AD-Net and SAVER-Net lidar networks for validation of ATLID products

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Abstract

Ground-based lidar networks are the essential infrastructure for the validation of ATLID aerosol and cloud products. We have deployed the AD-Net lidar network at 20 sites in East Asia to continuously observe vertical profiles of clouds and aerosols. In South America, we have developed the SAVER-Net lidar network at 9 sites in the framework of a tri-national (Japan-Argentina-Chile) project. Both AD-Net and SAVER-Net have the same configuration as CALIOP, which has two-wavelength (532 and 1064 nm) elastic and one polarization (532 nm) channels. Almost 10 observation sites have a 355 nm lidar as ATLID. For the elastic lidar, extinction coefficients can be retrieved during daytime if optical thickness measurement is available from AERONET or SKYNET instrument. All the elastic lidar data can be used to verify the feature mask and atmospheric boundary layer height. There are three sites in AD-Net and SAVER-Net that have Raman lidars at ultraviolet wavelengths, respectively. A 355 nm high-spectral-resolution lidar (HSRL) is operational at the Koganei validation supersite since 2019. HSRL and Raman lidar can measure particle backscattering and extinction coefficients and particle depolarization ratio, allowing direct comparison to ATLID L2A products. In the presentation, we will introduce the lidar networks and show a data set of optical properties of aerosols and clouds measured by the 355 nm HSRL.

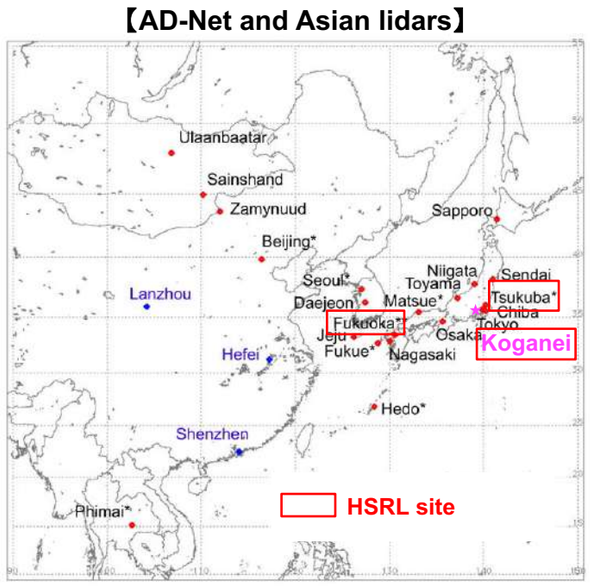
1. JAXA ATLID L2a product and validation method

Lidar networks (AD-Net in East Asia and SAVER-Net (South American Environmental Risk Network) in South America) are used to validate both release accuracy 9 months after launch and standard/target accuracy 3 years after launch. The ground-based lidars employ Mie-scattering lidar, High Spectral Resolution Lidar (HSRL), and Raman scattering lidar. Aerosol optical thickness data from SKYNET and AERONET are also used to estimate the extinction coefficient from the Mie-scattering lidar with the constrained method. Comparison with other satellites (CALIPSO and ADM-Aeolus) will be performed as necessary due to the risk of insufficient number of match-up data points. The accuracy will be evaluated by conducting statistical analysis of the match-up data between ground and satellite. JAXA ATLID research products are also the target of validation.

Parameter	Data for validation	Validation method (evaluation period 3~6M)
Feature Mask	AD-Net, SAVER-Net	Direct and statistical comparison with Mie/Raman scattering lidar and HSRL
	CALIPSO, ADM-Aeolus	Direct and statistical comparison with a match-up dataset
Target Mask	AD-Net	Direct and statistical comparison with target mask estimated from HSRL and Raman scattering lidar
	CALIPSO, ADM-Aeolus	Direct and statistical comparison with match-up dataset
Extinction coefficient	AD-Net	Direct and statistical comparison with Mie/Raman scattering lidar and HSRL
	SKYNET, AERONET	Compare with vertically integrated extinction coefficients
	CALIPSO, ADM-Aeolus	Direct and statistical comparison with match-up dataset
Backscattering coefficient	AD-Net	Direct and statistical comparison with Mie/Raman scattering lidar and HSRL
	CALIPSO, ADM-Aeolus	Direct and statistical comparison with match-up dataset
Lidar ratio	AD-Net	Direct and statistical comparison with Mie/Raman scattering lidar and HSRL
	ADM-Aeolus	Compare with lidar ratio estimated from Aeolus's extinction and backscatter
Depolarization ratio	AD-Net, SAVER-Net	Direct and statistical comparison with Mie/Raman scattering lidar and HSRL
	CALIPSO	Direct and statistical comparison with match-up dataset
Planetary boundary layer height	AD-Net	Direct and statistical comparison with Mie/Raman scattering lidar and HSRL

2. Validation facilities

【AD-Net and Asian lidars】



Mie/Raman lidar (MRL)

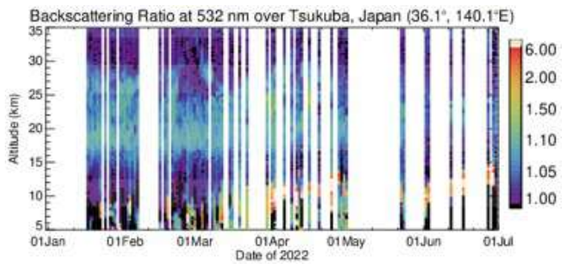
Mie-scattering lidar (ML)

Observation instrument and products for validation

Obs. site	Lat Lon	Instrument	Parameter
Koganei (Urban)	35.7N 139.48E	**355 HSRL (2019~) 355MFMSPL 355DWL**	**α**, **β**, **δ**, **S**: 355 (Day & Night) Attenuated backscatter: 355 (Day & Night) Attenuated backscatter: 355 (Day & Night) (Multiple scatter) Vertical wind
Tsukuba (Rural)	36.05N 140.12E	**HSRL**[*1] **(NIES)**	**α**, **β**, **δ**, **S**: 355 (Day & Night) **α**, **β**, **δ**, **S**: 532 (Day & Night) Attenuated backscatter: 355/532/1064 (Day & Night)
		ML (MRI)	**β**, **δ**: 532 (Day & Night) Attenuated backscatter: 532 (Day & Night)
Fukuoka (Rural-Urban)	33.52N 130.48E	**MRL =>MRHSRL (2021~)**	**α**, **β**, **δ**, **S**: 355 (Night) **α**, **β**, **δ**, **S**: 532 (Day & Night) *2021~ Attenuated backscatter: (Day & Night)
Hedo (Maritime)	26.87N 128.25E	**MRL**	**α**, **β**, **δ**, **S**: 355/532 (Night) Attenuated backscatter: 355/532/1064 (Day & Night)
Toyama (Rural)	36.7N 137.1E	**MRL**	**α**, **β**, **δ**, **S**: 355/532 (Night) Attenuated backscatter: 355/532/1064 (Day & Night)
Palau (Maritime)	7.34N 134.5E	**MRL**[*2] **(2019~)**	**α**, **β**, **δ**, **S**: 355/532 (Night) Attenuated backscatter: 355/532/1064 (Day & Night)
RV Mirai (Maritime)	Ocean	**MRL**	**α**, **β**, **δ**, **S**: 355/532 (Night) Attenuated backscatter: 355/532/1064 (Day & Night)
11 stations in East Asia		**ML**	Attenuated backscatter: 532/1064 (Day & Night) Total depolarization ratio: 532 (Day & Night)

*1) Transition to 355/532 HSRL from 2020. Intermittent measurements are being taken while improvements are being made; continuous measurements will be made during the mission after launch. *2) Palau site is scheduled to close in 2024 and is being considered for relocation.

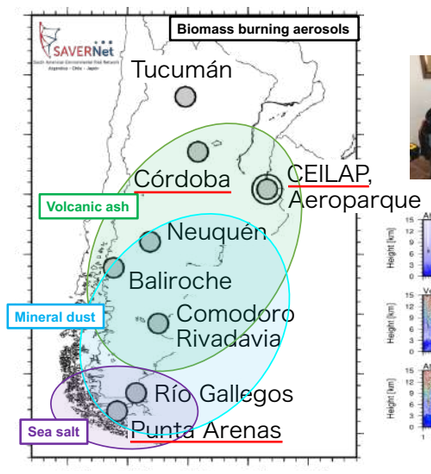
Stratospheric aerosol observation with MRI lidar at Tsukuba



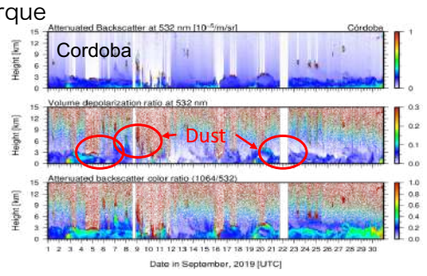
Shipborne lidar observation (JAMSTEC's research vessel Mirai)

Shipborne lidar observations have been conducted for many years by JAMSTEC's research vessel Mirai, which is equipped with a Raman scattering lidar. The observation schedule after EarthCARE launch has not yet been determined. When shipboard observations are conducted, the data will be used for validation of the offshore ATLID product in collaboration with JAMSTEC. The validation method will be the same as that for the ground-based Raman scattering lidar

【SAVER-Net lidar network in Argentina and Chile】

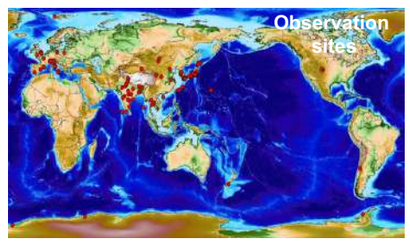


Cordoba Lidar

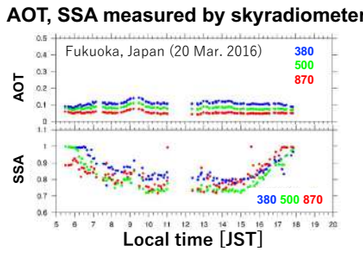


Obs. site	Lat Lon	Instrument	Parameter
Tucuman	26.8S 65.2W	**ML**	Attenuated backscatter with Depolarization 532/1064 (Day & Night)
Aeroparque	34.6S 58.4W	**ML**	Attenuated backscatter with Depolarization 355/532/1064 (Day & Night)
Cordoba	31.7S 63.9W	**ML**	Attenuated backscatter with Depolarization 355/532/1064 (Day & Night)
Neuquen	39.0S 68.1W	**ML**	Attenuated backscatter with Depolarization 532/1064 (Day & Night)
Bariloche	41.1S 71.2W	**ML**	Attenuated backscatter 532/1064 (Day & Night)
Comodoro Rivadavia	45.8S 67.5W	**ML**	Attenuated backscatter with Depolarization 532/1064 (Day & Night)
Punda Arenas	34.6S 58.5W	**ML**	Attenuated backscatter with Depolarization 355/532/1064 (Day & Night)

【SKYNET】



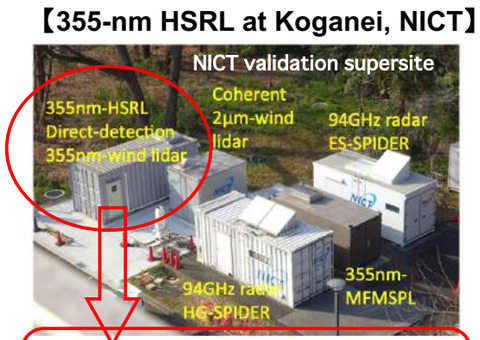
AOT, SSA measured by skyradiometer

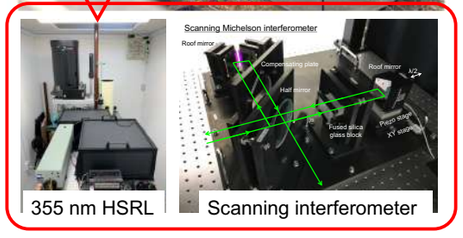


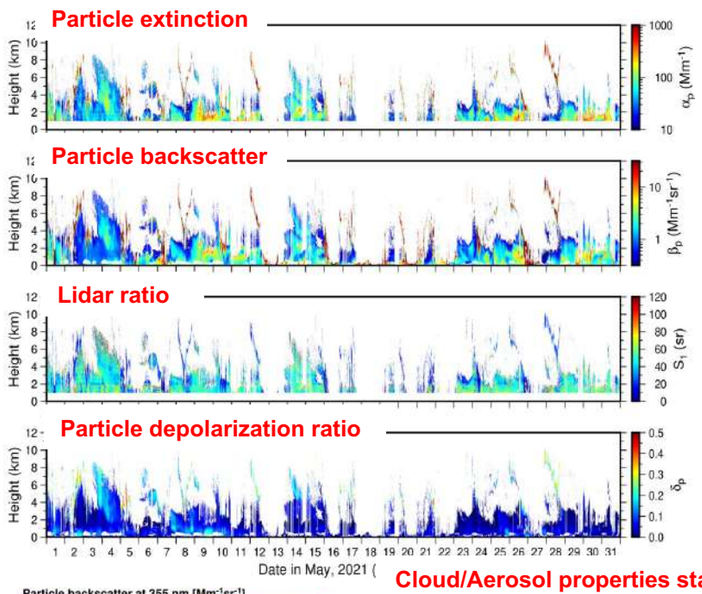
Skyradiometer (by Prede co, Japan)
✓Sun-scanning sunphotometer
✓Measured wavelengths:
315, 340, 380, 400, 500, 675, 870, 940, 1020, 1627, 2200nm
✓Data recorded every 10~15min
✓Derived parameters:
AOT, **Angstrom exponent, SSA, Size distribution, Refractive index**

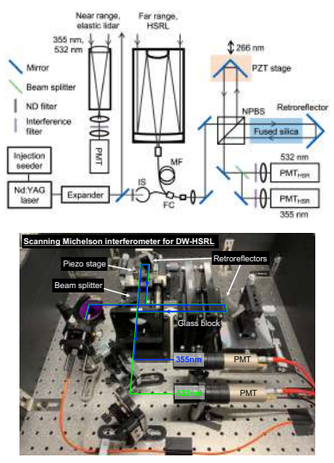
3. HSRL measurement at Koganei, Tsukuba, and Fukuoka

【355-nm HSRL at Koganei, NICT】

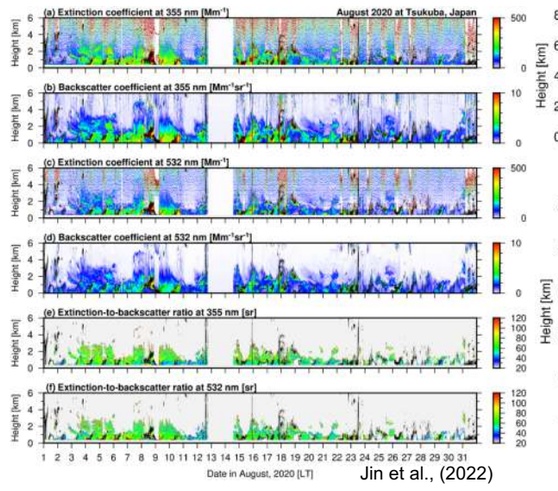




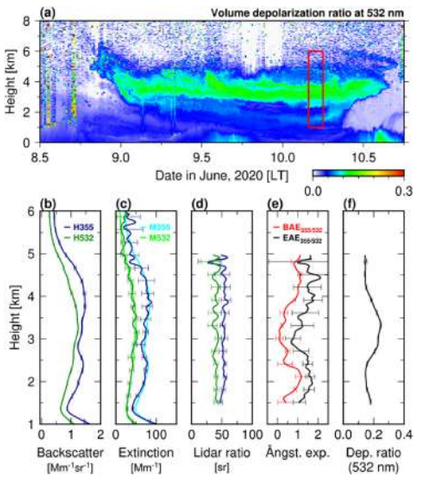




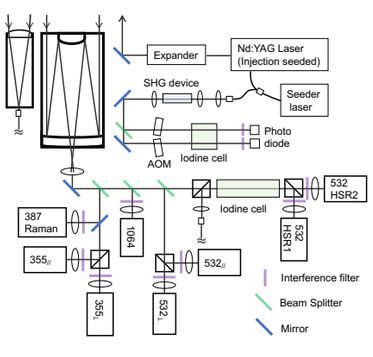
【Dual-wavelength HSRL (355/532) at Tsukuba, NIES】

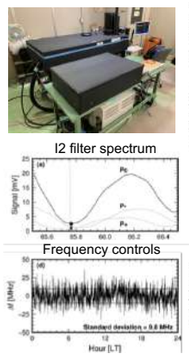


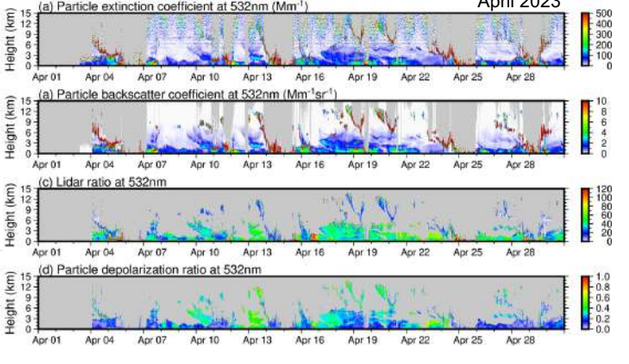
Jin et al., (2022)



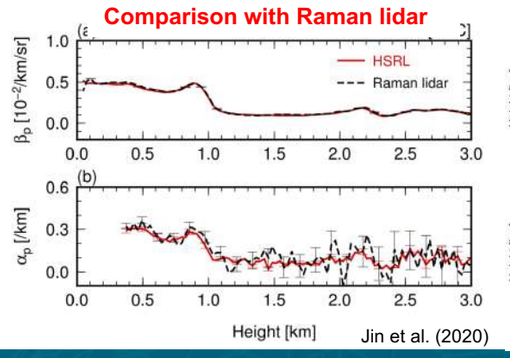
【532-nm HSRL at Fukuoka, Kyushu University】



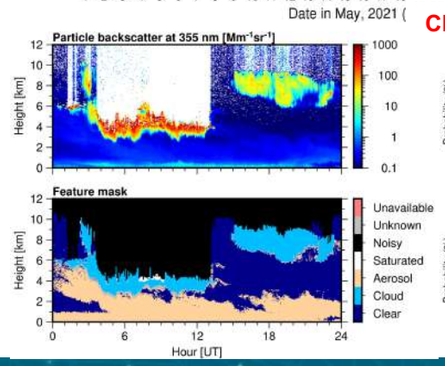




Comparison with Raman lidar



Jin et al. (2020)



Cloud/Aerosol properties statistics