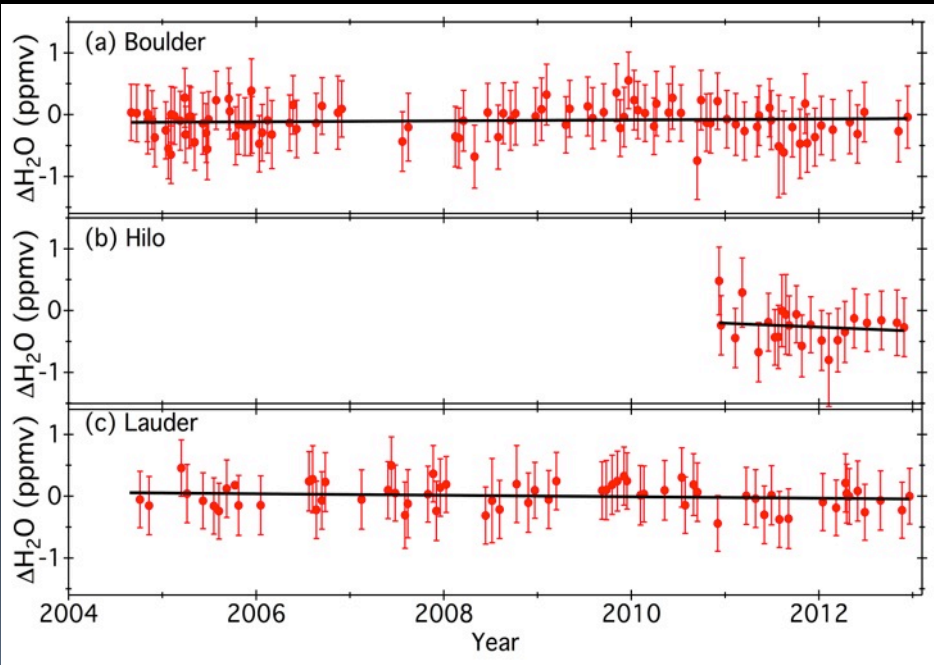


None of the B1 trends are statistically significant (95% confidence)

Two statistically significant trends for A2 are inconsistent with B1

Minimum Detectable Trends

From *Weatherhead et al. [1998]*



$$N = \left[\frac{3.3 \sigma_N}{|\omega_0|} \sqrt{\frac{1+\phi}{1-\phi}} \right]^{2/3}$$

N = record length
 σ_N = std dev of residuals
 ω_0 = trend
 ϕ = autocorrelation coef

	<u>N</u>	<u>Avg Obs Trend ppmv yr⁻¹</u>	<u>Avg MDT ppmv yr⁻¹</u>
Boulder	8.4 yr	0.03 ± 0.01 (0.6 ± 0.2%)	0.04 ± 0.01
Hilo	2.1 yr	0.08 ± 0.11 (1.7 ± 2.4%)	0.84 ± 0.24
Lauder	8.4 yr	0.02 ± 0.01 (0.3 ± 0.3%)	0.03 ± 0.01

Conclusions

From 68 to 26 hPa the mean differences between FPH and MLS are $<1\%$

Statistically significant biases as large as 0.46 ppmv (10%) exist at 100 and 83 hPa over Boulder and Hilo and at 100 hPa over Lauder.

Uncertainties of 10% in the abundance of water vapor in the UTLS have important implications for radiative transfer and climate models.

The vast majority of trends in FPH-MLS differences are not statistically significant, but ...

Most trends determined here are smaller than the minimum trends currently detectable in these data sets.

