Continuous observations with multi-parameter lidars in Asian Dust and aerosol lidar observation Network (AD-Net)

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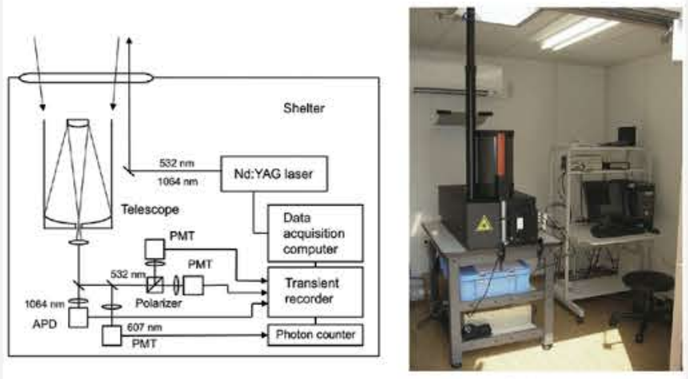
Introduction

Asian Dust and aerosol lidar observation Network (AD-Net) is a lidar network for continuous observations of dust and other aerosols in East Asia. A two-wavelength (532 nm and 1064 nm) polarization-sensitive (532 nm) Mie-scattering lidar is operated as the standard lidar system of AD-Net. Using the backscattering coefficient and depolarization ratio, extinction coefficients are estimated for non-spherical (dust) and spherical aerosols. A Nitrogen vibrational Raman scattering channel (607 nm) was additionally set to the standard lidar system at primary 6 stations to obtain extinction coefficients at 532nm during nighttime. At Tsukuba in Japan, we started continuous observation with a three-wavelength (1064 nm, 532 nm, and 355 nm) polarization-sensitive (532 nm and 355 nm) lidar. This lidar has a high-spectral-resolution receiver with an iodine filter at 532 nm and a Raman channel at 387 nm. Furthermore, continuous observation with a multi-wavelength Raman lidar was started at Okinawa and Fukuoka in Japan. The multi-parameter lidar data will be used for aerosol component analysis and data assimilation in chemical transport models.

Standard AD-Net lidar (2β+1δ) and Raman lidar (2β+1α+1δ)

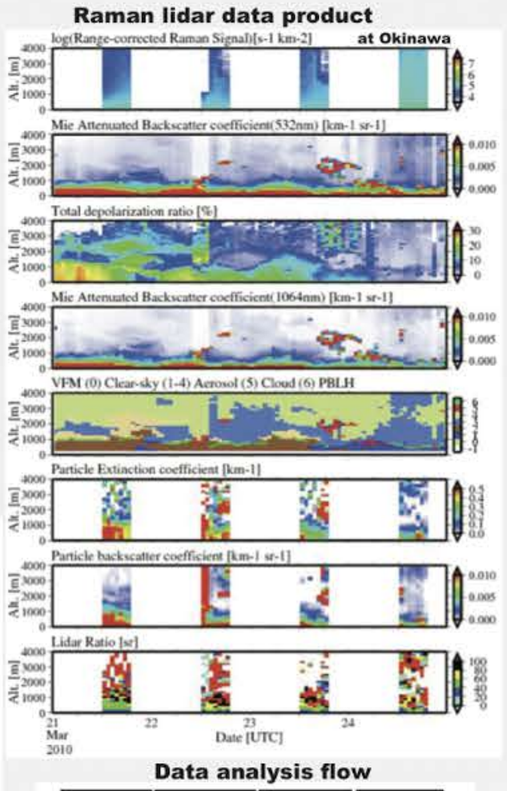
Lidars in AD-Net



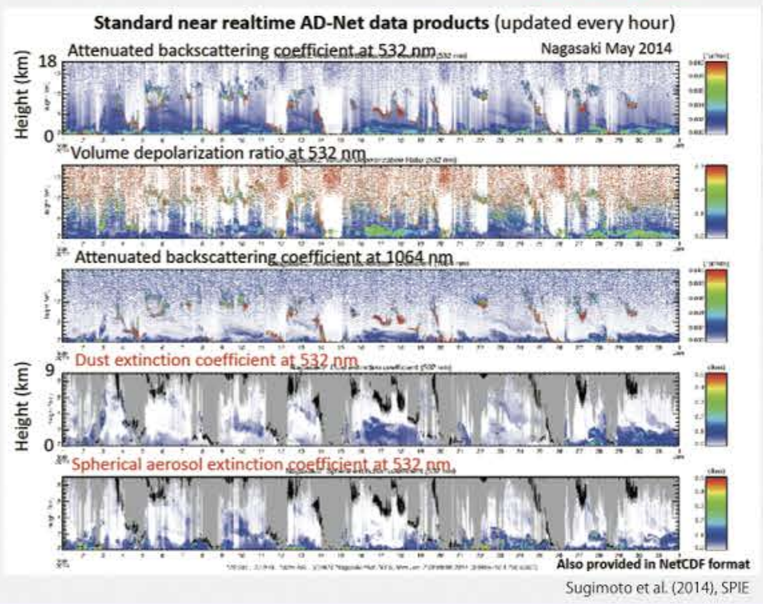
2β (532,1064)+1δ (532) lidar

β: backscattering, δ: depolarization

Raman lidar data product at Okinawa

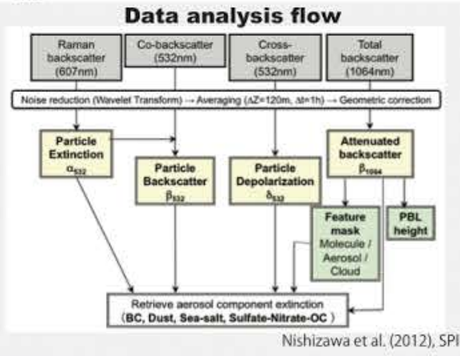


Standard near realtime AD-Net data products (updated every hour)



Sugimoto et al. (2014), SPIE

Data analysis flow

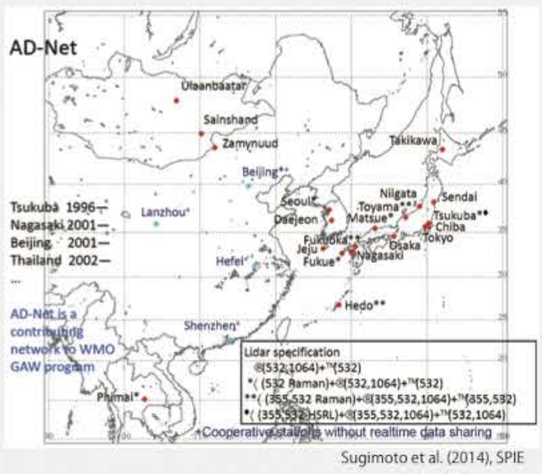


Nishizawa et al. (2012), SPIE

Observation site

A two-wavelength (532 nm and 1064 nm) polarization-sensitive (532 nm) Mie-scattering lidar is operated at 20 stations as the standard lidar system of AD-Net. In several years, continuous observations with advanced multi-parameter lidar systems are conducted for better estimation of aerosol optical properties.

Map of observation site



Sugimoto et al. (2014), SPIE

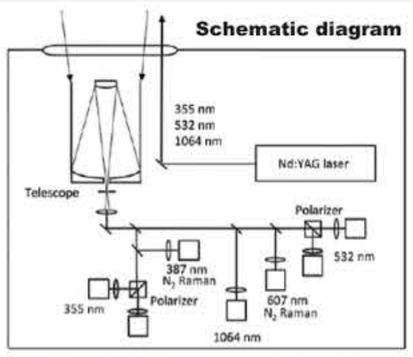
Information for the observation site

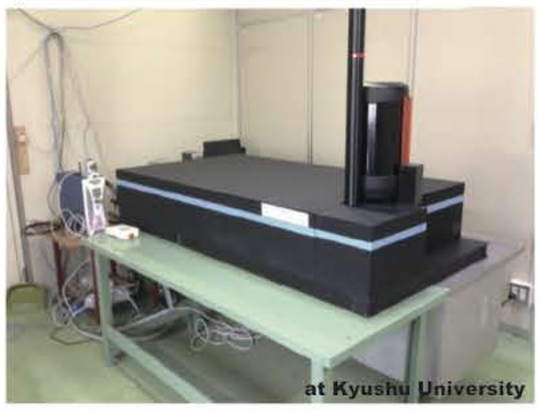
Site	Organization	Lon. (E)	Lat. (N)	Height (m)	Start of Observation	Lidar system*2
Tsukuba, Japan*1	NIES	140.12	36.05	30	1996	B, D
Toyama, Japan*1	MOE/Toyama	137.10	36.70	28	2004	A
Matsue, Japan	MOE/Shimane	133.01	35.48	5	2005	B
Nagasaki, Japan	MOE/Nagasaki	129.98	32.94	206	2001	A
Niigata, Japan	MOE/Niigata	138.94	37.84	1	2007	A
Tokyo, Japan	MOE	139.71	35.69	42	2008	A
Sapporo, Japan*1	Hokkaido Univ.	141.33	43.06	30	2003	A
Sendai, Japan*1	Tohoku Univ.	140.83	38.26	154	2005	A
Chiba, Japan*1	Chiba Univ.	140.12	35.62	20	2007	A
Osaka, Japan	Kinki Univ.	135.59	34.65	19	2008	A
Fukue, Japan*1	Chiba Univ. / NIES	128.68	32.75	50	2002	B
Hedo, Japan*1	NIES	128.25	26.87	60	2005	C
Fukuoka, Japan*1	Kyushu Univ.	130.48	33.52	30	2012	C
Seoul, Japan*1	Seoul Nat. Univ.	126.95	37.46	116	2006	B
Gosan Jeju, Korea	Seoul Nat. Univ.	126.16	33.29	35	2010	A
Daejeon, Korea	Mokwon Univ.	127.34	36.33	80	2002	A
Ulaanbaatar, Mongolia	IMH	106.90	47.92	1320	2007	A
Sainshand, Mongolia	IMH	110.12	44.87	937	2007	A
Zamyuud, Mongolia	IMH	111.90	43.72	962	2007	A
Phimai, Thailand*1	Chulalongkorn Univ.	102.57	15.18	212	2002	B

*1 SKYNET. *2 A indicates 2β (532,1064) + 1δ(532) Mie lidar system; B indicates 1α(532) + 2β(532,1064) + 1δ (532) Mie-Raman lidar system; C indicates 2α (355, 532) + 3β (355, 532,1064) + 2δ (355, 532) Raman lidar system; and D indicates 2α (355, 532) + 3β (355, 532,1064) + 2δ (355, 532) HSRL-Raman lidar system.

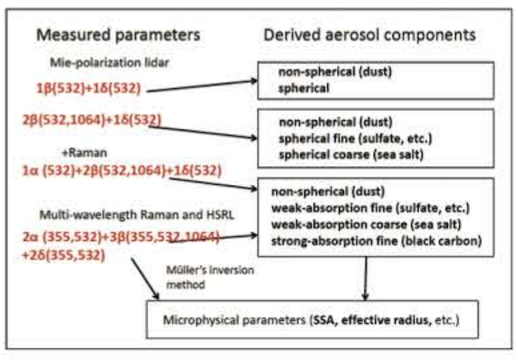
Multi-wavelength Raman lidar (3β+2α+1δ)

Schematic diagram

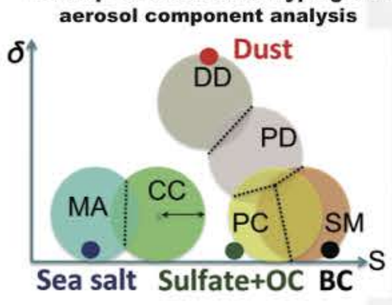




Aerosol component analysis method



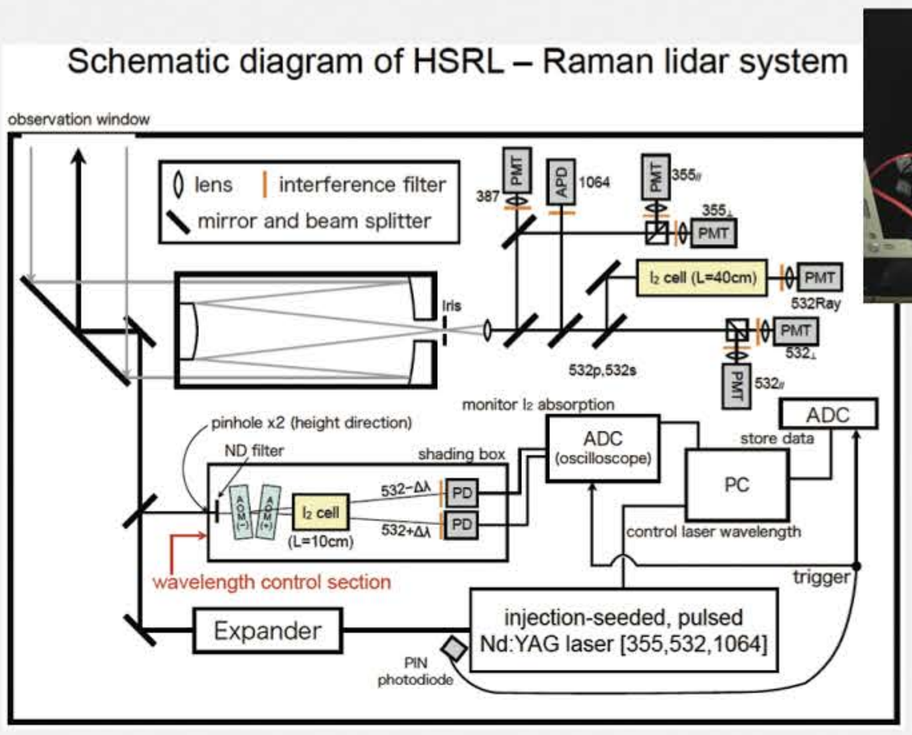
Concept of the aerosol typing and aerosol component analysis

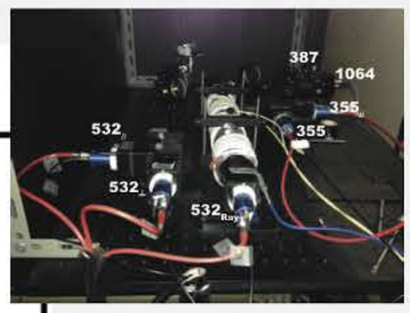


Sugimoto et al. (2014), SPIE

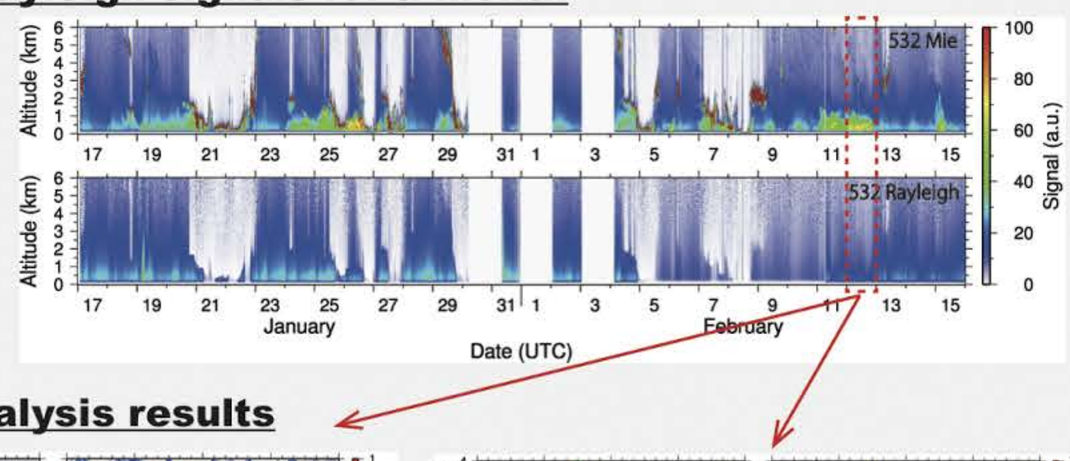
Continuou observation with HSRL – Raman lidar (3β+2α+2δ)

Schematic diagram of HSRL – Raman lidar system

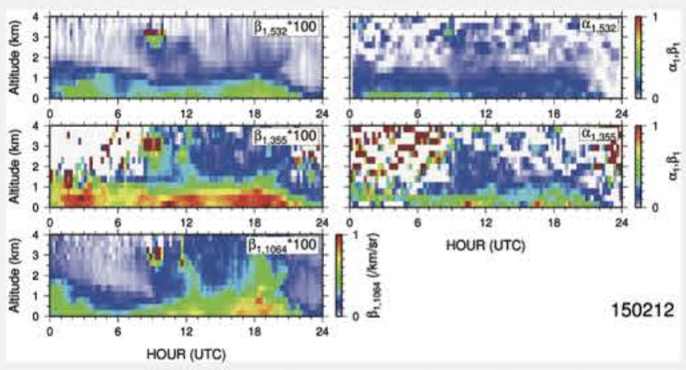


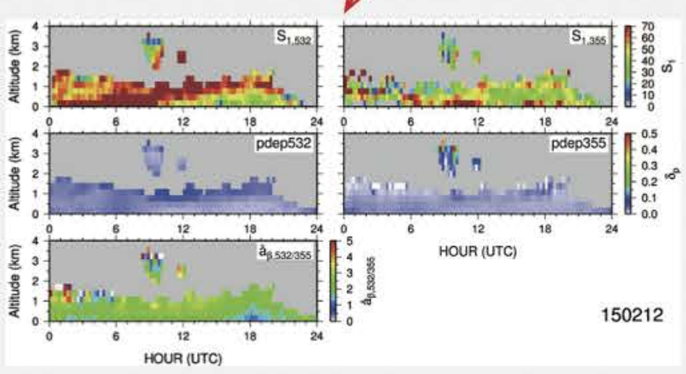


Rayleigh signals for a month

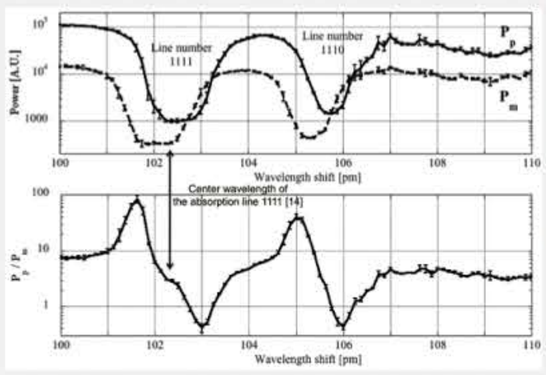


An example of analysis results

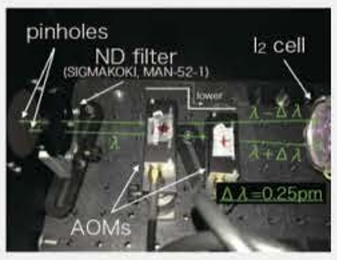


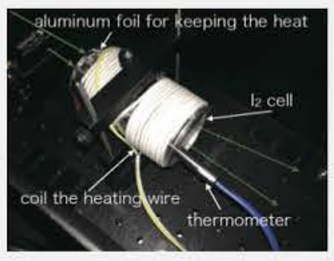


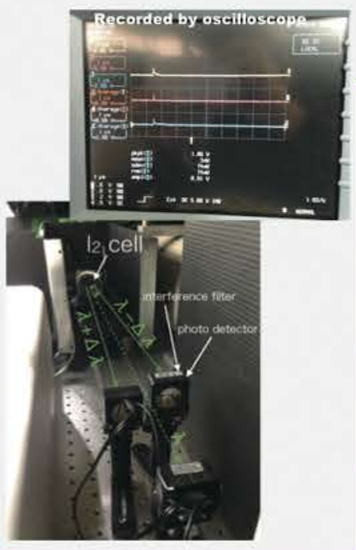
Laser wavelength tuning



Nishizawa et al. (2010), SPIE







References

[1] Sugimoto et al., 2014: Characterization of aerosols in East Asia with the Asian Dust and aerosol lidar observation network (AD-Net), Proc. of SPIE 9262, 92620K

[2] Nishizawa et al., 2012: Improvement of NIES Lidar Network Observations by Adding Raman Scatter Measurement Function, Proc. of SPIE Vol. 8526, 85260Q.

[3] Nishizawa et al., 2010: Development of a dual-wavelength high-spectral-resolution lidar, Proc. of SPIE Vol. 7860, 78600D.

[4] Shimizu et al., 2004: Continuous observations of Asian dust and other aerosols by polarization lidar in China and Japan during ACE-Asia, J. Geophys. Res., 109, D19S17, doi:10.