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Measurements Of Humidity in the Atmosphere: Validation Experiments (MOHAVE I and MOHAVE II): Results overview and implication for the long-term lidar monitoring of water vapor in the UT/LS

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MOTIVATION

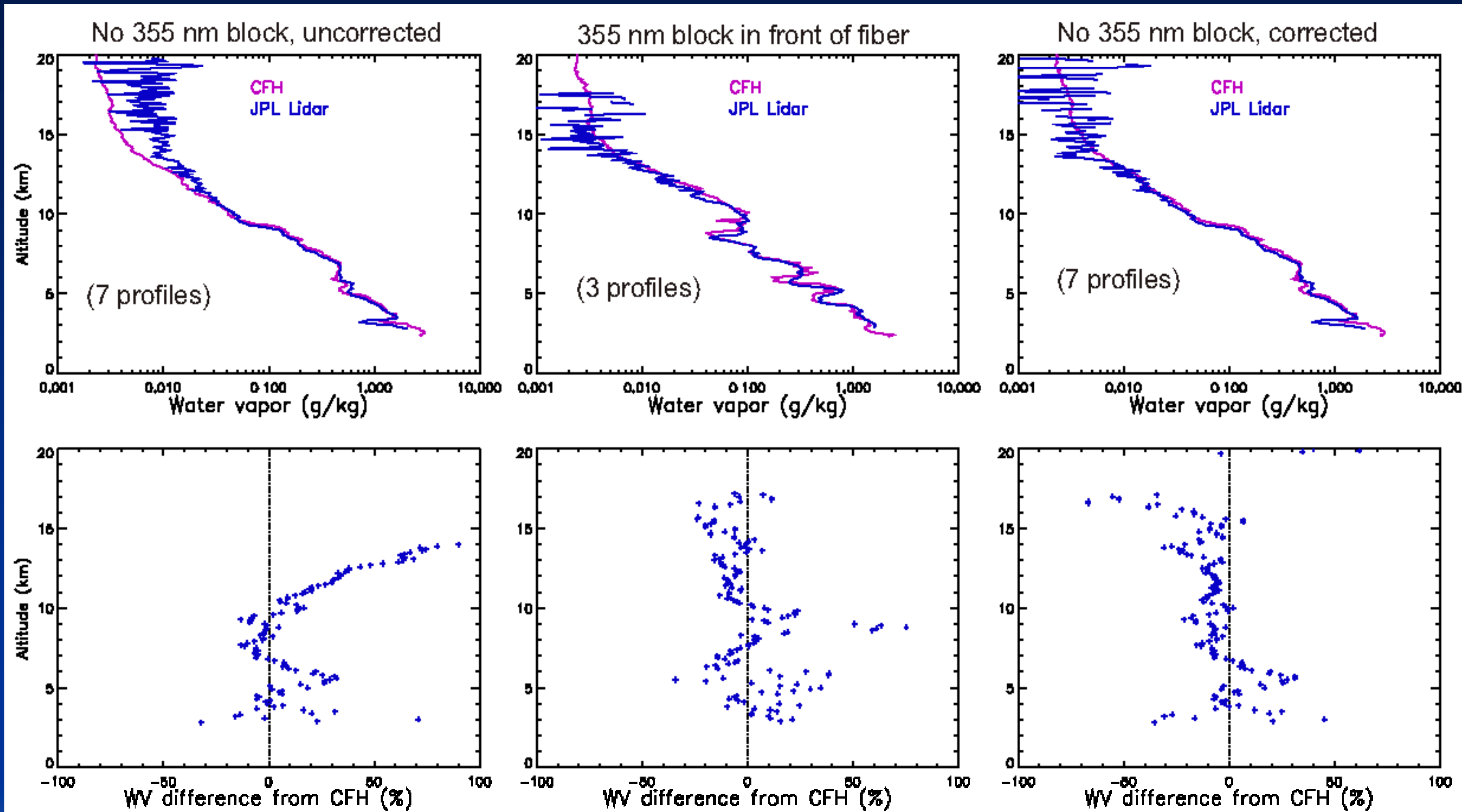
1. Water Vapor (WV) in UT/LS plays major radiative role
2. WV in UT/LS variability and trends not yet well understood
3. Accurate WV measurements in the UT/LS remains very difficult

➔ The NDACC recently included WV Raman lidar among its suite of long-term monitoring instruments

The MOHAVE and MOHAVE II campaigns (Oct 2006 and Oct 2007) were designed to assess the current (and future) measuring capabilities of the WV Raman lidars

Campaigns involved 5 lidars, >40 PTU sondes, 10 CFH sondes, GPS, and more…

Flash-back to MOHAVE I (October 2006)



Left column: Presence of fluorescence in lidar receiver

Middle column: 355 nm blocking filter inserted at entrance of lidar receiver

Right column: Empirical correction of 1/700 of 387 nm low-intensity signal subtracted from H20 signal

➔ If fluorescence is removed, agreement with CFH becomes extremely good

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MOHAVE II : 6-17 October 2007

Campaign operation similar to MOHAVE :

3 co-located WV Raman lidars (<u>improved receivers</u>)

AT Lidar (McGee, GSFC)

ALVICE (Whiteman, GSFC)

JPL-TMF (Leblanc/McDermid, JPL)

41 simultaneous co-located Vaisala RS-92 PTU profiles

10 simultaneous co-located ECC/CFH profiles

co-located GPS receiver and WV Microwave

➔ 240 hours of WV lidar measurements

(also 80 hours of tropospheric O3 measurements 3-27 km)

MOHAVE II

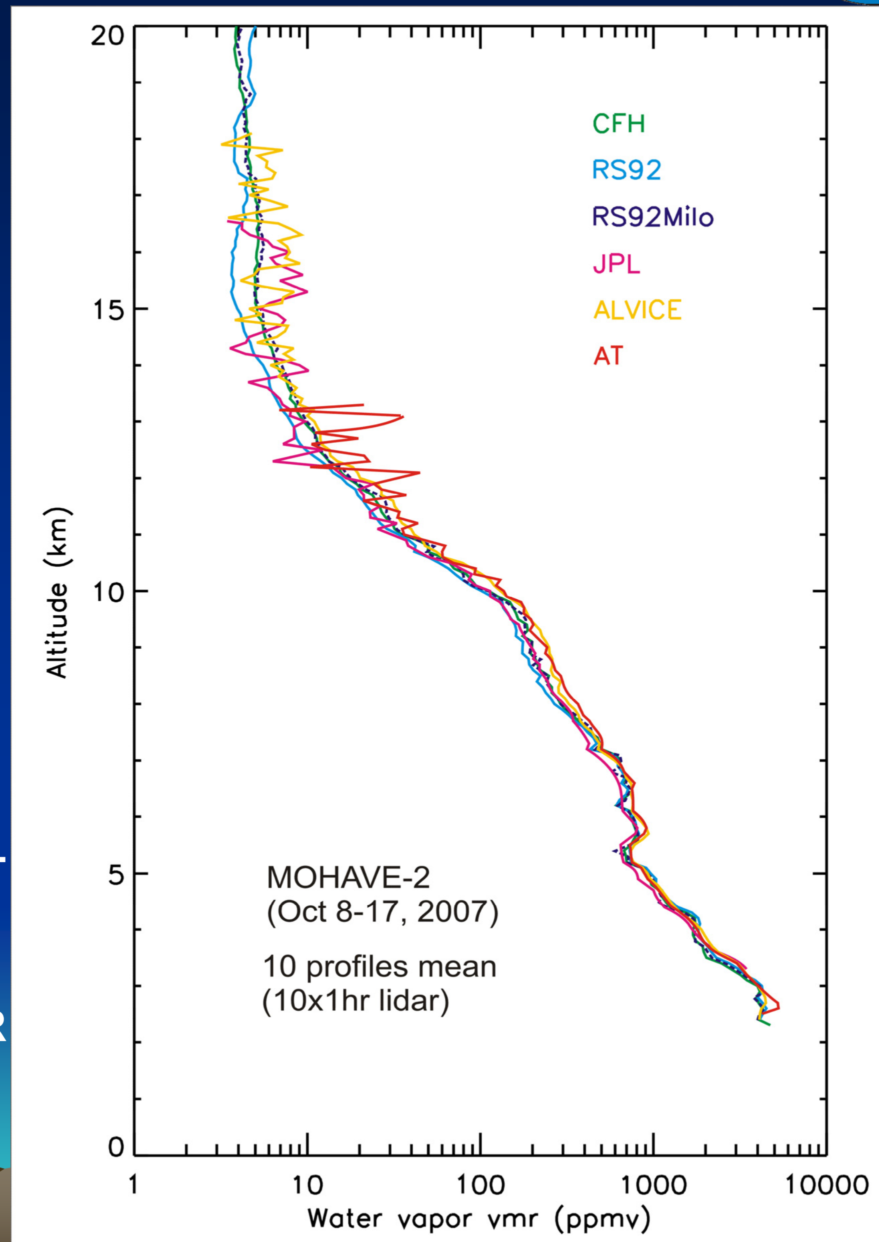
Result #1:
Fluorescence is now gone!
(most likely)

Other results:

- All three lidars agree very well with CFH up to 12 km

-1-hour integration reach 18 km, 16 km, and 13 km for ALVICE, JPL, and AT lidar respectively

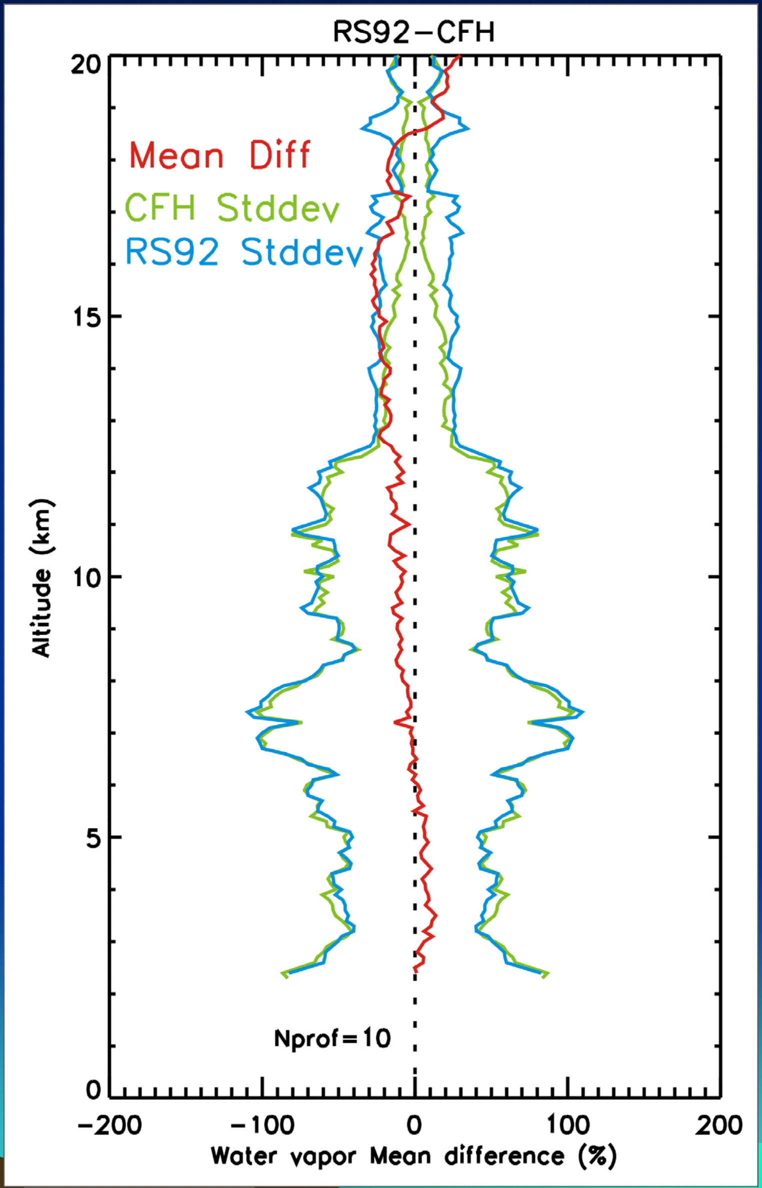
- New RS92 time-lag + dry bias correction by Larry Miloshevich, NCAR



MOHAVE II

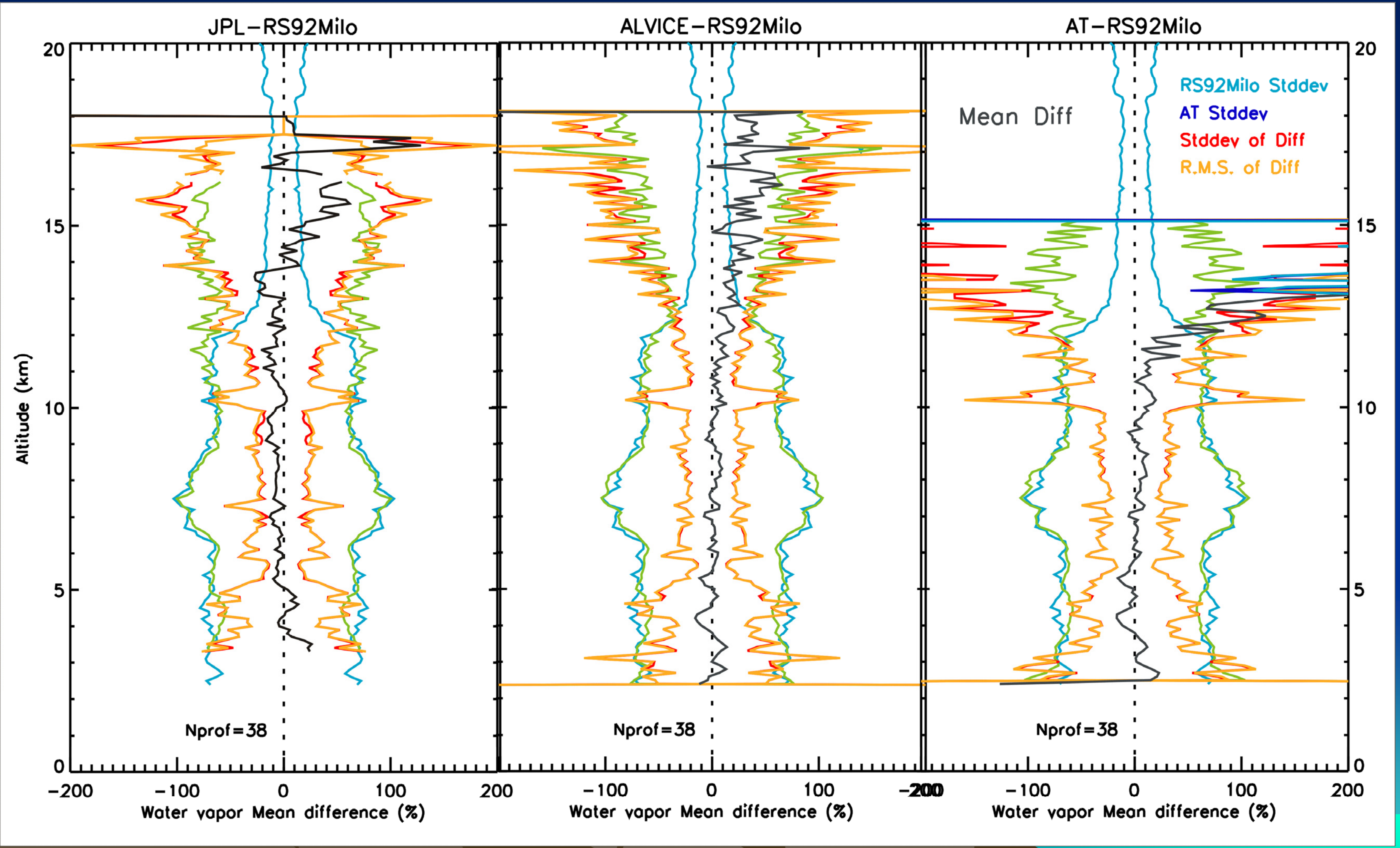
RS92 dry bias before Miloshevich's correction

Note: Percentage variability drops above 12 km



MOHAVE II

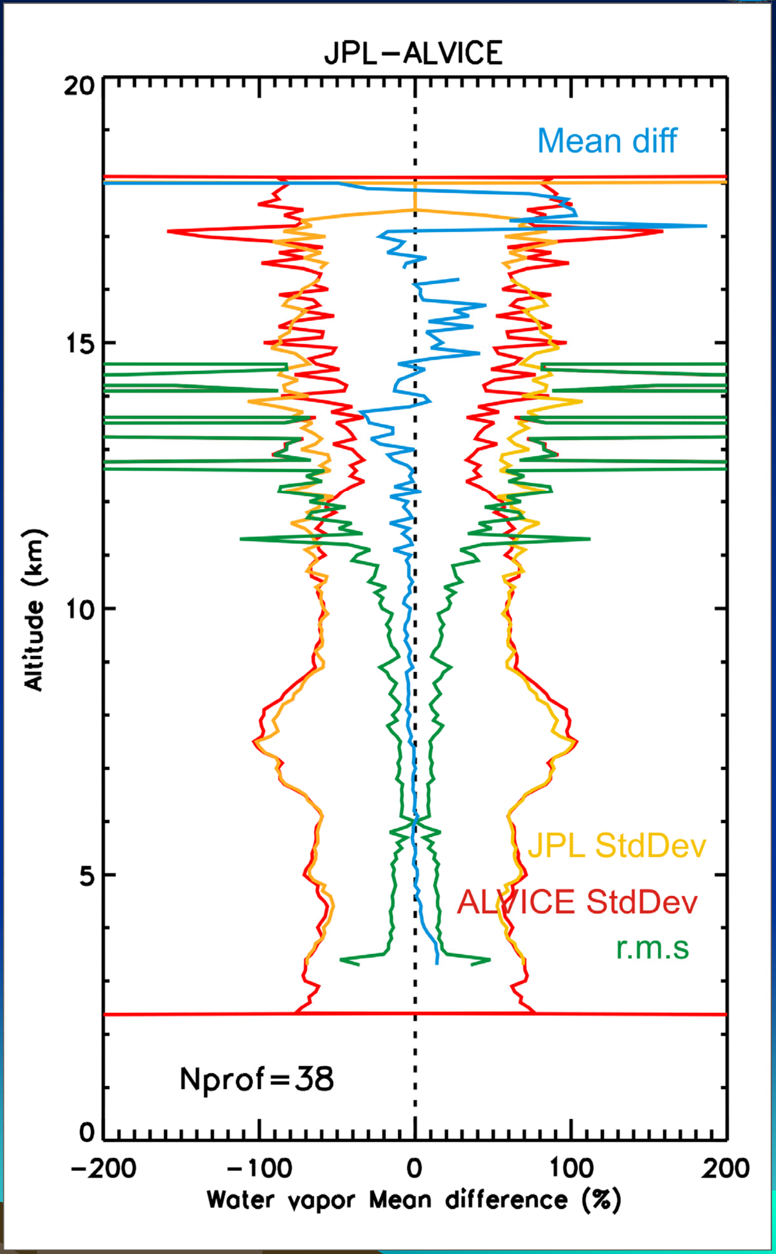
Lidar vs. corrected RS92



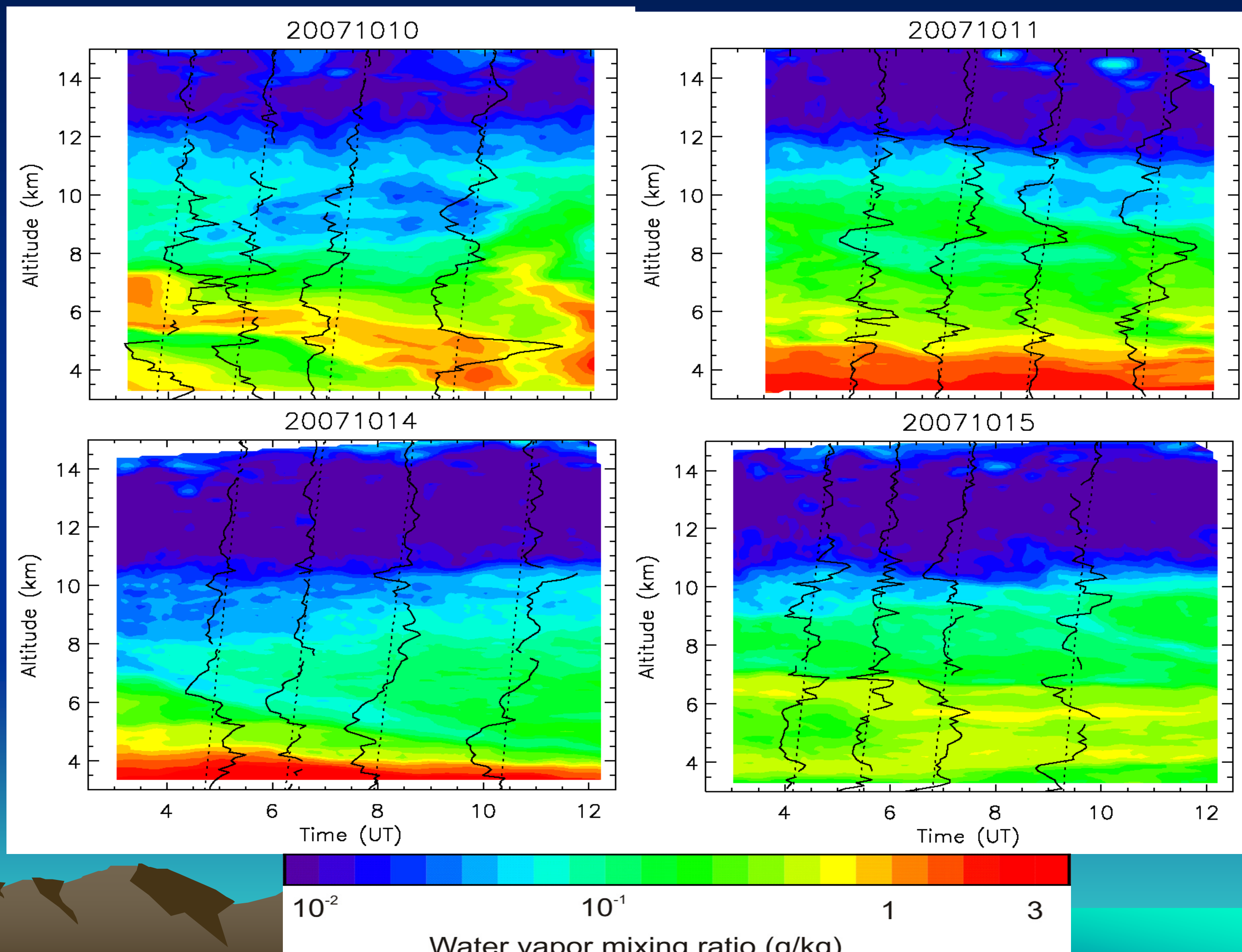
MOHAVE II

ALVICE vs. JPL

Difference remains within 5% up to 12 km, then noise limited



JPL 5-min integration profiles time-series:
WV can vary by 200% over 2-hours → calibration issue



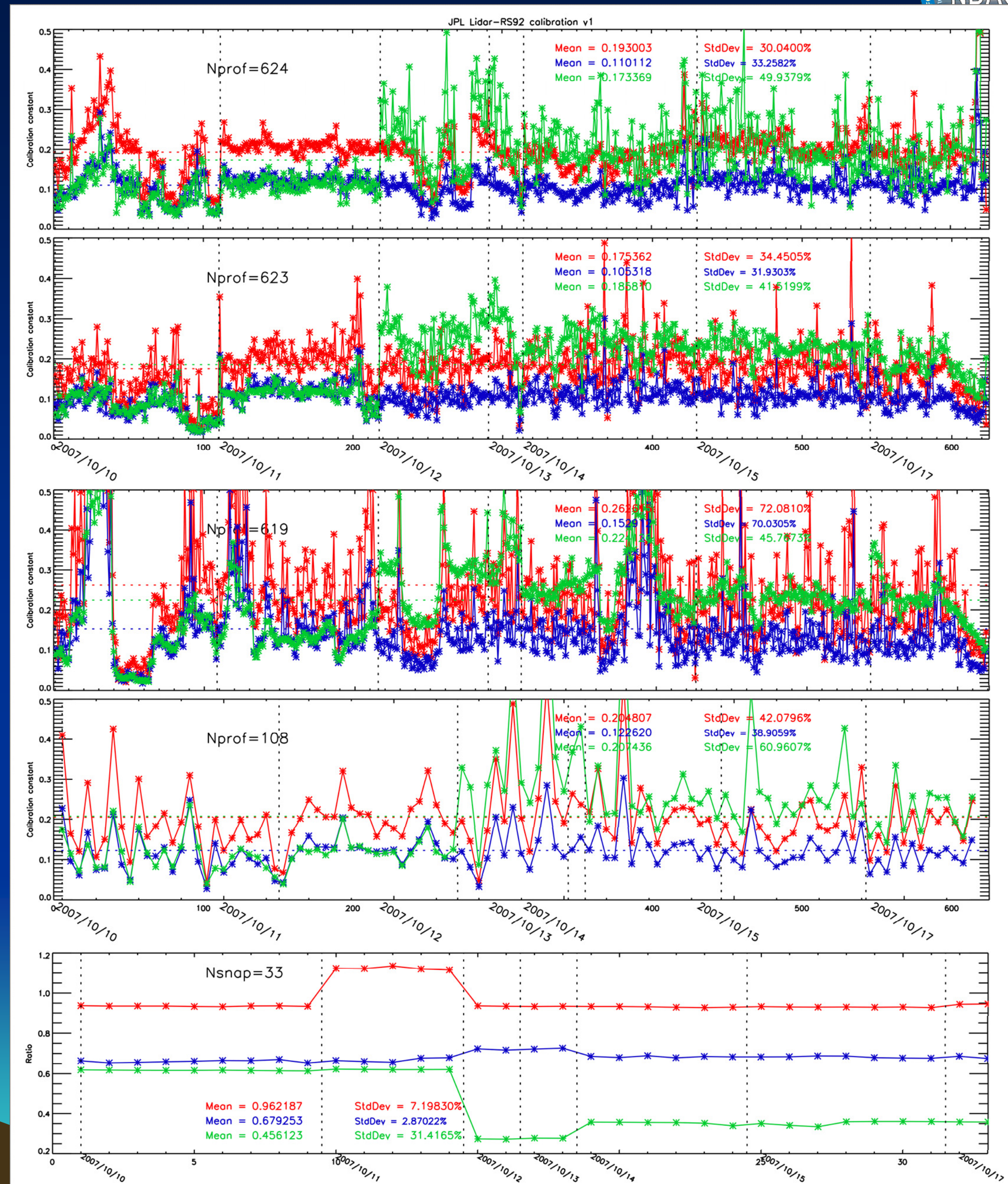
Calibration

Figures a, b, c, d:
Calibration constants obtained using different methodologies

All yield same conclusion:
Variability easily reaches 30%, with jumps not easily identifiable

Bottom figure:
407/387 channel ratio obtained using lamp

➔ Little variability if instrumental setup remains unchanged



Calibration (2)

Top:

RS92 vs. lidar calibration

Middle:

Lamp vs. lidar calibration

Bottom:

Lamp vs. RS92 calibration

Conclusion:

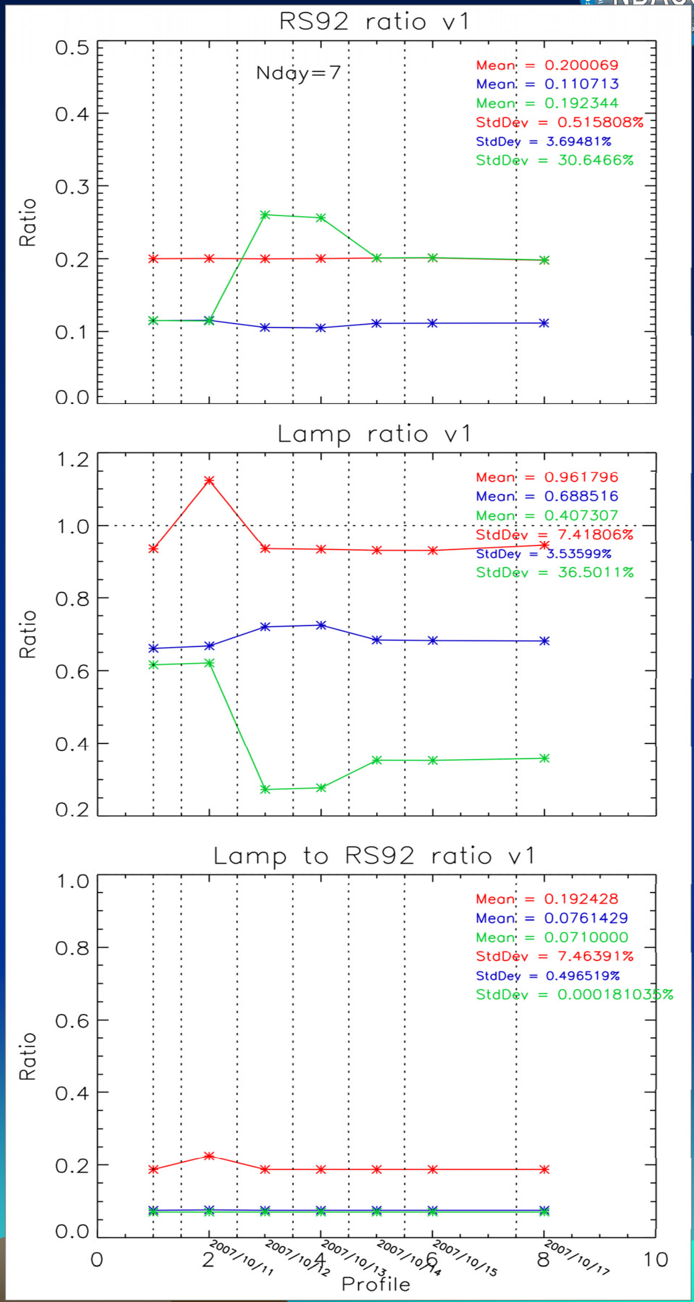
- A new, more stable, calibration approach:

1/ Do not use individual RS92

2/ Do not use a climatological RS92 constant alone

3/ Use a calibration lamp for everyday tracking, and the climatological RS92 for long-term drift

- NDACC WV mobile systems must include both a radiosonde station and a calibration lamp



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CONCLUSIONS

1. MOHAVE+MOHAVE II = very successful
2. MOHAVE ➔ Fluorescence was found to be inherent to all three participating lidars
3. MOHAVE II ➔ Fluorescence was removed and agreement with CFH was extremely good up to 16-18 km altitude
4. MOHAVE II ➔ Calibration tests revealed unsuspected shortfalls of widely used techniques, with important implications for their applicability to long-term measurements
5. A factor of 5 in future lidar signal-to-noise ratio is reasonably achievable.

➔ **When this level is achieved water vapor Raman lidar will become a key instrument for the long-term monitoring of water vapor in the UT/LS**