Plan for Lidar Network Observation of SPM in East Asia And Validation of MDS Lidar Data

N. Takeuchi*, H.Kuze*, S-C. Yoon**, and H. Hu***
CEReS, Chiba Univ., Japan, ** Seoul Nat. Univ.. Korea, *** AIOFM. CAS. China

Natural and anthropogenically-produced aerosols(suspended particulate matters: SPM) are a serious problem from global environmental point of view. It also affects global radiation budget[1]. The global aerosol quantity over ocean can be derived from satellite data based on no reflection of radiation in the infrared region[2]. However over land it is very difficult due to variable reflectivity of the ground surface. For developing an aerosol deriving method from satellite data, aerosol characteristics are very important parameters as well as the ground reflectivity. Aerosol characteristics is planned to be monitored in East Asia combined with a lidar network for monitoring anthropogenically-produced air pollution[3].

In a space shuttle experiment "LITE", the aerosol flux over west Pacific Ocean was clearly monitored by the lidar observation and wind information[4]. In this case, for the better estimation, information of aerosol characteristics is required. The estimate of global strengths of aerosol particles is 8,000 - 9,000 Tg/yr. Among them, 15 % is from gas-to-particle conversion, to which the anthropogenic source greatly contributes, and 5 % is from biomass burning [5]. Recently the air pollution in large cities in south-east Asia is serious and the SPM concentration often shows several times of the upper limit of the environmental standard, which far exceeds hazardous level advised by WMO. Indonesian forest fire smoke also shows big influence on climate, human health, agriculture and transportation. The basic properties of aerosol characteristics were monitored by one of authors et al at Singapore and at off-shore of Jakarta. [6]. The biomass burning of Indonesian Forest Fire is clearly observed by satellite (NOAA and GMS) data. In Fig. 1, we shows the NOAA AVHRR data (Sept. 6 to 11, 1997). The exponent (α) of wavelength dependence of optical thickness (τ) monitored in Singapore in October is shown in Fig. 2 ($\tau = \beta \cdot \lambda$^($-\alpha$)). The larger value than 1 means the smaller size particle rich aerosol.

The aerosol characteristics is also important for atmospheric correction (AC) of satellite data and also for reliable derivation of optical thickness from lidar data. In a case of AC, temporally and spatially aerosol and water vapor are too much variable. So the amount and the characteristics (complex refractive index, and particle shape and size distribution) are strongly desired to estimate scattering and absorbing properties. Usually Mie theory is used in calculation and there the sphere shape is assumed (size "radius" in the distribution is just effective). As no direct method is known to measure the real part of refractive index, the chemical composition is analyzed in order to estimate it (imaginary part is derived from absorption). Once aerosol characteristics is obtained, optical thickness, phase function, and single scattering albedo can be estimated. Then the mass density can be translated from the optical thickness. Lidar parameter, (extinction / back-scattering) also can be calculated, which enables to do atmospheric correction [7,8]. In Fig. 3(a), particle size distributions of typical aerosol models are shown, and in Fig. 3(b), lidar parameters for each aerosol models are calculated as a function of wavelength under the condition of refractive index of $1.50 + i \cdot 0.05$.

As mentioned above, the aerosol characteristics is very important parameters for air pollution, lidar measurement, satellite data analysis, and aerosol monitoring from lidar and satellite data, Asian lidar research groups plan to construct lidar monitoring network to do cooperative lidar monitoring as well as to do the study of aerosol characteristics.[3]. The member of the lidar network group is shown in Table 1. The location of members are shown in Fig. 4. Some of members use MPL's (Micro Pulse Lidar). Some example of MPL automatic monitoring data is shown in Fig. 5.

MDS lidar is a direct and more reliable method to monitor SPM from space. The above mentioned lidar monitoring network is also effective for validation of the MDS lidar capability and data reliability.

Table 1. Member of lidar network

(MPL)
* Chiba University (Chiba) and MRI (Tsukuba/Japan)
* Seoul National University (Seoul/ Korea)
* AIOFM, CAS (Hefei/China)
* Sukhothai (Chiba U./Thailand until the end of 1998)

(Lidar research groups)
* IAP/CAS (Beijing/China)
* Kinhee U. (Suwan/Korea)
* Hongkong City College (Hongkong)
* Manila Observatory (Manila/Philippine)

(Other possible candidates)
KAIST (Tadjeon /Korea)
CRL lidar sites
KMLT/Thailand,
Innermongolia /China,
Bangdong/Indonesia
OTIDS lidar monitoring system (Jakarta/Indonesia)
MRI lidar site (Bangdong/Indonesia)

(Aerosol monitoring cooperative group)
ERTC (Bangkok/ Thailand)
EMC (Serpong/ Indonesia)

[REFERENCE]
[1] Harshvardhan (1993): Aerosol-cloud Interaction, in Aerosol-cloud-climate Interactions, ed. P.V. Hobbs, Academic Press, p. 75-95.
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[4] R. M. Hoff, K.B. Strawbridge (1996): LITE observation of anthropogenically produced aerosols, in Advances in Atmospheric Remote Sensing with Lidar, Eds by A. Ansmann et al, 145-148, Springer.
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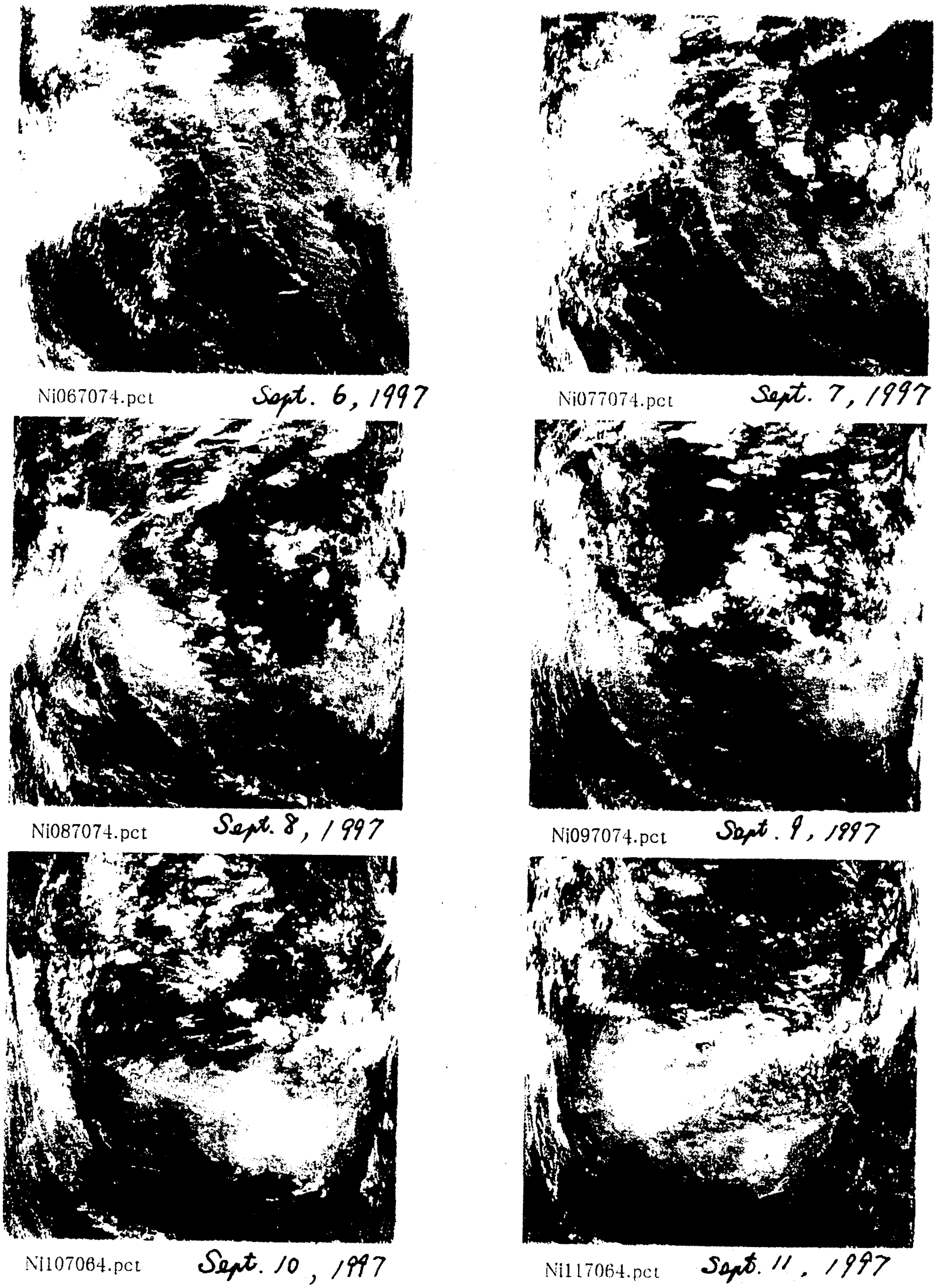
[7] D. Tanre, et al(1992): Atmospheric correction algorithm for NAA-AVHRR products: theory and application. IEEE Trans. Geoscience and Remote Sensing, 32(2) 231-248.
[8] Y.J. Kaufmann (1998): Correction methods for aerosol and thin cirrus effects on remote sensing. P.89-101, in ref. [3].



NOAA 14, AVHRR

ch. 1→ R
ch. 2→ G
TT : B

Fig. 1. Biomass burning of Indonesian Forest Fire monitored by NOAA AVHRR (Sept. 6 to 11, 1997).

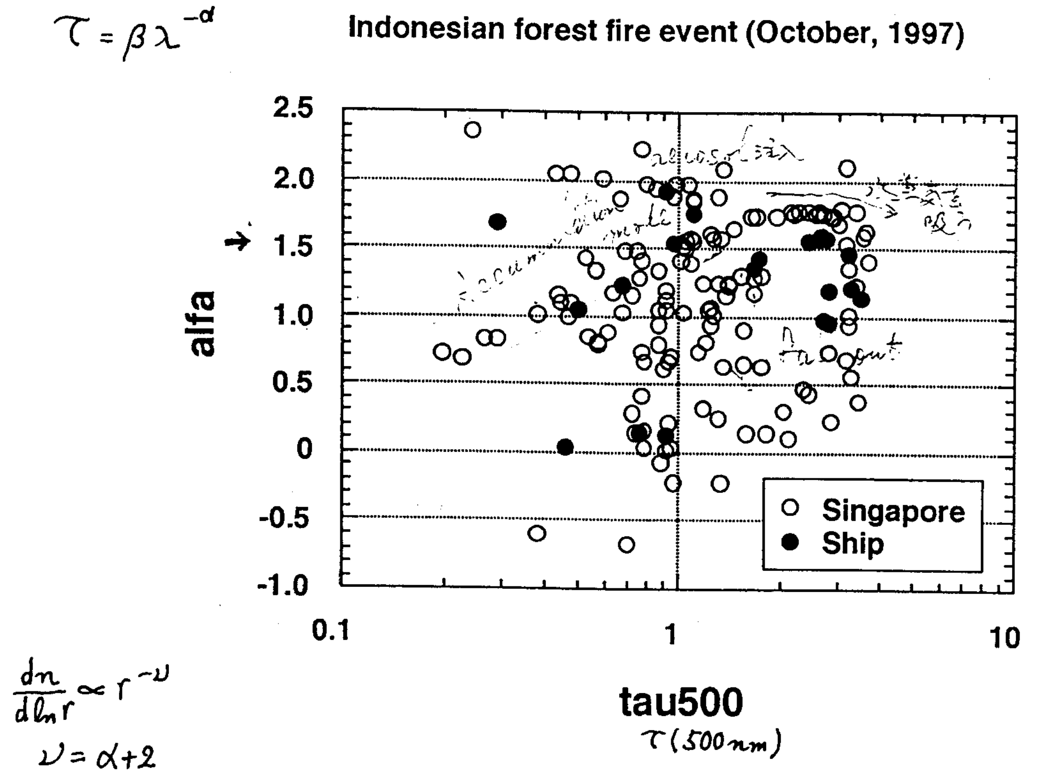


Fig.2 The exponent (α) of wavelength dependence of optical thickness (τ) monitored in Singapore in October. ($\tau = \beta \cdot \lambda$ ^(- α)).

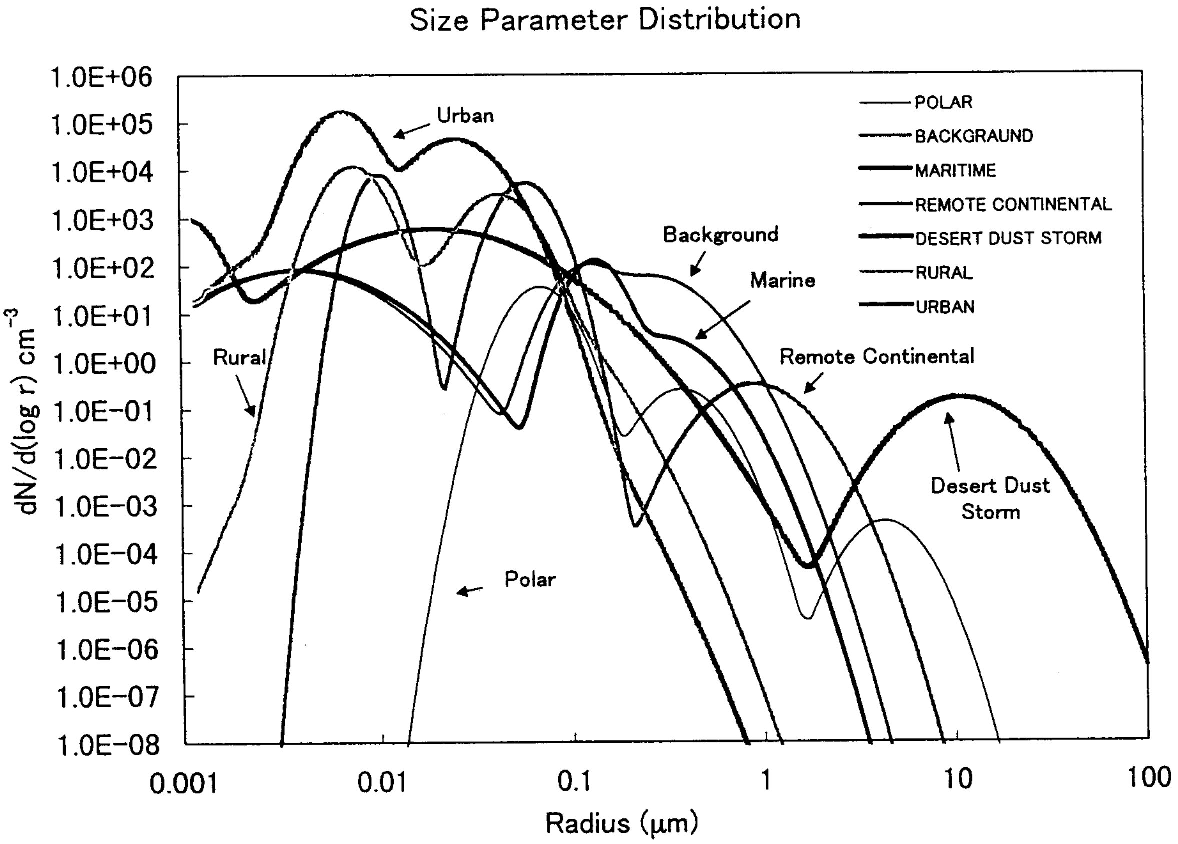


Fig. 3(a), particle size distributions of typical aerosol models.

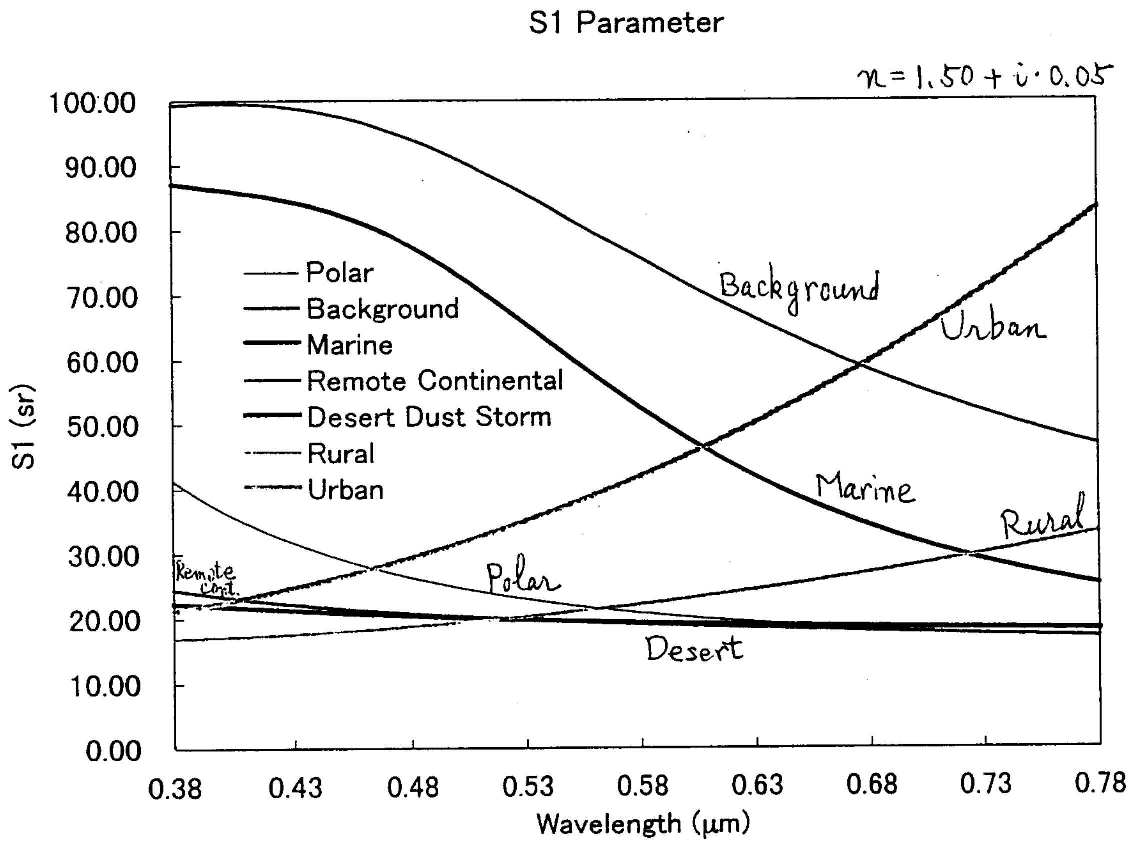


Fig. 3(b), lidar parameters for each aerosol models as a function of wavelength under the condition of refractive index of 1.50 + I·0.05.

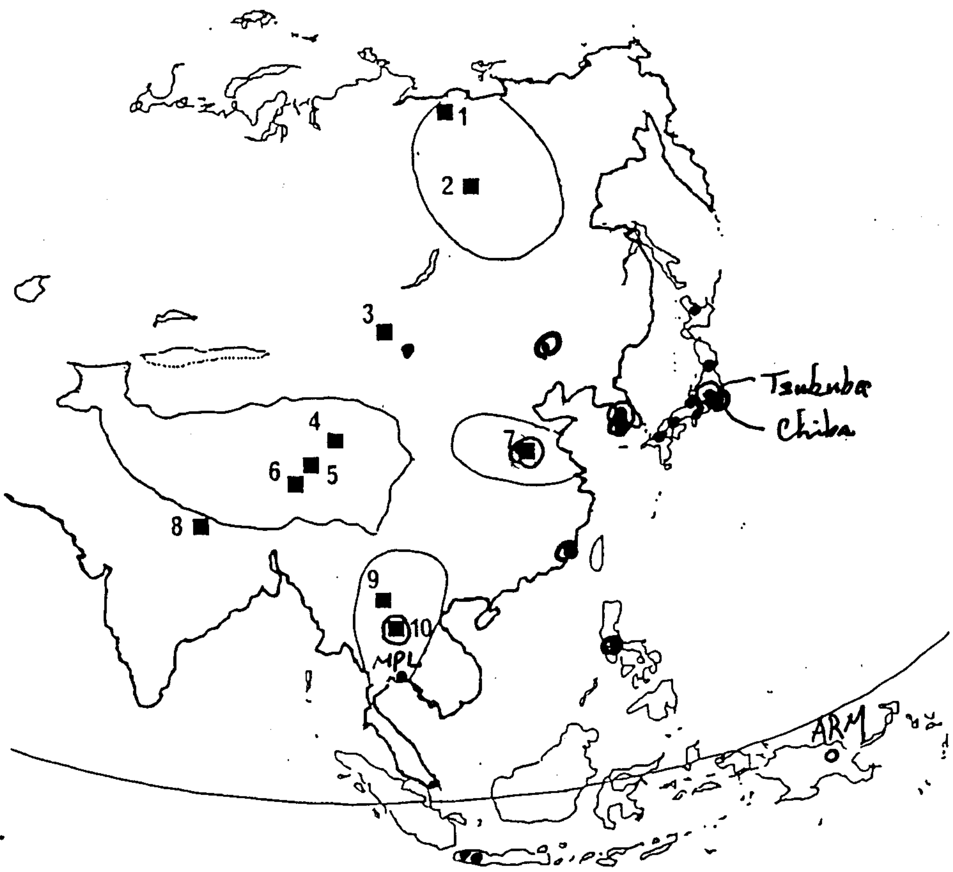
AWSを設置する場所

Lidars in Asia

Location of Automatic Weather Station

AWS 観測装置　配置図

1. Tiksi
2. Yakutsk
3. Arvaikheer
4. Amdo
5. Naqu
6. Toutouhe
7. Shou-Xian
8. Shangboch
9. Tak
10. Sukhotai



O MPL
• Lidar
◎ Lidar network group

Chiba U.
- 4λ (1064, 756, 532, 355nm)
- polarization
- Raman

Fig. 4 The location of lidar network members. Some of members use MPL's (Micro Pulse Lidar).

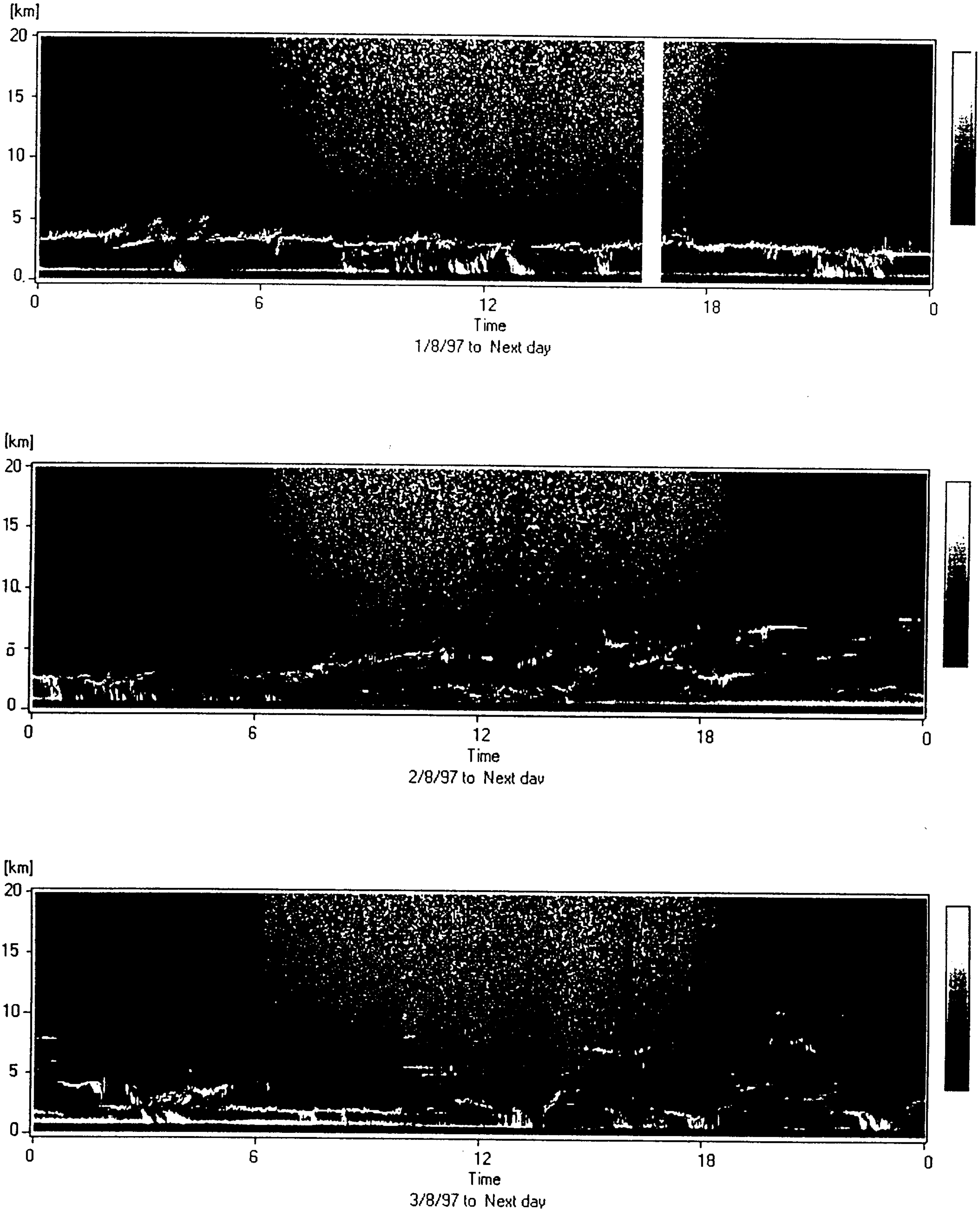


Fig. 5 Some example of MPL automatic monitoring data in Sukhothai, Thailand.