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FLIGHT TESTS OF A RANGE-RESOLVED AIRBORNE DIAL WITH TWO MINI-TEA CO_2 LASERS

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It is important to measure regional distributions of ozone concentrations in a short time for understanding a mechanism of photo-chemical smog development. Several ways of airborne laser remote sensing should be featured as a powerful technique for this purpose. One of the best ways is an airborne CO_2 DIAL (Differential Absorption Lidar) since this is active and sensitive.

An airborne DIAL system with two low-power mini-TEA CO_2 lasers has been developed for measuring three-dimensional distributions of ozone in the lower troposphere. The CO_2 DIAL is a nadir-looking system and is designed to measure ozone profiles between ground and airplane by using atmospheric aerosols as a distributed radar target. A twin-engine aero-commander, which can carry 8 passengers, is selected to carry the DIAL System. Characteristics of the system are shown in Table 1. The transmitter of the DIAL is composed of two mini-TEA CO_2 lasers and a telescope. The discharge section of the flowing-type CO_2 laser has an electrode of Chang's profile, a metal mesh and a SiC ceramics preionizer. Output of the laser in flight tests is 200mJ. A receiving telescope has an almost diffraction-limited primary mirror with a diameter of 300mm and a F-number of 2 to efficiently collect photons backscattered from aerosols. One laser is triggered 100μsec after the other to provide a near-simultaneous dual-wavelength operation with only one 1mm square HgCdTe detector by means of the direct detection.

First flight tests with a single laser have been conducted in February 1985 over the Tokyo area. The system was operated at an altitude of 5000ft(1.7 km). All flight path lines of the flight mission on Feb. 23, 1985 are shown in Fig.1. Receiving power (P_r) of the laser radar is given by

$$P_r = K\ B\ \exp(-\int \sigma_t dR)\ /\ R^2$$

where K = system efficiency
B = aerosol backscattering coefficient
R = range from the system
σ_t = atmospheric extinction coefficient

The receiving power corrected by R^2 vs. height is shown in Fig.2. The corrected receiving power is given by

$$P_r R^2 = K B \exp(-\int \sigma_t dR).$$

The number at the top of Fig.2 indicates the flight path line. Note that results of the first flight tests show that the height profiles of the received power in the boundary layer were different between over land and ocean. The received power has to be inverted to an expression of a single optical parameter to see real aerosol distributions. Inversion of the lidar signal to the aerosol extinction has been performed by using Klett's solution. We will discuss the inversion of the lidar signal at the meeting.

Second flight tests with two lasers will be made soon. We hope to report results of the second flight tests to measure ozone at the meeting.

Table 1: CHARACTERISTICS OF AIRBORNE DIAL

Trasmitting telescope		
	Diameter	100mm
	Type	Galilei
	Objective	off-axis mirror
Laser		
	Type	mini TEA CO_2 laser
	Output	300mJ
Receiving telescope		
	Diameter	300mm
	Focal length	600mm
	Type	Newton
Detector		
	Material	HgCdTe
	Size	1mmSquare
	D*	$10^{10} W^{-1} Hz^{1/2} cm$

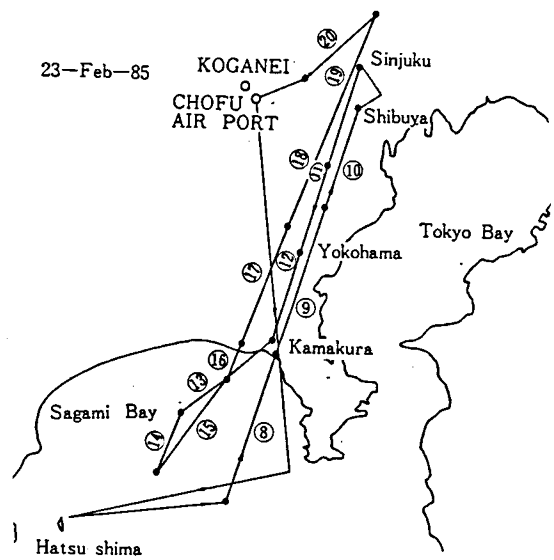

Fig. 1

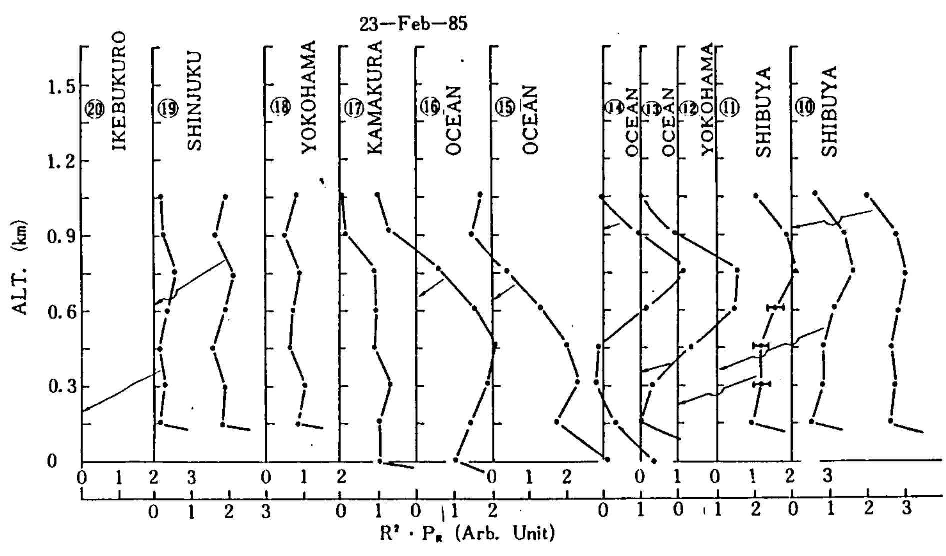

Fig. 2