EPJ Web of Conferences **176**, 04015 (2018) https://doi.org/10.1051/epjconf/201817604015
ILRC 28

MEASUREMENTS OF WATER VAPOR PROFILES WITH COMPACT DIAL IN THE TOKYO METROPOLITAN AREA

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ABSTRACT

In recent years, the frequency of occurrence of locally heavy rainfall that can cause extensive damages, has been increasing in Japan. For early prediction of heavy rainfall, it is useful to measure the water vapor vertical distribution upwind cumulus convection beforehand. For that purpose, we have been developing compact water vapor differential absorption lidar (DIAL).

We show the results of the measurements with lidar in summer when the local heavy rainfall frequently occurs in Japan. We also show the preliminary result of the assimilation of the lidar data to the numerical model and impact on the heavy rainfall prediction.

1 INTRODUCTION

Locally heavy rainfall is a severe weather hazards to affect urban areas in Japan. For early prediction of the heavy rainfall, numerical weather model is employed using the conventional meteorological station data. However, the lead time and accuracy of the prediction are limited because of the coarse spatial and temporal resolutions of the data. To improve them, it is useful to measure the water vapor distribution upwind of cumulus convection beforehand and assimilate the data into the model. Figure 1 shows schematic of this study.

For that purpose, we have developed compact and mobile diode-laser-based differential absorption lidar (DIAL) that can measure the vertical distribution of water vapor in the lower troposphere.

2 DIAL SYSTEM

The DIAL employs two distributed Bragg reflector (DBR) lasers operating at 829.054 nm for the online wavelength and 829.124 nm for the offline wavelength with tapered semiconductor optical amplifier (TSOA) in a master oscillator power amplifier (MOPA) configuration. The lidar measure the vertical distribution of the water vapor in the lower troposphere with a vertical resolution of a few tenths of a meter and temporal resolution of a few tenths of a minute.

Table 1 Specifications of DIAL system.

Transmitter：	
Laser	DBR diode laser x2 (seed laser), 80 mW+TSOA
Wavelength	829.124 nm (Off-line) 829.054 nm (On-line)
Pulse Energy	4 uJ
Repetition	10 kHz
Receiver：	
Telescope	Cassegrain
Diameter	35 cm
Field of View	0.25～2.8 mrad (adjustable)
Detector	PMT (Hamamatsu H9422P-50)
Operation	Photon Counting
Interference Filter	
Center wavelength	829.11 nm
FWHM	0.275 nm
Transmission	47%

3 MEASUREMENT RESULTS

We show the results of the 24H continuous measurements with lidar in summer (26 August 2016) when the local heavy rainfall frequently occurs in Japan in Figure 2.

Figure 3 shows the results of comparison with JMA mesoscale analysis (MSM) and radiosonde at Tsukuba, 80 km northeast from the lidar observation site Hino.

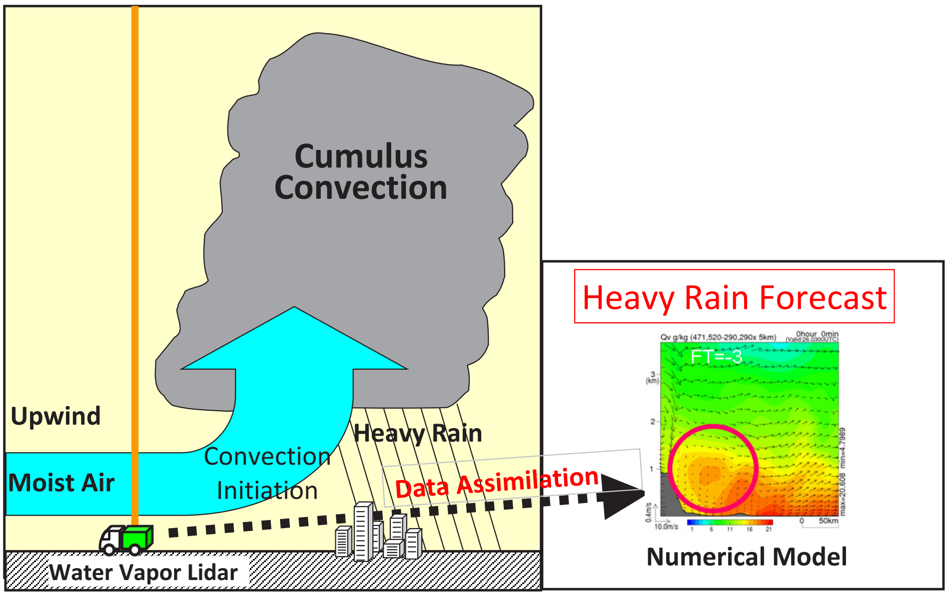

Figure 1. Schematic of this study.

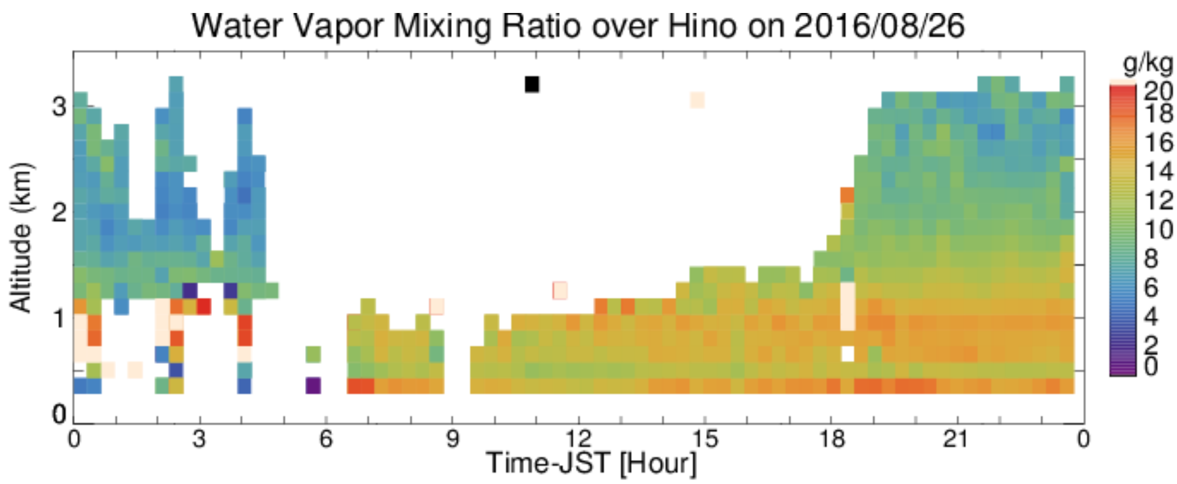

Figure 2. Temporal and height cross section of water vapor mixing ratio obtained with compact DIAL over Hino (35.7°N, 139.4°E) on 26 August 2016.

https://doi.org/10.1051/epjconf/201817604015

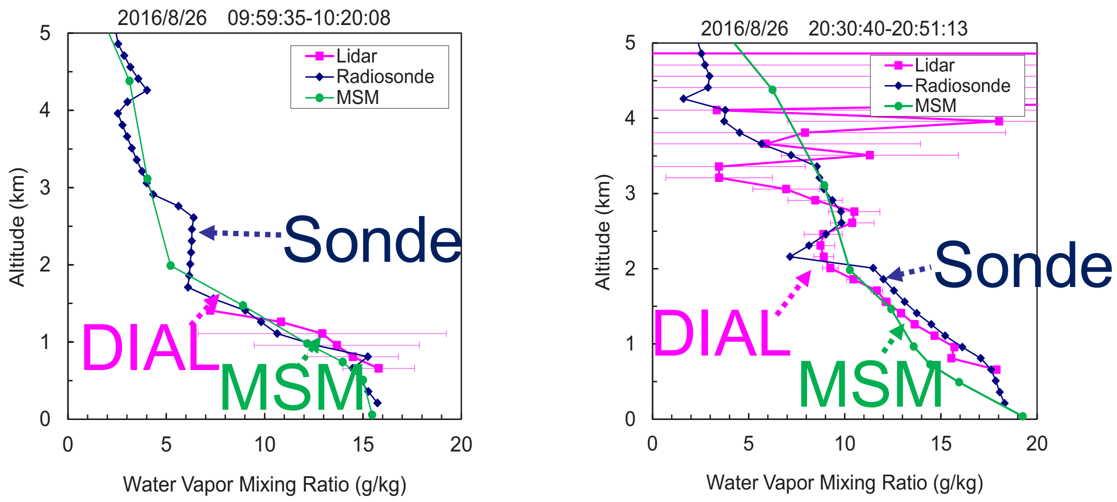

Figure 3 The results of comparison with JMA mesoscale analysis (MSM) and radiosonde at Tsukuba (80 km northeast).

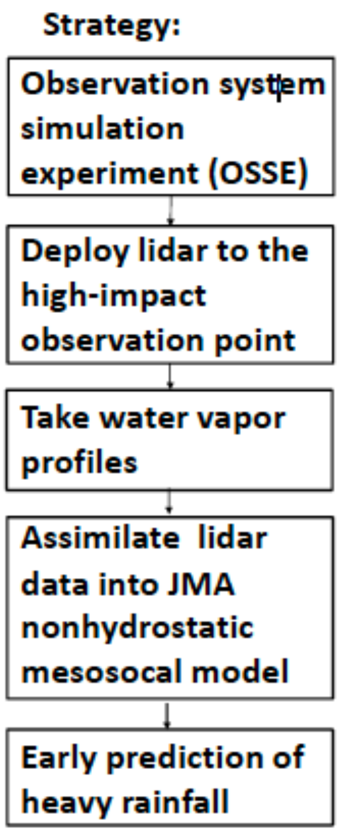

Figure 4. Strategy of early prediction of the heavy rainfall with numerical weather model and water vapor profiles observed by lidar.

4 CONCLUSIONS

We have been developing water vapor lidars for local heavy rainfalls forecast. Now measurement range is 0.5−3 km in night time and 1 km in daytime with 150 m vertical and 20 min time resolution with uncertainty within 30%.

We are charanging to increase daytime measurement range to 3 km for DIAL using etalon and increasing laser power.

Next step, we are planning to conduct field experiment in Tokyo in the summer of 2017 and to assimilate the lidar data to mesoscale model and study the impact on it.

ACKNOWLEDGEMENTS

This work was supported by JSPS KAKENHI Grant Number JP26282115.

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