Validation of Aura Microwave Limb Sounder stratospheric water vapor measurements by the NOAA frost point hygrometer

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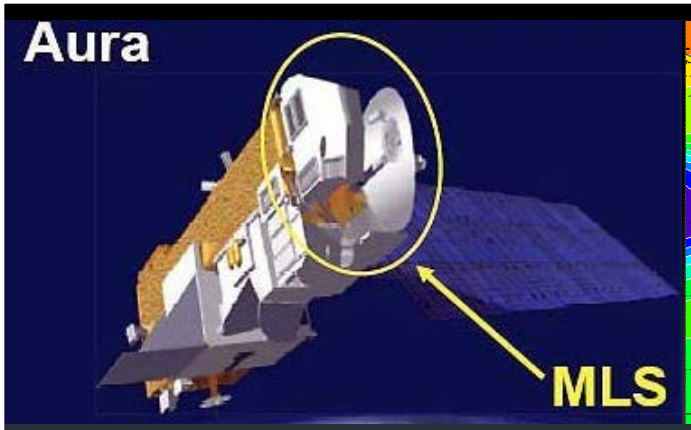
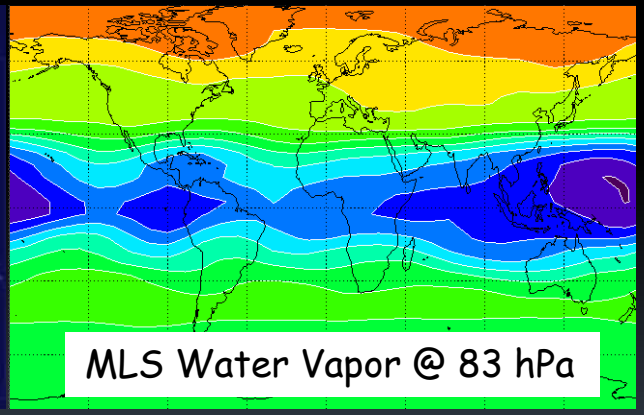
The Instruments





Aura MLS

Near-global coverage

~3500 profiles per day

316 hPa to well above 0.1 hPa

Operational since August 2004

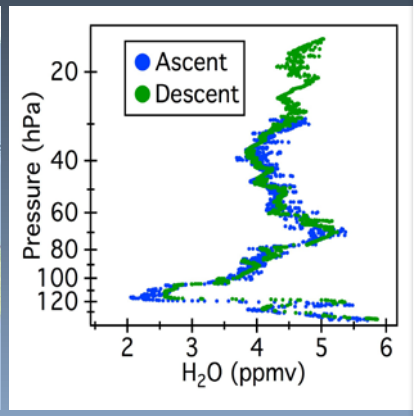
NOAA FPH

Three sites world-wide

Monthly vertical profiles

Surface to ~20 hPa

High resolution (5-10 m)



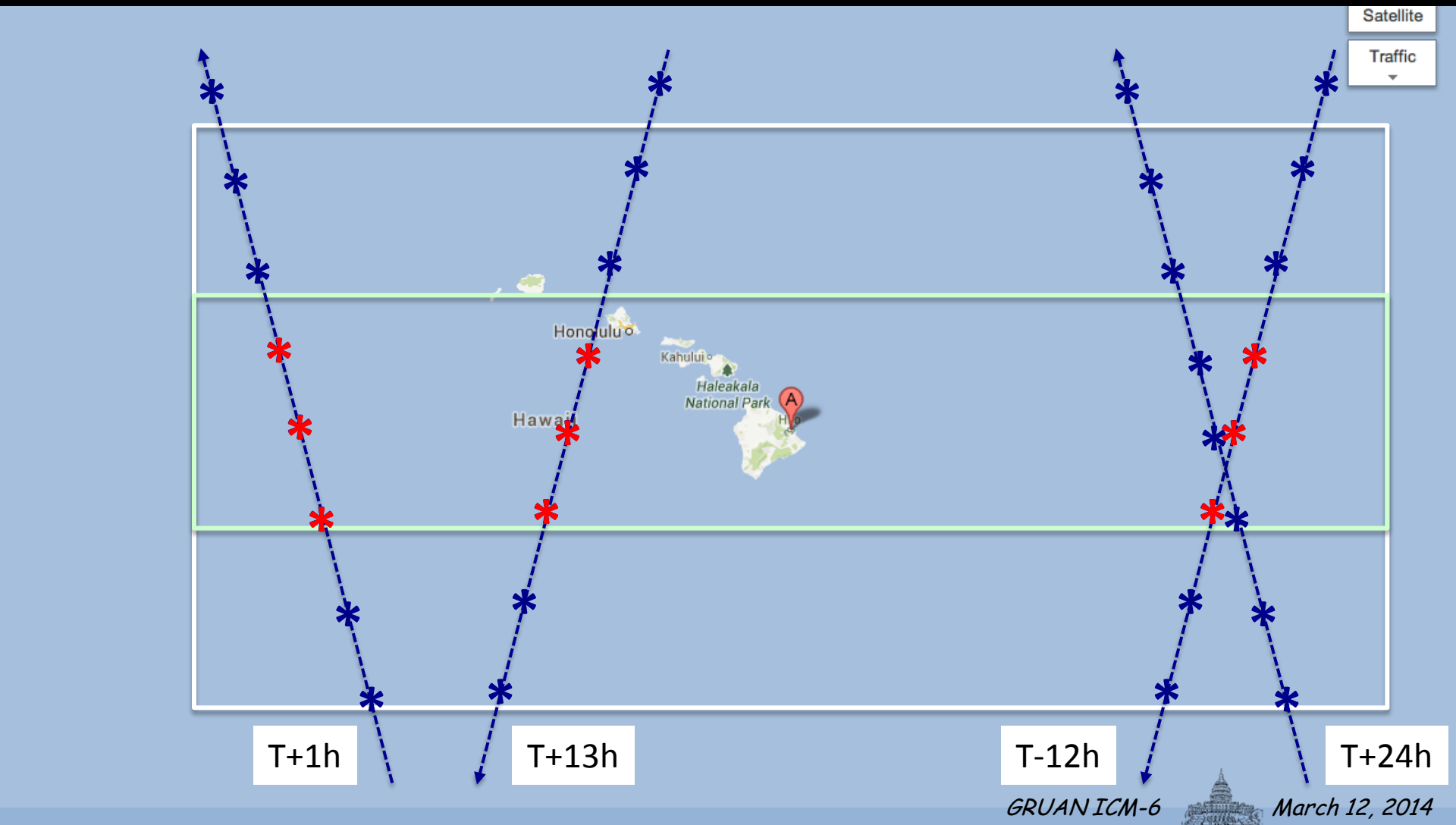
Boulder	Aug 2004 - Dec 2012
Hilo	Dec 2010 – Dec 2012
Lauder	Aug 2004 – Dec 2012

Coincidence Criteria for MLS Overpasses of FPH Sites

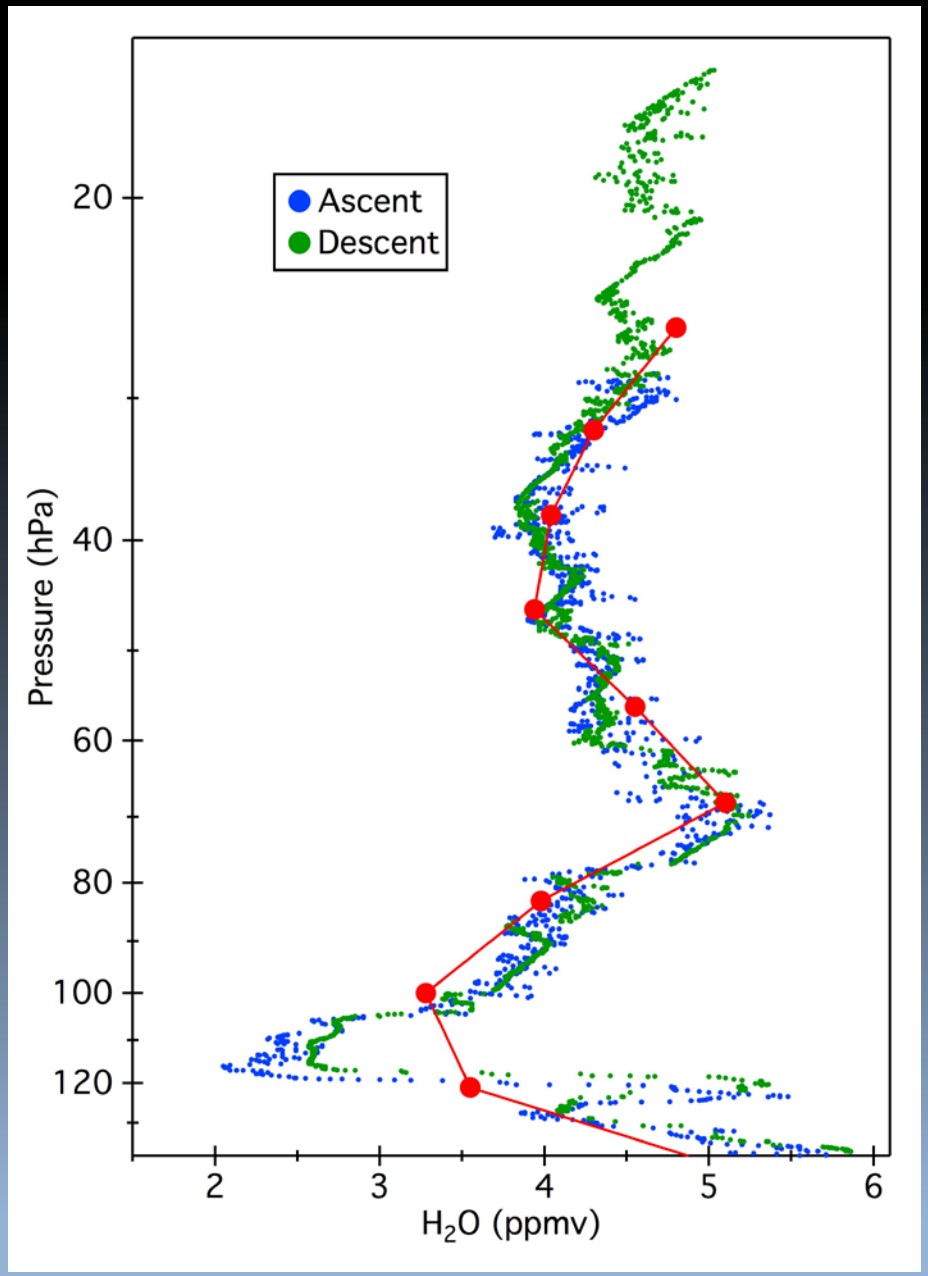
Spatial: AVDC recommends ±5° Latitude, ±8° Longitude

We further constrain to ±2° Latitude, ±8° Longitude

Temporal: ±16 hours from FPH launch



Reducing FPH Profile Resolution



Native resolution is 5-10 m

How to compare with MLS profiles?

Convolve the FPH profile with the MLS averaging kernels

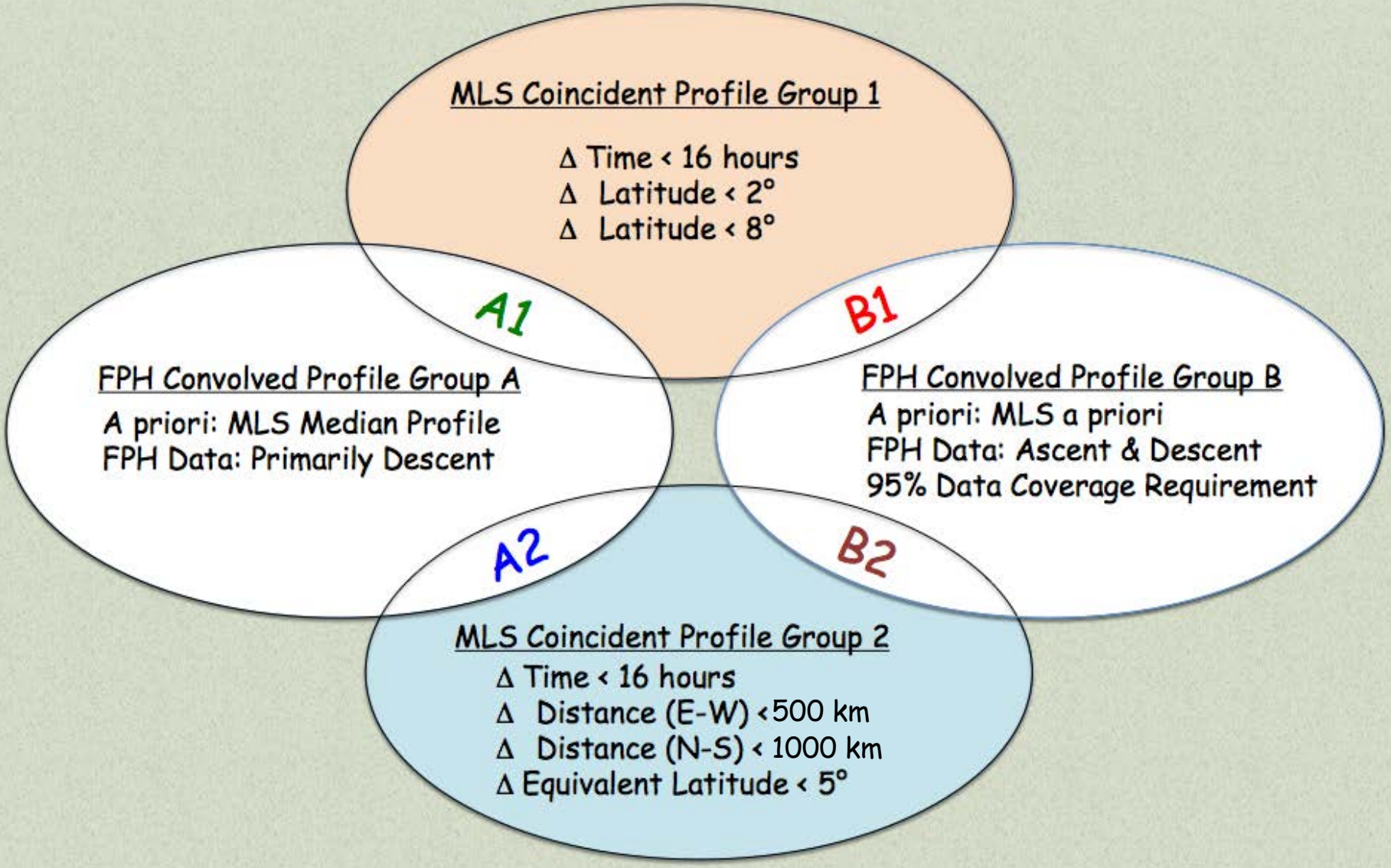
What to use as the *a priori* profile?

MLS *a priori* or something different?

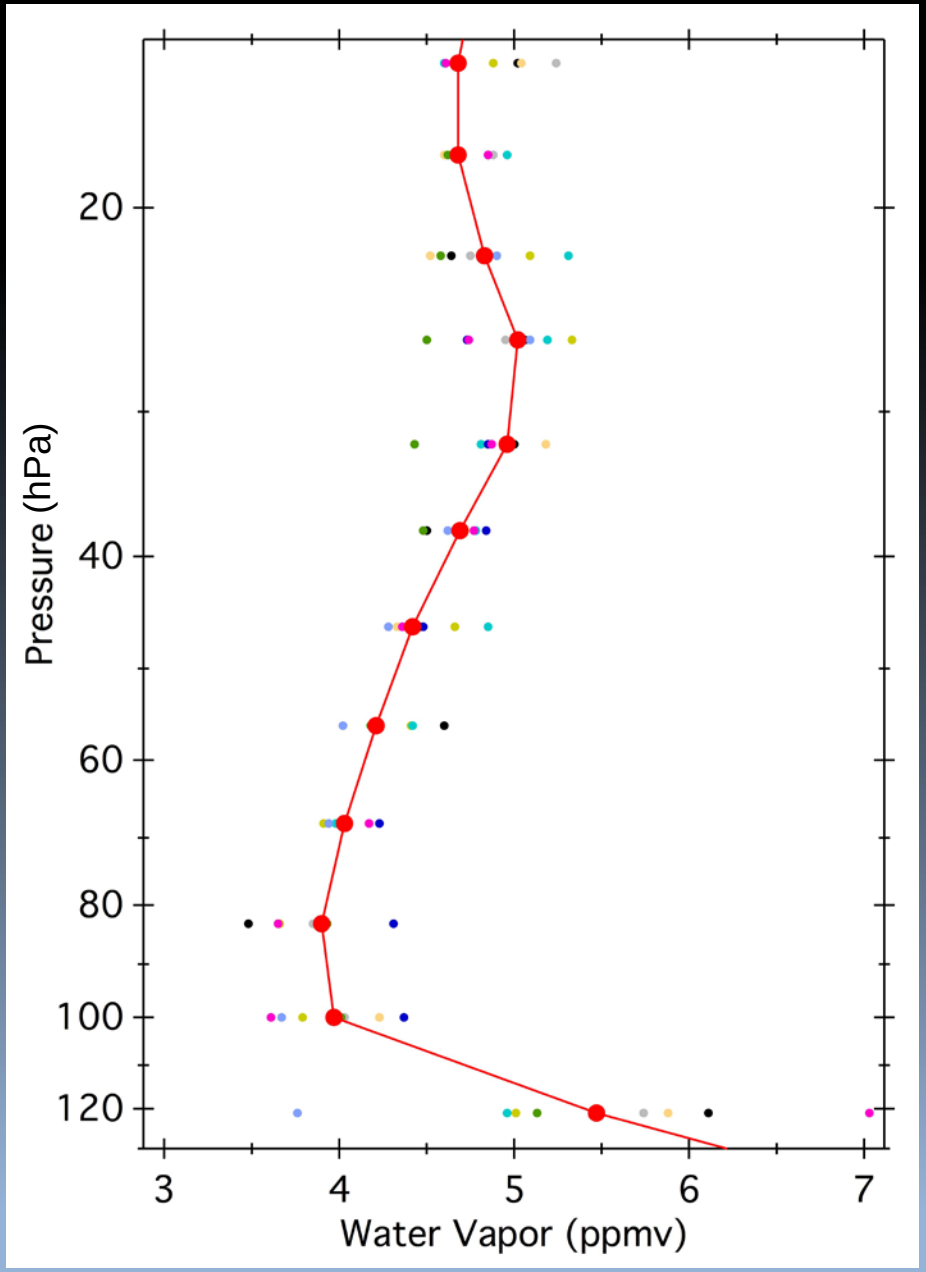
Which FPH profile data to use?

Ascent, descent or a combination?

Coincident and Convolved Profile Groups



Cluster of Coincident MLS Profiles

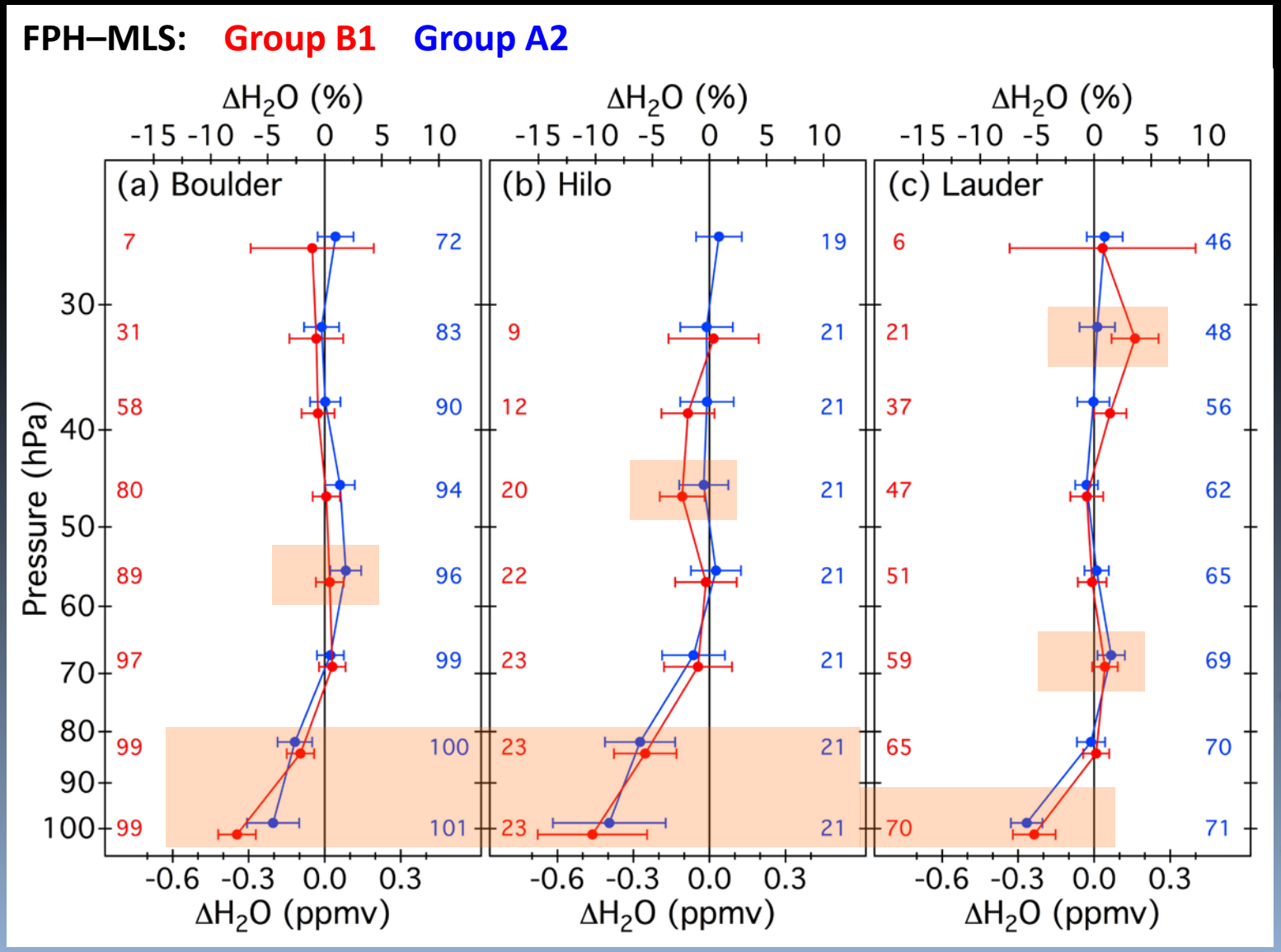


9 MLS profiles met the coincidence criteria:

How to compare this MLS cluster with the FPH profile?

Distill the 9 profiles into one MLS median profile

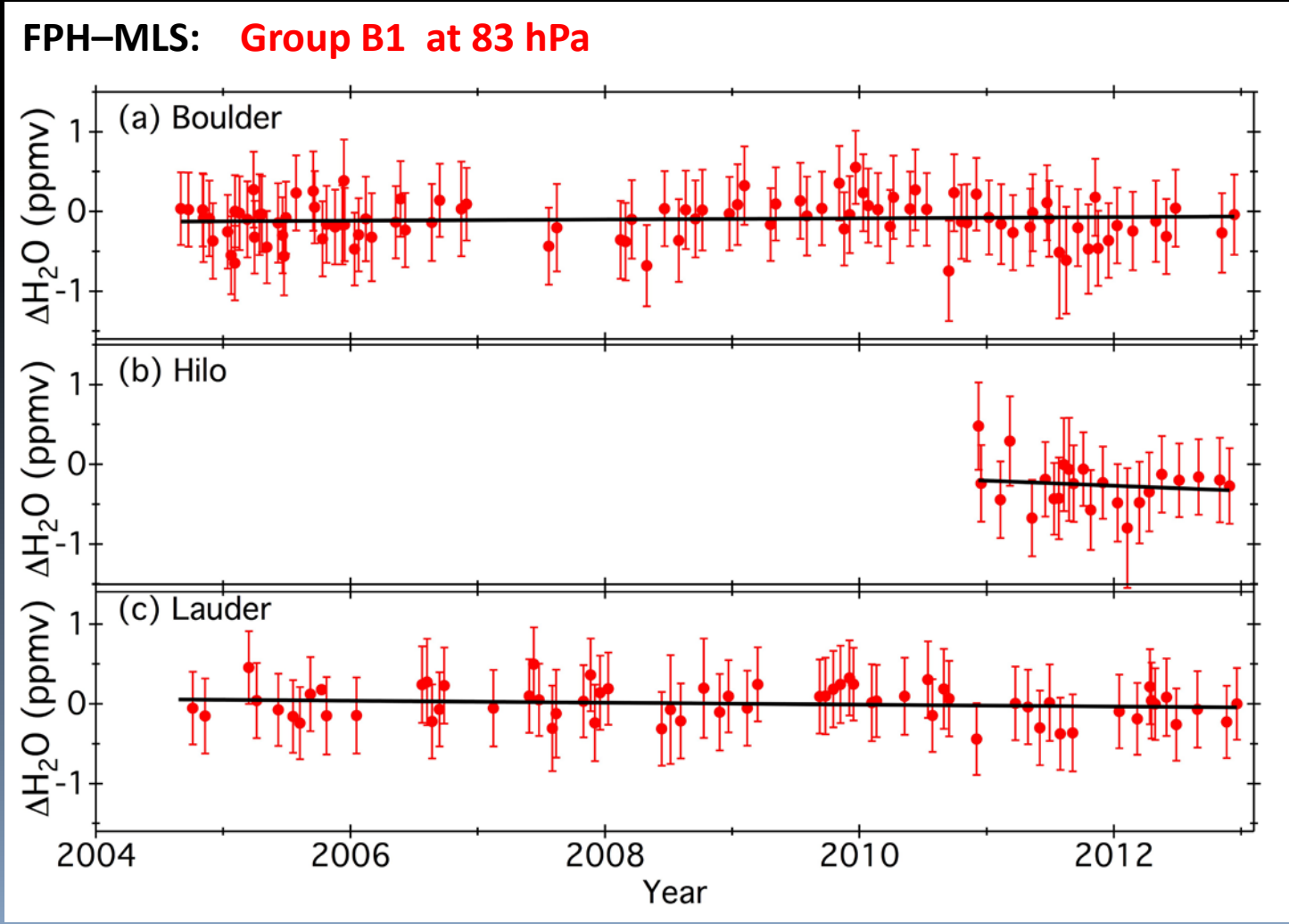
Evaluation of FPH–MLS Biases



Mean differences ± 95% confidence intervals

N profiles determine the mean difference

Evaluation of Temporal Trends in FPH–MLS



Slope ± 95% CI
ppmv yr^{-1}
(% yr^{-1})

0.01 ± 0.04
(0.2 ± 0.8%)

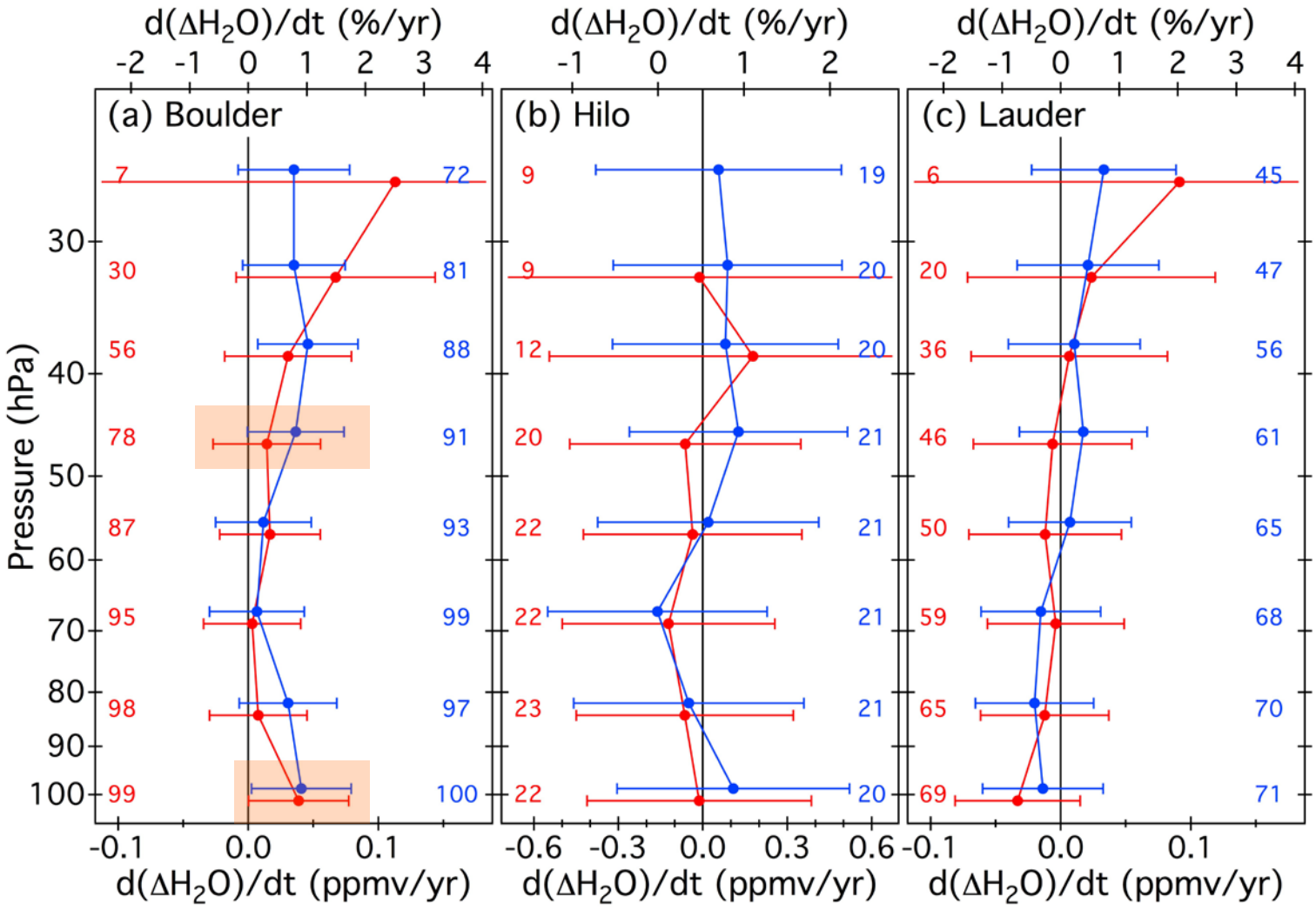
-0.06 ± 0.39
(-1.4 ± 8.6%)

-0.01 ± 0.05
(-0.3 ± 1.1%)

Weighted Linear Regression

Regression Slopes for FPH–MLS

FPH–MLS: Group B1 Group A2

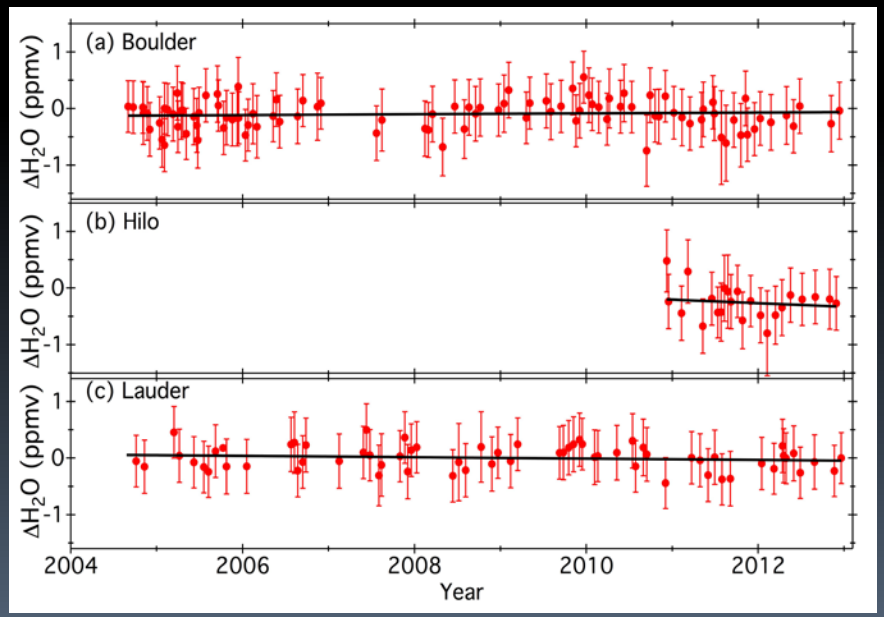


There are no statistically significant trends for the B1 profile group.

There are two statistically significant trends for the A2 profile group but these are inconsistent with the B1 profile group.

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

	N	Avg Trend ppmv yr^{-1}		Avg MDT ppmv yr^{-1}
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 TTL and LS have important implications for radiative transfer and climate models.

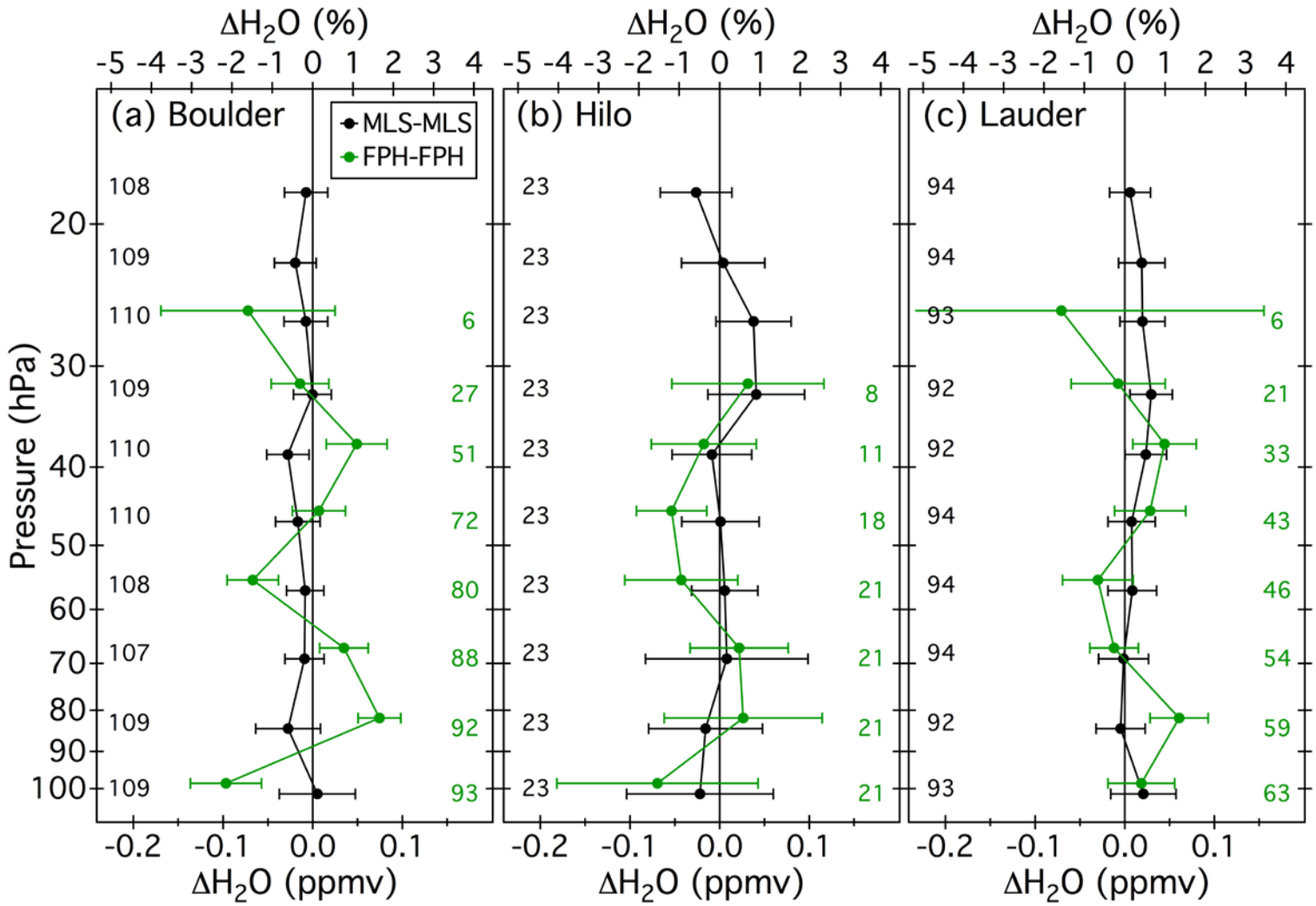
The vast majority of trends in FPH–MLS differences are not statistically significant.

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

The future availability of a homogeneous GRUAN frost point hygrometer data product from a global network of sites will be very valuable.

MLS and Convolved FPH Profile Group Differences

MLS: Group 2 – Group 1 **FPH: Group B – Group A**



MLS-MLS

0.02 ppmv
0.4%

FPH-FPH

0.05 ppmv
1.1%

Mean differences ± 95% confidence intervals

N profiles determine the mean difference