

NDACC Water Vapor Workshop, 5 July 2006

Water vapor observations in the upper troposphere and lower stratosphere

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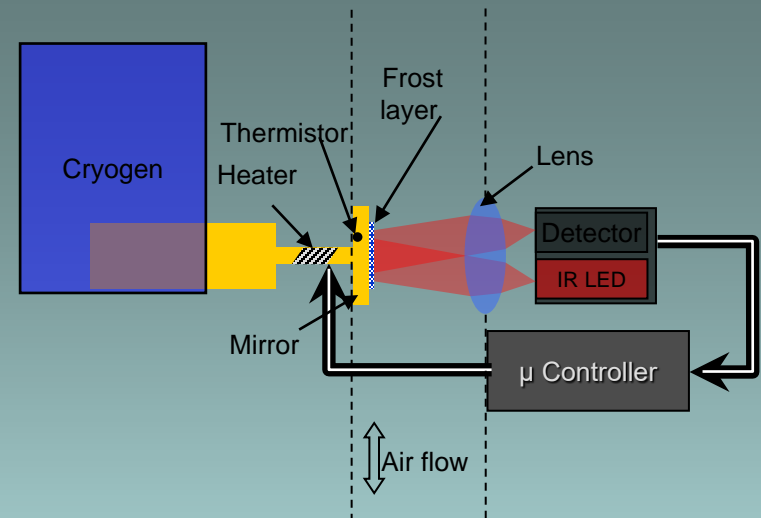
NASA for their support

Overview

- Frost point
- Lyman- α
- TDL
- Summary

Cryogenic Frostpoint Hygrometer (CFH)

- Microprocessor control
- Vertical Range: surface to ~28 km
(surface to ~25 km on ascent)
- Uncertainty: troposphere: > 4% MR
stratosphere: ~ 9 %
- Phase sensitive detector:
electronic sunlight filter
- No liquid/ice ambiguity
- Weight: ~ 400 gr
- Currently interfaced with ECC ozone
sonde and Vaisala RS80
- Based on NOAA/CMDL frost point
hygrometer
- 162 soundings



Sounding overview 2003-2006

• Bandung, Indonesia:	8
• Beltsville, MD	1
• Biak, Indonesia:	9
• Boulder, CO:	35
• Heredia, Costa Rica:	60
• Hilo, HI:	13
• St. Denis, La Reunion:	11
• Midland, TX:	1
• ARM/CART, Oklahoma:	12
• San Cristobal, Galapagos:	9
• Sodankylä, Finland:	12
• Tarawa, Kiribati:	<u>2</u>
Total (June 2006):	172

Tropical CFH observations

Cold tropopause season:

Costa Rica January/February 2006

30 CFH/ECC soundings

Biak, Indonesia, January 2006

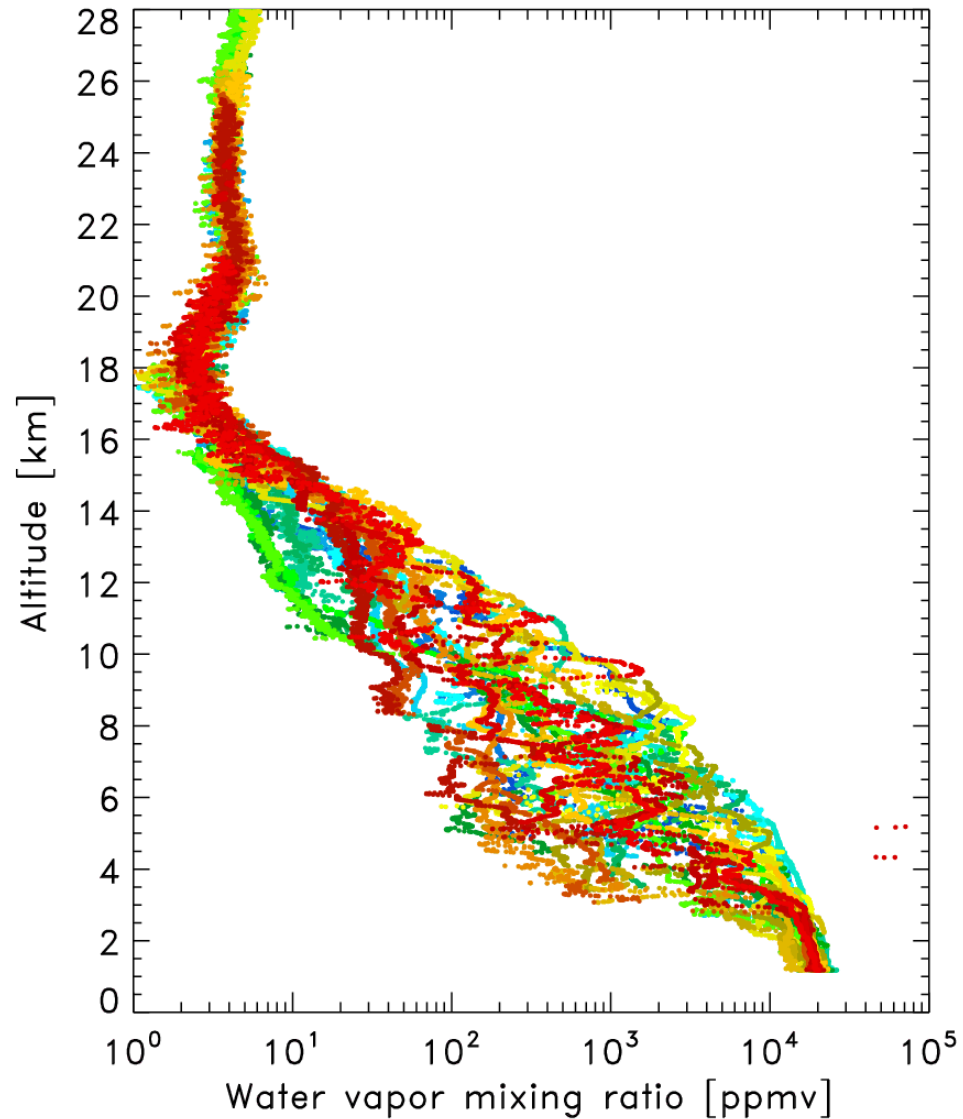
9 CFH/ECC soundings

Bandung, Indonesia, Dec 2004, Dec 2005

8 CFH/ECC soundings

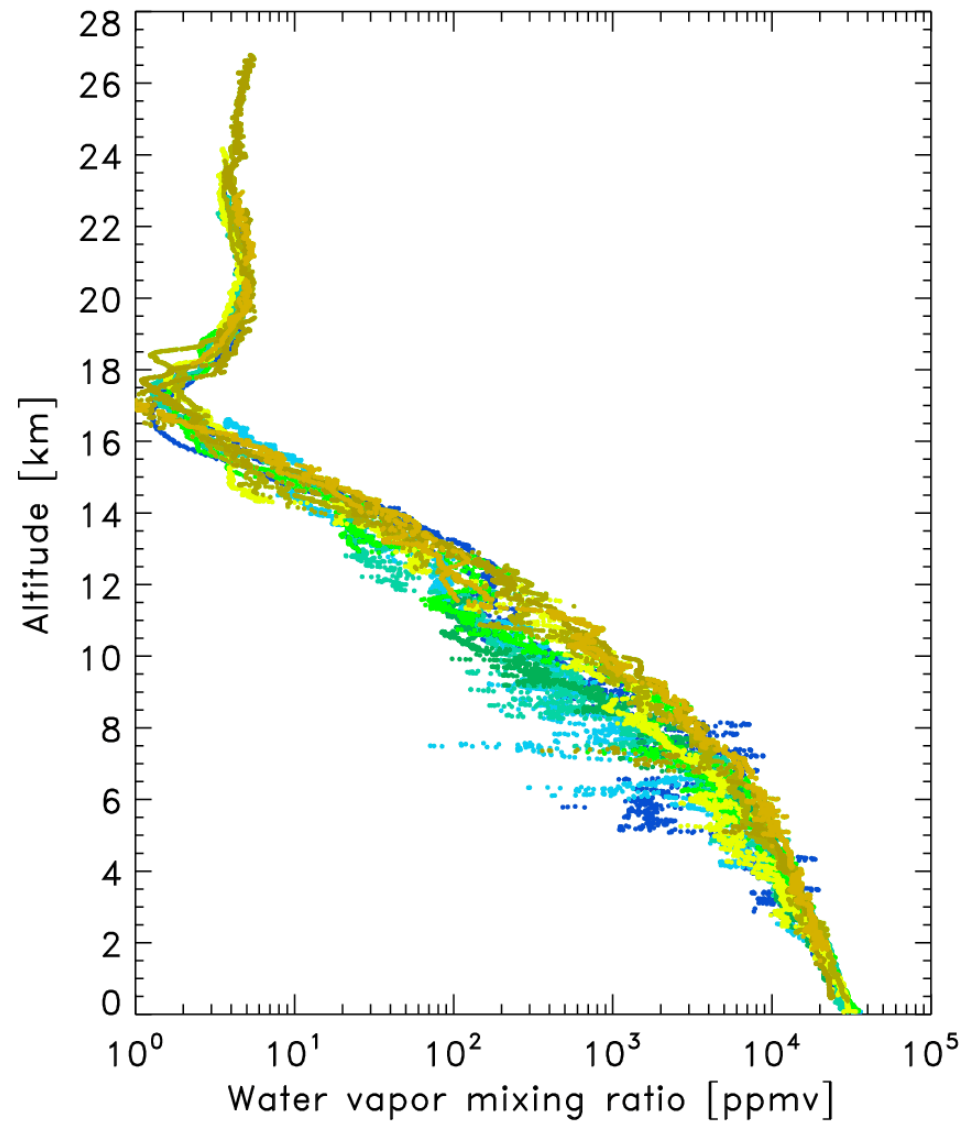
Water vapor mixing ratio

Ticosonde 2006, Jan 4 – Mar 4, 2006



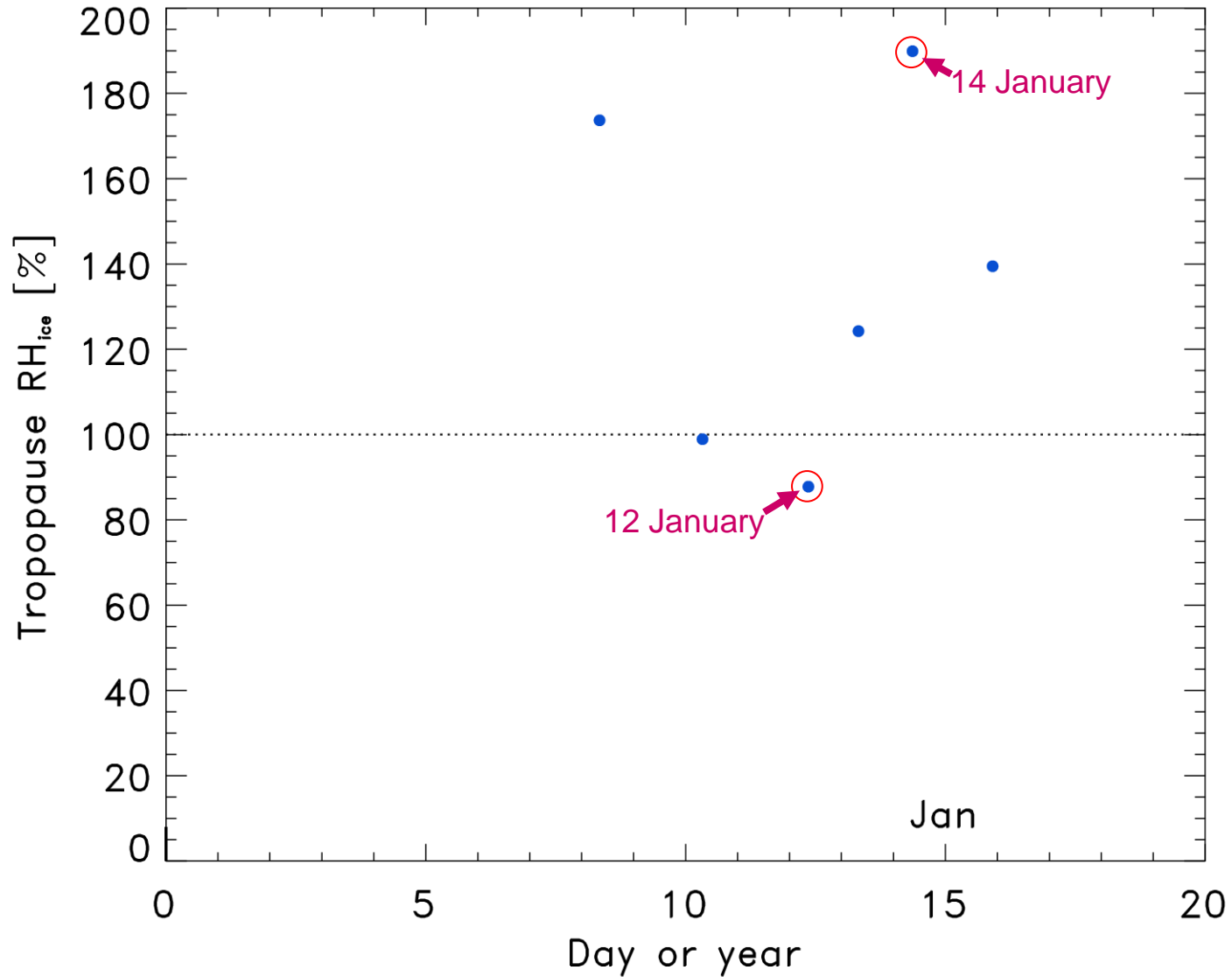
Water vapor mixing ratio

Biak, Indonesia, Jan 8-14, 2006



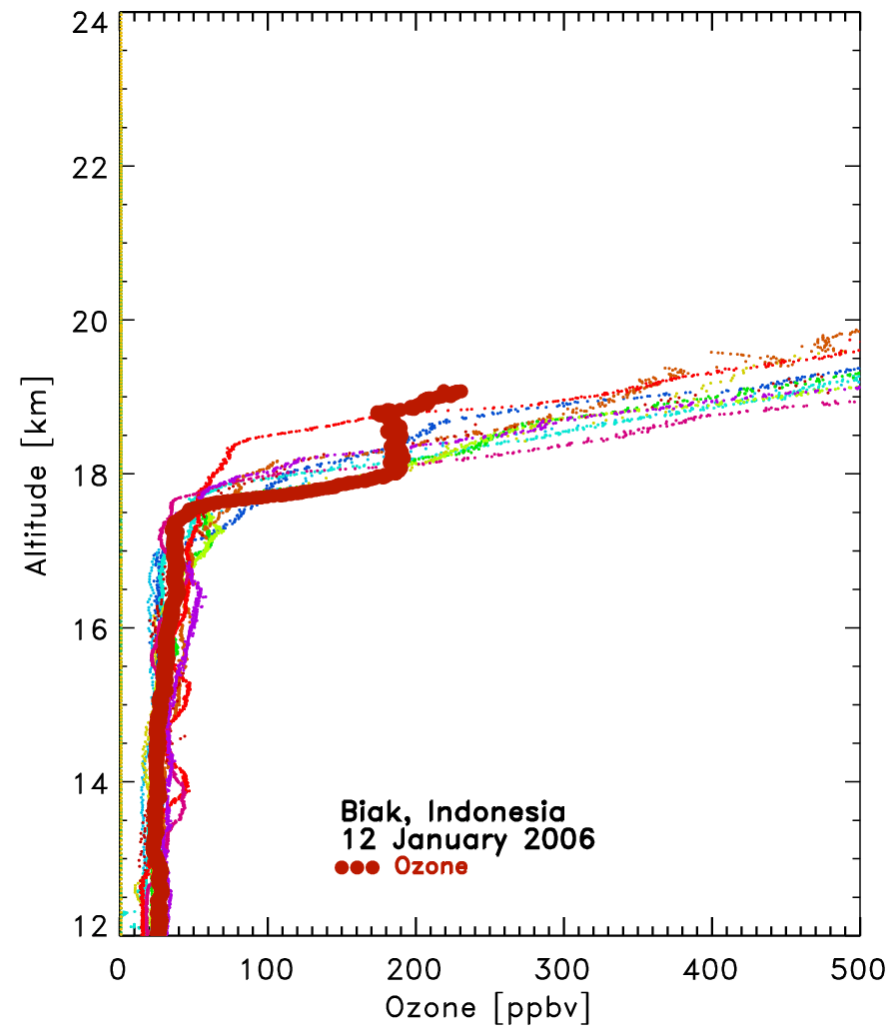
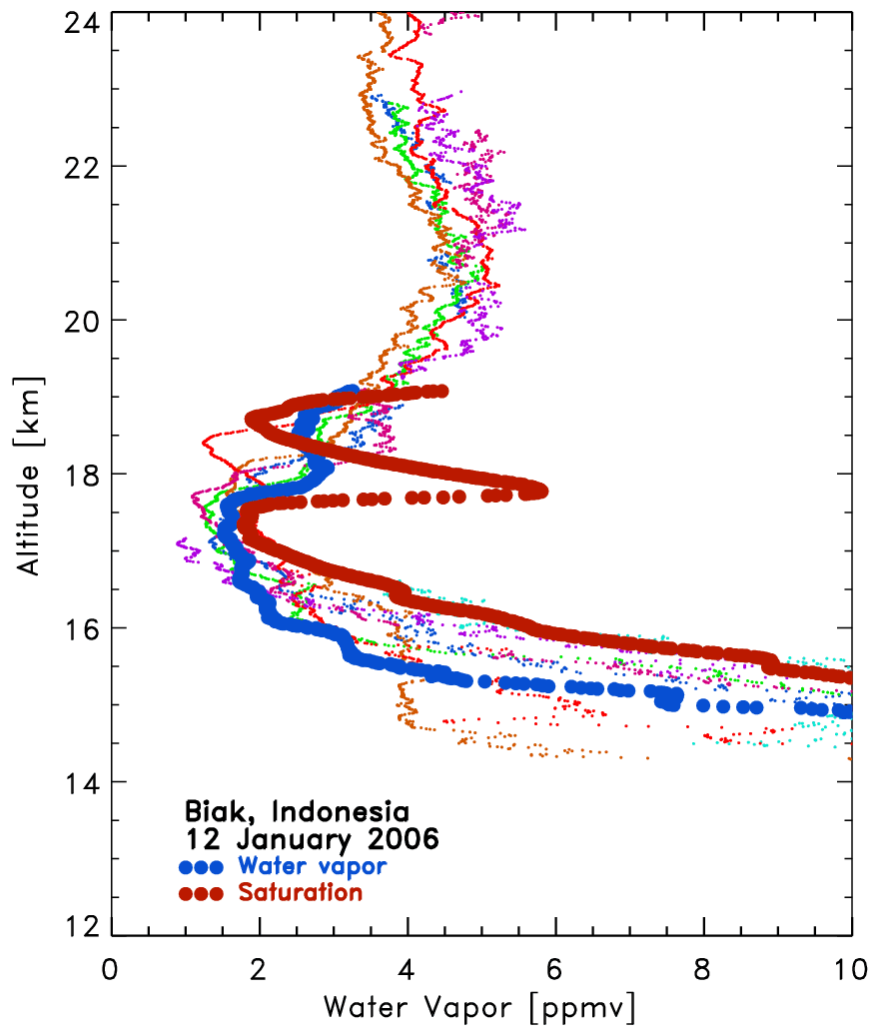
Tropopause relative humidity (ice)

Biak, Indonesia, Jan 8-16, 2006

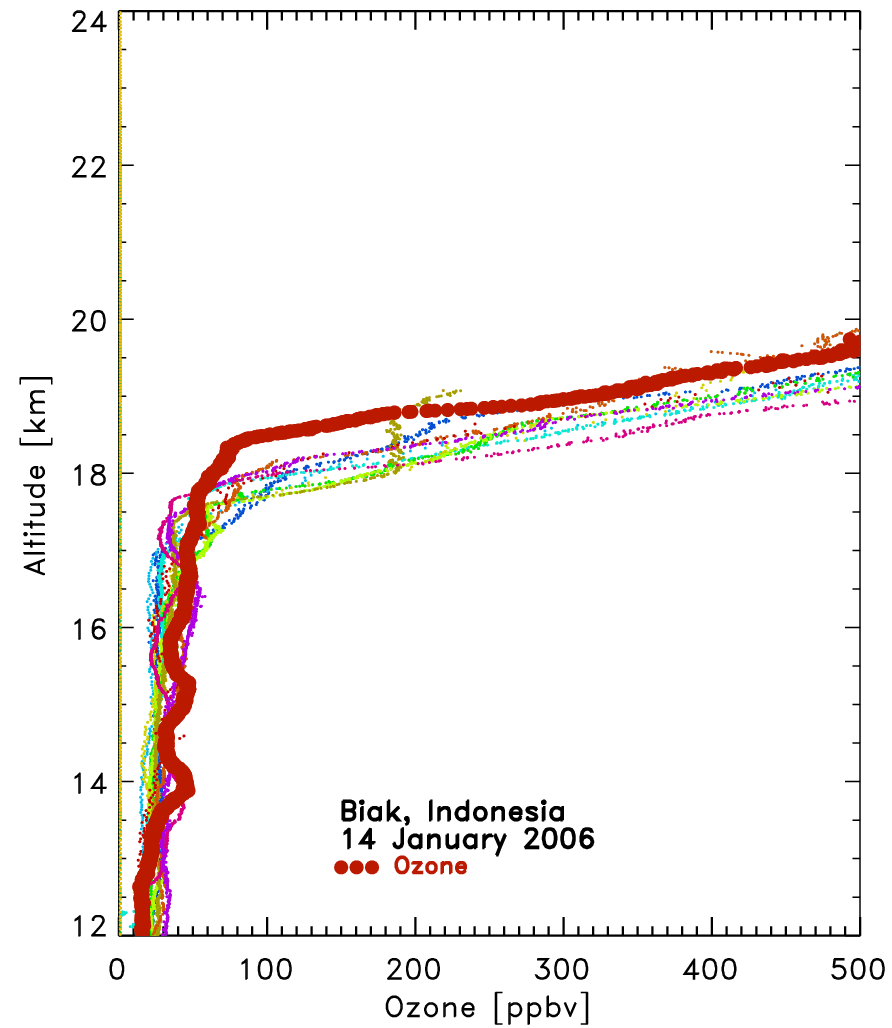
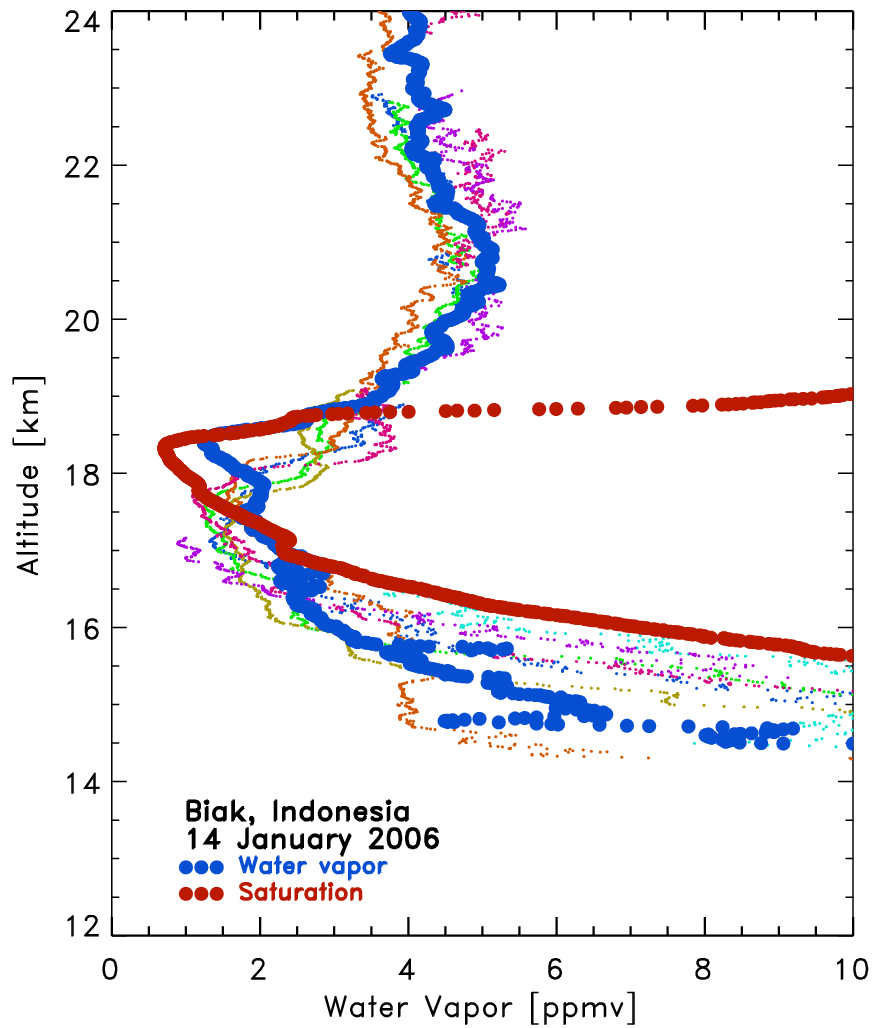


Wave related dehydration: Double tropopause

Biak, Indonesia, Jan 8-14, 2006

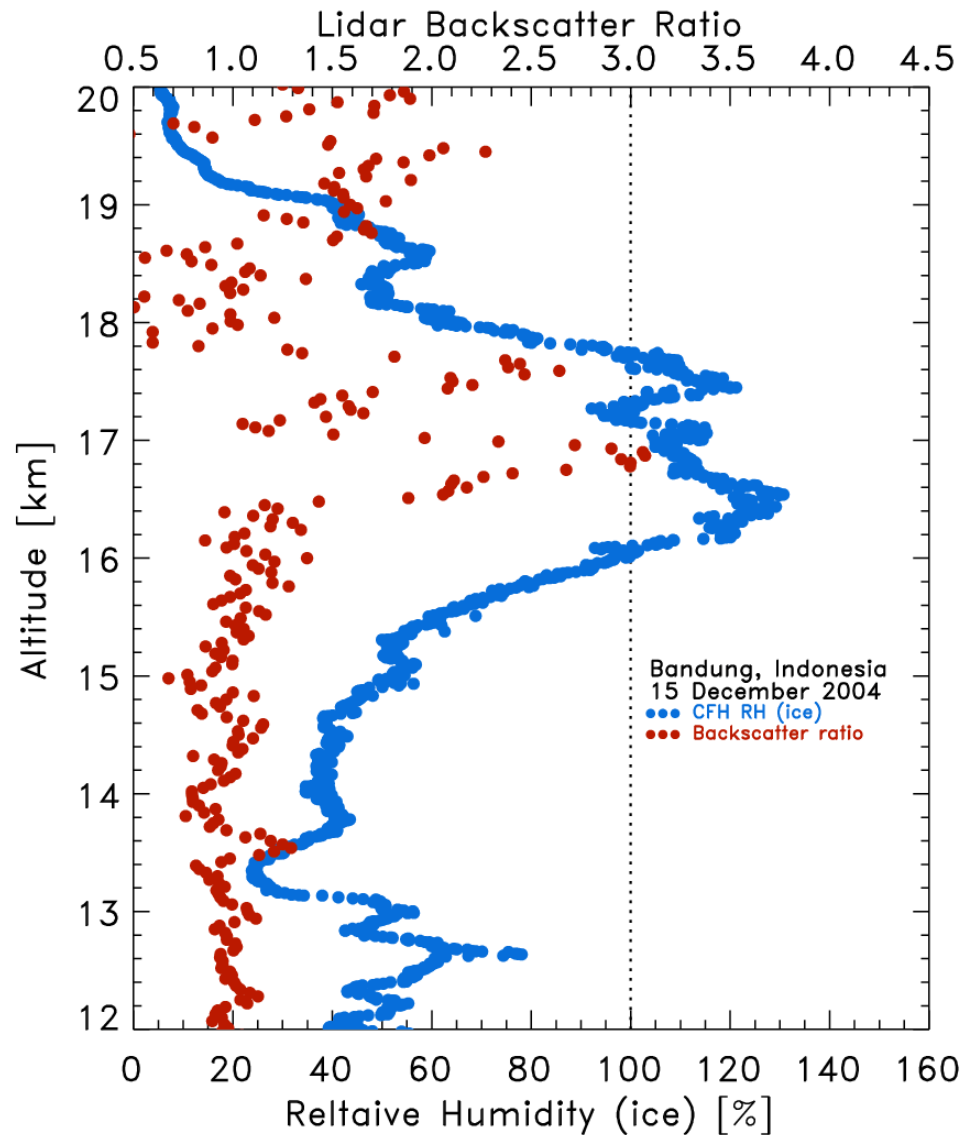


Extreme dehydration Biak, Indonesia, Jan 8-14, 2006



RH(ice) & lidar backscatter ratio

Bandung, Indonesia, Dec 15, 2004

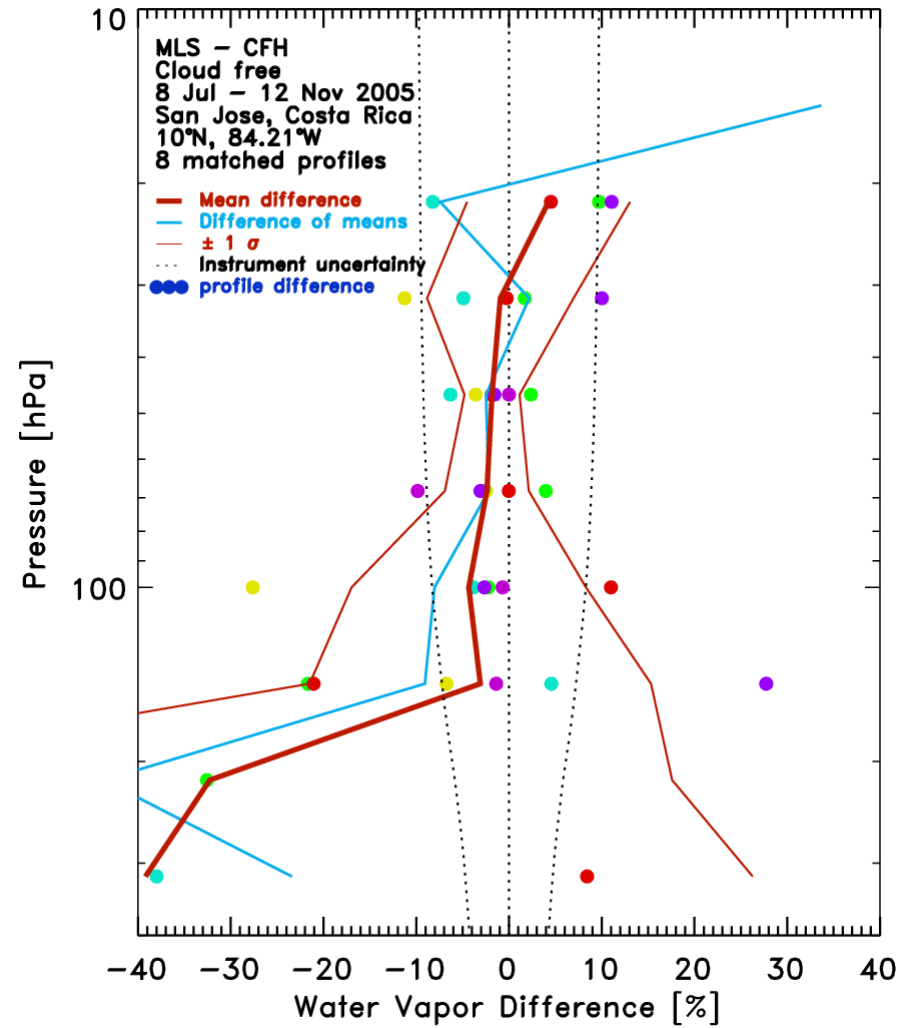
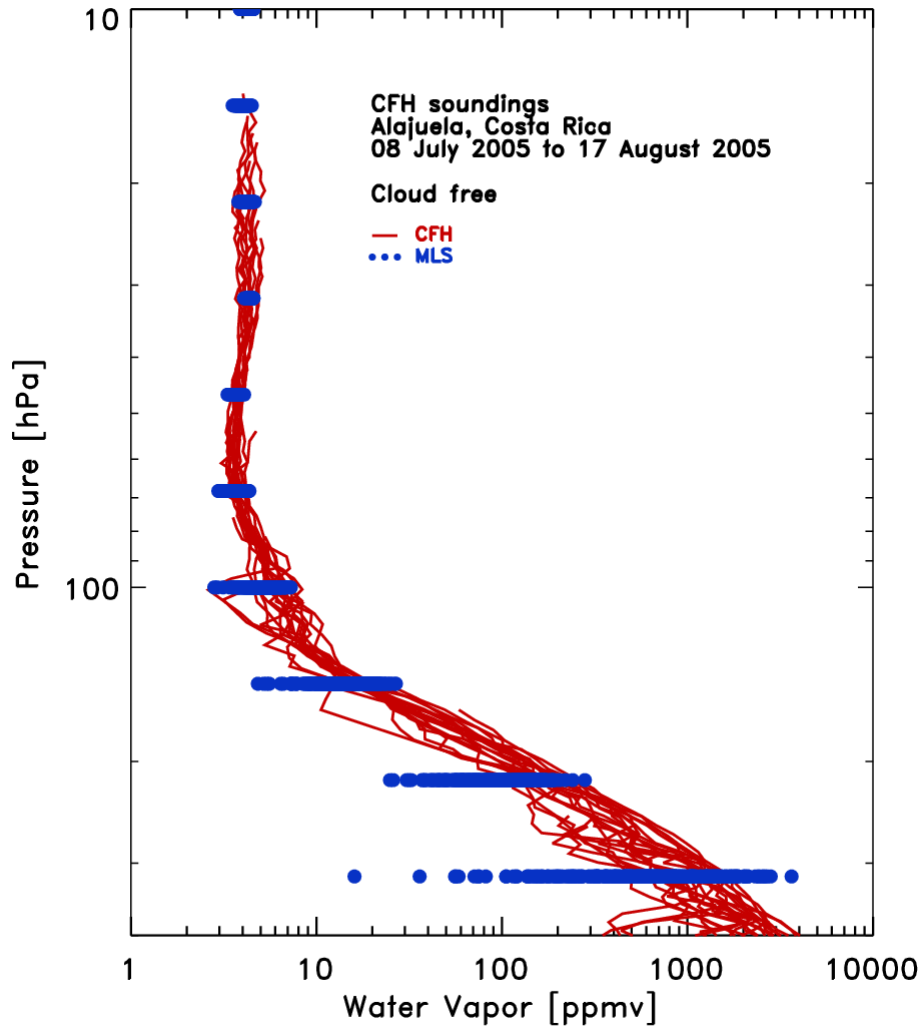


Instrument validations

- RS92 humidity
- AURA / MLS water vapor
- JPL TDL
- Harvard Lyman-alpha

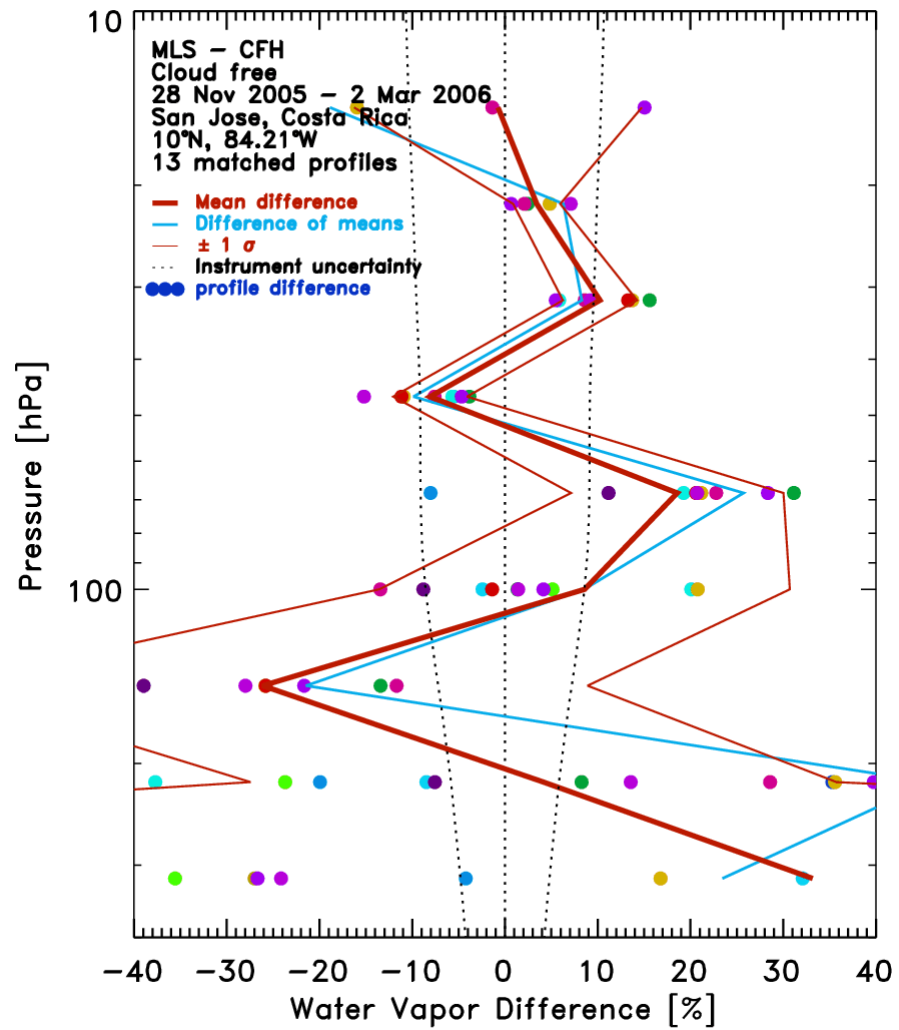
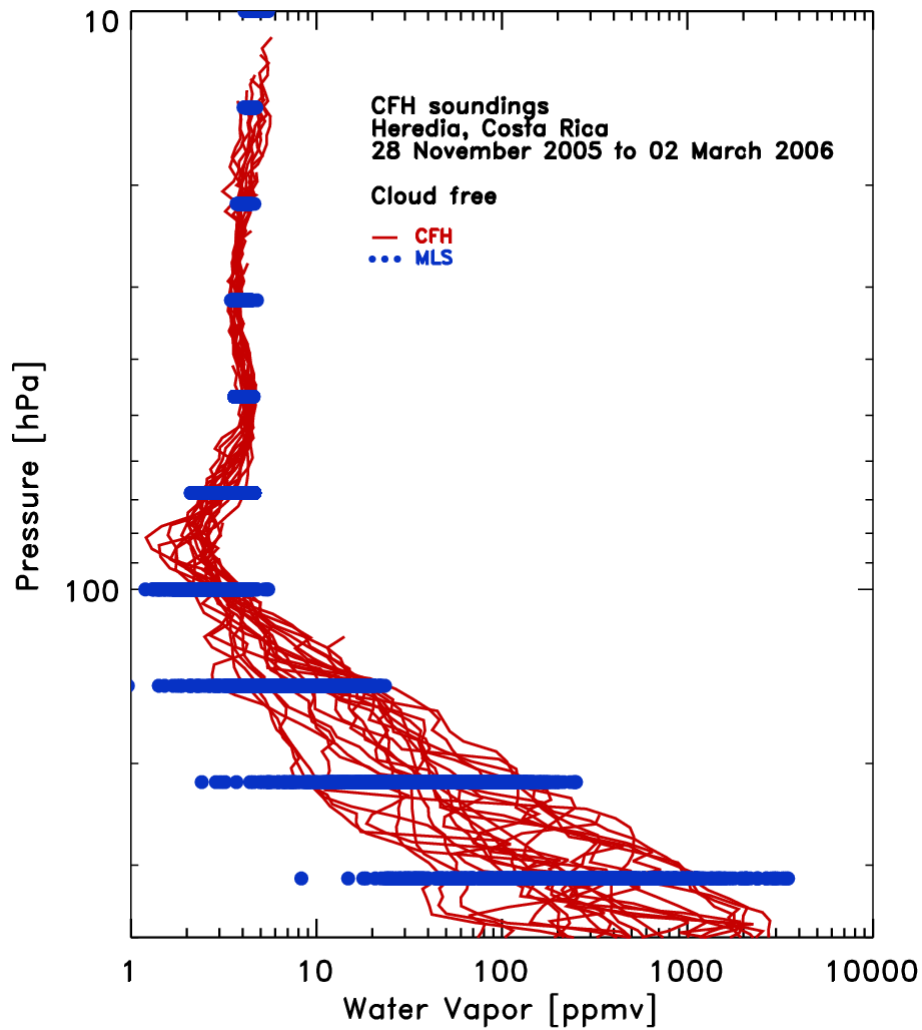
Ticosonde 2005, July 8-24, 2005

AURA MLS vs CFH



Ticosonde/CR-AVE 2006, 28 Nov 2005 – 2 Mar 2006

AURA MLS vs CFH



CFH Advantages

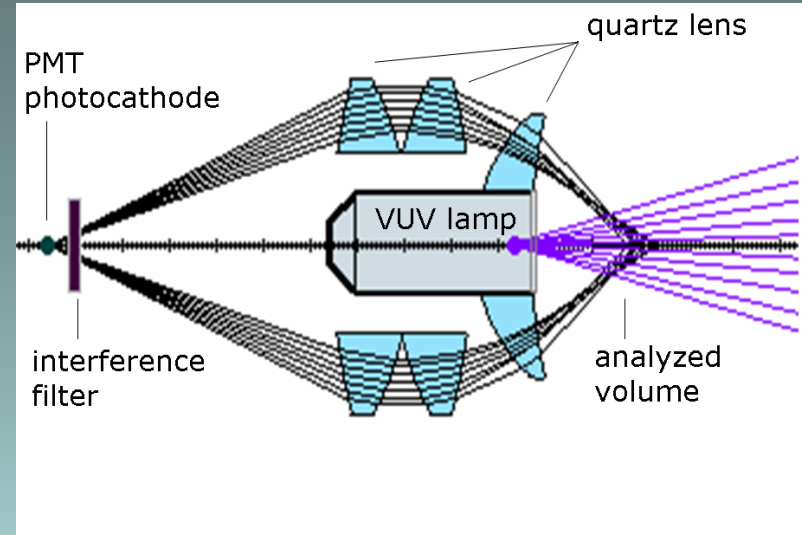
- Measurement based on simple physics
- Measurement not calibrated for water vapor, but rather for temperature (assume vapor pressure equation is correct)
- Extremely large dynamic range
- Long history for technology
- Can be deployed easily at existing sounding sites

CFH Limitations

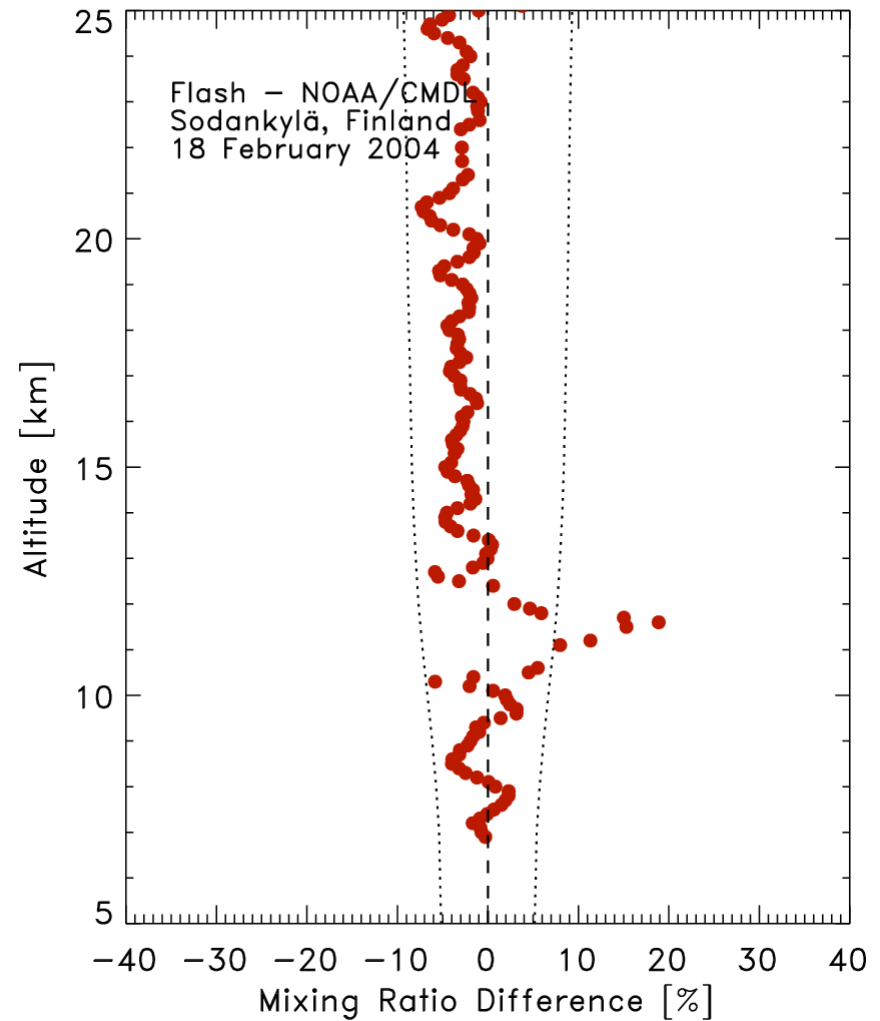
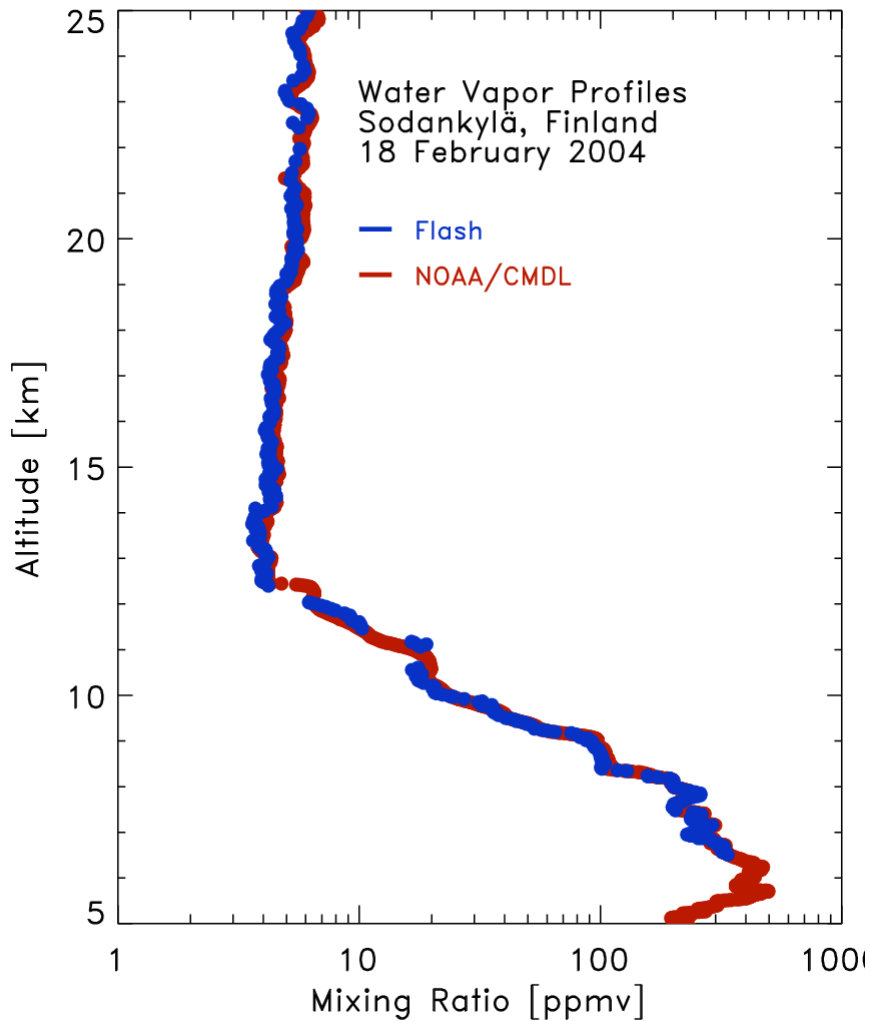
- Instrument may fail completely in “thick” liquid clouds
- High cost
- Availability of cryogen
- Instrument needs minor preparation
- Data product needs understanding of instrument

FLASH - Lyman- α

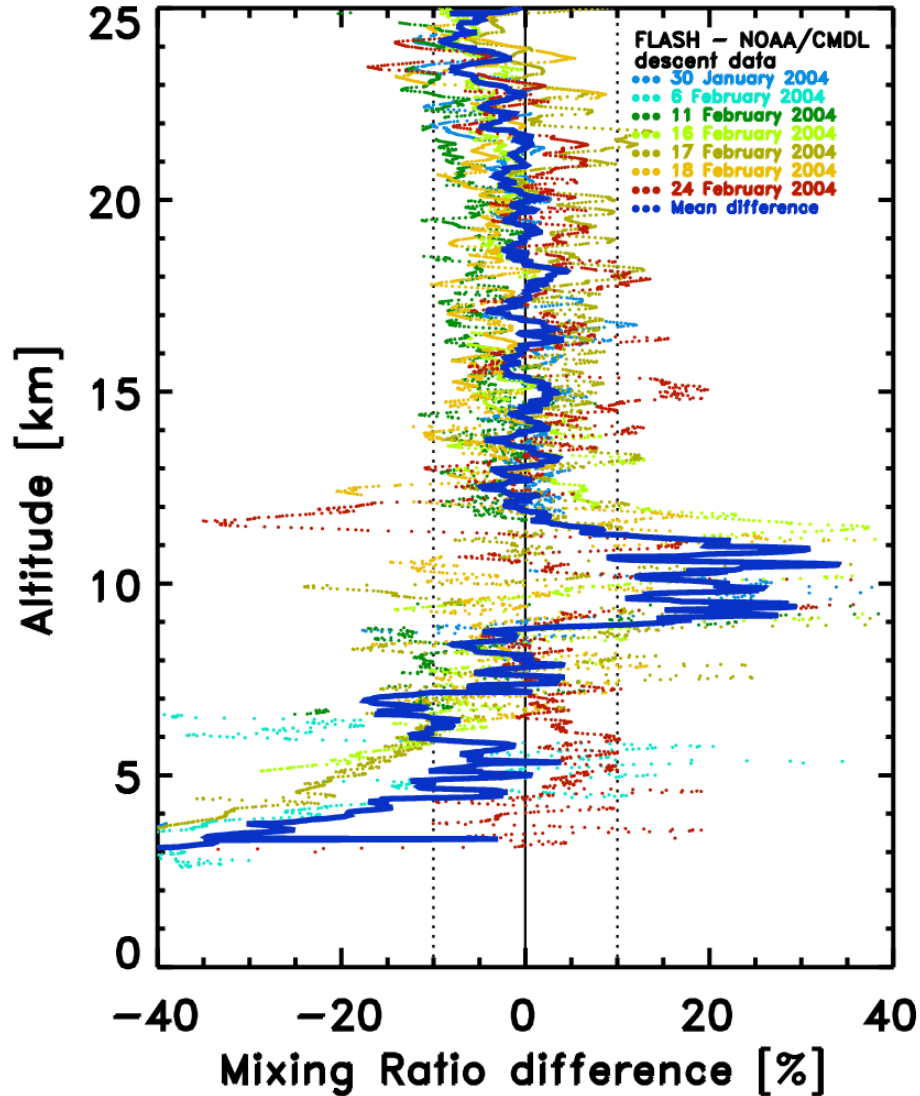
- Fluorescent Lyman Alpha Stratospheric Hygrometer (FLASH)
- Vertical Range: upper troposphere to stratosphere (0.5 to 500 ppmv)
- Calibrated against reference frost point
- Uncertainty: 9% MR
- Night time (descent) only
- Weight: ~ 1 kg
- Currently interfaced Vaisala RS80
- 45 soundings



FLASH - Lyman- α



FLASH - Lyman- α



FLASH Advantages

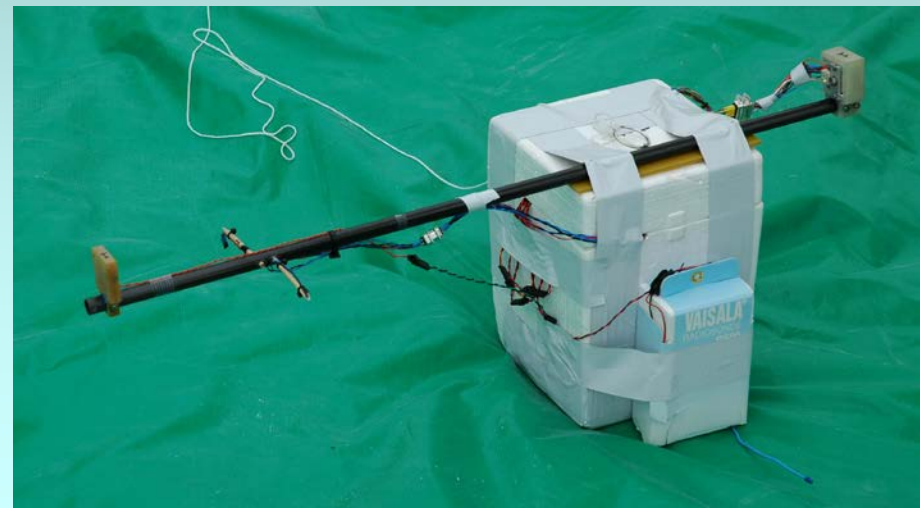
- Calibrated against frost point standard
- High measurement precision
- Very fast sensor
- Largely insensitive to clouds
- Large dynamic range (low mixing ratios)

FLASH Limitations

- Instrument measures properly on descent
- Can only measure during night time
- Full moon limits data range
- High cost
- Measurement range : 0.5 to 500 ppmv
- Currently can't check calibration in the field

MayComm TDL

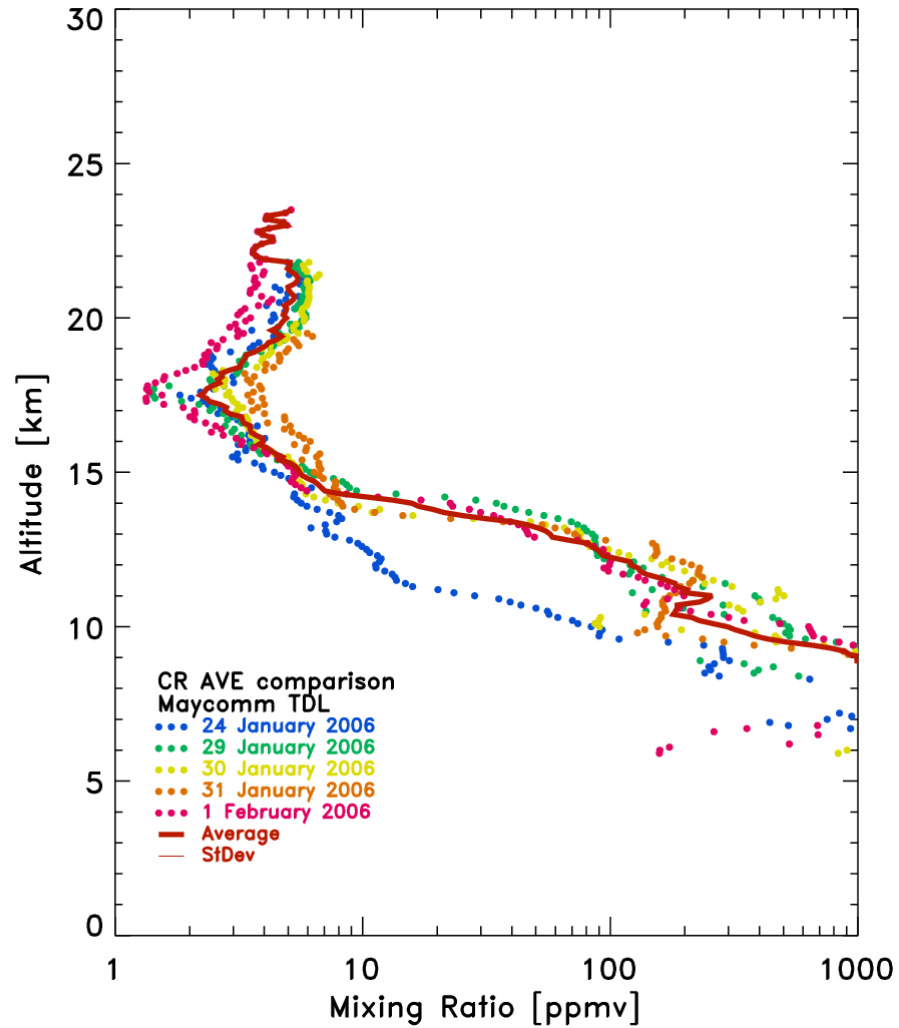
- Tunable Diode Laser
- Vertical Range: mid troposphere to stratosphere
- Calibrated against reference frost point
- Uncertainty: 5% MR or 0.5 ppmv
- Payload weight: ~ 1 kg



MayComm TDL

Costa Rica
January/February 2006

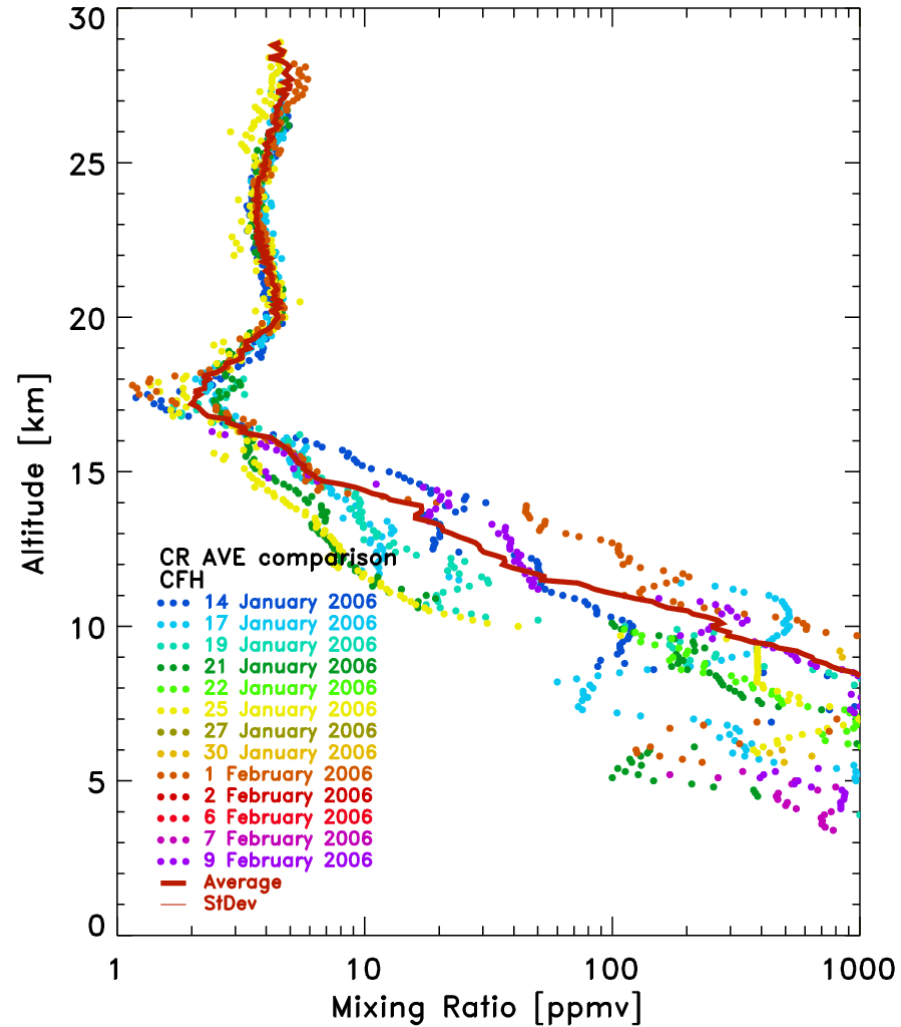
5 TDL soundings



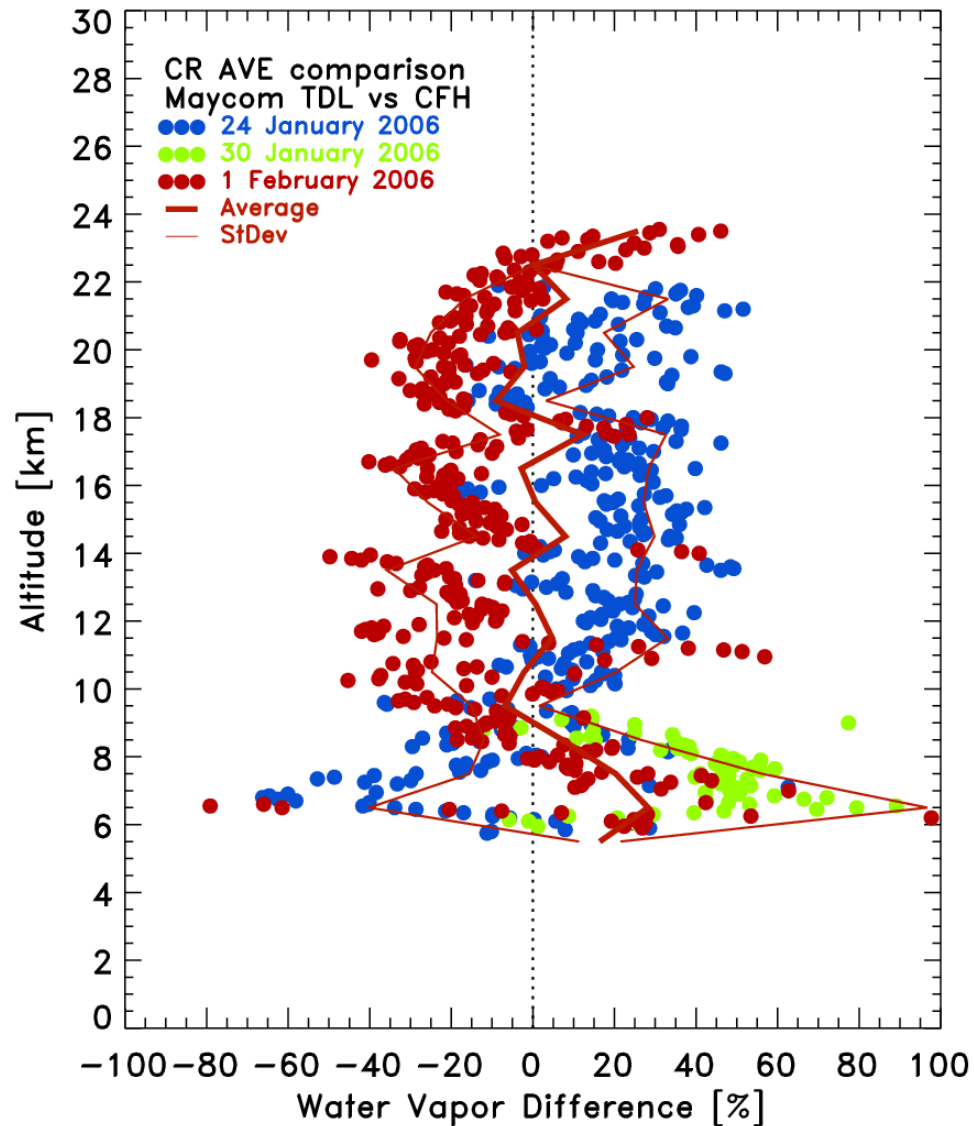
MayComm TDL vs CFH

Costa Rica
January/February 2006

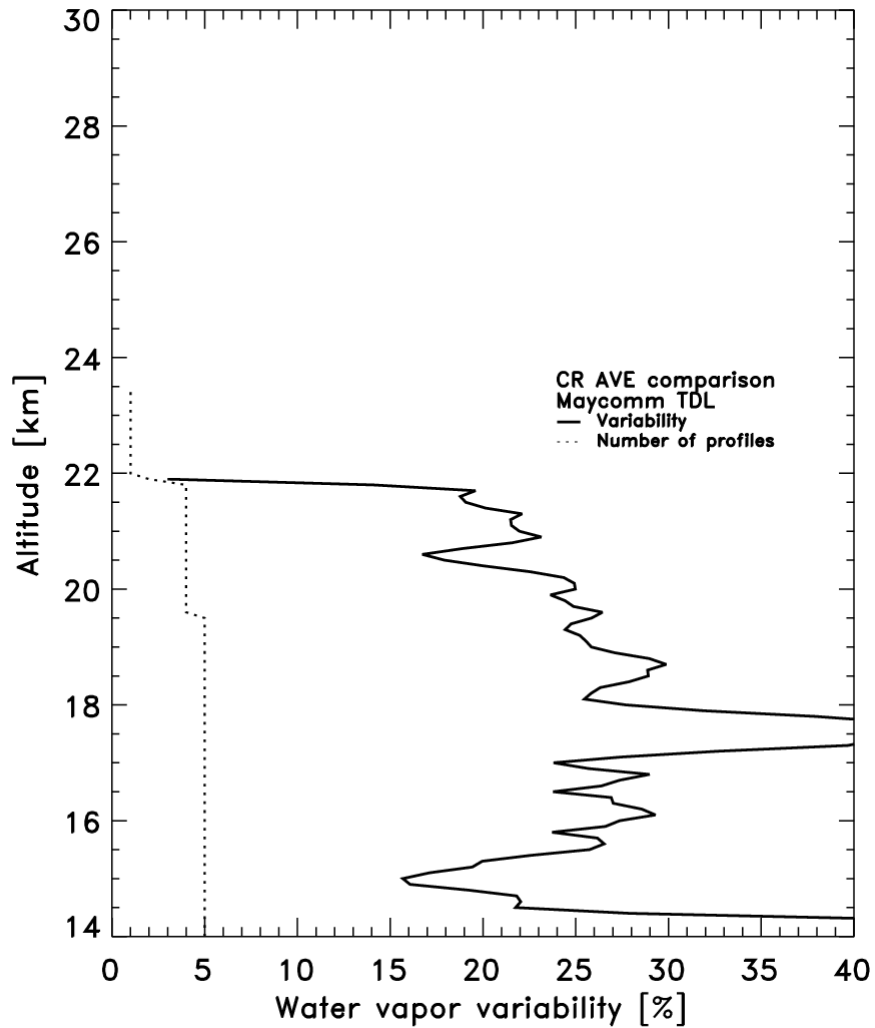
13 CFH soundings



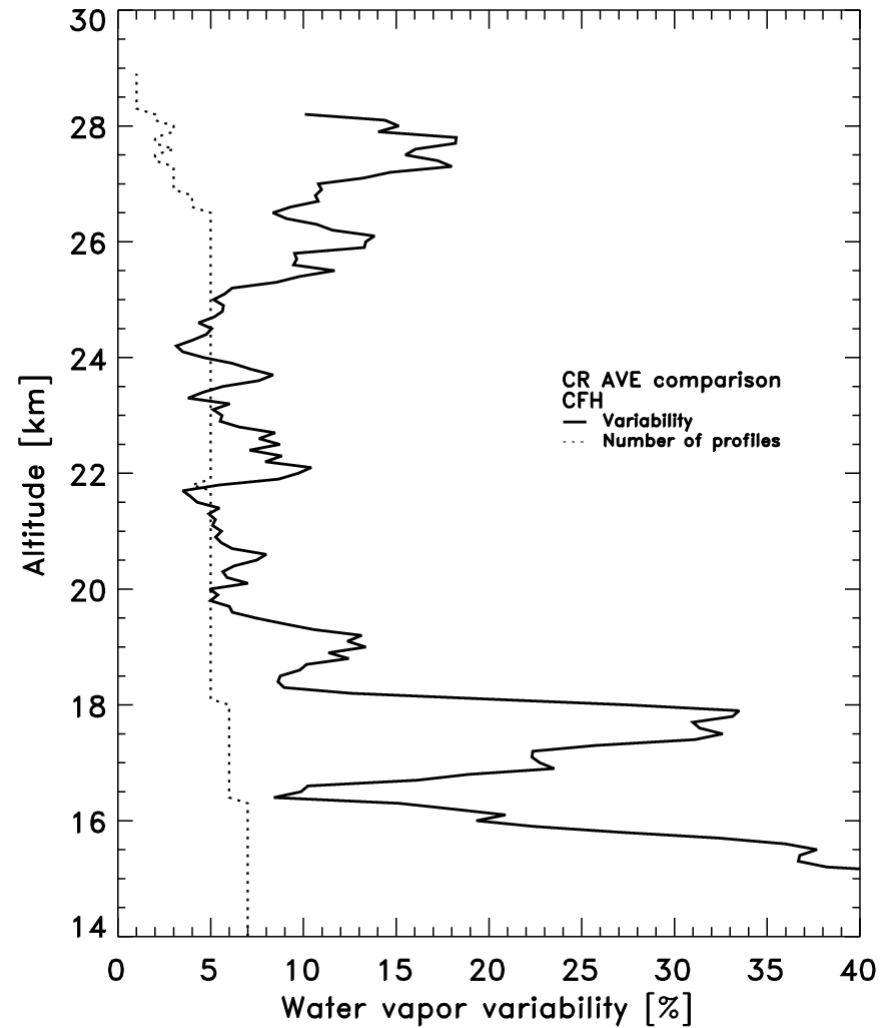
MayComm TDL – CFH comparison



MayComm TDL Variability



TDL



CFH

MayComm TDL Advantages

- High measurement precision
- Very fast sensor
- Insensitive to clouds
- Large dynamic range (low mixing ratios)
- Easy to use

MayComm TDL Limitations

- Prototype only
- High cost
- No lower troposphere
(Can extend to surface with second path)
- No stable interface/telemetry system yet

	Claimed accuracy	Calibration	Limitations	Dynamic range	History	Cost	Ease of use	Engineering status
CFH	0.5°C DP/FP 4-9%	++	No "wet" clouds	++	+	-(o)	o	research / small series
Snow White	0.1°C DP/FP	+	Some clouds RH > 3-6% No stratosphere	o	+	o	++	production small series
Lyman-alpha (FLASH)	9% (20% below 2 ppmv)	+	Night time only Descent only No lower troposphere	+	o	--	+	research / small series
TDL (MayComm)	5% 0.5 ppmv	o	?	+	-	--	(++)	Proof of concept
Polymer (Vaisala RS92)	1% RH	-	No stratosphere Large radiation error Chemical contamination Very hard to trace sensor/calibration changes	-	+	++	+ (++)	Large scale production



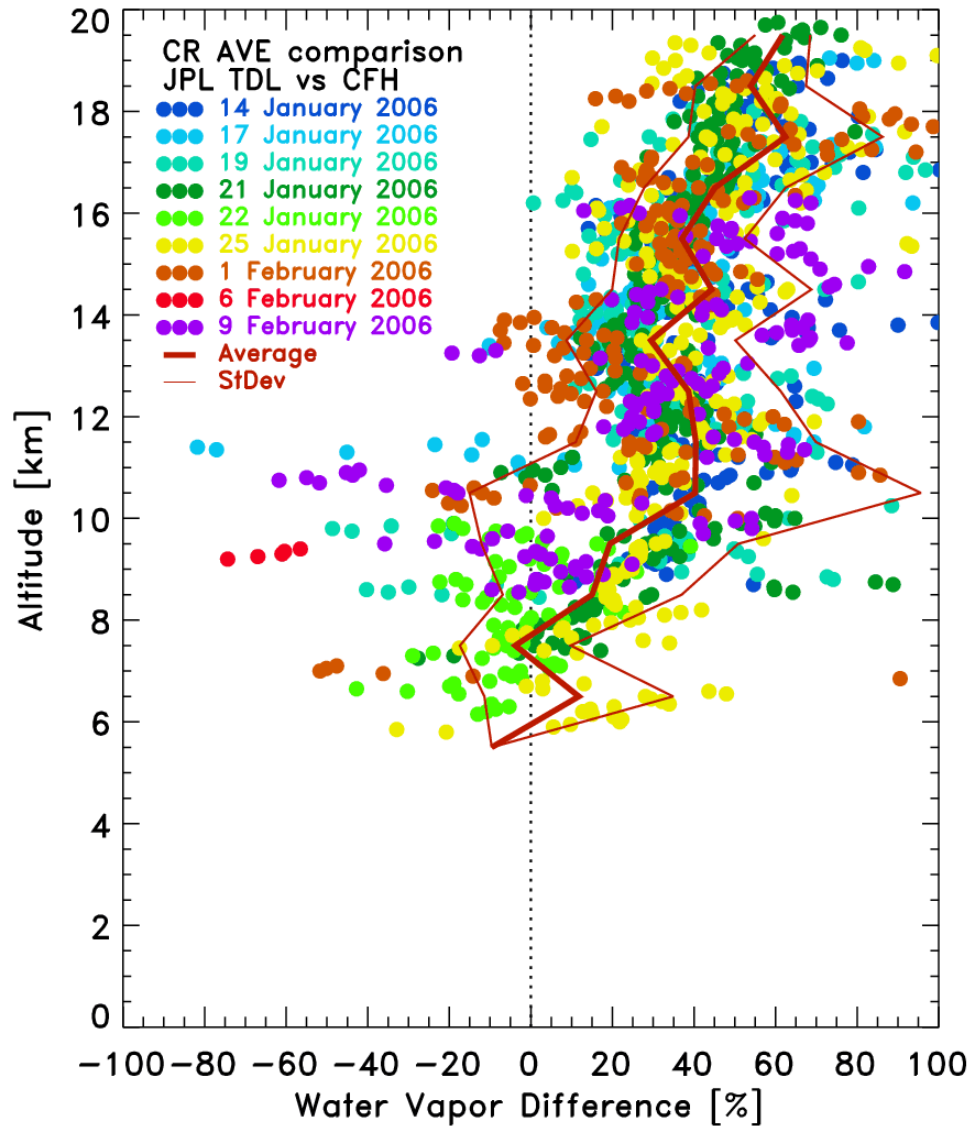
Questions?

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Ticosonde/CR-AVE 2006, 14 Jan 2006 – 10 Feb 2006

JPL TDL vs CFH

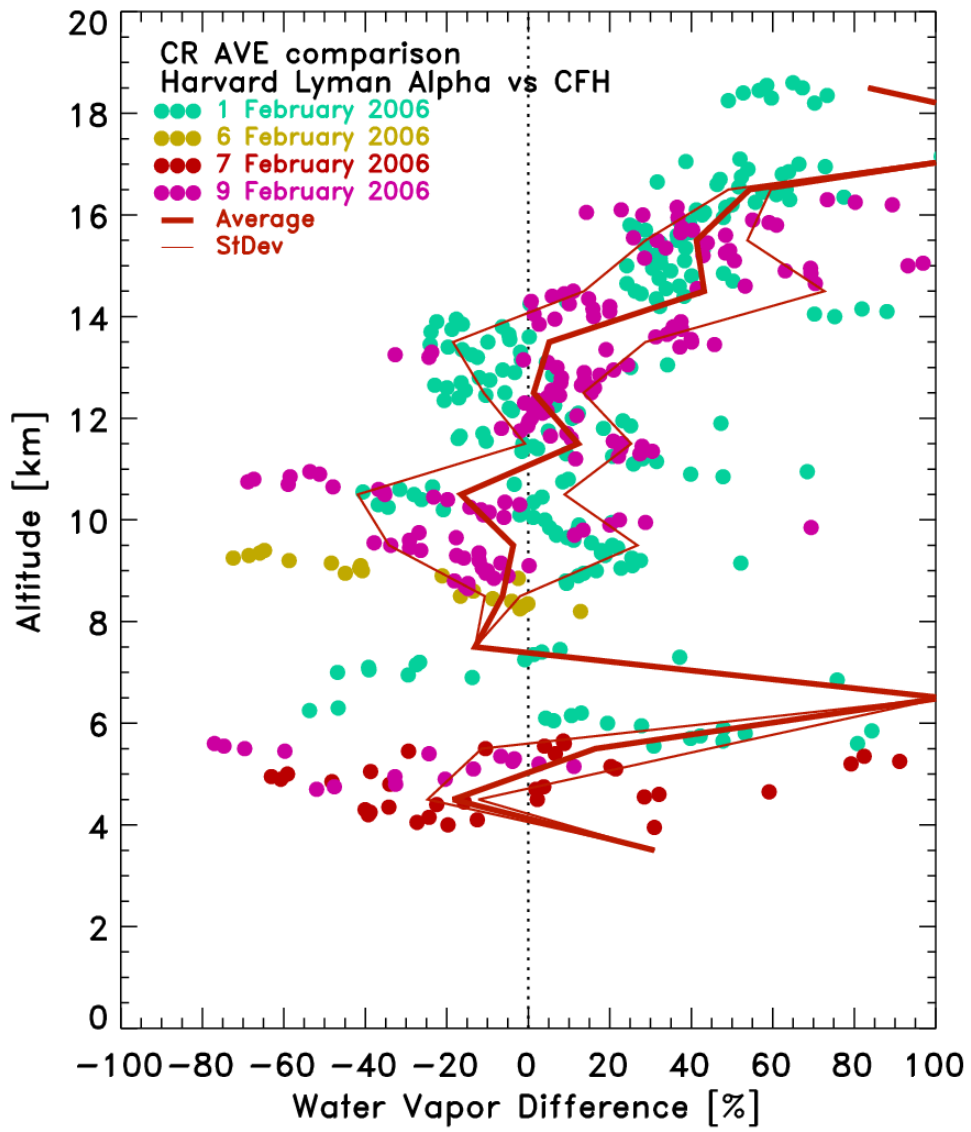


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Harvard Lyman- α vs CFH



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