Closing Remarks as summary

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Earth environment scientists have been seeking new spaceborne instruments to measure with larger improvements in an accuracy and a spatial resolution than sensors currently in use. Lidar has been nominated as one of them. The lidar provides remote measurements of atmospheric properties, i.e. cloud, aerosols, Planetary Boundary Layer (PBL), concentrations of molecules, wind, with the high horizontal and vertical resolution, and land properties, ice sheet, surface, vegetation etc. Thus, the lidar has a unique capability to make many measurements from space covering an altitude range from the stratosphere through the troposphere to the surface of the earth.

From the achievements of actual spaceborne lidar experiments such as LITE, SLA and ALISSA, future programs of spaceborne lidar such as GLAS, MDS-lidar, ATMOS-B1, and ATLID, to scientific issues related to clouds, aerosol and radiation budgets, 44 papers were presented in the second workshop in order to discuss on aspects in spaceborne lidar programs. As special sessions , an eye safety and multiple scattering problems were also discussed.

In this closing remarks, I would like to summarize the eye safety issue discussed at the session , necessities and possibilities of the international spaceborne workshop recommended at the sessions, respectively.

1. Eye safety

No one can neglect to consider the "eye safety issue" for the spaceborne lidars in order to avoid any accidents for viewing by the optically aided eye (binoculars or telescope), since it is legally prohibited to break the allowable maximum permitted exposure(MPE) for a safe eye exposure standardized by ANSI or each country. MPE is characterized by an output energy of laser transmitter and a beam divergence related to a footprint illuminated on the ground. On the other hand, the measurement accuracy strongly depends on the transmitted laser energy.

In the workshop, some appropriate data for spaceborne lidar programs proposed /or scheduled including LITE mission were presented to discuss on the eye safety. The data presented in the eye safety session were tabulated in Table 1. As shown in this table, it is obvious that the output energy of laser transmitter of lidar systems designed by each space agency differ from each other in spite that determinations of transmitted laser energy should obey the MPE. The reason mainly seems to be in a criterion for the optically aided eye, namely diameters of binoculars or telescope and safety factors. As one of the conclusions in the workshop, therefore, it must be requested to keep discussing on this eye safety issue internationally to standardize the criterion regarding diameters of

binoculars or telescope and safety factors.

	LITE	ALISSA	ELISE	GLAS	ATLID
	NASA	CNES-RSA	NASDA	NASA	ESA
	*Cloud *Aerosol *PBL	*Cloud	*Cloud *Aerosol *PBL	*Cloud *Aerosol *PBL *Earth surface	*Cloud *Aerosol *PBL
Altitude	260 km		550 km	700 km	800 km
Laser footprint / or beam diver.	190m(355nm) 245m(532nm) 365m(1064nm)	0.15 mrad	0.15 mrad	0.14mrad (532nm) 0.2mrad (1064nm)	100 m -500 m
Pulse energy	160mJ(355nm) 560mJ(532nm) 440mJ(1064nm)	40mJ (532nm)	4.4mJ (526nm) 90mJ (1053nm)	50mJ (532nm) 100mJ (1064nm)	100mJ (1064nm)
Optics diameter for criterion	20cm ϕ	?	30cm ϕ	20cm ϕ	15cm ϕ

Table 1

2. Necessity and Possibility for next workshop

The International Workshop on Spaceborne Lidar was originally organized under the joint auspices of Earth Observation Committee / Earth Science & Technology Forum and National Space Development Agency of Japan (NASDA). The purpose of workshop is to encourage lively and useful discussions helping to lay the foundations for progress in this challenging area, according to one of the recommendations adopted at the NASDA session in the 17th International Laser Radar Conference (17ILRC) held at Sendai Convention Center, Sendai, Japan, July 25-29, 1994.

The first workshop was held at Nara Prefectural Culture Hall in Nara, Japan on October 24-26, 1995 . Most concentrated discussions were made from the view points of resolutions for the climate change problem related to interactions between cloud, aerosols and radiation budgets. This time is the second workshop. As shown in previous presentations of this proceeding , many instruments have been planned and proposed. All of participants strongly recognized through valuable discussions for four days that this international workshop might play an important role for not only developments of instruments and systems but also studies of the earth environment. It was concluded, therefore, the workshop should be continued under supports of many space agencies.