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RANDOM MODULATION CW DYE LIDAR FOR MEASURING MESOSPHERIC SODIUM LAYER

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High-resolution temperature and wind structure of the mesopause region can be obtained by a narrowband Na lidar which consists of a cw ring dye laser and a pulsed dye amplifier. The linewidth of the pulsed laser is limited by the pulse length. The pulse length of the injection-seeded Nd:YAG laser pumped dye amplifier is a few nanoseconds, and it corresponds to several hundreds MHz linewidth. However, the linewidth of the cw ring laser is less than 1 MHz. If the cw ring laser can be used for a transmitter directly, the accuracy of the temperature and wind measurements will be improved. The lidar technique using a pseudo-random code modulated cw laser (RM-CW lidar) can be applied for the cw lidar to obtain the spatial resolution. This technique was mainly applied for the Mie scattering lidar using a diode laser. We investigated about RM-CW technique applying to the ring dye laser for measuring the mesospheric sodium layer.

The SNR of the RM-CW lidar and the SNR of the pulsed lidar is given as

$$SN_{Pulse} = \sqrt{M}\,\frac{n_s}{\sqrt{n_s + n_d}} \quad \cdots\cdots\cdots\cdots\cdots (1)$$

$$SN_{RMCW} = \sqrt{M}\,\frac{\tilde{n}_s N/2}{\sqrt{N/2 \sum_{i=1}^{N} \tilde{n}_s + N\,\overline{n_d}}}$$

$$= \sqrt{MN}\,\frac{\tilde{n}_s}{\sqrt{2 \sum_{i=1}^{N} \tilde{n}_s + 4\,\overline{n_d}}} \quad \cdot\cdot (2)$$

M : accumulated number

n_s : photon number of signal

n_d : photon number of background noise

N : length of pseudorandom code

~ : expectation value

– : ensemble average

The SNR of the RM-CW lidar is greatly influenced by a term of Σn_s in the equation (2). For improving this SNR, strong signals from lower altitude should be decreased as possible. To decrease these strong signals, the overlap of the laser beam and the field of view must be taken as far as possible.

The SNR of the typical RM-CW lidar is simulated by the computer. The SNR values are calculated assuming that range resolution is 1km, cw laser power is 500mW, a receiving aperture is 60cm, and accumulation time is 60 minutes. The atmospheric parameters such as the backscattering coefficient and the extinction coefficient are converted from the values obtained by the actual pulsed dye lidar. Simulated results are shown in Figure 1. In the Figure 1, the overlap factor is assumed to be 1 above 10km and above 30km respectively. We can get the result that if the laser beam and the field of view of the receiving telescope overlap above 30km altitude, precision of Na densities measured by the RM-CW technique is comparative with that of Na densities measured by the usual pulse lidar.

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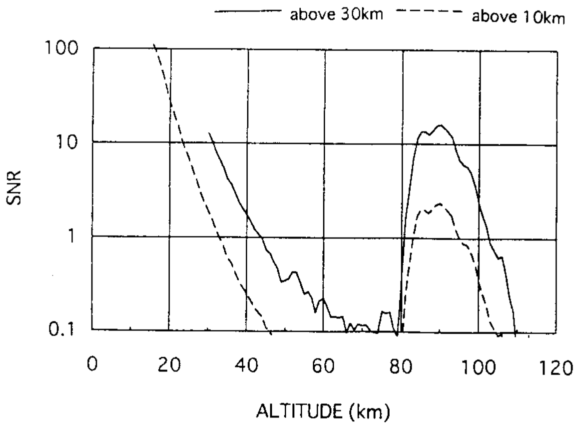

Fig. 1 Simulated SNR of the RM-CW dye lidar when the overlap factor is 1 above 10km and above 30km, respectively.