Observation of Water Vapor Profiles by Raman Lidar with 266 nm Laser in Tokyo

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09 - Atmospheric temperature, water vapor, wind, turbulence, and waves

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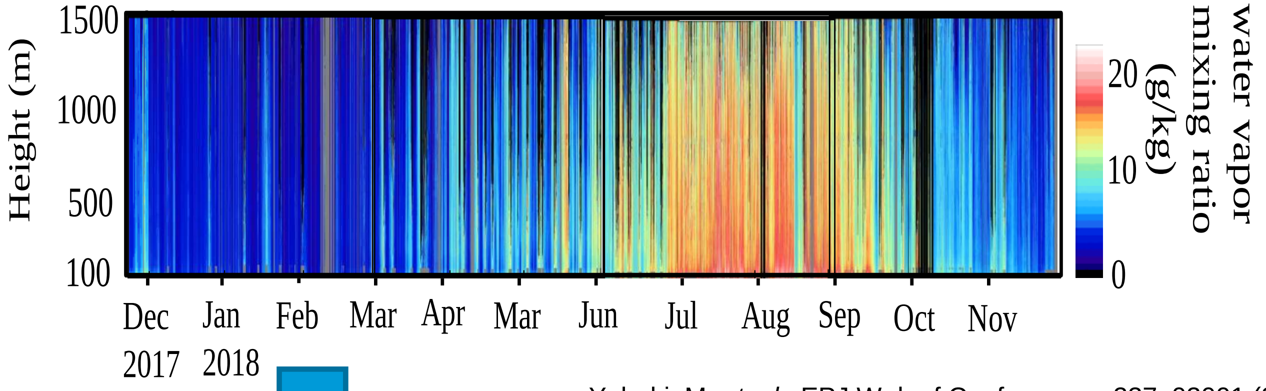
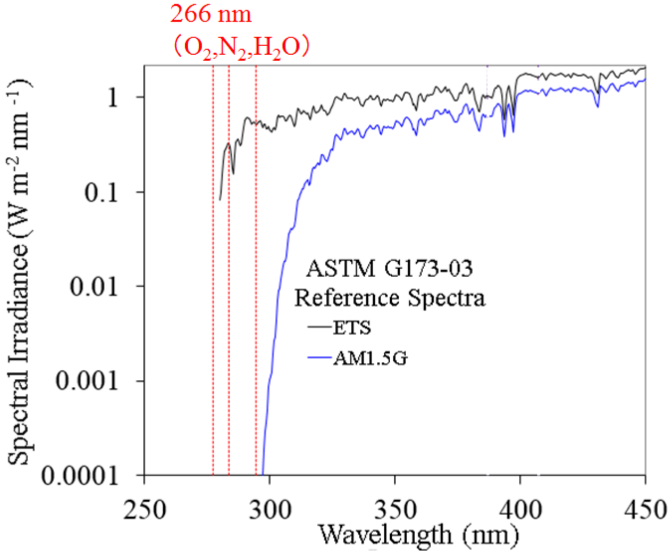
Raman Lidar with 266-nm Laser

Solar background can be reduced due to absorption by the ozone layer.

Water vapor profiles can be measured with low background noise in daytime.

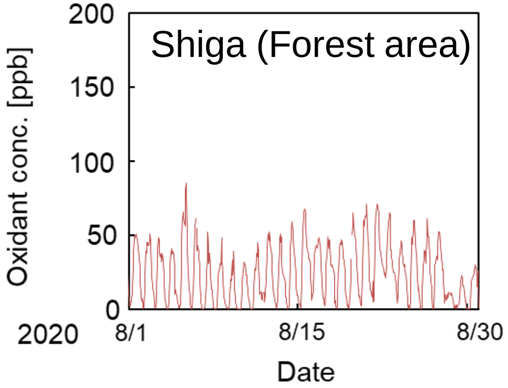


Yabuki, M. *et. al.*, EPJ Web of Conferences, 237, 03001 (2020).



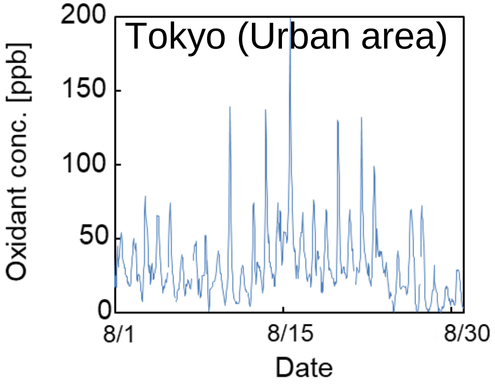
ASTM G173-03, ASTM International (2012).

Surface ozone: Low



We set the Raman lidar in urban area, Tokyo

Surface ozone: High



Check the performance of the Raman lidar

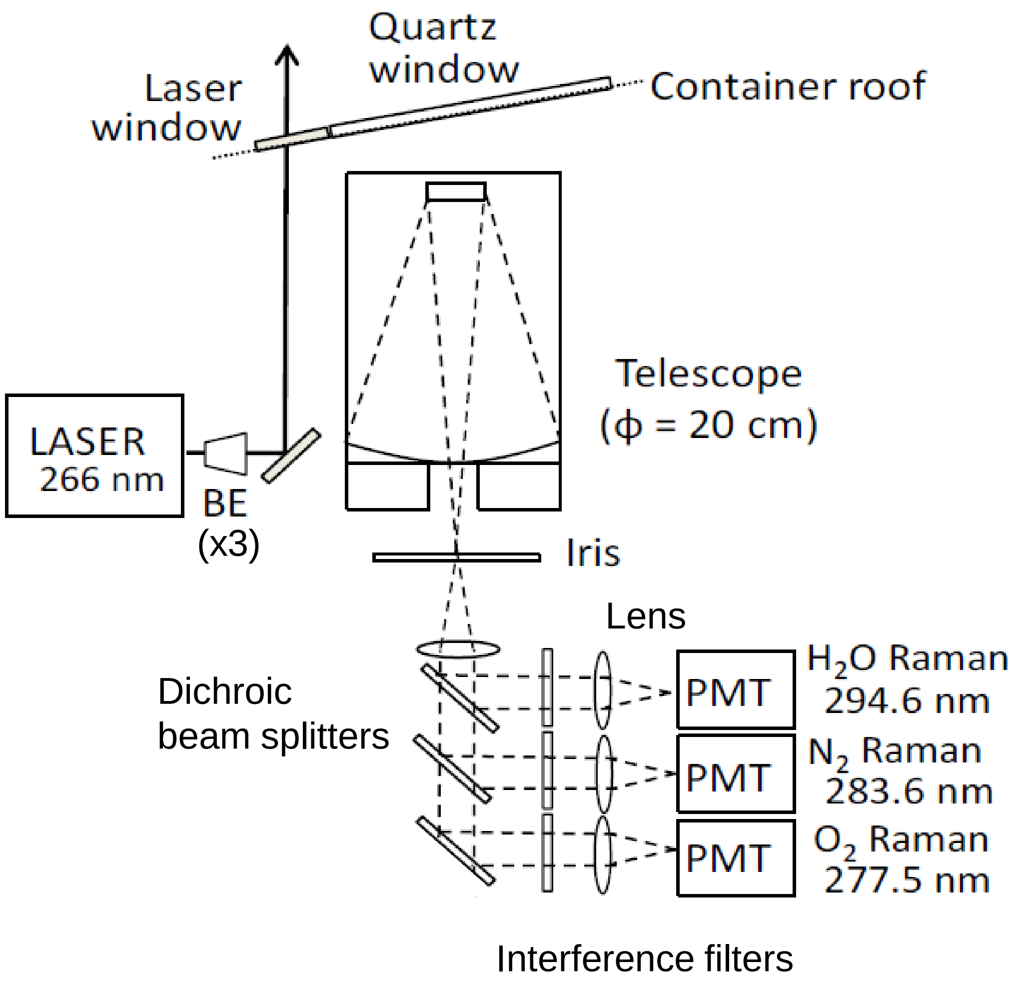
Raman Lidar Specification

Laser	Nd:YAG
Wavelength	266 nm
Pulse energy	50 mJ
Pulse width	7 nsec
Repetition rate	10 Hz
Beam divergence (full)	<1 mrad
Telescope	Cassegrain
Diameter	20 cm
FOV (full)	4.5 mrad

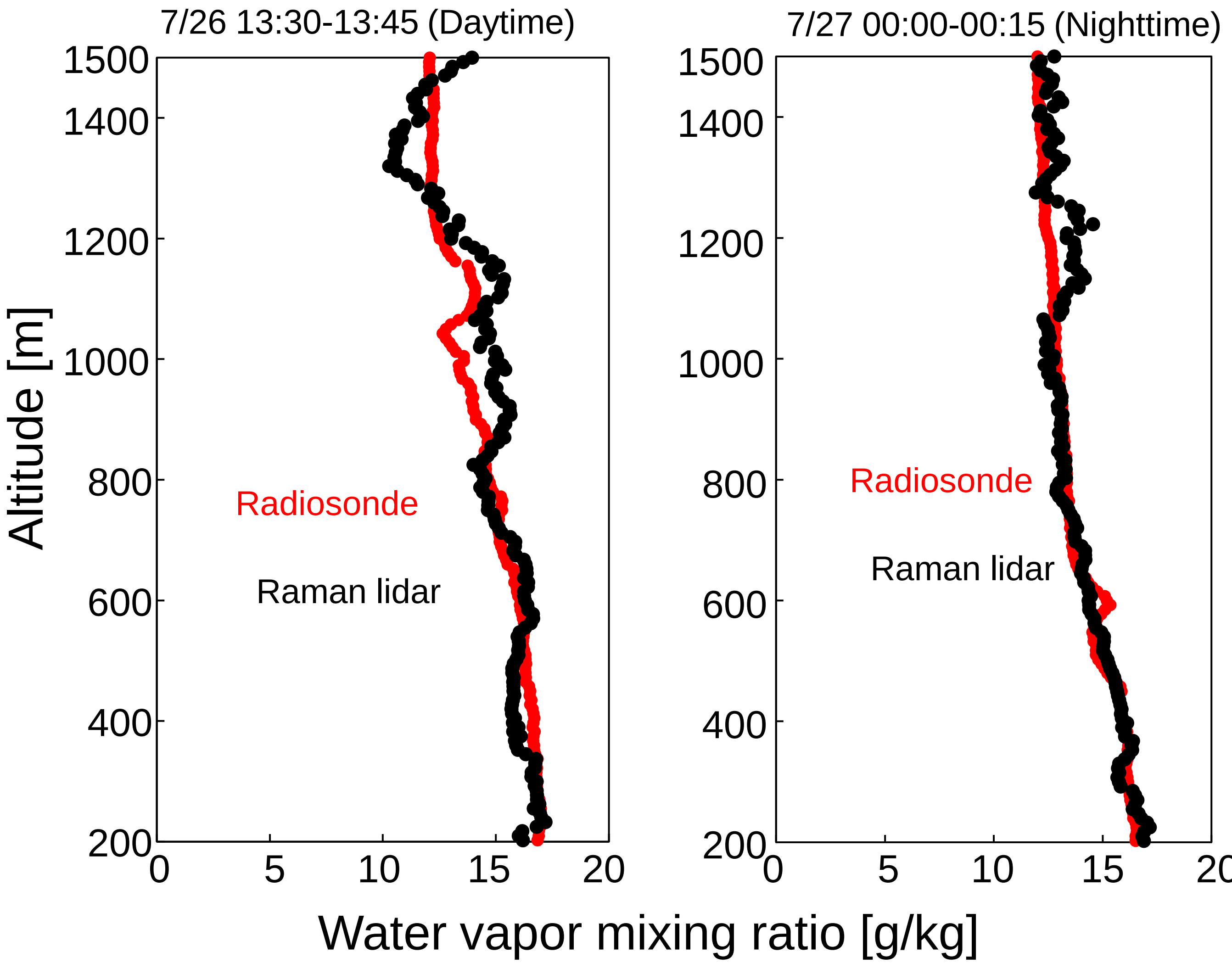
Water vapor mixing ratio *m* in range *R*

$$m(R) = K\frac{P_{H2O}(R)}{P_{N2}(R)} \times \left[\frac{P_{O2}(R)}{P_{N2}(R)}\right]^{\gamma}$$

K: Calibration constant
γ: Correction factor for ozone absorption



Raman Lidar v.s. Radiosonde



Accumulation time: 15 min
Range resolution: 75-150 m

The results obtained with the Raman lidar agreed well with that by radiosonde.

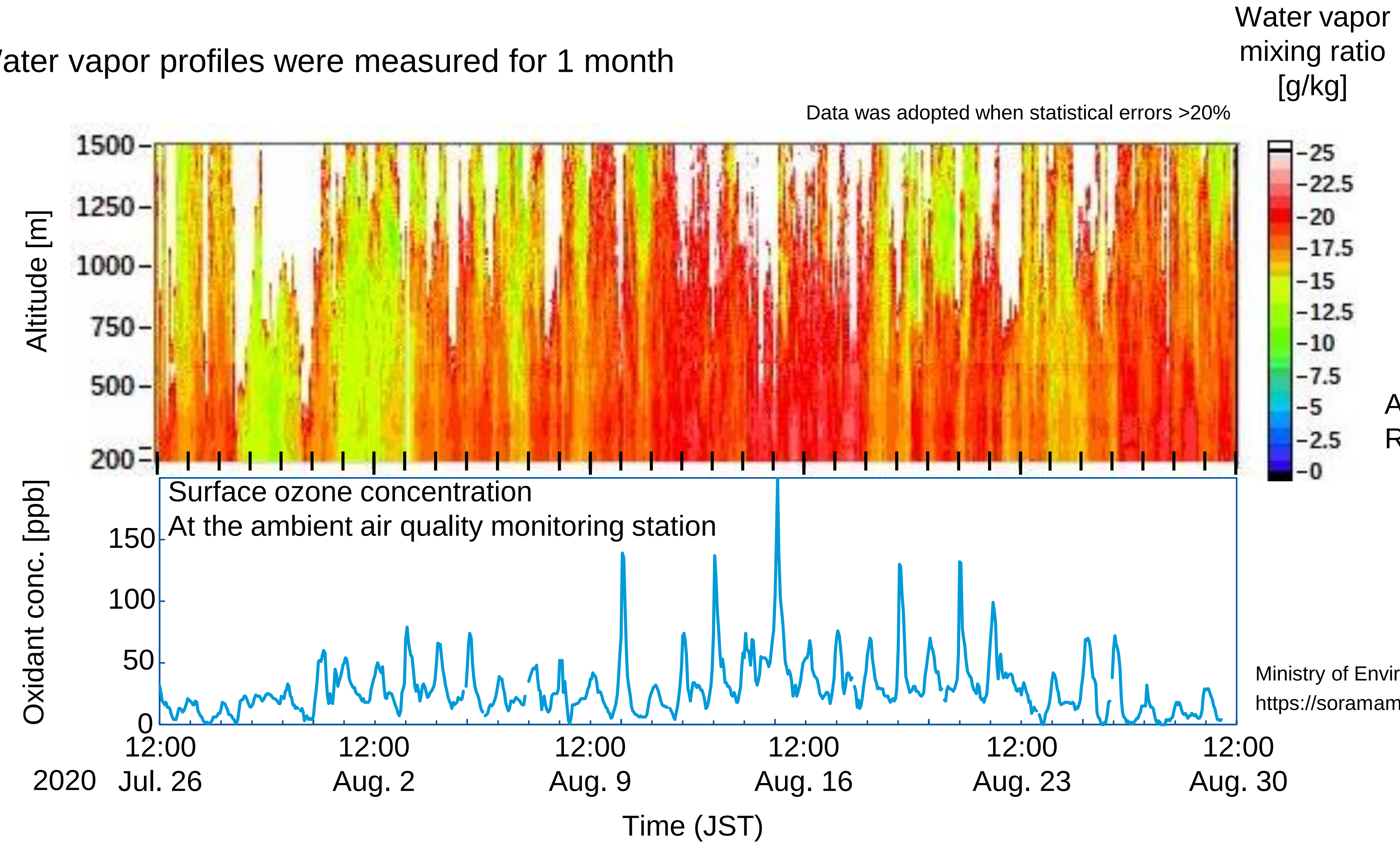
Variation in calibration constant for 1 month (N = 20)

	Calibration constant	Coefficient of variation
Analog	171.1±6.4	3.7%
Photon count	140.2±5.1	3.6%

The lidar system was highly stable

Continuous Water Vapor Observation Results

Water vapor profiles were measured for 1 month

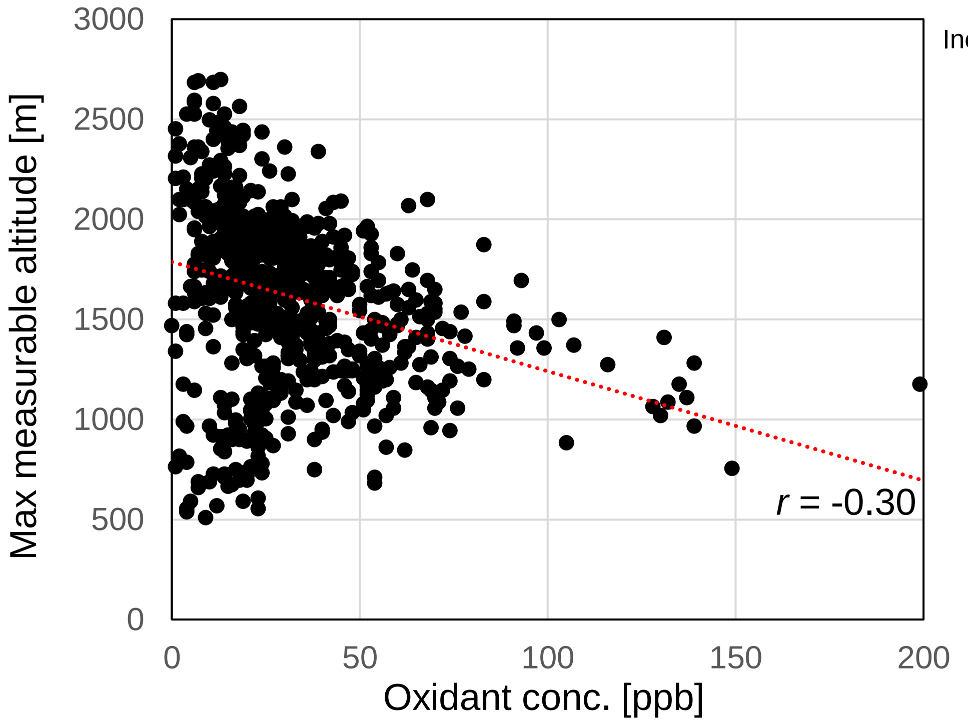


Accumulation time: 15 min
Range resolution: 75-150 m

Ministry of Environment website (Japanese)
https://soramame.env.go.jp

Surface Ozone Concentration Affected to Measurable Altitude

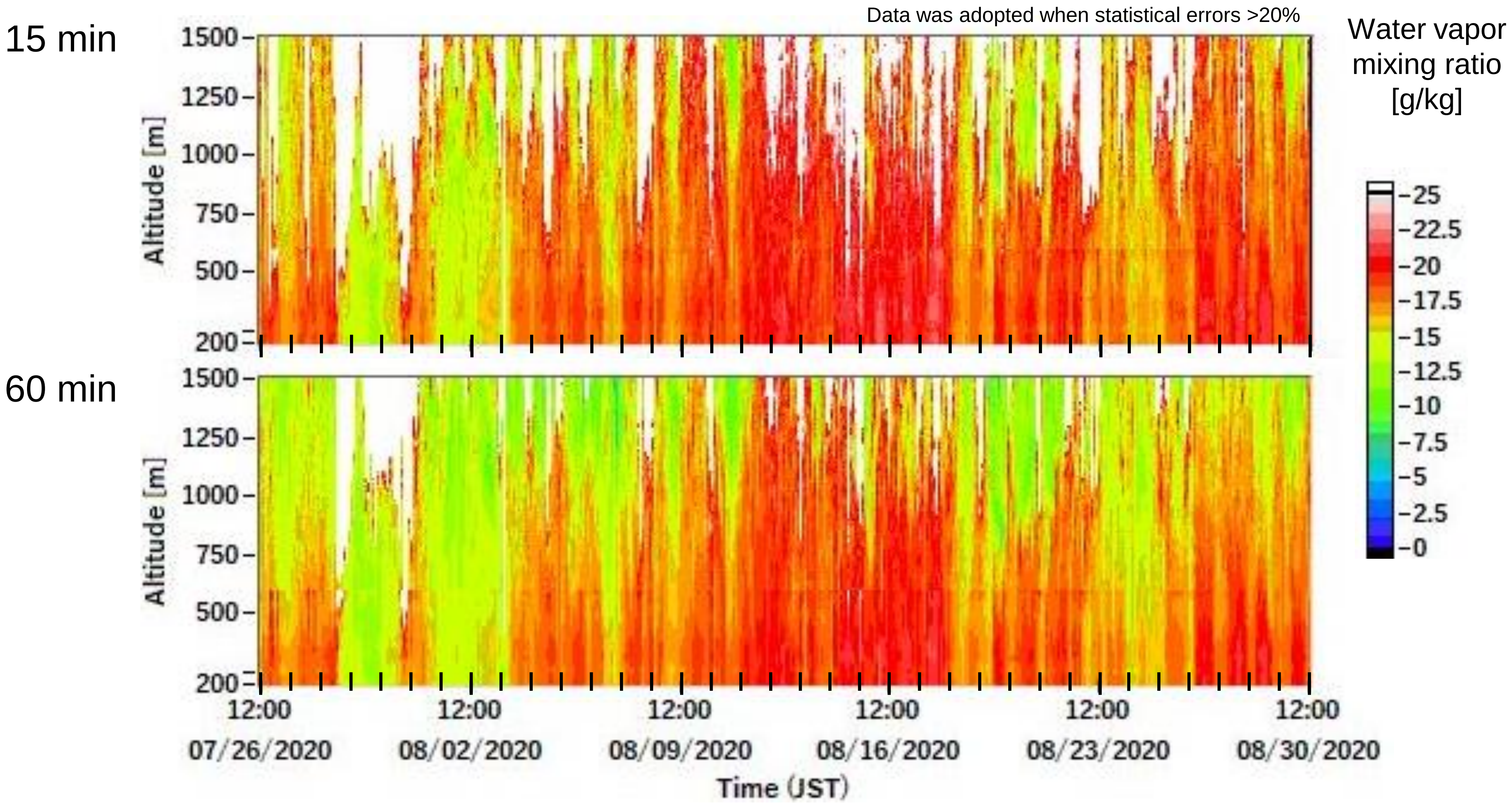
Maximum measurable altitude is correlated with the surface ozone concentrations



Including cases that max measurable altitude was limited by cloud

Care should be taken when measuring water vapor at times and locations of high surface ozone concentrations.
In such a case, it would be effective to increase accumulation time or range resolution.

Increasing Accumulation Time



The maximum measurable altitude improved as increasing accumulation time