SODIUM LIDAR OBSERVATIONS WITH THE UPGRADED MU RADAR, AND AN ALL SKY IMAGER (OMTI) OVER KYOTO AREA

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ABSTRACT

We report an outstanding campaign of coordinated observations with the Na temperature lidar and the MU meteor radar as well as all-sky imagers over Kyoto area. The MU radar at Shigaraki (35N, 136E) was upgraded to 25 channels of the ultra-multi digital receiver system. Combined with lidar temperature data and the wave structures measured by an all-sky imager (OMTI), vertical and horizontal wave structures and propagations can be discussed.

1. INTRODUCTION

The mesopause region, located between 80 and 110 km, uniquely combines scientific relevance and observational inaccessibility, at the far range of most routine sensing systems. A sodium lidar has been one of the most powerful tools to investigate vertical motions of atmospheric waves, e.g., gravity waves or tides. The extended measurement technique enables us to measure temperature and winds as well as sodium density variation. Based on an injection-seeding Nd:YAG lasers, Shinshu University group developed all solid state, high power, stable and less maintenance sodium lidar system for the temperature measurements. After completing three-year observation (2000-2002) at Syowa station, Antarctica ([1], [2]), the lidar was installed at Uji campus of Kyoto University (about 30 km west from Shigaraki), Japan, in 2005. The purpose of the installment is the simultaneous observation with the MU radar that has been proceeding further upgrade for the meteor wind observation. The initial observation campaign was carried out in October/November 2005. In this paper, we introduce the coordinated observation with optical instruments and the radar, and show the initial results.

2. THE SODIUM LIDAR AND THE UPGRADED MU METEOR RADAR

The transmitter of the Shinshu NaT lidar is constructed with two injection seeding Nd:YAG lasers for 1064 and 1319 nm pulses, generating 589 nm laser pulses (35 mJ/pulse, 10 Hz, 35 nsec) through a non-linear crystal (BBO). The frequency is narrowed and tuned by the seeder lasers to measure the temperature from Na D_2 Doppler width as well as sodium density variations. The temperature profiles observed with the lidar provides important information of N^2 (Buoyancy frequency squared) in discussing vertical wave propagation and instability.
The MU radar meteor echo observation has been used to derive precise horizontal wind velocities in the MLT region (80 - 100 km) as in [3] and [4]. In 2004, the MU radar receiver was upgraded from four-channel to ultra-multi channel digital receivers (25 channels). And the new GPS synchronized radar operation enables multichannel-multistatic meteor radar observations. In principle, three dimensional (horizontal and vertical) structures of the wind velocity field can be derived (Figure 1). OMTI (Optical Mesosphere Thermosphere Imagers; Nagoya University) is one of the all-sky imagers installed at Shigaraki to measure 2-dimensional wave structures. Observation parameters are shown in Table 1. It is expected that observed

Table 1. Parameters of the lidar, MU radar and OMTI at Kyoto area

	lidar	MU radar	OMTI
parameter	T, Na dens.	u, v, (+w)	2-dim. images
direction	Vert.	Vert.+horiz.	Horiz.
Alt.range(km)	80-105	80-100	87 (OH)
T resol.(min)	5	10-30	5

characteristics and propagations of the waves in the airglow imager data can be discussed using the vertical temperature structures and sodium density variations from the lidar, and the wind field from the MU radar.

3. INITIAL RESUTLS

The coordinated observations with the sodium lidar, the MU radar and OMTI were conducted in October/ November 2005. Figure 1 shows density variations measured by the lidar (Nov. 1st). The clear downward wave propagation suggesting tide was seen in the E-W wind in Figure 2 measured with the MU radar on Oct. 31st. Variations of wind, temperature and sodium density showed significant effect of atmospheric tides.

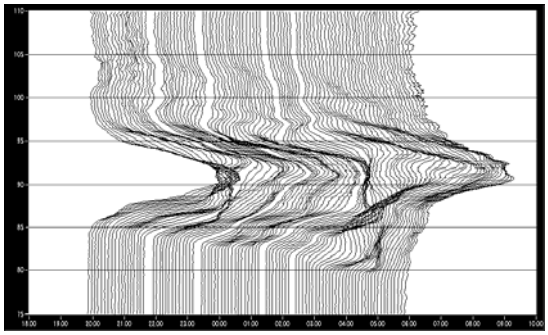

Figure 1. Sodium density variations observed on Oct. 31st.

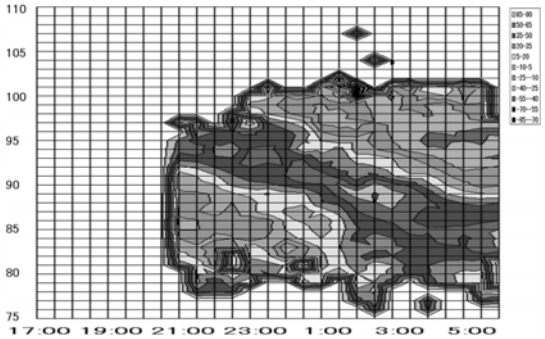

Figure 2. East-West wind variations observed with the MU radar. Downward phase velocity is about 1.6 km/h.

4. FUTURE UPGRADE OF THE NA LIDAR

The Na lidar observation will be upgraded for the daytime observation with a dispersive Faraday filter. The design is similar to the one used by the Colorado State University group. A new material for the sodium cell is applied instead of Pyrex glass, so that the reaction between 'hot' sodium atoms and the cell wall should be minimized. The long life time sodium cell for the filter enables stable, routine operation during both day and night to study atmospheric tides and gravity waves with the MU radar.

5. Summary

We introduced a new observation plan of coordinated instruments such as the sodium temperature lidar, the MU radar and the all-sky imager OMTI. Those instruments have a capability to investigate the detail about the wave propagation or breaking process in the MLT region. The initial observation was conducted in winter, 2005. Wave structures were clearly observed in each day.

6. References

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