S3-7 Achievement and Prospect of the Laser Atmospheric Sensing at AIOFM, China

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The invention of laser provided a new technique, lidar, for monitoring of the atmosphere. With the development of lidar technique, it becomes a powerful tool to study atmospheric structure, composition and dynamics with high temporal and spatial resolution. The L625 lidar, an UV-DIAL lidar, and a mobile dual-wavelength lidar have been constructed in Anhui Institute of Optics & Fine Mechanics (AIOFM), which are used in measurements of the aerosol and ozone profiles in stratosphere and troposphere. A large number of data have been obtained. A Raman lidar is being constructed at AIOFM for measurement of water vapor in the air The first set of water vapor data has been obtained. The other two new projects have started at AIOFM with respect to new lidar systems: one is a mobile multi-wavelength lidar for monitoring of air pollution: SO_2, NO_2, O_3 and aerosol, and another is an air-borne Mie-lidar.

1. L625 lidar system for the measurement of stratospheric aerosol profile

Stratospheric aerosol plays very important role in atmospheric radiation. L625 lidar was constructed at AIOFM in 1990 to measure the aerosol profile in stratosphere. It consists of a double-frequency YAG laser, a receiving telescope with diameter of 625mm, and photon counting unit (table 2). L625 lidar has been running routinely since January of 1991. The large amount of stratospheric aerosol data, including

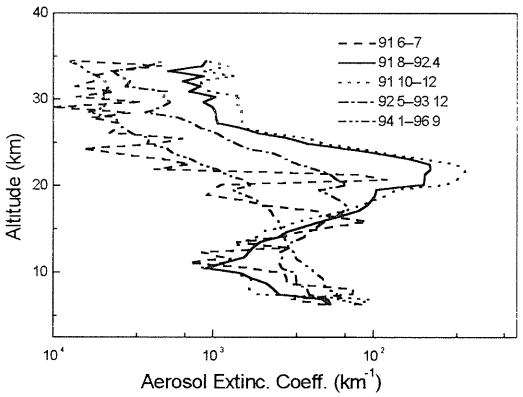

Fig 1 Variation of Pinatubo volcanic cloud at Hefei

Pinatubo volcanic cloud, has been obtained at Hefei. Fig.1 shows some average profiles of aerosol according to the measured data of 345 nights at Hefei, which indicate the variation of Pinatubo cloud in its initial, growing, and attenuating stages. Table 1 gives its statistics, in which τ_a and IBC mean respectively aerosol optical depth and integrated back-scattering cross-section from 16km to 27km

Table 1 Statistics of Pinatubo volcanic cloud at Hefei

Period	Duration	τ_a	IBC
Pre-bkgd	91.1-91 5	.0079	.199e-3
Volcanic	91.6-93.12	.0672	.221e-2
Maximum	91 11-12	.1716	.506e-2
bkgd #1	94.1-96.9	.0140	.401e-3
bkgd #2	96.10-98.5	0099	.239e-3

2. An UV-DIAL lidar for measurement of stratospheric ozone Profile

The first UV-DIAL system in China has been constructed at AIOFM in 1993 to measure the stratospheric ozone. Figure 2 indicates its scheme

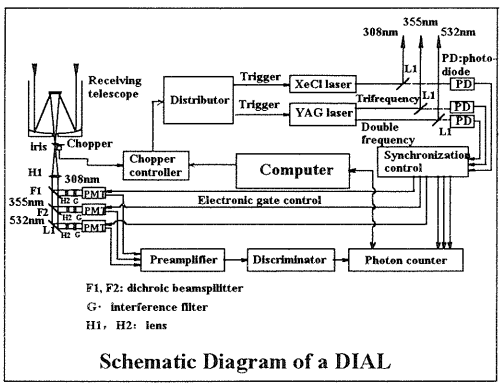

Fig 2 UV-DIAL system scheme

Table 2 shows its specification. The on-line wavelength is 308nm generated by XeCl laser (400mj/pulse, 25Hz). The off-line wavelength is 355nm provided by the third harmonic of Nd:YAG laser. The first ozone density profile was obtained at Hefei on Dec. 28 of 1993. Since then, the stratospheric ozone profiles are measured routinely.

Table 2 Specification of UV-DIAL system

Laser	XeCL	Nd.YAG	
Wavelength (nm)	308	355	532
Repetition (Hz)	50	10	10
Output (mJ)	200	60	70
Receiver telescope			
Type	Cassegran		
Diameter (mm)	625		
PMT	9214QB	9817B	
Cooling unit	EMI FACT 50x3 (-25°)		
Data acquisition	Photon counting		
	EG&G 914Px3, 150MHz		

3. A Dual-DIAL lidar for measurement of ozone profile in troposphere

Measurements of ozone in the troposphere have become increasingly important during the past decade, because the ozone increases threaten the vitality of the plant and the animal kingdom, and ozone is a greenhouse gas For measurement of ozone in the troposphere, the shorter wavelength is needed. The on-line wavelength is 289nm , generated by Raman shift output of D_2 gas pumped by quadric-harmonic frequency (λ=266nm) of YAG. And the off-line wavelength is 308nm. The ozone vertical profiles have been obtained from 3km to 11km at Hefei. In order to minimize the effect of aerosol on ozone measurements in the troposphere, a dual-DIAL method of three-wavelength (266nm, 289nm, 308nm) was proposed The simulated and real measured results indicate that it is better than DIAL method of two-wavelength.

4. Mobile dual-wavelength lidar for measurement of aerosol profile in the troposphere

A mobile dual-wavelength lidar was constructed at

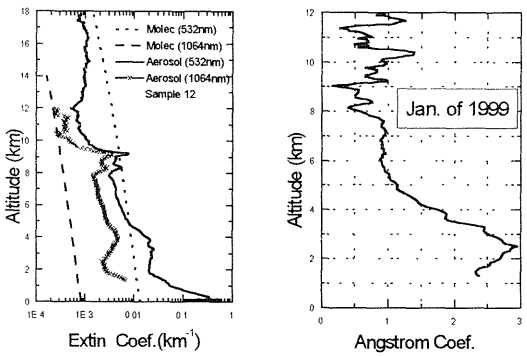

Fig.3 Mean Angstrom Coeff in Jan of 1999

AIOFM in 1995 It consists of Nd.YAG laser with the both wavelengths of 1064nm and 532nm, a telescope with diameter of 300mm, PMTs, and A/D converter. Aerosol extinction coefficient profiles were obtained from 3km to 18km, including some examples of Yellow Sand Fig 3 shows the profile of aerosol mean Angstrom coefficient at Hefei in January of 1998 with 12 samples

5. Raman lidar for measurement of atmospheric water vapor

Water vapor is one of the most important constituents in the atmosphere. It plays a major role in dynamics and radiation transfer. A Raman lidar developed in AIOFM was successful to measure water vapor at night from 1km to about 5km at Hefei in May of 1999 Fig 4 gives an example of water vapor profile measured on June 2, 1999.

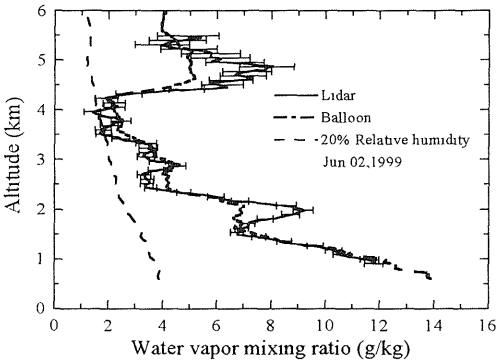

Fig.4 Water vapor profile on June 2, 1999

6. The project of mobile multi-wavelength lidar for monitoring of air pollutants

Lidar is a very useful tool for measuring air pollutants. Under a new project, a mobile lidar system is being constructed at AIOFM for measuring SO_2, NO_2, O_3 and aerosol, which is consists of a Ti:Sapphire laser, a telescope of 300mm diameter. The wavelength-pairs of the laser output for the three gases are given in table 3

Table 3 Laser wavelength-pairs for the gases

	SO_2	NO_2	O_3
λ_{on}(μm)	286.9	398.3	282.4
λ_{off} (μm)	286.3	397.0	286.3

7. The project of air-borne lidar

Another project started recently at AIOFM is the construction of an air-borne lidar for measuring aerosol and cloud, based on diode-pumped YAG laser with dual-wavelength of 1064nm and 532nm.

The scientists of AIOFM will continue to pay their attention to the developments of laser atmospheric sensing and lidar technology.