Evaluation of a compact water vapor DIAL technology in various climates

Raisa Lehtinen (Vaisala)

Pekko Tuominen (Vaisala), Rob K. Newsom (PNNL), David D. Turner (NOAA), Markus Kayser, Christine Knist, & Volker Lehmann (DWD)
Christoph Münkel (Vaisala, retired)

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Content

- Water vapor (WV) DIAL
- WV DIAL evaluation in humid climate
- DWD remote sensing testbed
- WV DIAL permanent installation at arctic site

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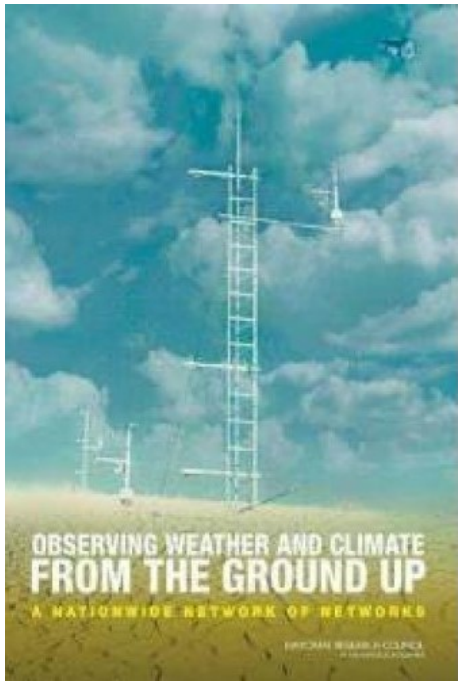
Need for improved boundary layer profiling

- NMHSs are active in planning **mesoscale operational profiling networks**

- First-priority needs

  / National Research Council, USA, report, 2009 (2010, 2012)

  - Height (and structure) of the PBL
  - Soil moisture and temperature profiles
  - High-resolution vertical profiles of atmospheric humidity
  - Air quality concentrations above the atmospheric surface layer



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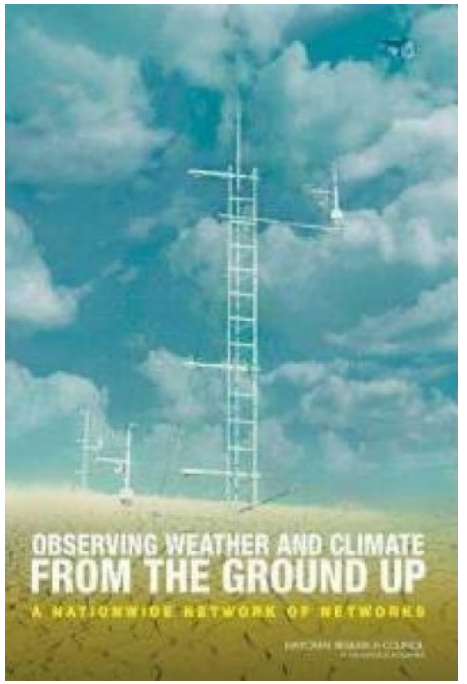

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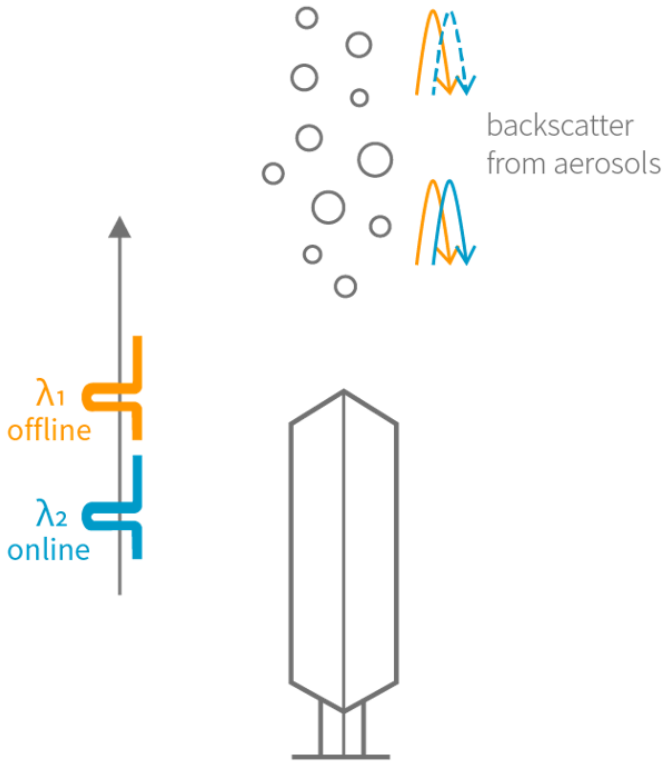
Vaisala water vapor DIAL (differential absorption lidar)



WV DIAL prototype	
Instrument type	Pulsed laser diode, eye-safety class 1M
Wavelength	910 nm range
Maximum range	Boundary layer top / max. 3000 m
Averaging time	20 min
Optical units	Coaxial TX/RX, separate units for low/high altitude

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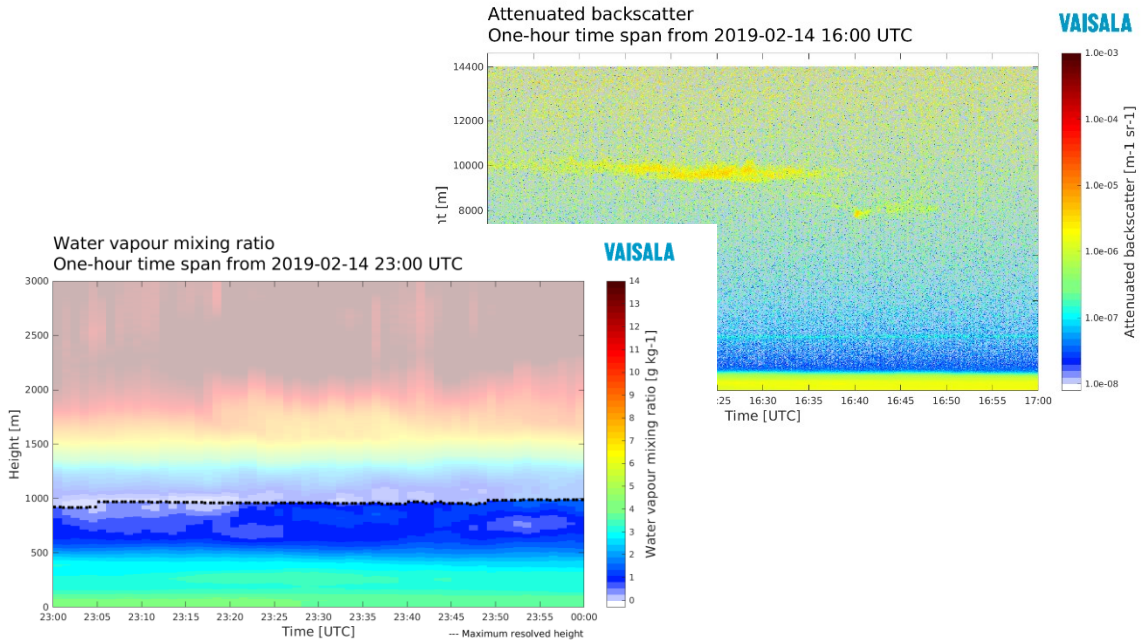
Current prototype design

- Design for manufacture
- Improved state-of-the-art electronics (RX, TX, CPU)
- Increased signal-to-noise ratio
- Data client for output files and graphs



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Water vapor DIAL evaluation in humid climate

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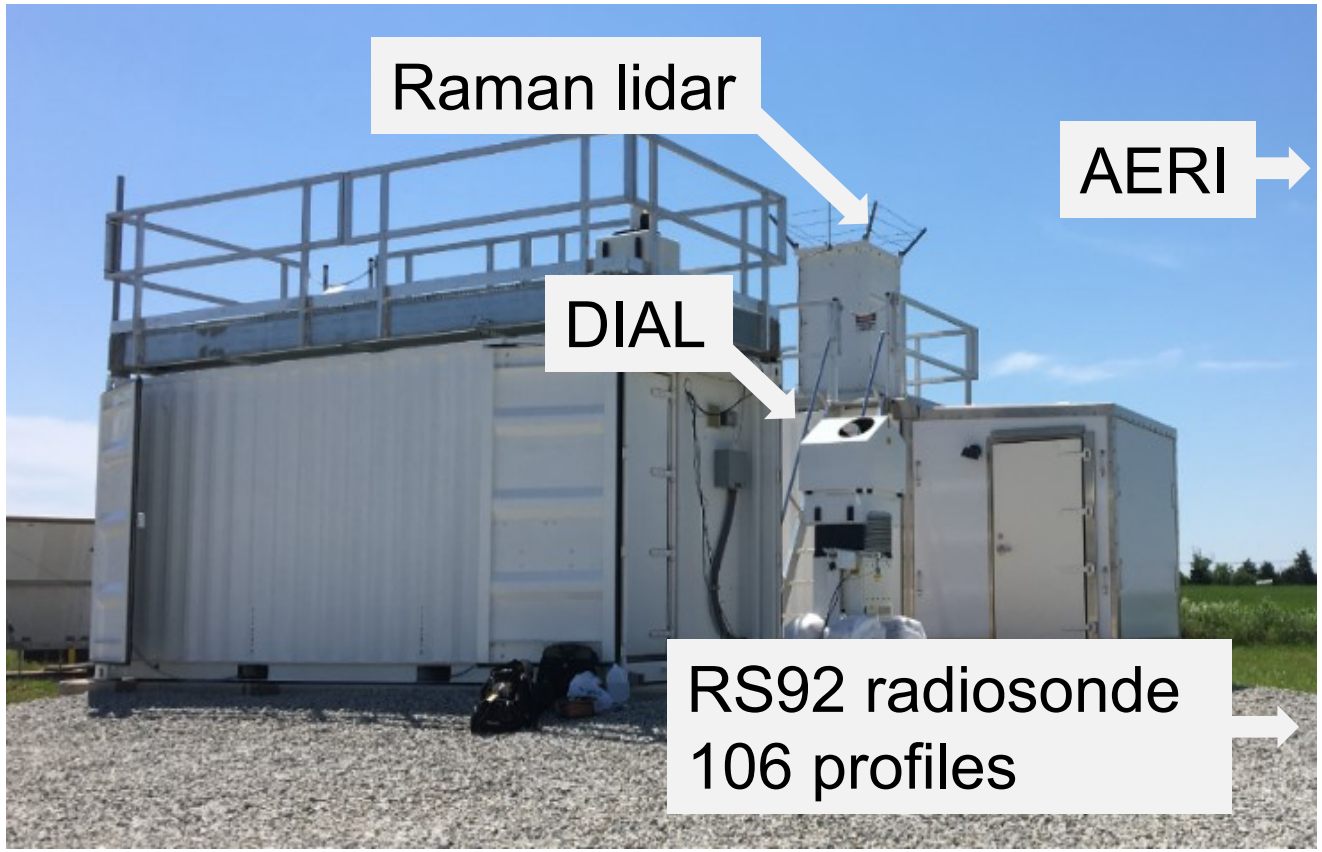
Oklahoma, USA (36.4N 97.3W)
Atmospheric Radiation Measurement (ARM)
Southern Great Plains (SGP) site

- 15 May to 12 June 2017
- Mid-latitude continental summertime conditions



ARM

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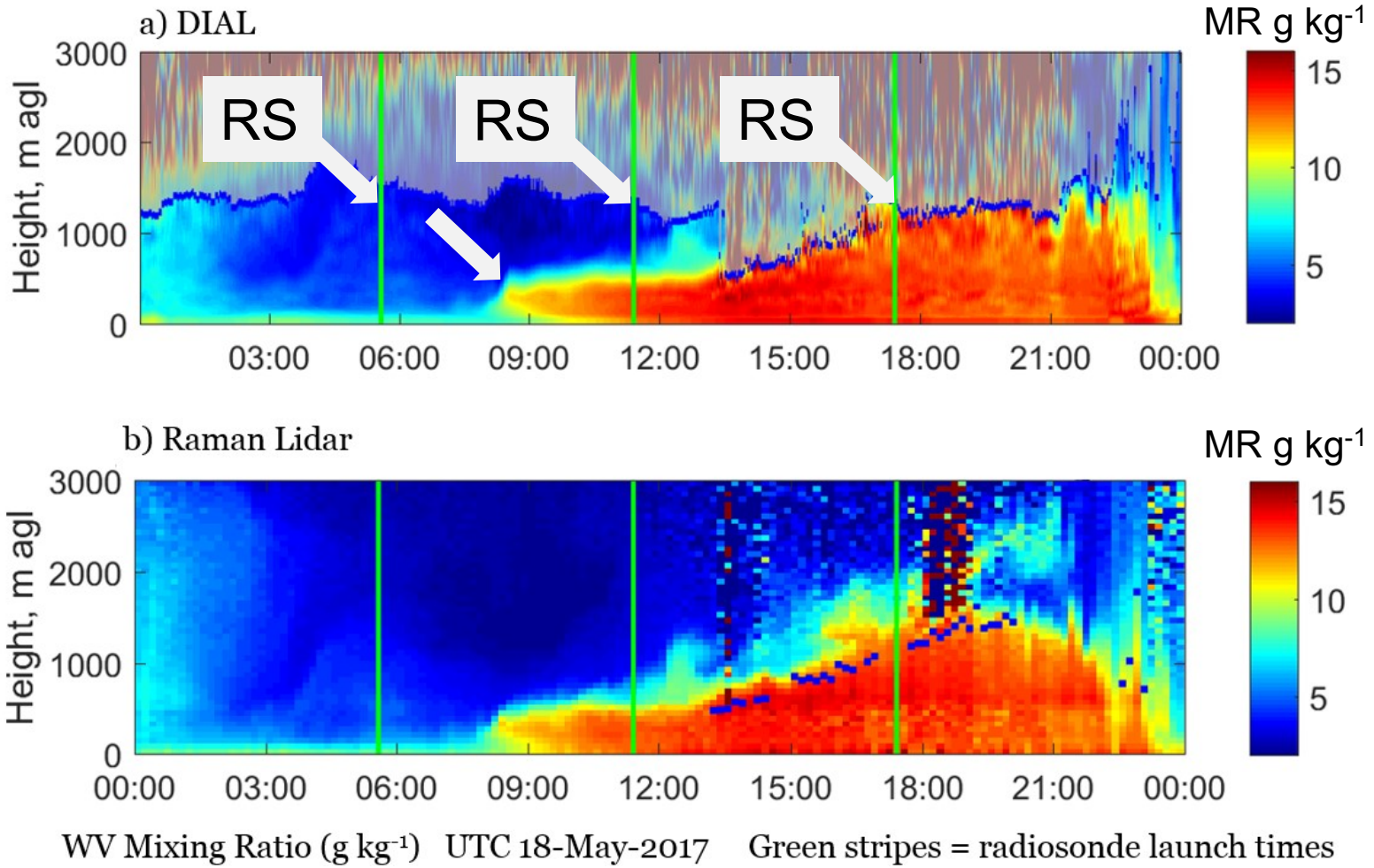
Example, May 18, 2017: Continuous monitoring of humidity MR profiles during severe weather



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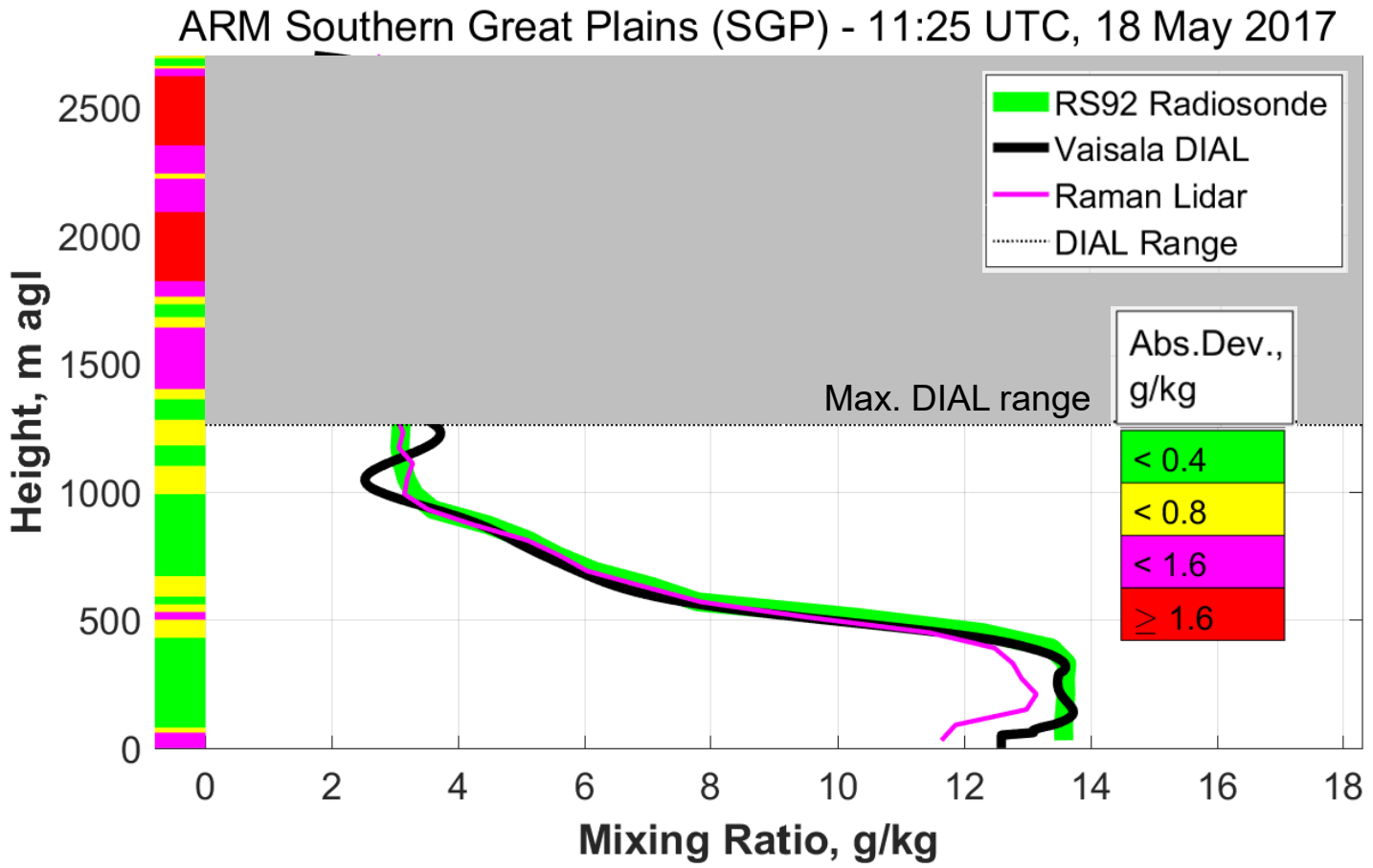
Example, May 18, 2017: Comparison of humidity profiles



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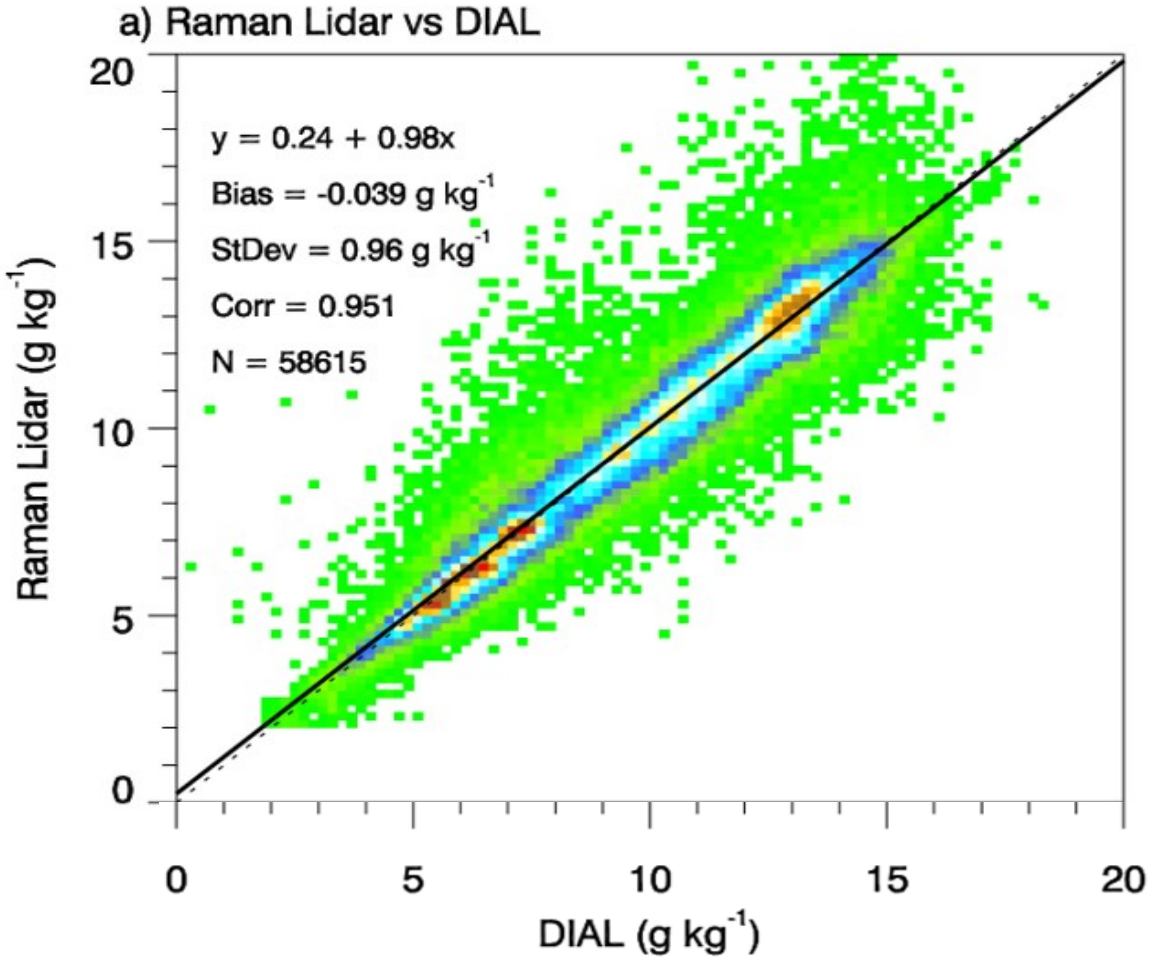
Raman Lidar vs. DIAL comparison



All campaign, all valid heights

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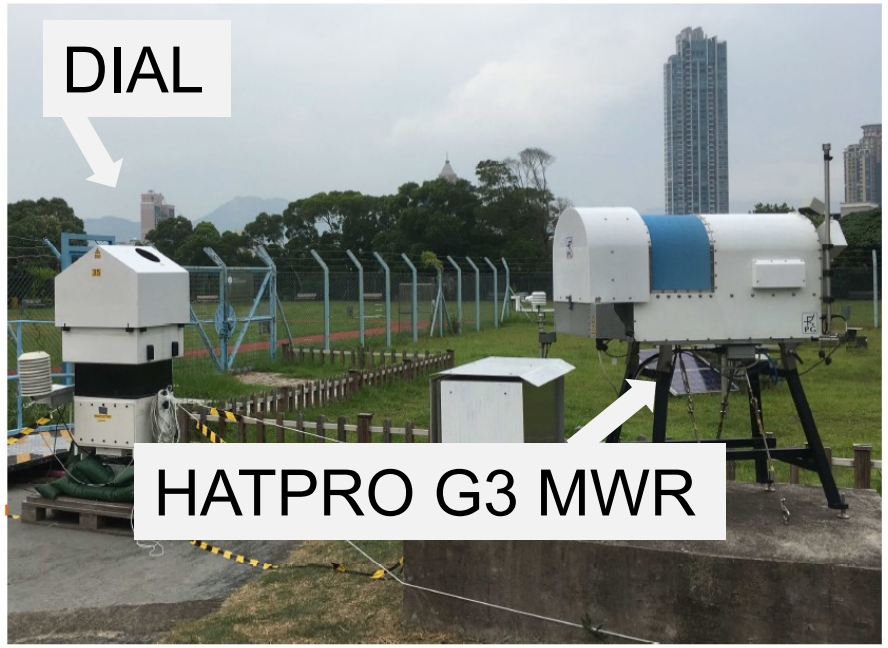
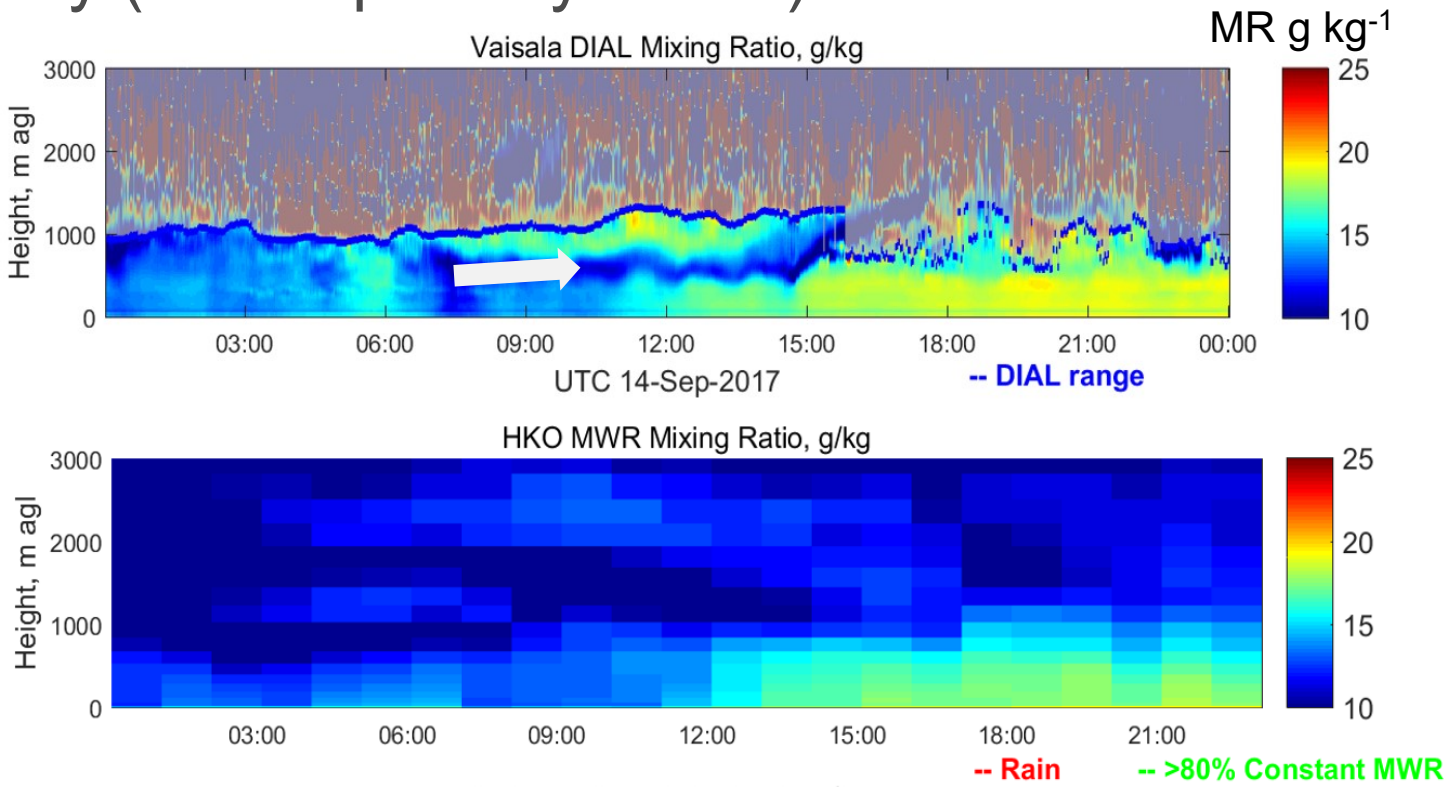
Hong Kong observatory (22.2N 114.1E)

- 22 August to 12 October 2017
- Tropical conditions, high humidity (two tropical cyclones)





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DWD remote sensing testbed

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DWD – remote sensing testbed

Testbed sites

(1) Observatory Lindenberg:
reference station, initial tests
(2) Testbed site Aachen-Orsbach:
weather station, quasi-operational setting

Doppler lidar
WV DIAL
MWR, cloud radar

Deployment

Instrument reliability

sustainability

operational costs

maintenance

system/data monitoring

…

Data Quality

(RMSE/Bias)

comparison with observations from other sources

comparison with NWP model output (O-B statistics)

…

NWP Impact

(NWC,SINFONY)

data integration to CIRRUS-DB: WMO-BUFR, netCDF (CF)

data assimilation impact

forecast skill

…

For more information:
Christine Knist, DWD

DWD Working groups: *Observatory Lindenberg, Data Assimilation, Observing Networks/Data, Service and Logistics*

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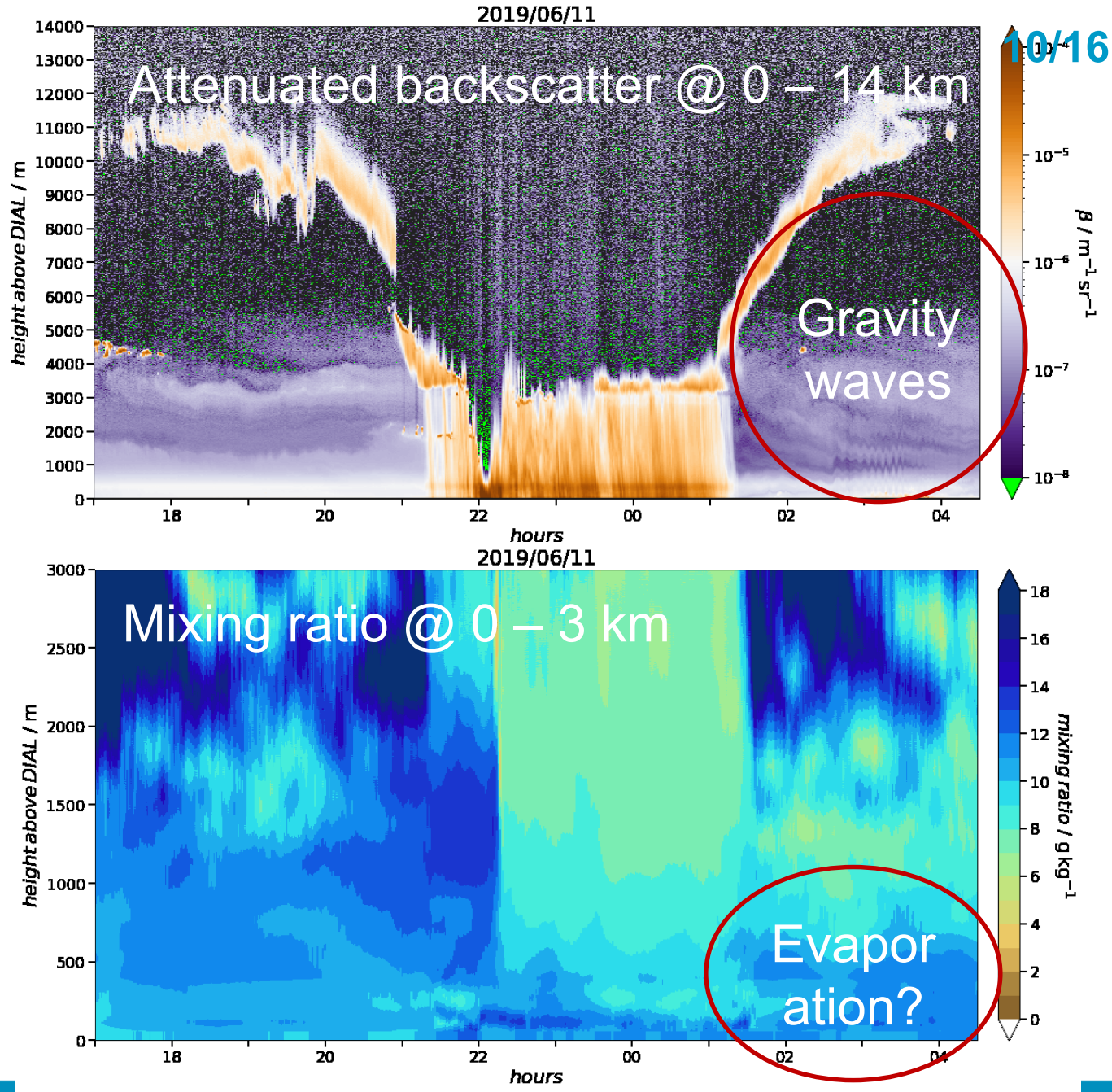
DIAL at Lindenberg Observatory

Observation of a cyclone on June 11th, 2019

- Complementary information, not available from radiosonde observations
- Interesting research opportunities e.g. gravity waves + evapolation



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Water vapor DIAL permanent installation at arctic site

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Iqaluit, Canada (63.8N 68.5W)
Customer: ECCC

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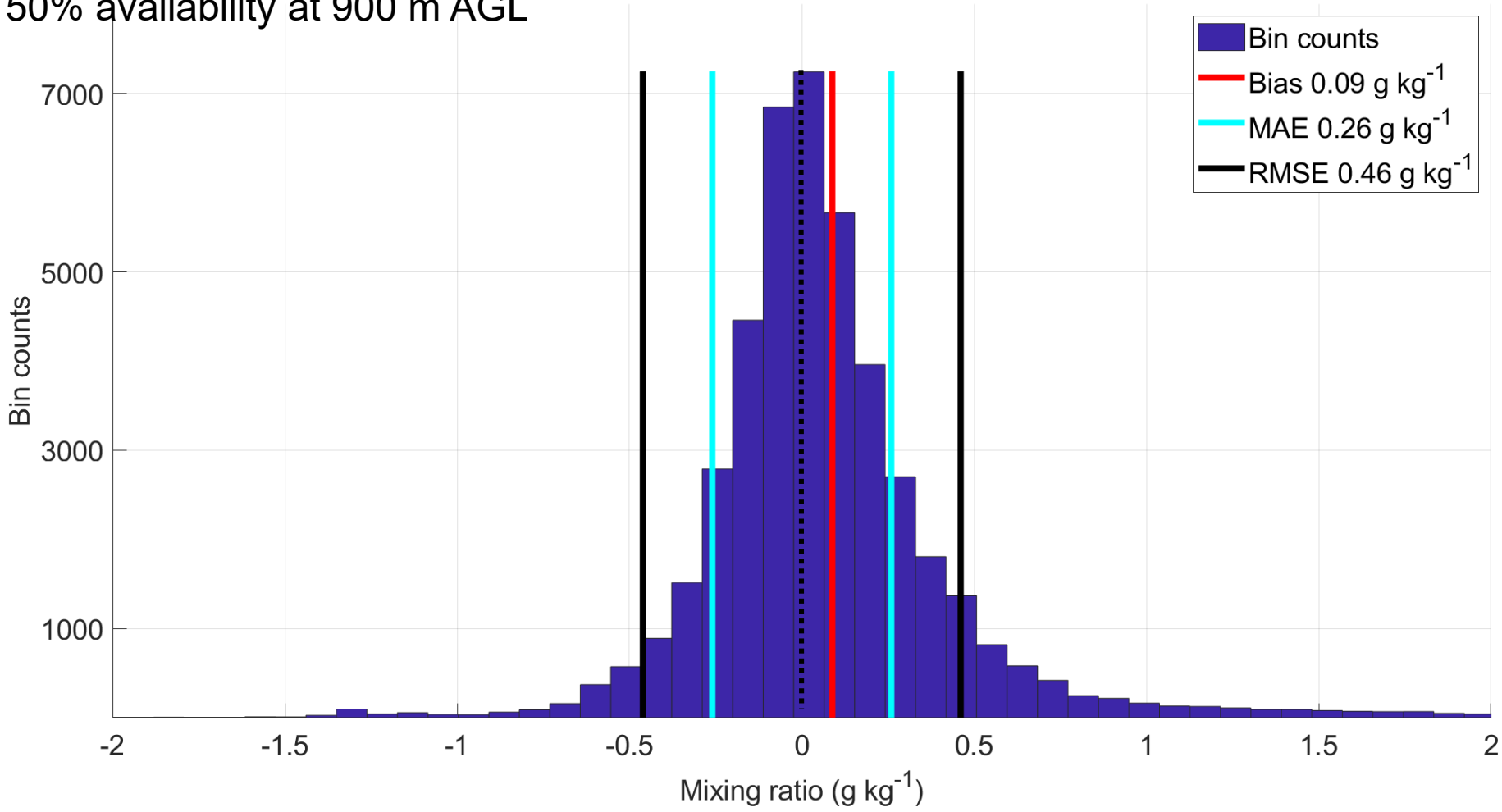
DIAL – RS humidity MR: distribution of differences October 2018 – February 2019

235 radiosonde profiles, includes all heights where DIAL result is available
50% availability at 900 m AGL



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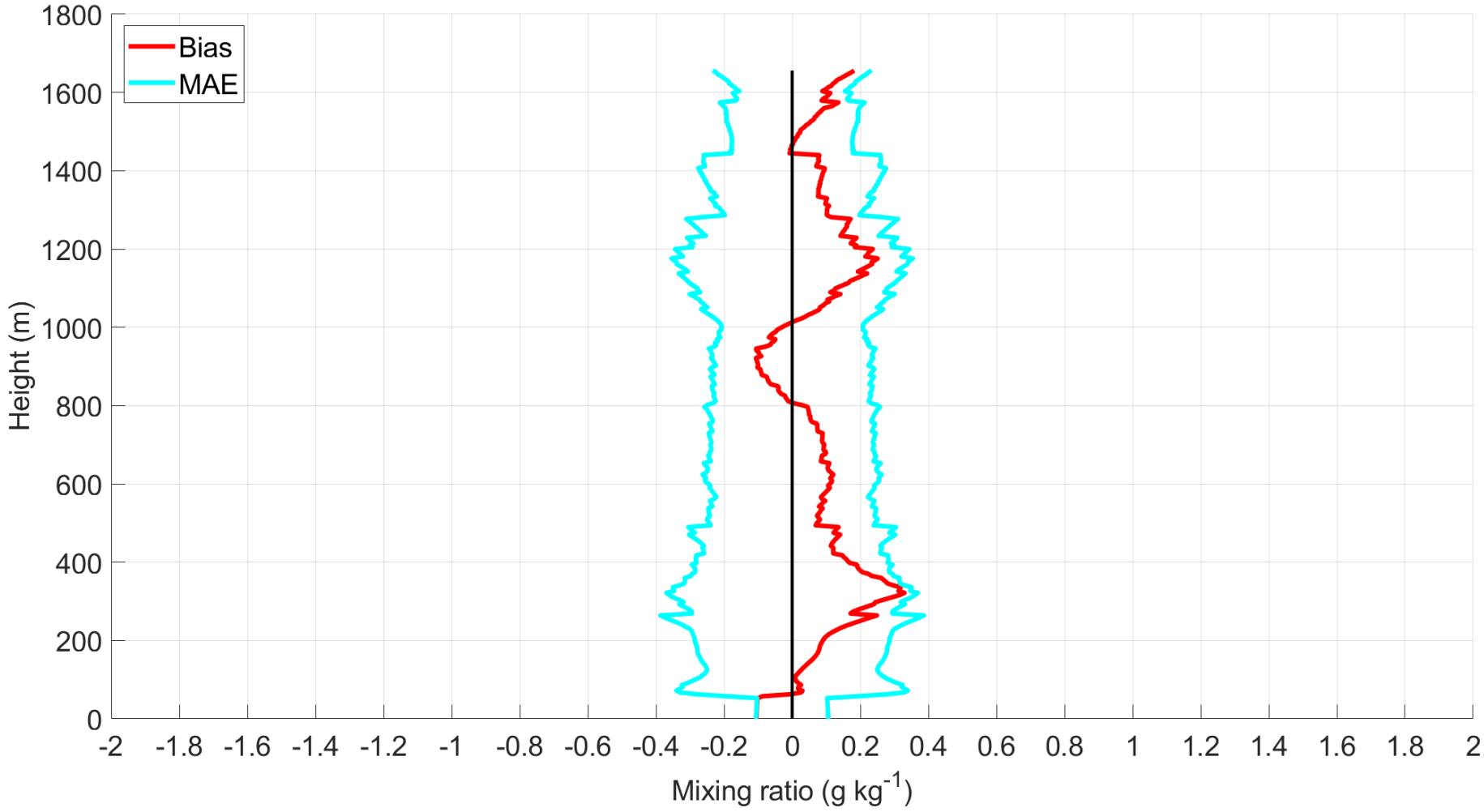
DIAL – RS humidity MR: bias and mean absolute error

N ≥ 20



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Way forward

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Thank you.

Acknowledgements

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Environment and Climate Change Canada (ECCC)

U.S. Department of Energy ARM Climate Research Facility

Hong Kong Observatory