Longstanding Discrepancies in Stratospheric Water Vapor Measurements Revisited During the 2011 Mid-latitude Airborne Cirrus Properties Experiment (MACPEX)

Earth System Research Laboratory
Global Monitoring Division

Dale Hurst
Emrys Hall
Allen Jordan

Harvard Department of
Chemistry & Chemical Biology

Jessica Smith
Maryann Sargent
David Sayres

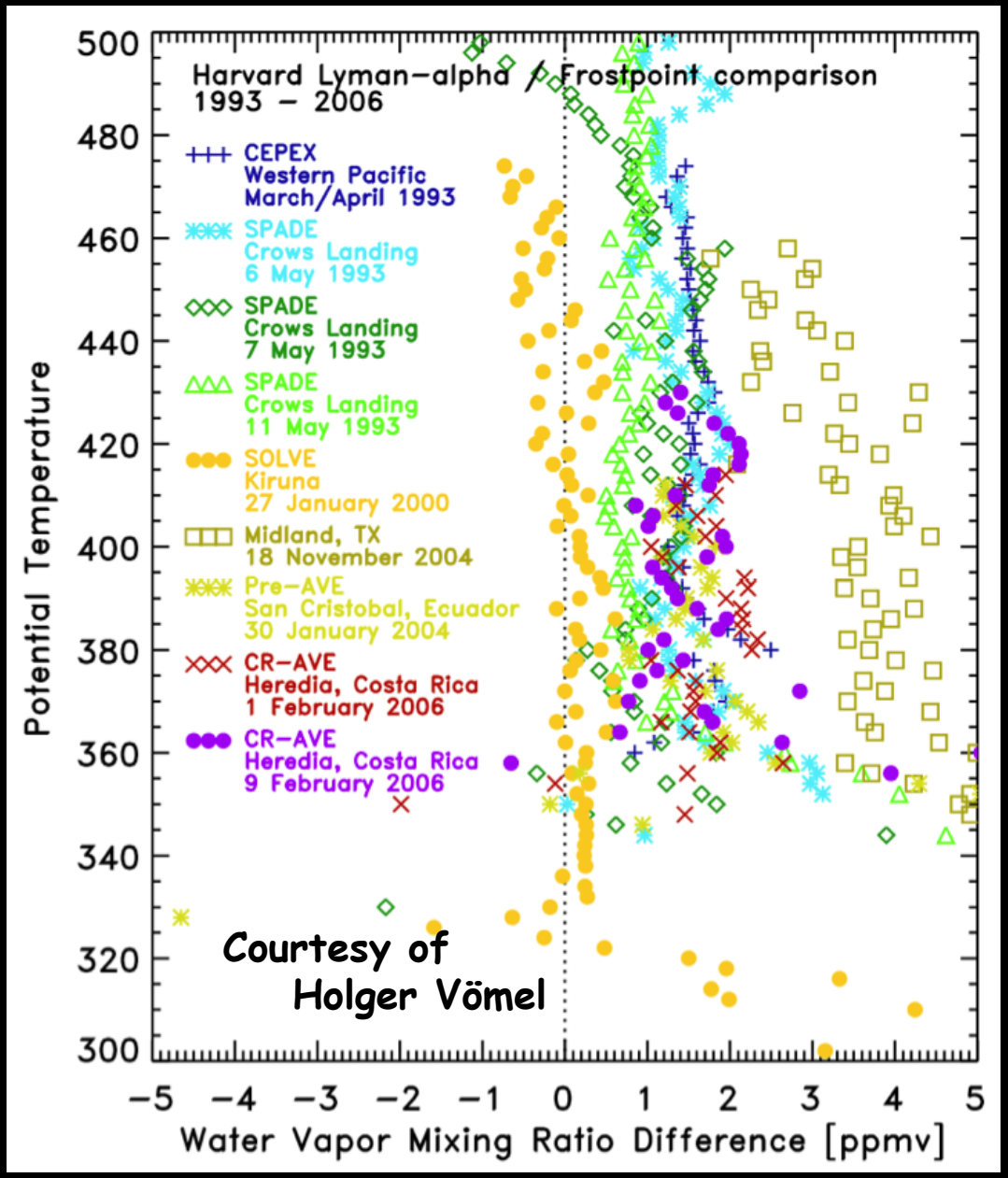
Earth System Research Laboratory
Chemical Sciences Division

Troy Thornberry
Drew Rollins
Ru-Shan Gao
Sean Davis
Karen Rosenlof
David Fahey

JÜLICH
FORSCHUNGSZENTRUM
Institute for Energy and Climate Research
Stratosphere (IEK-7)

Cornelius Schiller
Martina Krämer
Tim Klostermann

Stratospheric water vapor differences – one historical view



These differences are:

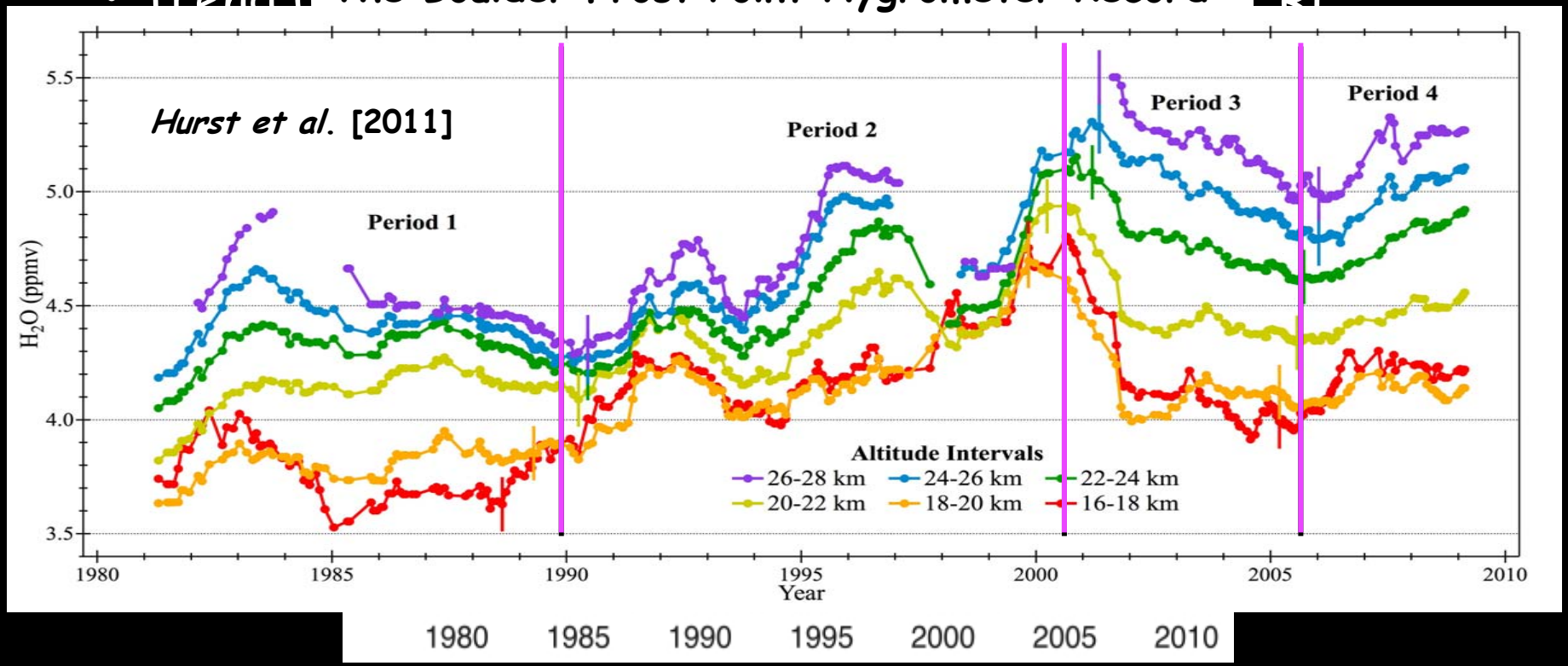
Fairly consistent with altitude during each flight

Quite variable from one flight/campaign to the next

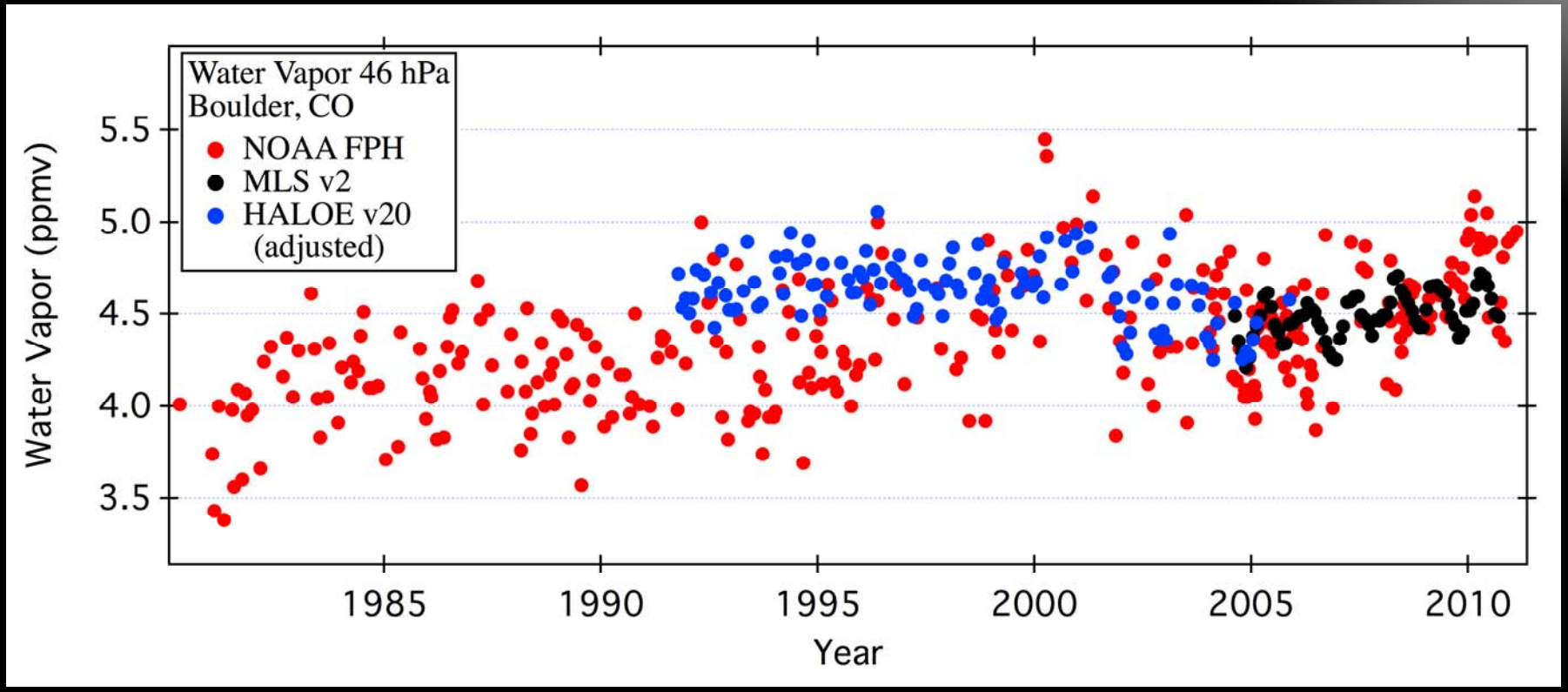
Typically 15-60% of the water vapor mixing ratio

Why are water vapor measurement differences a concern?

- Disparities of this magnitude infer sizeable uncertainties in water vapor measurements (inaccuracy)
- Biases that vary with time add significant uncertainties to long-term water vapor trends
- Trend u… …RE



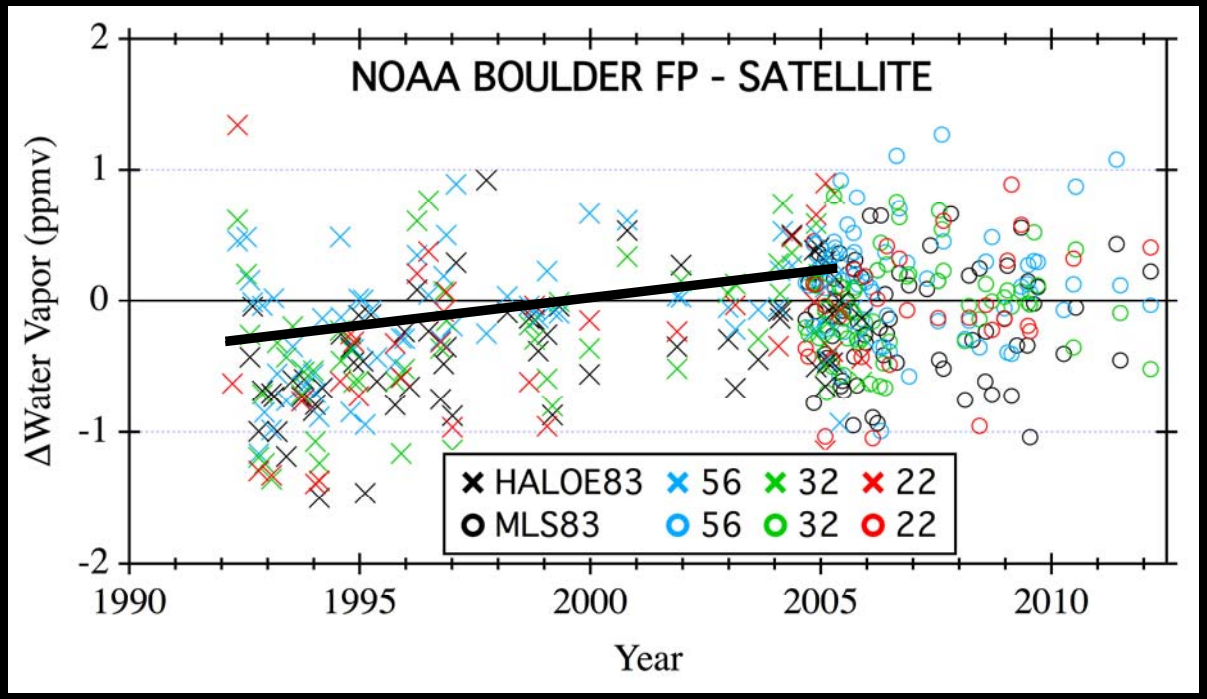
Differences Also Exist Between Satellite-Borne Sensors

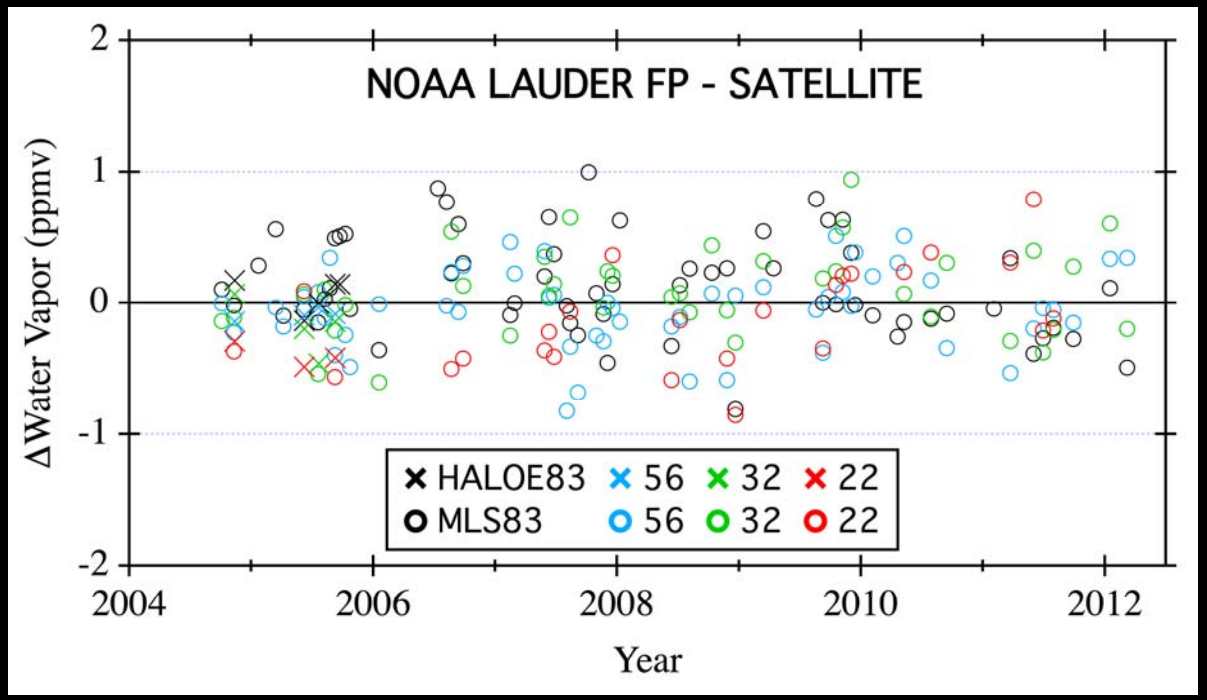


MLS – HALOE ≈ 0.5 ppmv during 16-month operational overlap

➔ Good agreement between MLS and FPH suggests HALOE adjustment

➔ Adjusted HALOE: +0.5 ppmv (Davis and Rosenlof)





Frost Point – Satellite

- HALOE (adjusted)
- MLS

Boulder Overpasses

No statistical biases

Significant trends:

FP-HALOE: 18-100 hPa

FP-MLS: none

Lauder Overpasses

No statistical biases

No significant trends (MLS only)

MACPEX Payload Layout

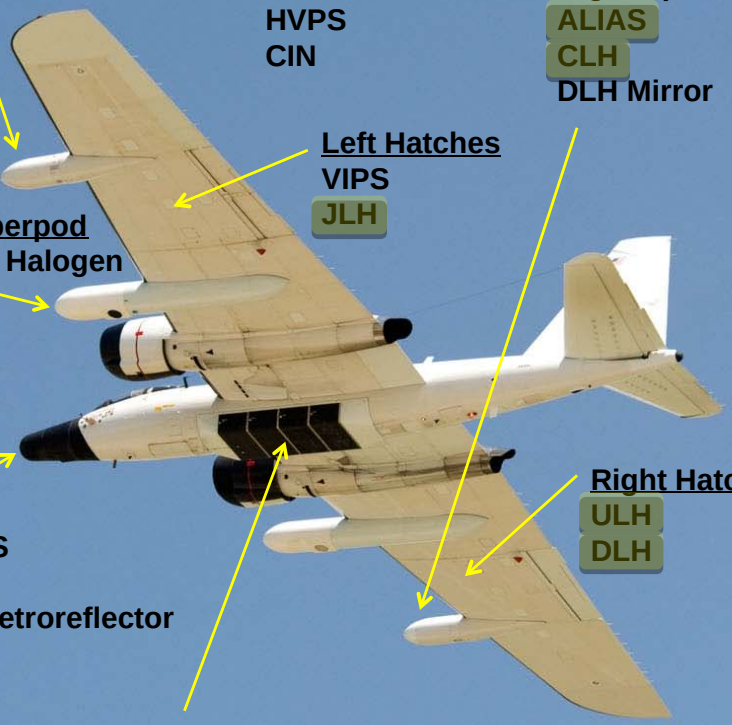
Left Spear Pod
Harvard Water Vapor
(includes HHH)
SID3

Right Superpod (with spear pod forebody)
2DS
CPI
FCDP
HVPS
CIN

Right Spear Pod
ALIAS
CLH
DLH Mirror

Left Hatches
VIPS
JLH

Left Superpod
Harvard Halogen



Nose
PALMS
MMS
DLH Retroreflector

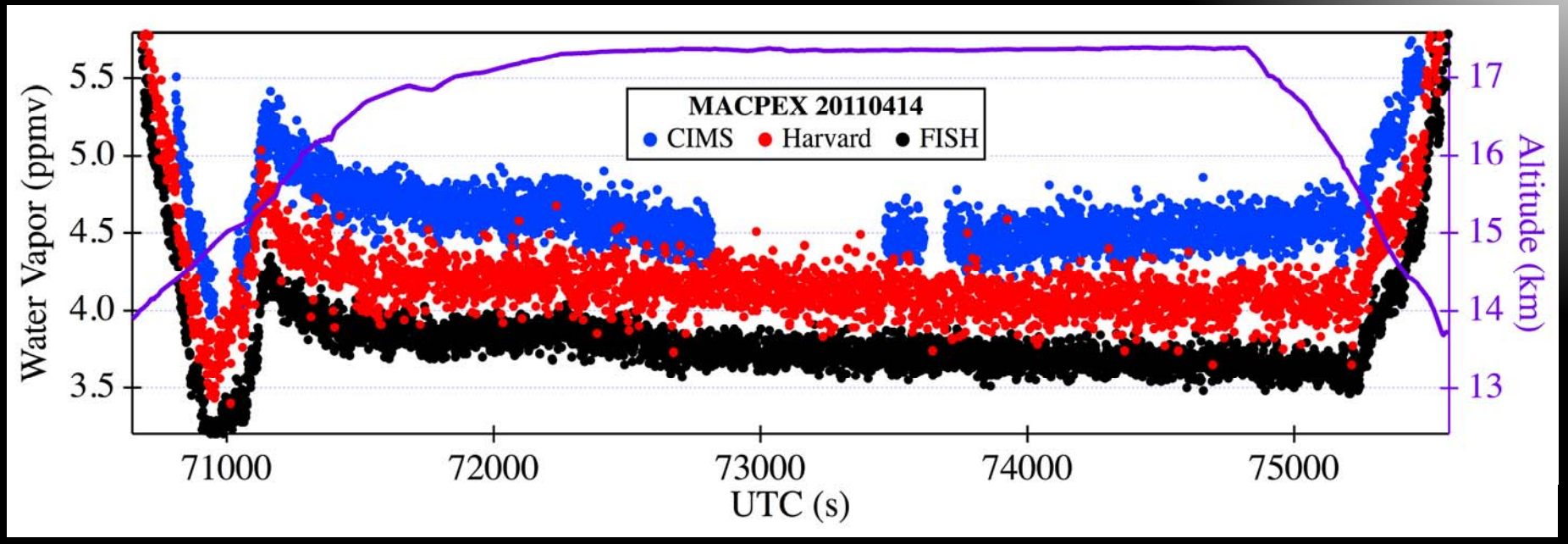
Right Hatches
ULH
DLH

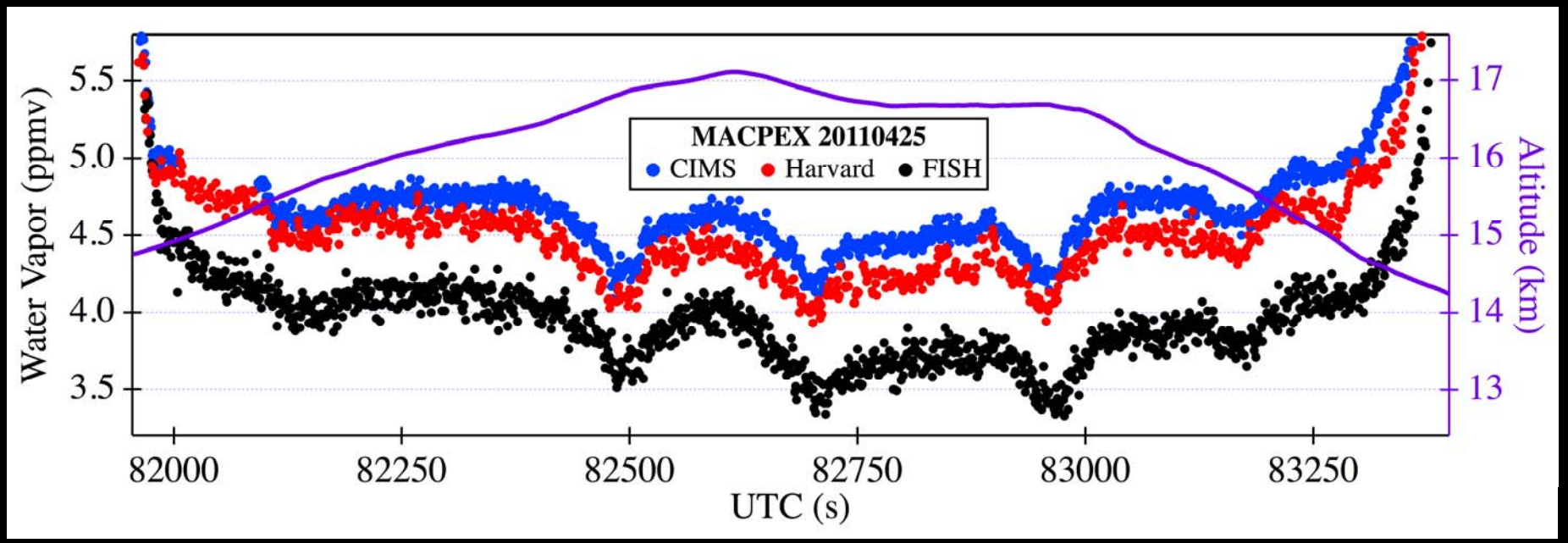
Payload Bay:
Forward transition – MMS electronics, O3
Pallet 1 (P305) – Harvard Total Water
Pallet 2 (P301) – FCAS, NMASS
Pallet 3 (P306) – CIMS, SP2, O3Lite
Pallet 4 (P303) – FISH

As of 24 Mar 11

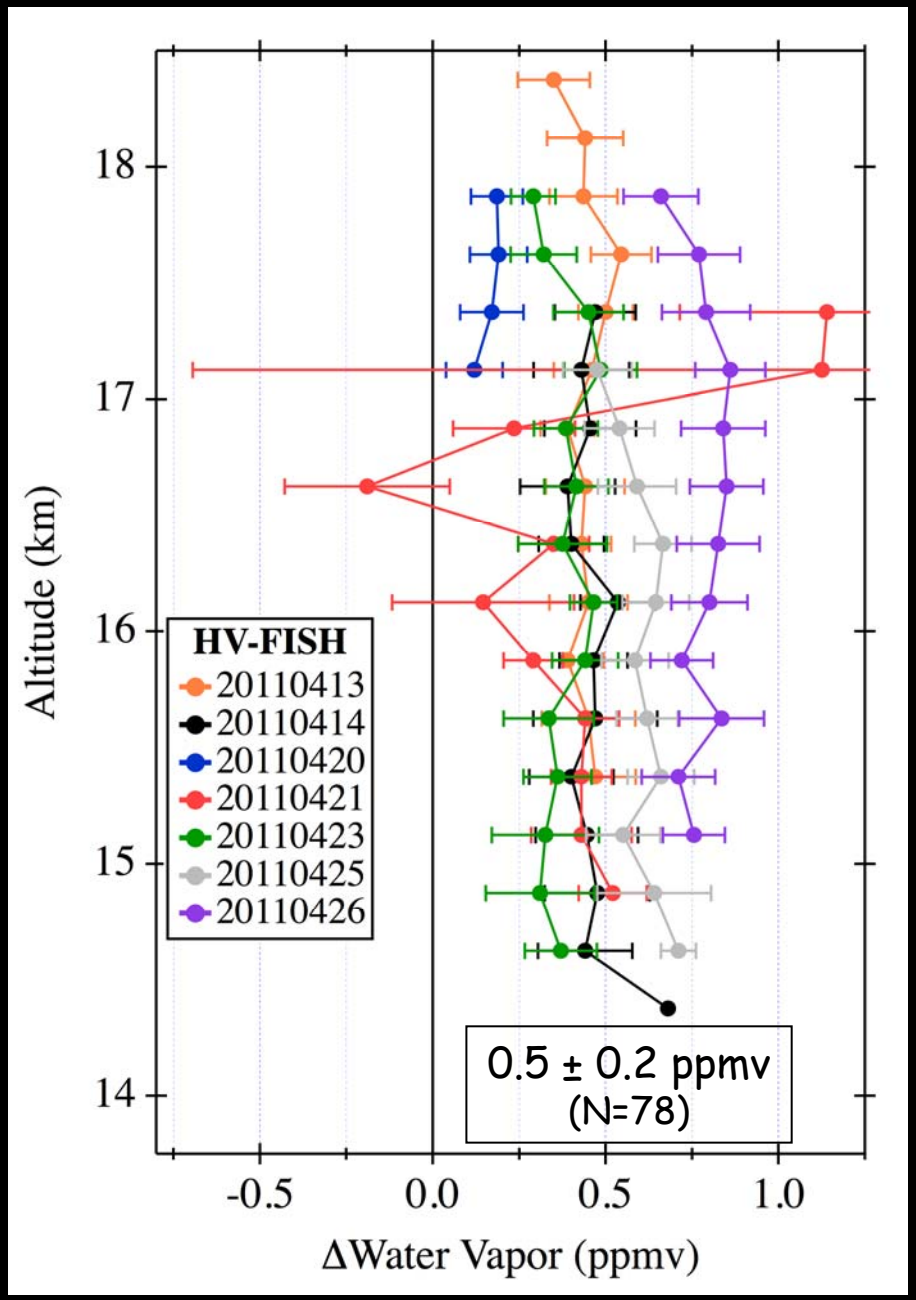
NASA
MACPEX
Mid-Latitude Airborne Cirrus Properties Experiment
Houston, TX
February - March 2011

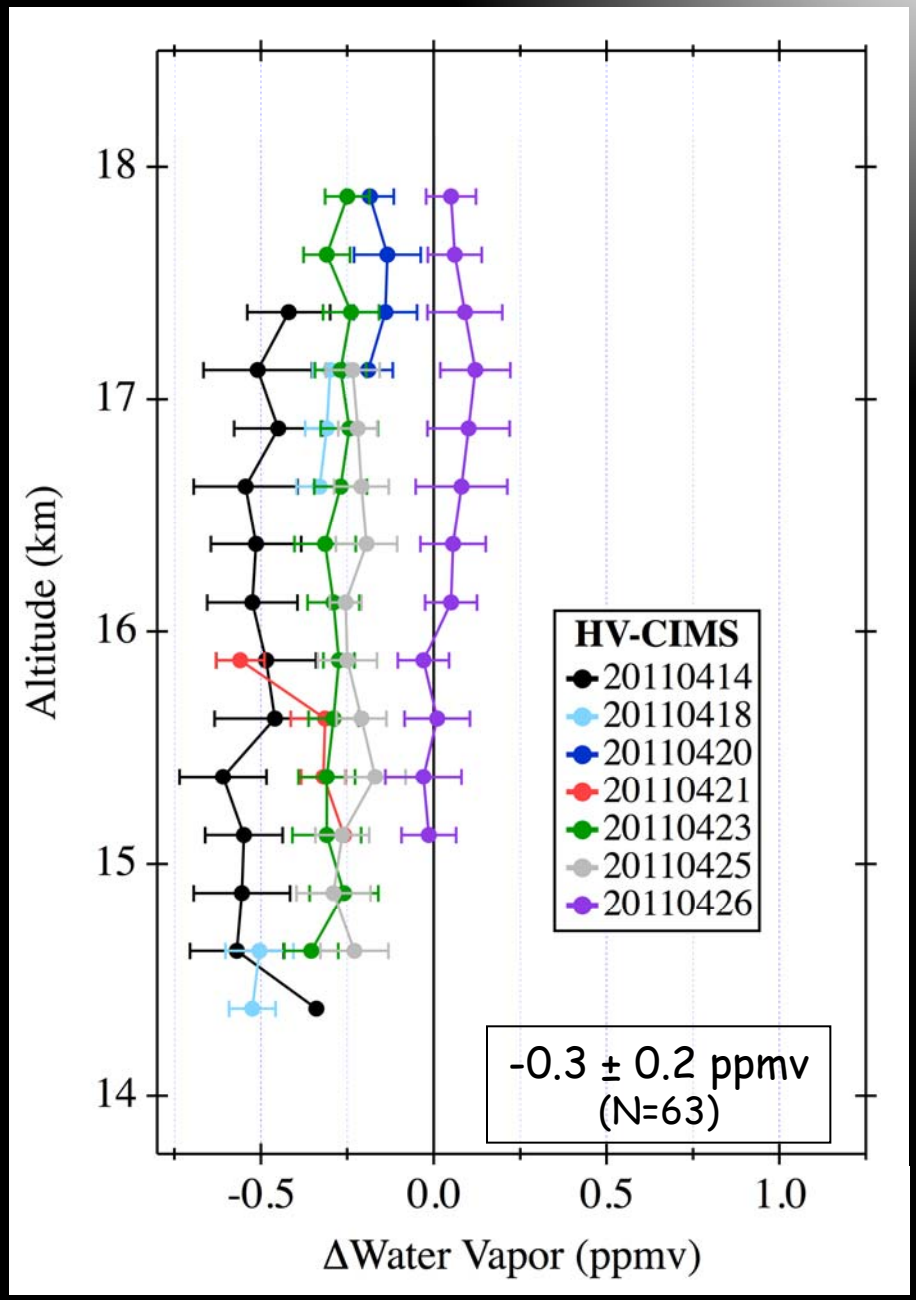
Aircraft Instrument Comparisons





Aircraft Instrument Differences – Summary Statistics





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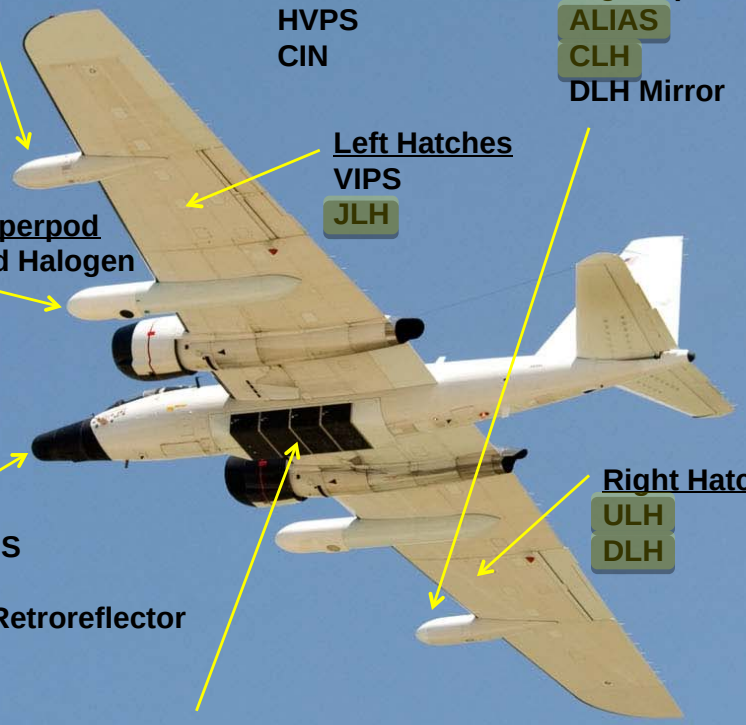

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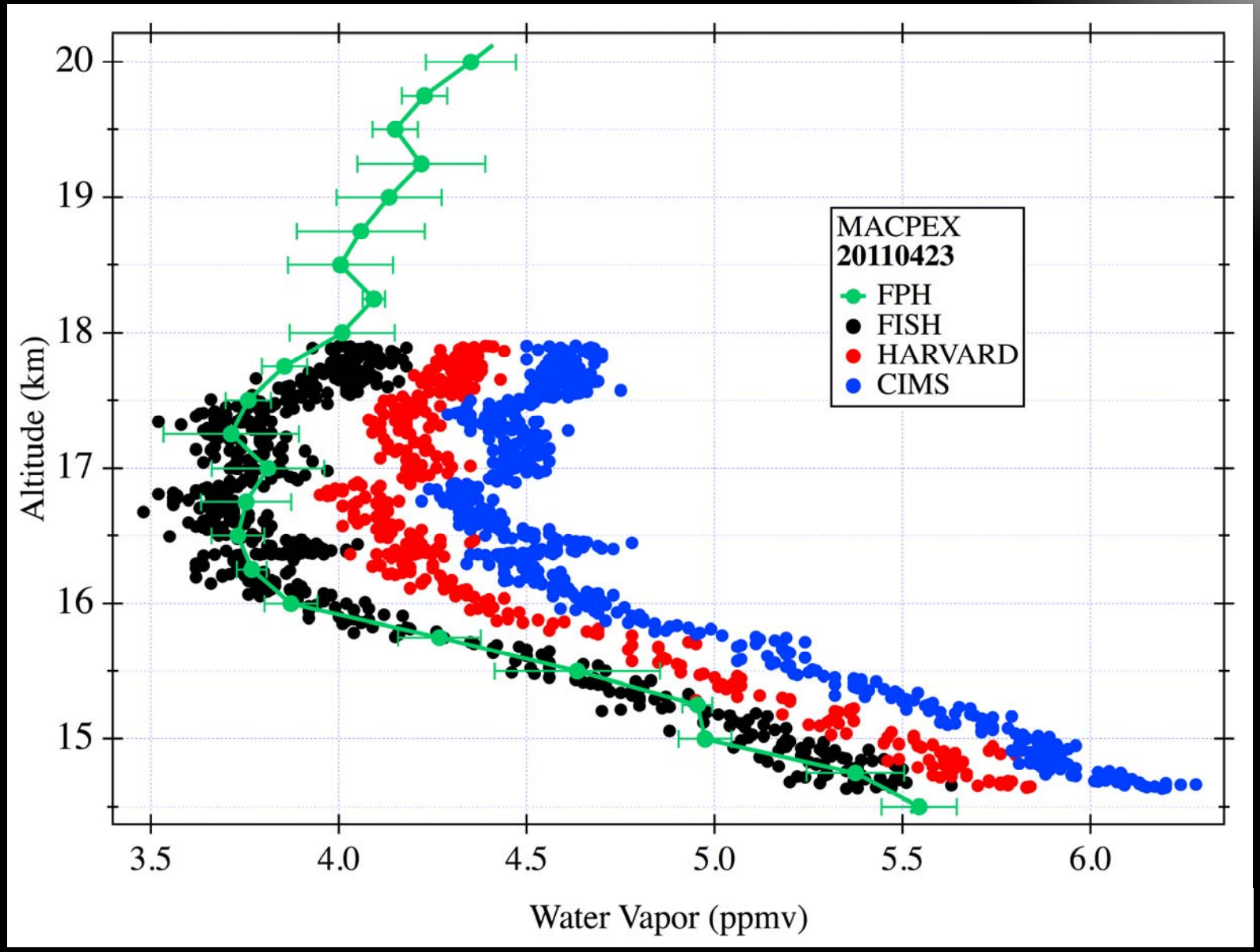
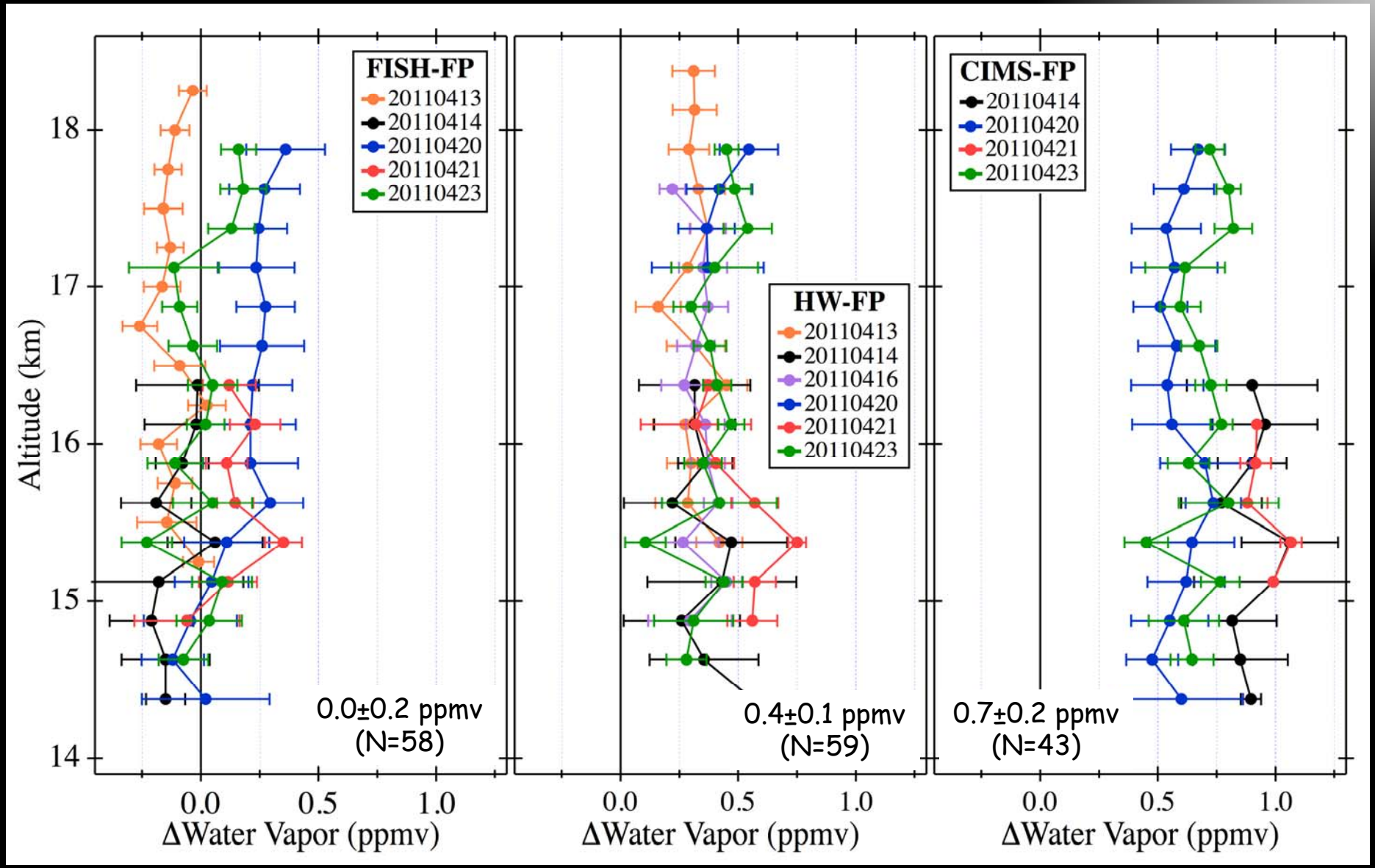
As of 24 Mar 11

Balloon vs Aircraft Instrument Comparisons



A/C Instrument - Frost Point Differences: Summary Stats



Conclusions

Since 1993: campaign-dependent biases of 15-60% between Harvard Lyman-α and NOAA Frost Point Hygrometers

Biases between HALOE & MLS/FPH in 2004-05 suggest HALOE adjustment

- FP-adjusted HALOE: significant trends at 18-100 hPa (1991-2005)
- FP-MLS: No biases or trends (2004-2012)

MACPEX: statistically significant biases between 3 aircraft instruments

HW-FISH (0.5±0.2 ppmv) & HW-CIMS (-0.3±0.2 ppmv)

MACPEX: no statistically significant bias between FP and FISH (0.0±0.2 ppmv)

MACPEX: statistically significant biases between FP and HW and CIMS

HW-FP (0.4±0.1 ppmv) & CIMS-FP (0.7±0.2 ppmv)

(these are consistent with the biases between aircraft instruments)

Biases revealed during MACPEX are smaller than most historical differences between HW and the Frost Point Hygrometers

This indicates progress in eliminating water vapor measurement biases but further efforts are clearly necessary

Thank you for your attention

Aircraft – Balloon Coincidences