Current Status of the Asian Network of Pandora and Future Plans

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T. Chuentragun, K. Limpakom, E. S. Adiningsih, G. J. Perez, S. Ganjuur, V. Phomsouvah, R. Macatangay, N. Thongboonchoo, P. Lestari, J. Bernard, B. Simpas, T. T. Hien, S. Erdene, M. T. Latif, S. Salinas, T. Moolchan, N. Kitratporn, S. Phoompanich, Risyanto, E. Adetya, A. Veloria, A. J. Sabuito, T. P. Thi, N. A. N. Thi, E. Davaanyam, U. Delgermaa, M. Chittaphong, S. Douangphachan, H. Chandath, Y. Narith

GEMS STM, 11 November 2022, Incheon, Republic of Korea

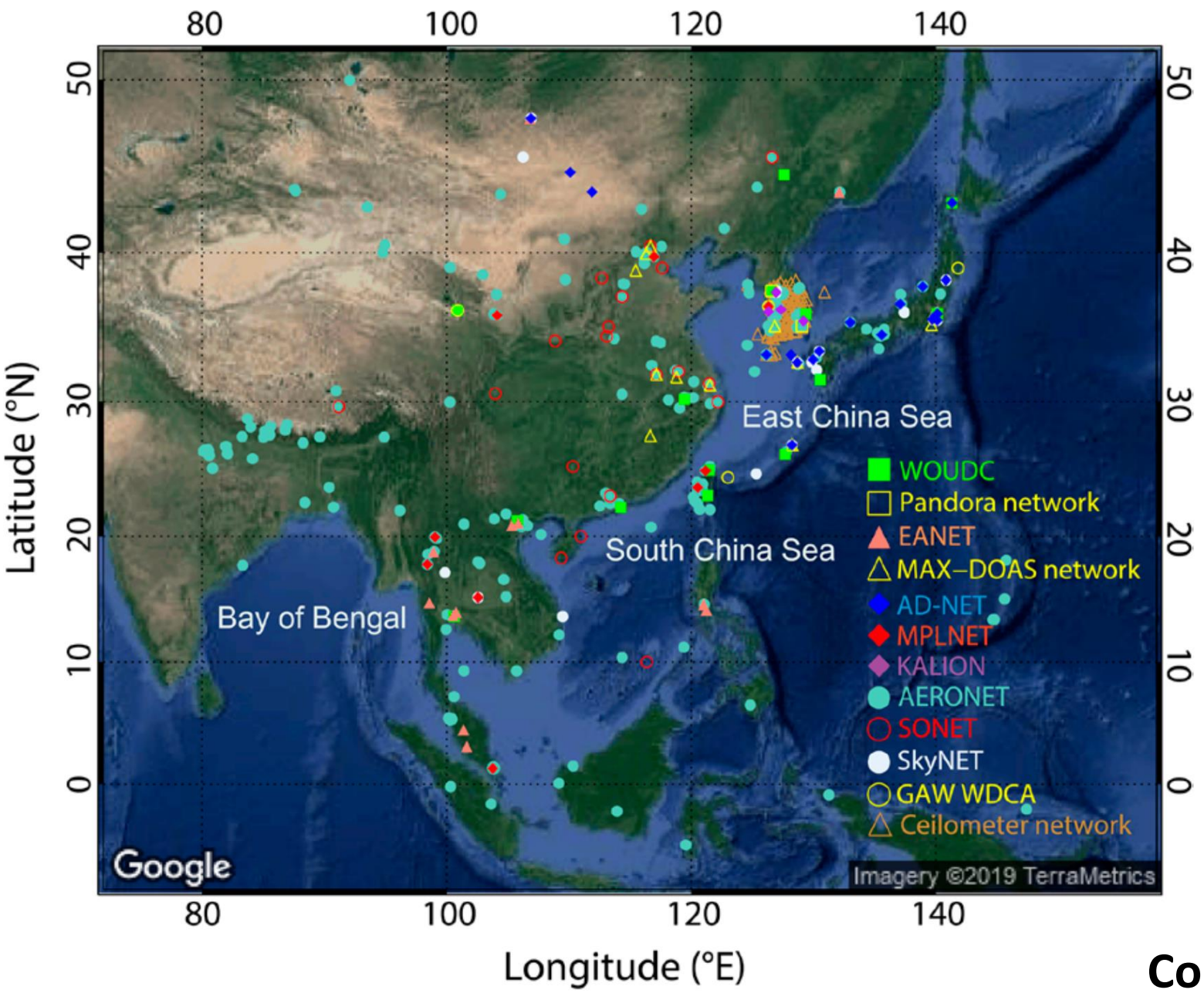


Fig. 7. Validation network for aerosols and trace gases within GEMS domain.

So far, we have a fare amount of ground-based networks over Asia.

But wasn't enough to validate/assess trace gas products from the GEMS

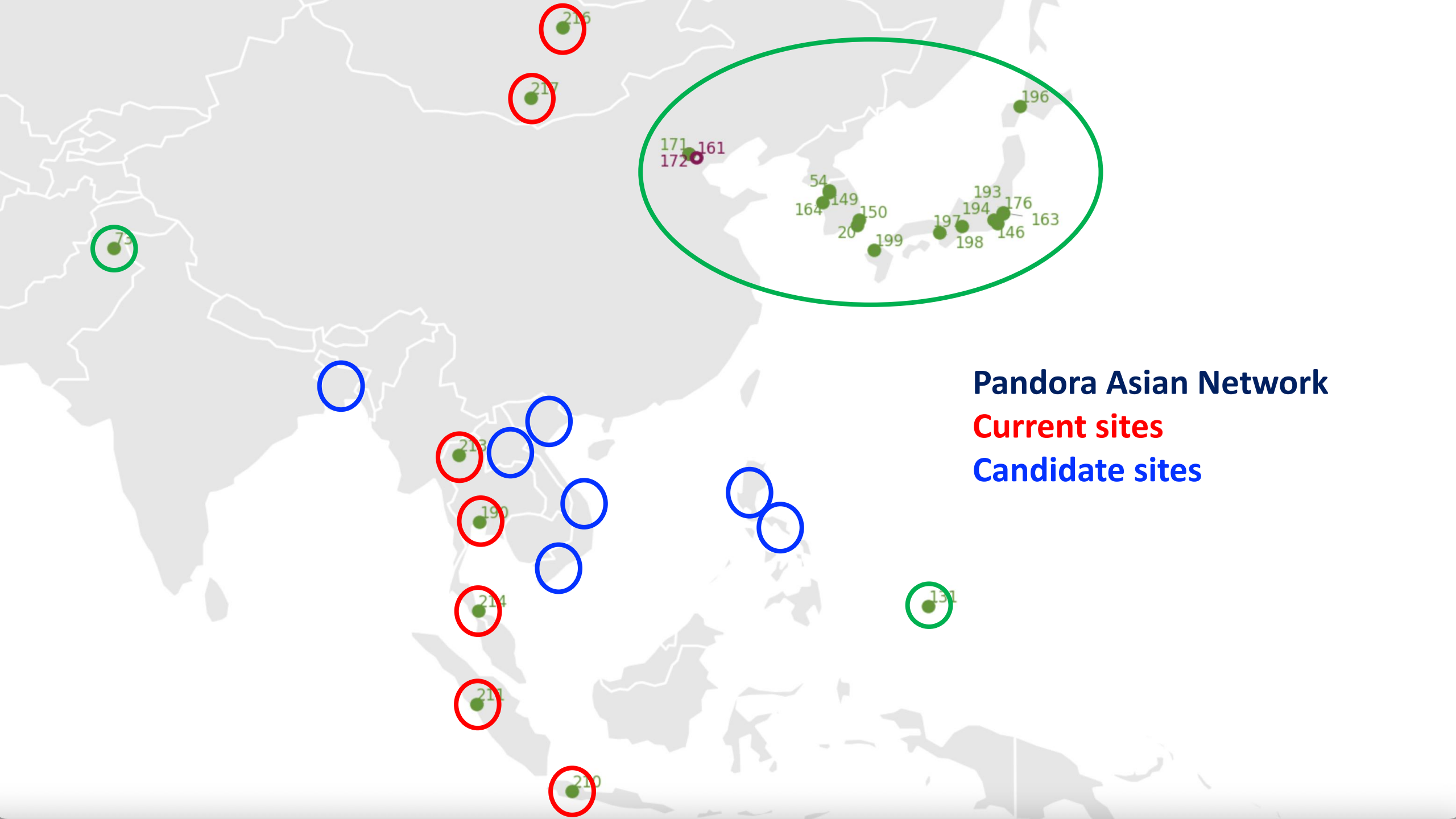
→ Korean government (NIER, KOICA) decided to donate over 20 Pandora instruments to Asian countries

Courtesy of Jhoon Kim et al. (2020)

Milestones of each site

Site		Delivery	Site Check	Installation Training	Installation	Initial Setup	Data Transfer	Completed
Mongolia	Ulaanbaatar	✓	✓	✓	✓	✓	✓	✓
	Dalanzadgad	✓	✓	✓	✓	✓	✓	✓
Indonesia	Bandung	✓	✓	✓	✓	✓		
	Agam	✓	✓	✓	✓	✓		
	Pontianak	✓	✓	✓				
Cambodia	Phnom Penh	✓	✓	✓	✓			
Thailand	Bangkok	✓	✓	✓	✓	✓	✓	✓
	Chiang Mai	✓	✓	✓	✓			
	Song Khla	✓	✓	✓	✓	✓		
Laos	TBD (1 sites)							
Bangladesh	TBD (1 sites)							
Vietnam	TBD (3 sites)							
Philippines	TBD (2 sites)							

Looking for additional sites, Most of the stations are to be completed by early 2023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73
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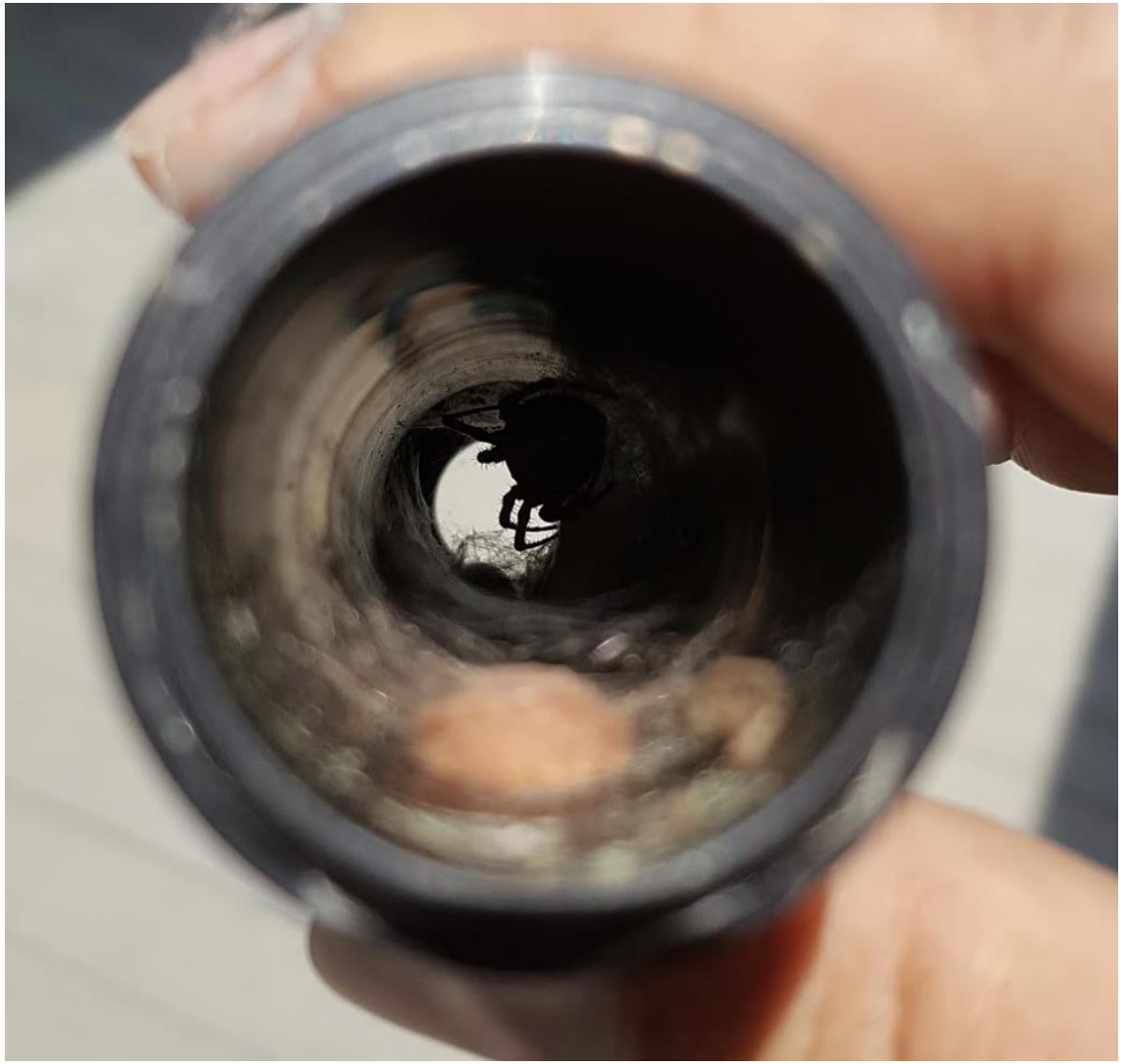
214
131
211
210
Pandora Asian Network
Current sites
Candidate sites

We don’t want to measure SPIDER optical depth or SPIDER column density !!!



$$\tau_{Atmos} = \tau_{cld} + \tau_{aer} + \tau_{gas} + \tau_{Spider}$$

It’s NOT just about science and technology, it is about people who are taking care of the instruments !!!

UN/ESCAP Capacity Building Training Programme

- Asian Participants
- Pandora operation and data handling
- Science and applications

Future Plans: NIER as the Asian Hub of the PGN, and for providing AEROSOL inversions to the Asian community

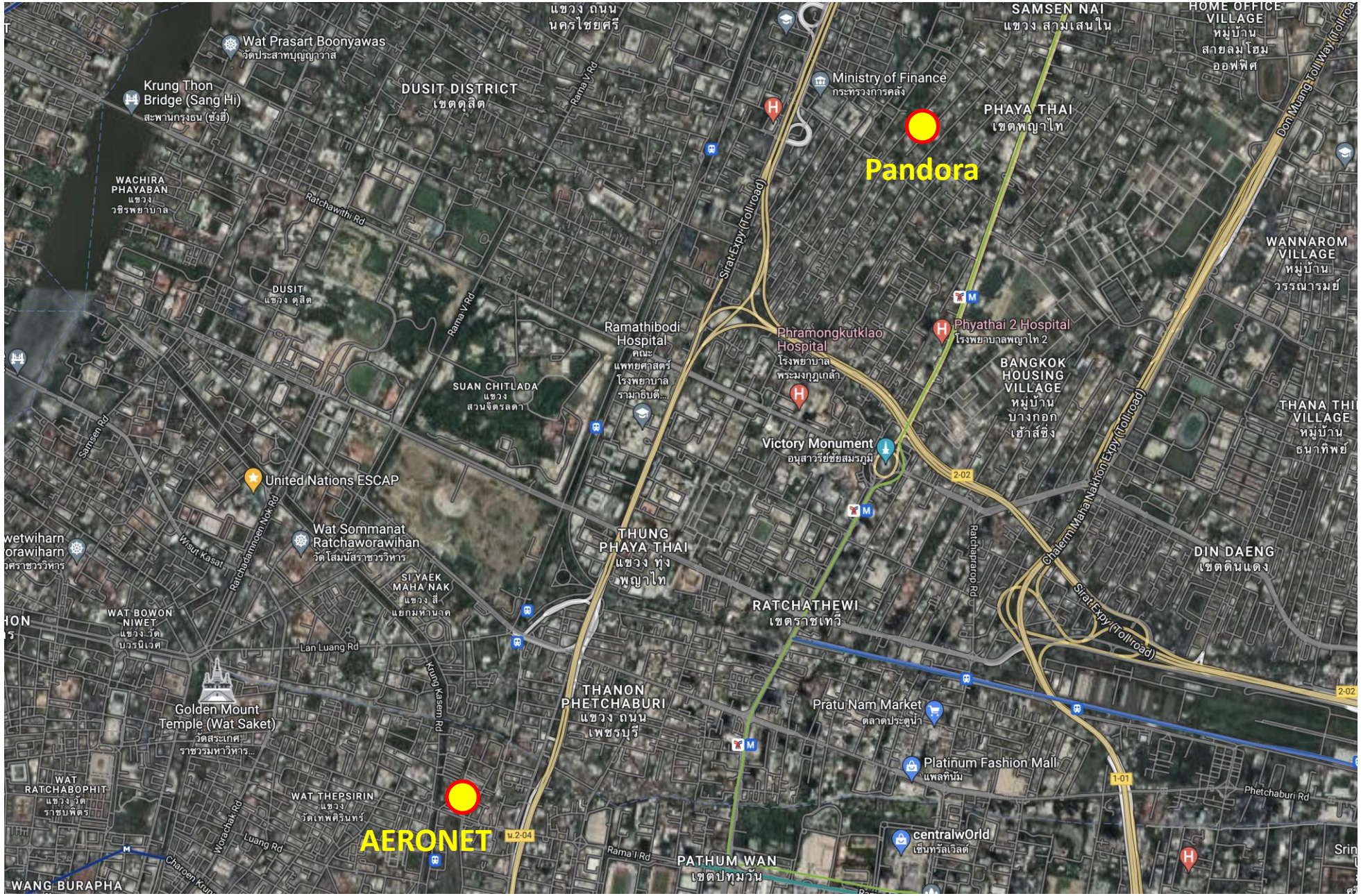
- Installation of the pandoras in candidate countries

- Host instrument operation and application training sessions by collaboration with the UN/ESCAP

- Establish calibration facilities in the NIER (both for trace gases and aerosols)

- Provide aerosol inversions from the network instruments (aerosol algorithm processed by the NIER)

Comparison of AOT from AERONET and Pandora measured in Bangkok (~5 km apart)



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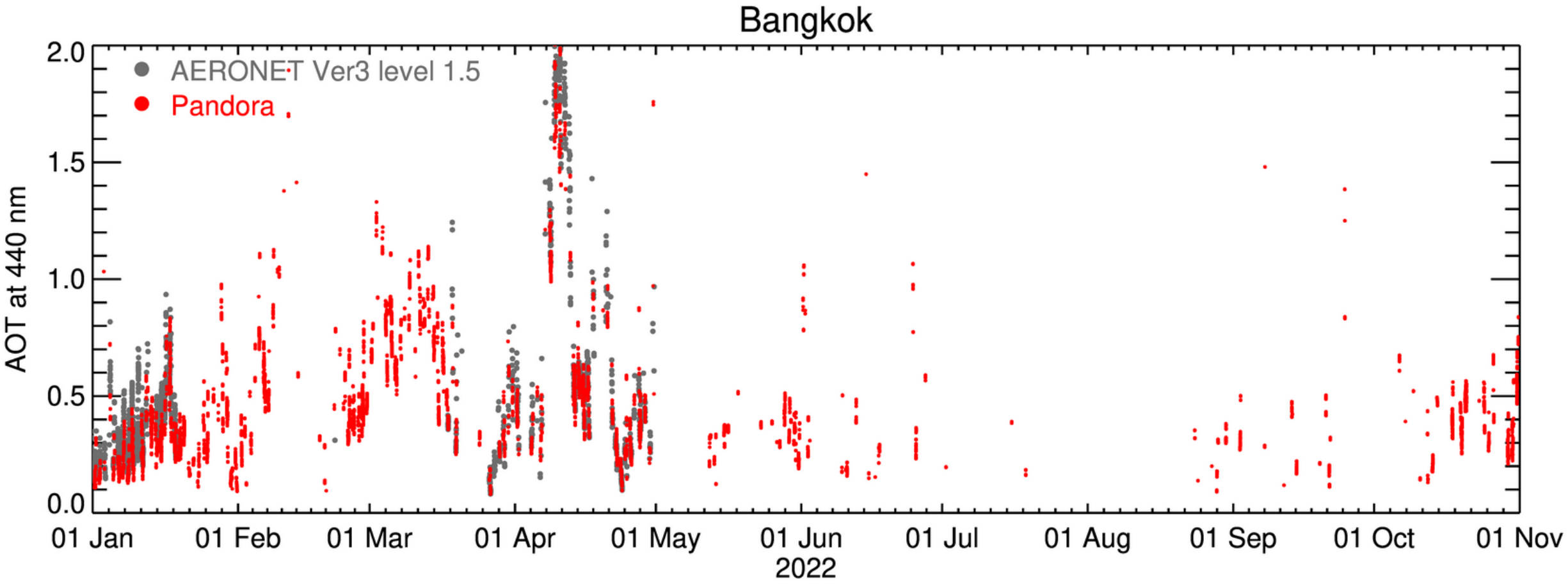
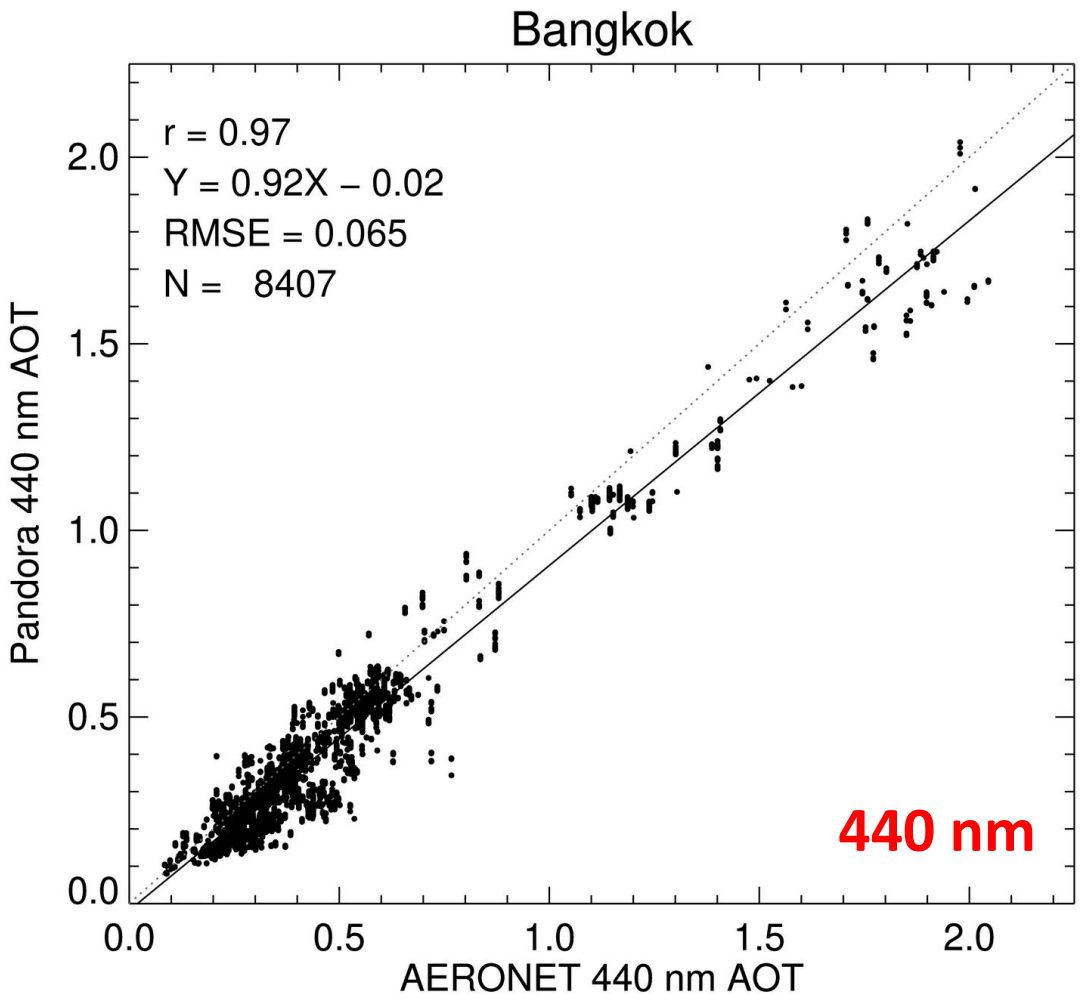
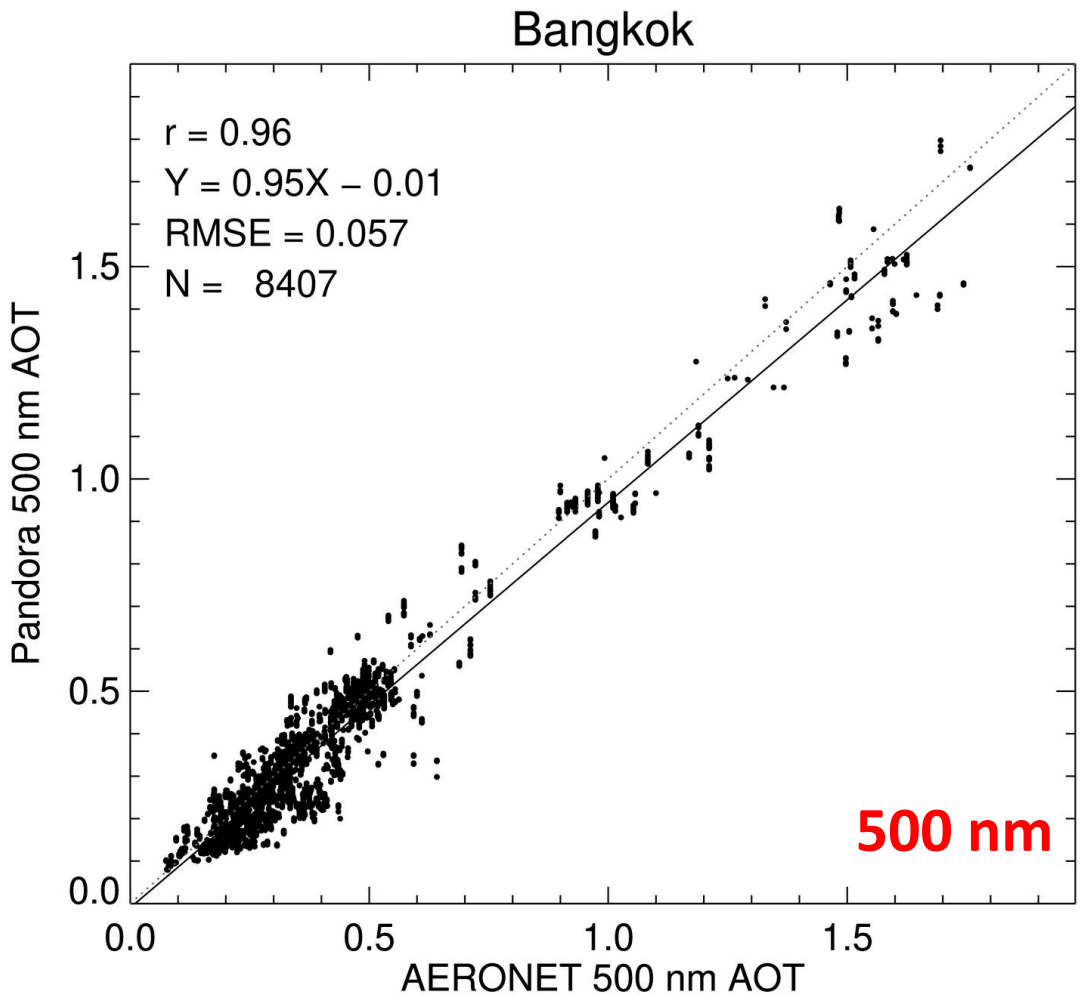
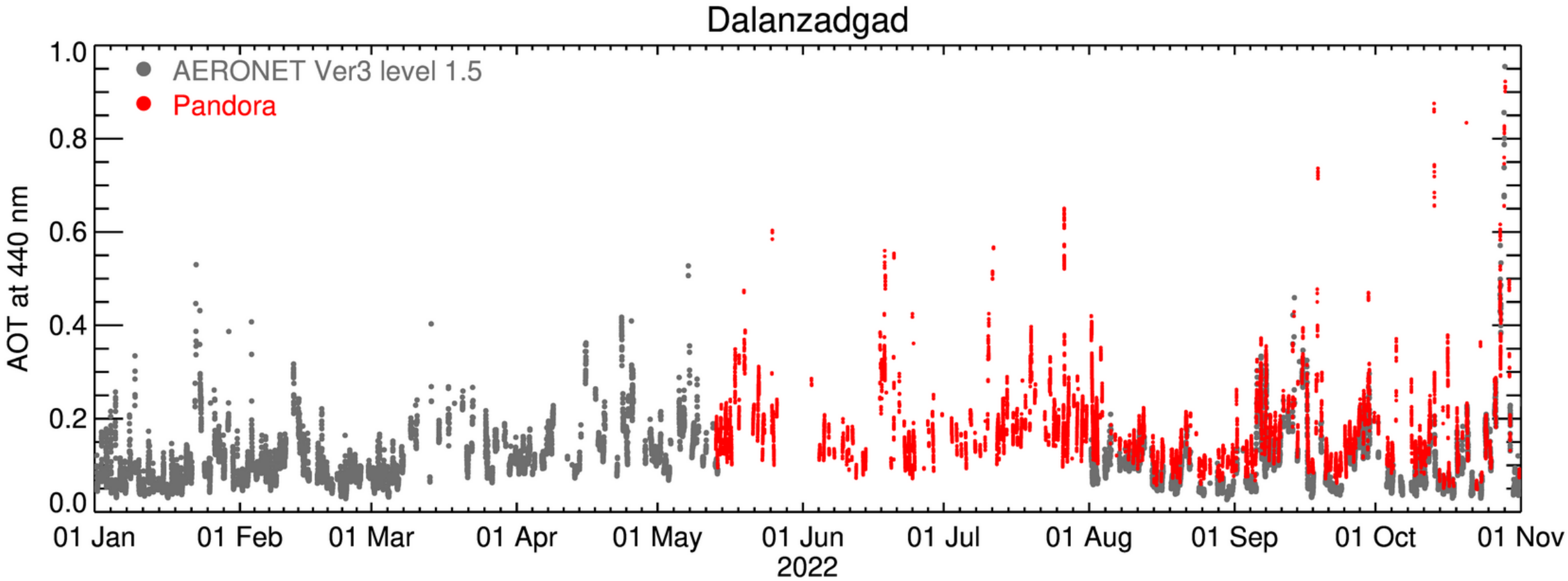


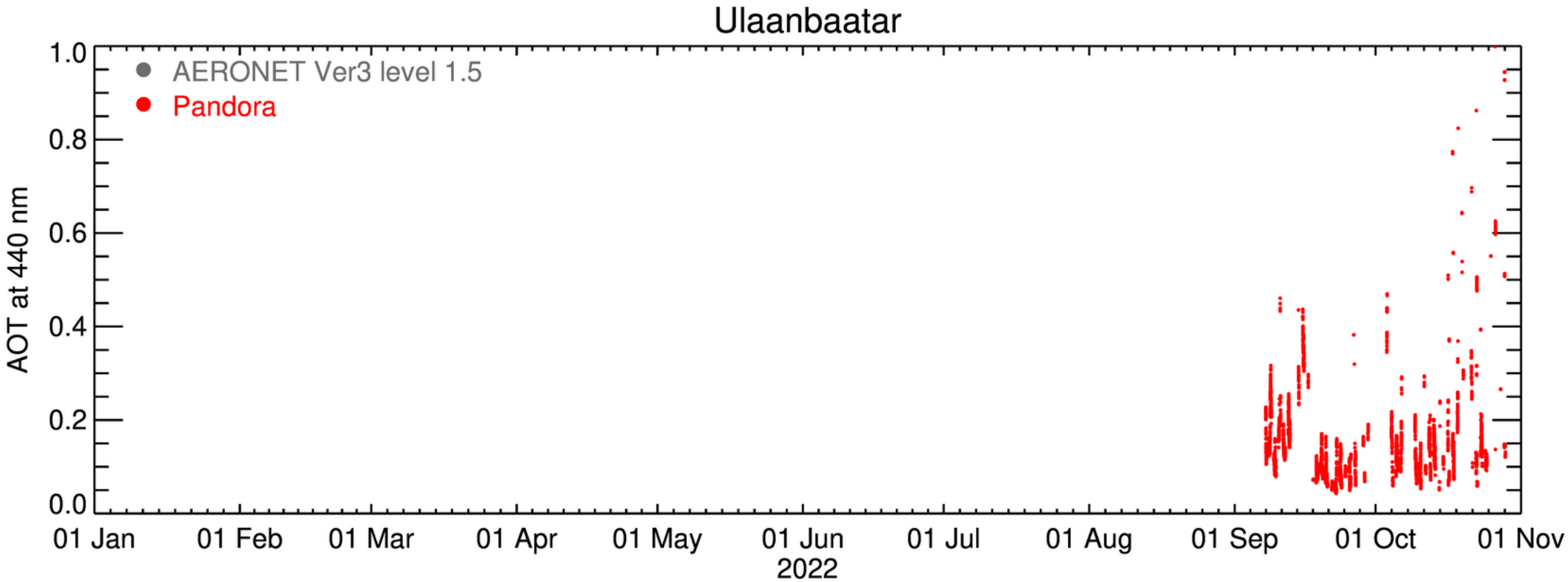
Validation of Pandora AOT with that of collocated AERONET at Dalanzadgad, Mongolia





Comparison of AOT from AERONET and Pandora measured in Dalanzadgad (collocated)


Dalanzadgad
AERONET Ver3 level 1.5
Pandora
AOT at 440 nm
1.0
0.8
0.6
0.4
0.2
0.0
01 Jan
01 Feb
01 Mar
01 Apr
01 May
01 Jun
2022
01 Jul
01 Aug
01 Sep
01 Oct
01 Nov


Ulaanbaatar
AERONET Ver3 level 1.5
Pandora
AOT at 440 nm
1.0
0.8
0.6
0.4
0.2
0.0
01 Jan
01 Feb
01 Mar
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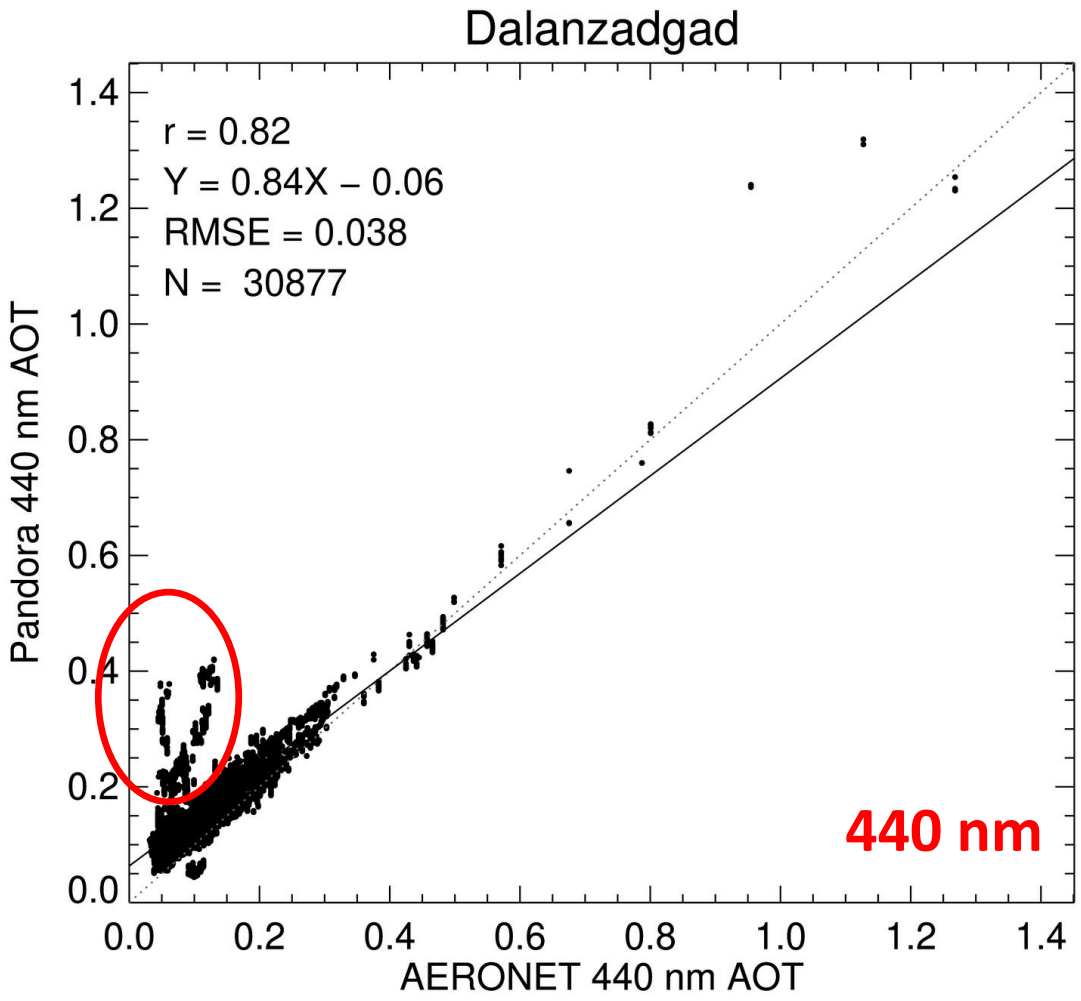
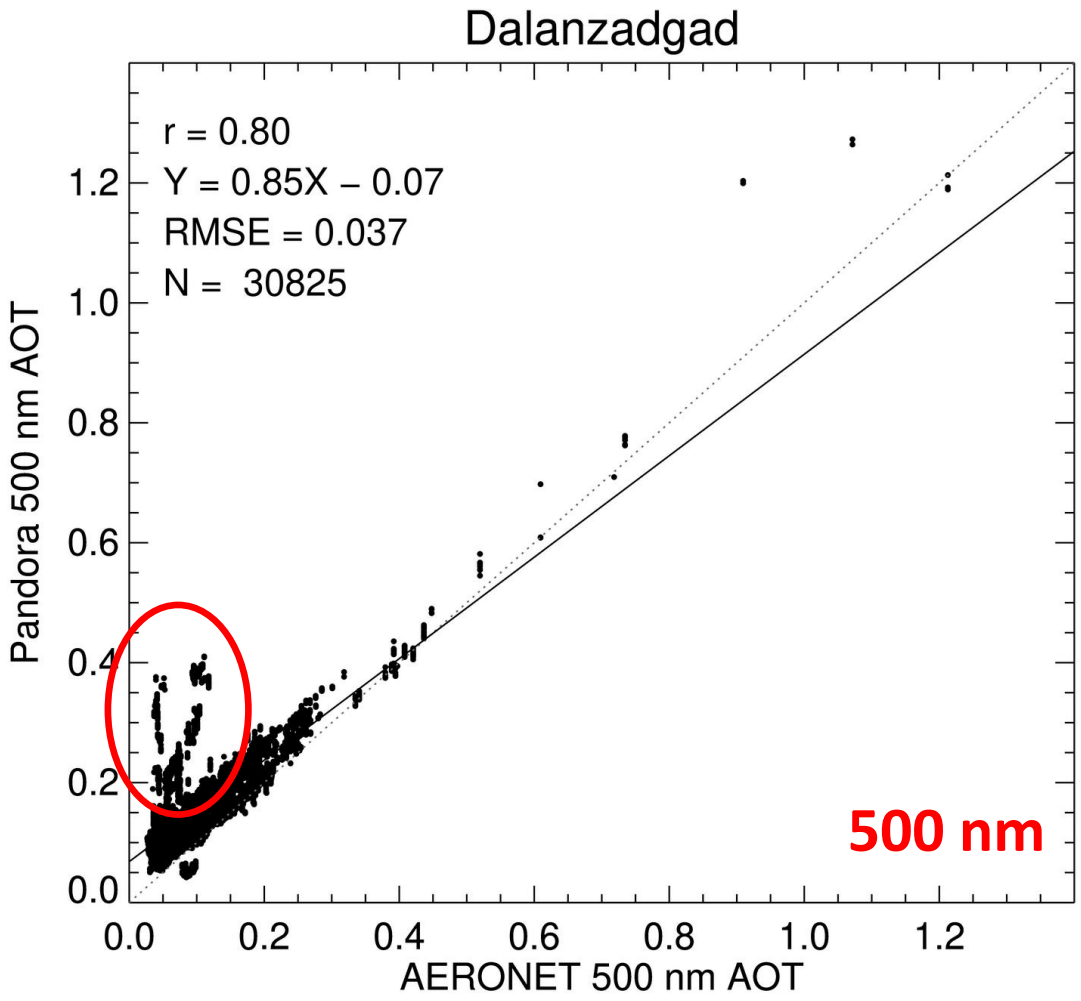
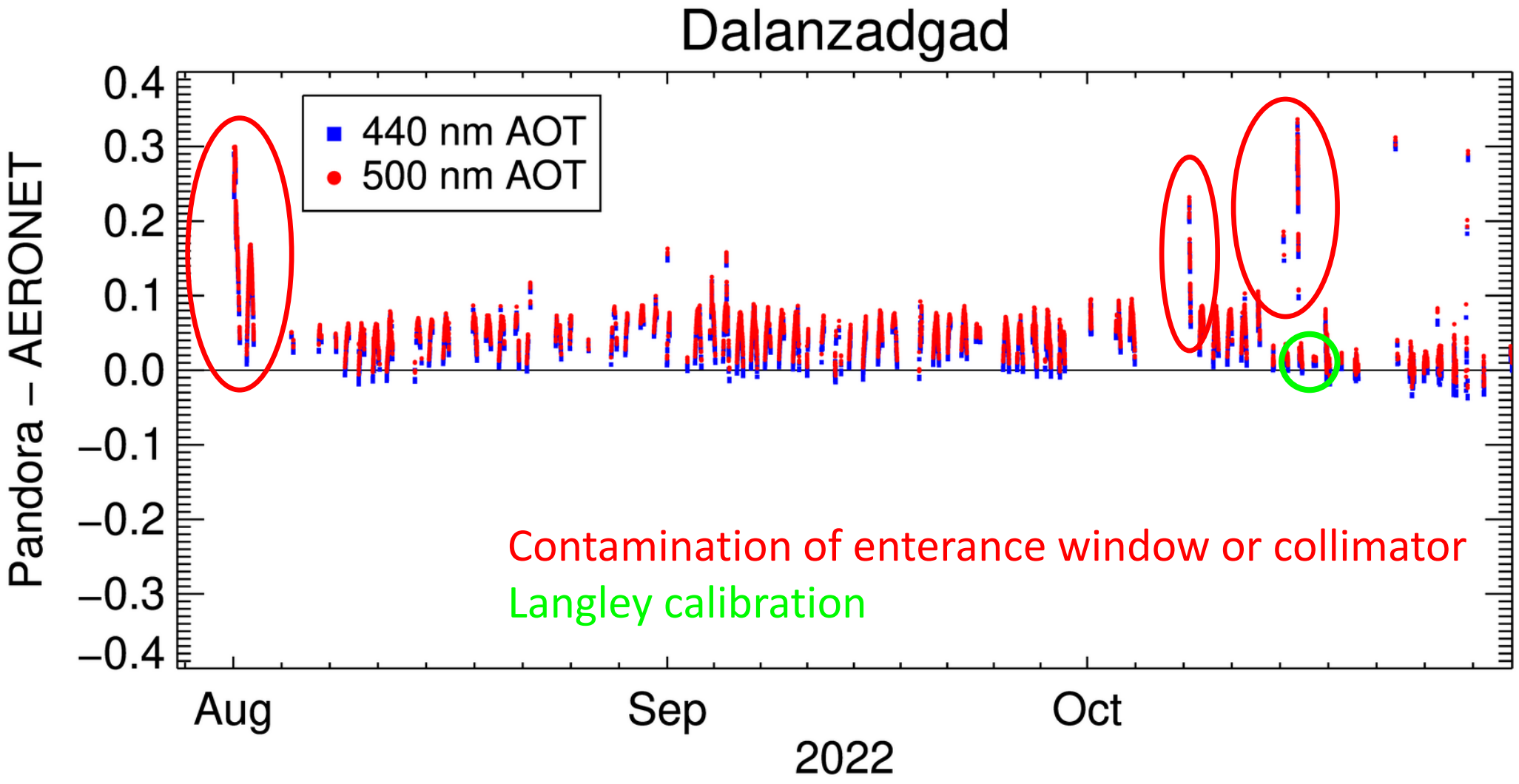
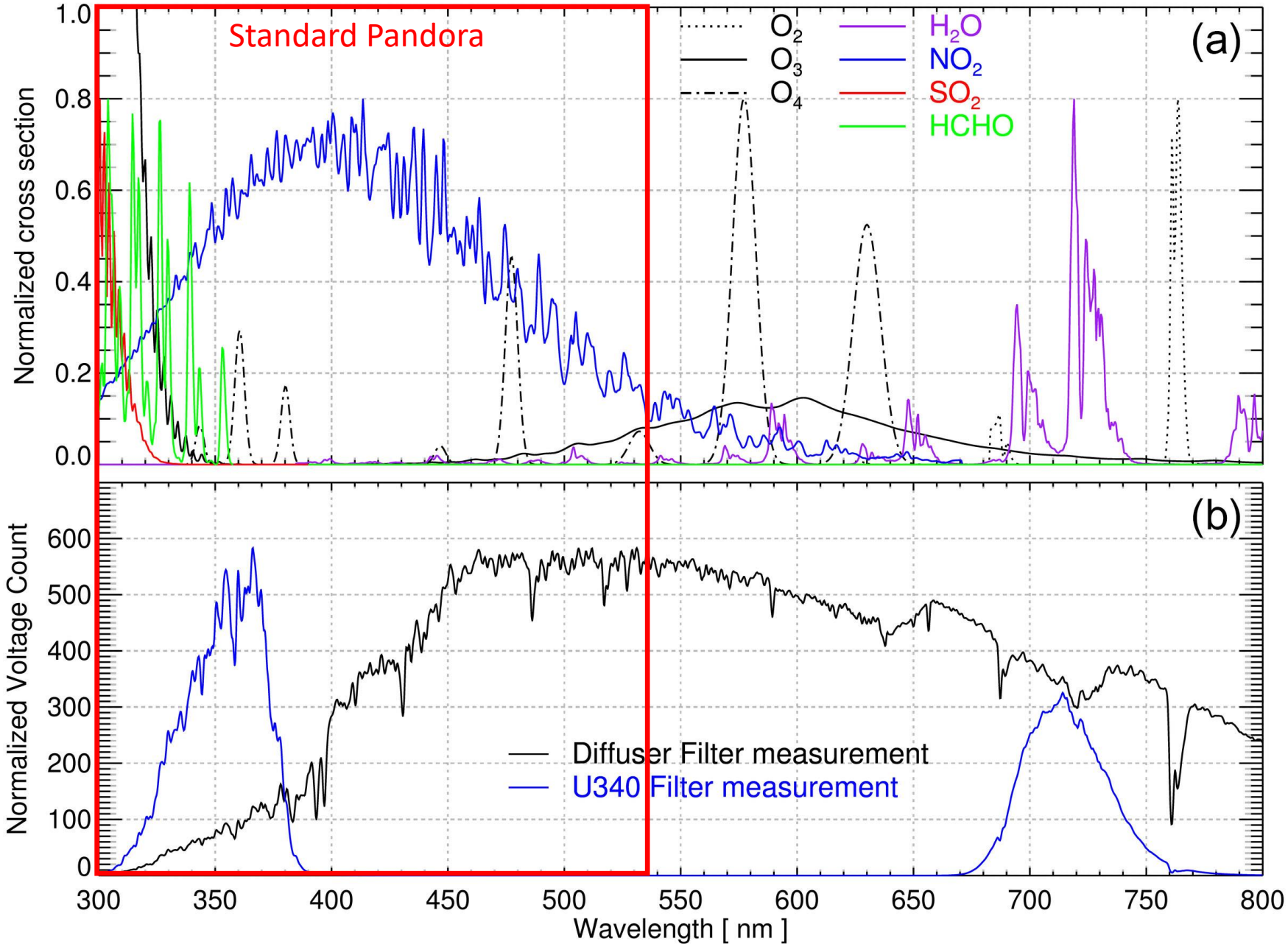
Validation of Pandora AOT with that of collocated AERONET at Dalanzadgad, Mongolia






Dalanzadgad
440 nm AOT
500 nm AOT
Pandora – AERONET
0.4
0.3
0.2
0.1
0.0
−0.1
−0.2
−0.3
−0.4
Aug
Sep
Oct
2022
Contamination of enterance window or collimator
Langley calibration

Aerosol inversions from the extended-range Pandora (SMART-s)



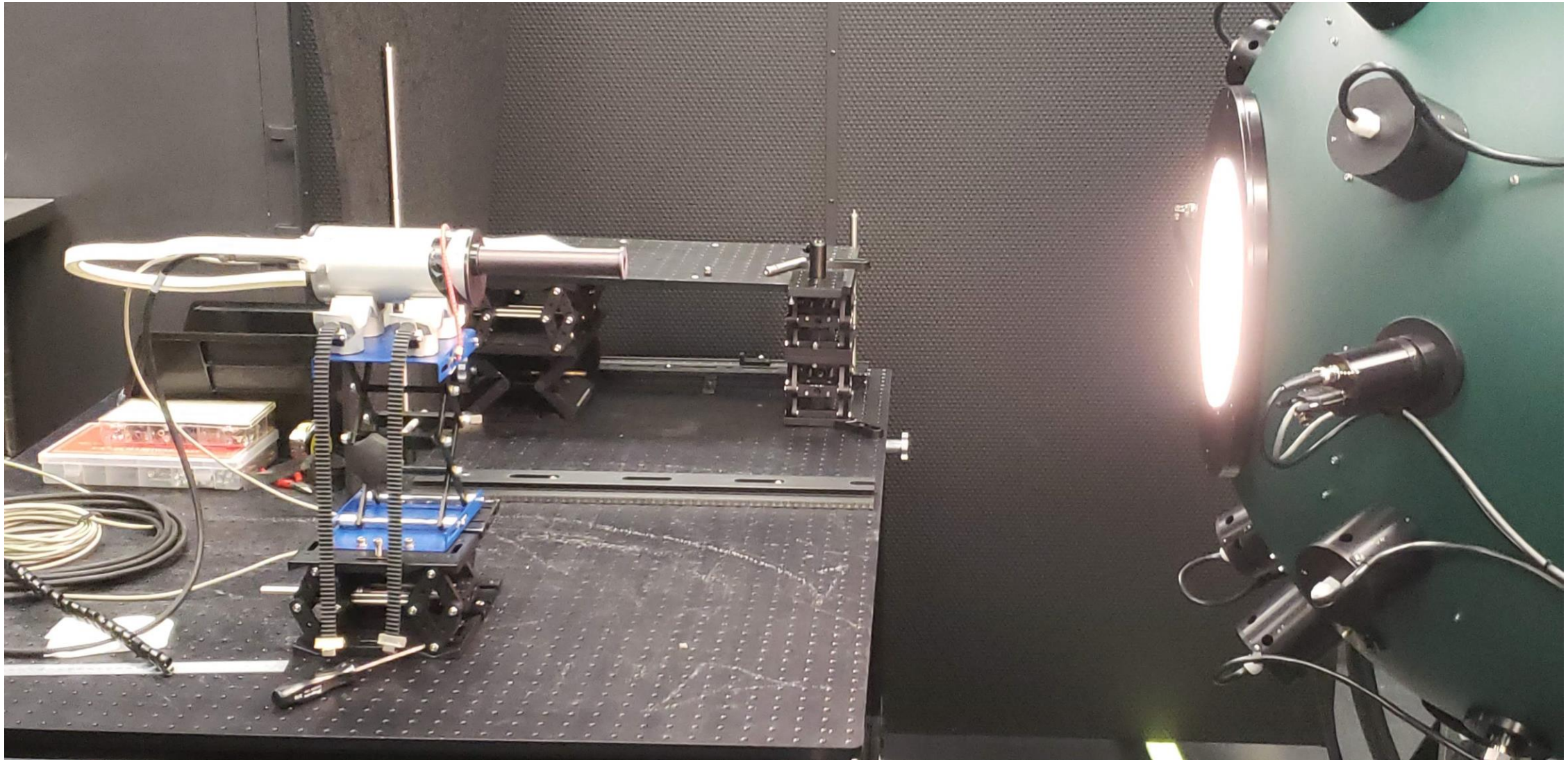
Standard Pandora
Spectral range: 270 – 580 nm
Spectral resolution: 0.6 nm
Sampling resolution: 0.13 nm
Products: **O_3, NO_2, SO_2, HCHO**
Research products: **AOT**

Extended-range Pandora
Spectral range: 280 – 820 nm
Spectral resolution: 1.1 nm
Sampling resolution: 0.26 nm
Products: **O_3, NO_2, H_2O, Aerosol (AOT + other properties)**
→ **Optimized for aerosol retrieval**

NIER is establishing the SMART–s network, and data will be available through the website (currently under preparation).

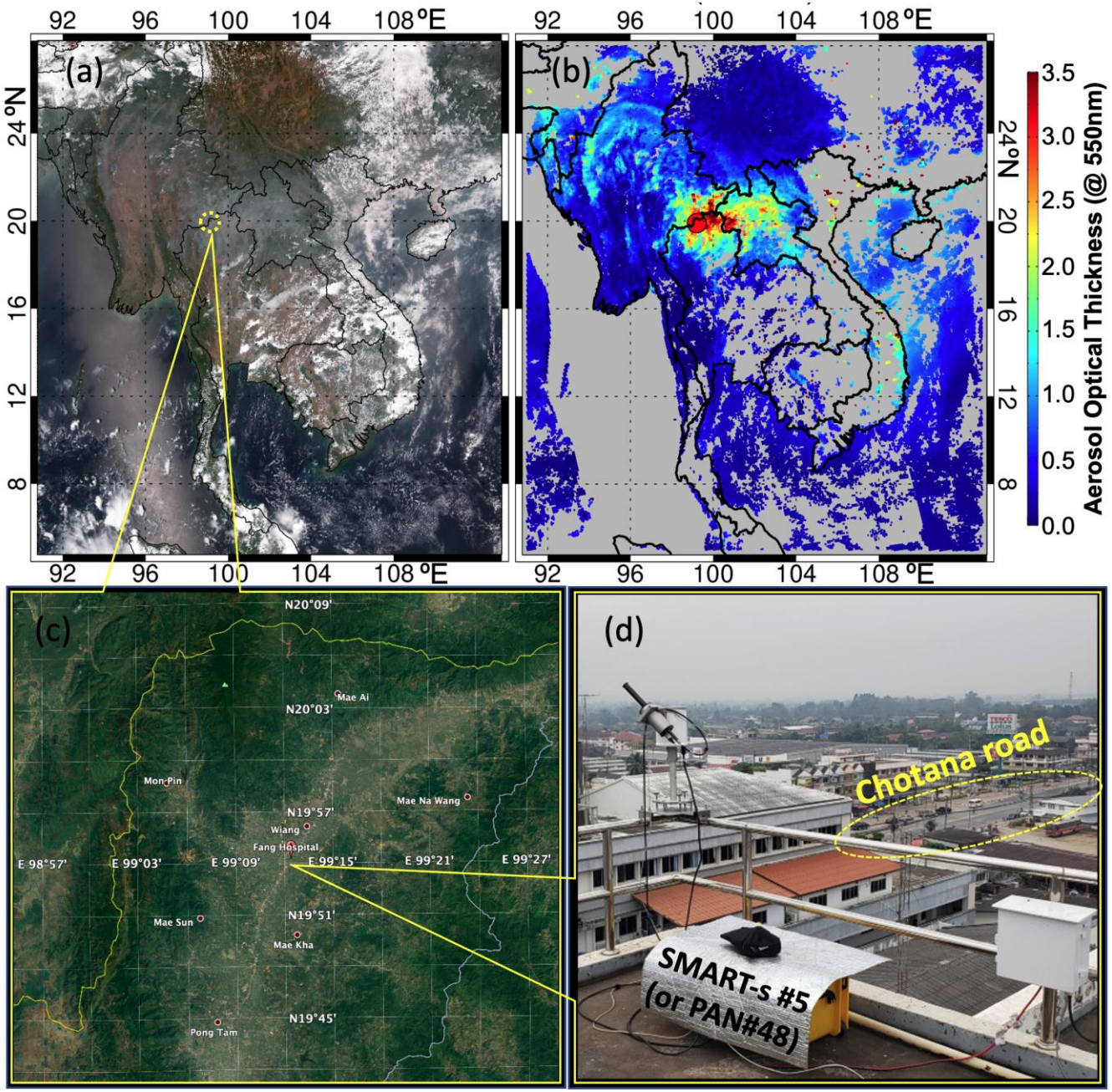
SMART–s: Spectral Measurements for Atmospheric Radiative Transfer – spectroradiometer (Jeong et al., 2018; 2020; 2022)

Laboratory radiometric calibrations for the aerosol retrievals

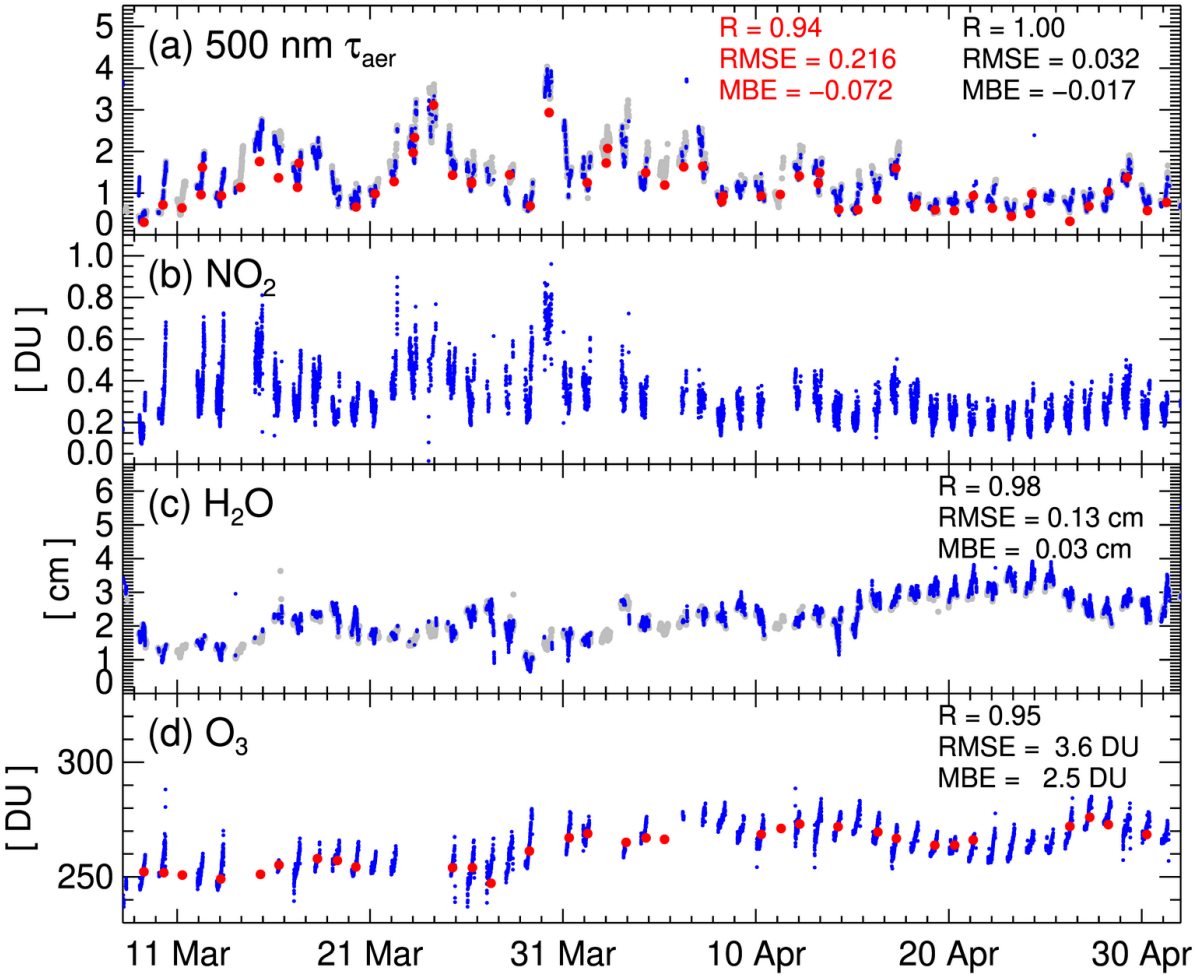


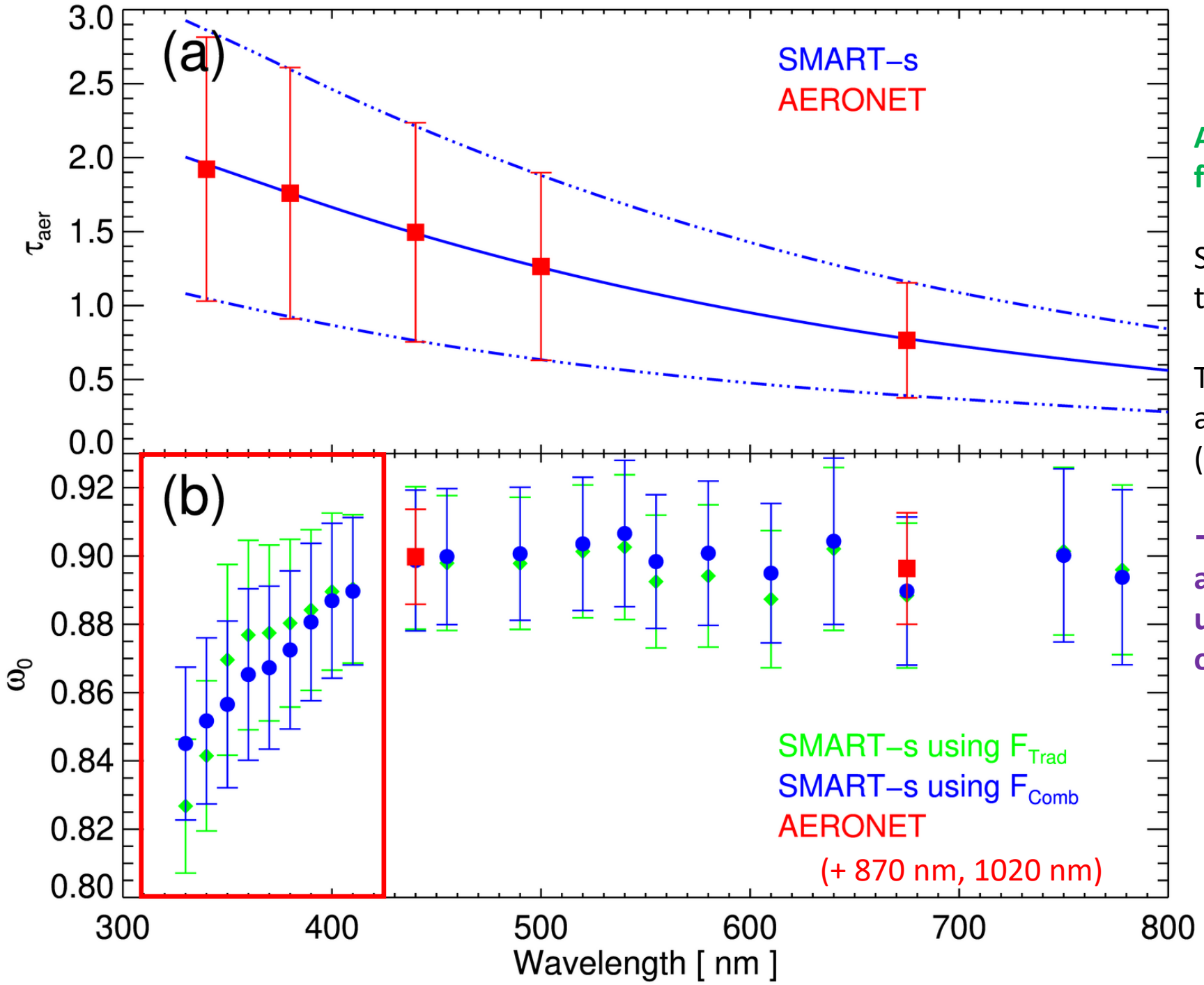
Radiometric calibration of the extended-range Pandora using a 1-m diameter integrating sphere at the NASA/GSFC RCL

SMART-s 7-SEAS deployment at Fang, Thailand during the pre-monsoon season in 2019



Details are at Jeong et al., 2022





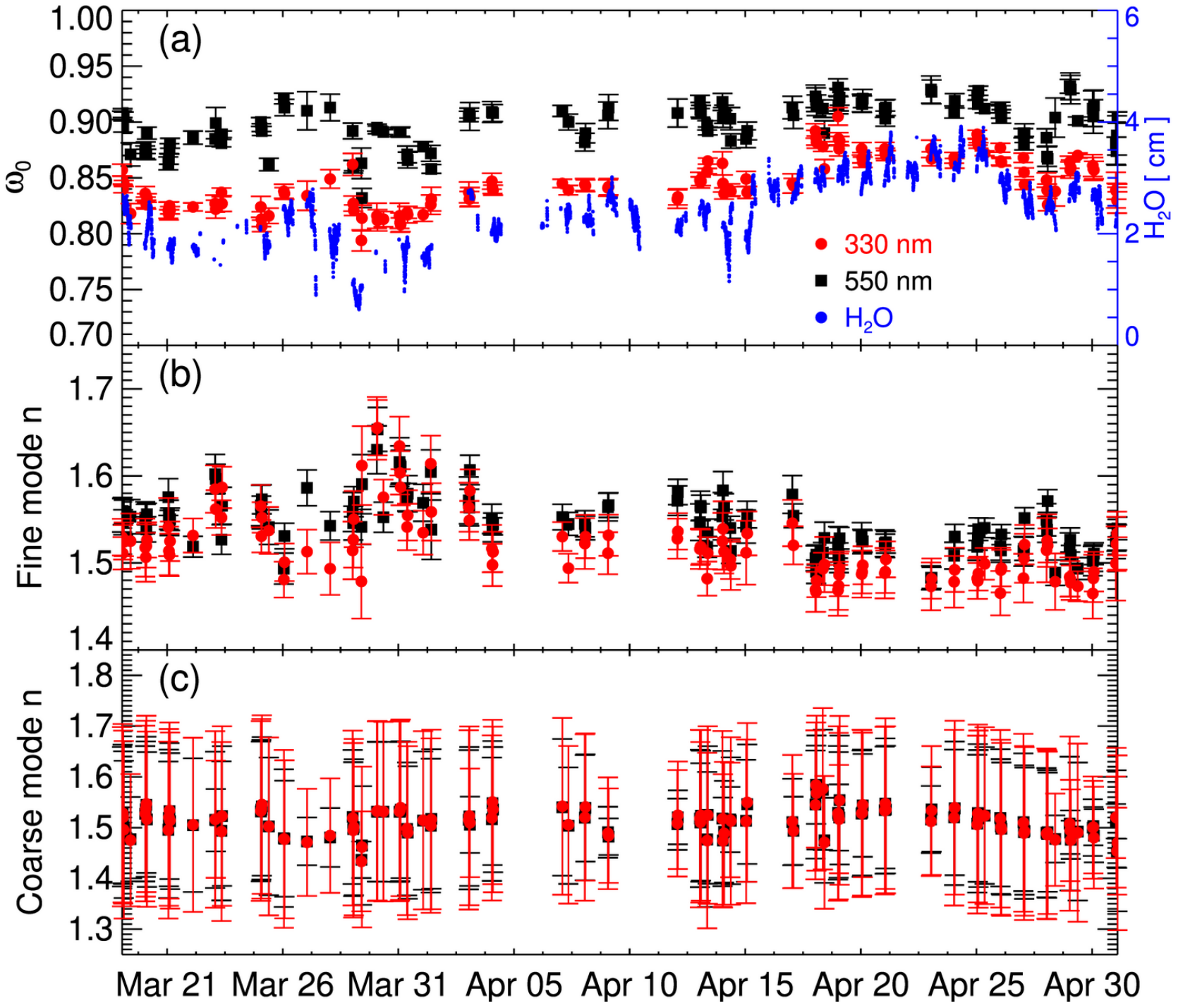
Aerosol Optical Property retrievals from the SMART-s

Strong spectral absorption features in the UV by carbonaceous particles.

The UV aerosol optical properties are also sensitive to aerosol chemistry (e.g., aging, hygroscopic growth).

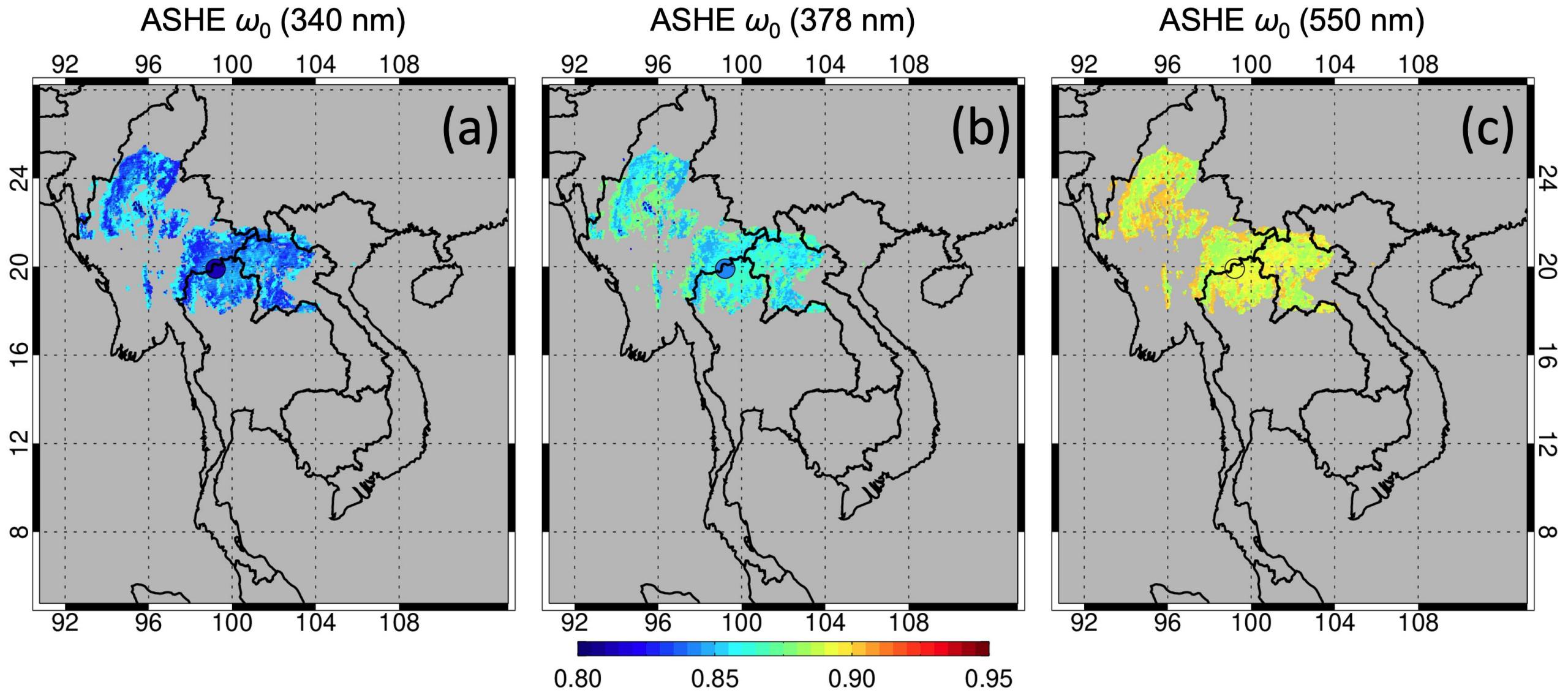
→ Simultaneous retrievals of aerosols trace gases can provide unique comprehensive information on atmospheric chemistry.

Temporal variations in aerosol optical properties



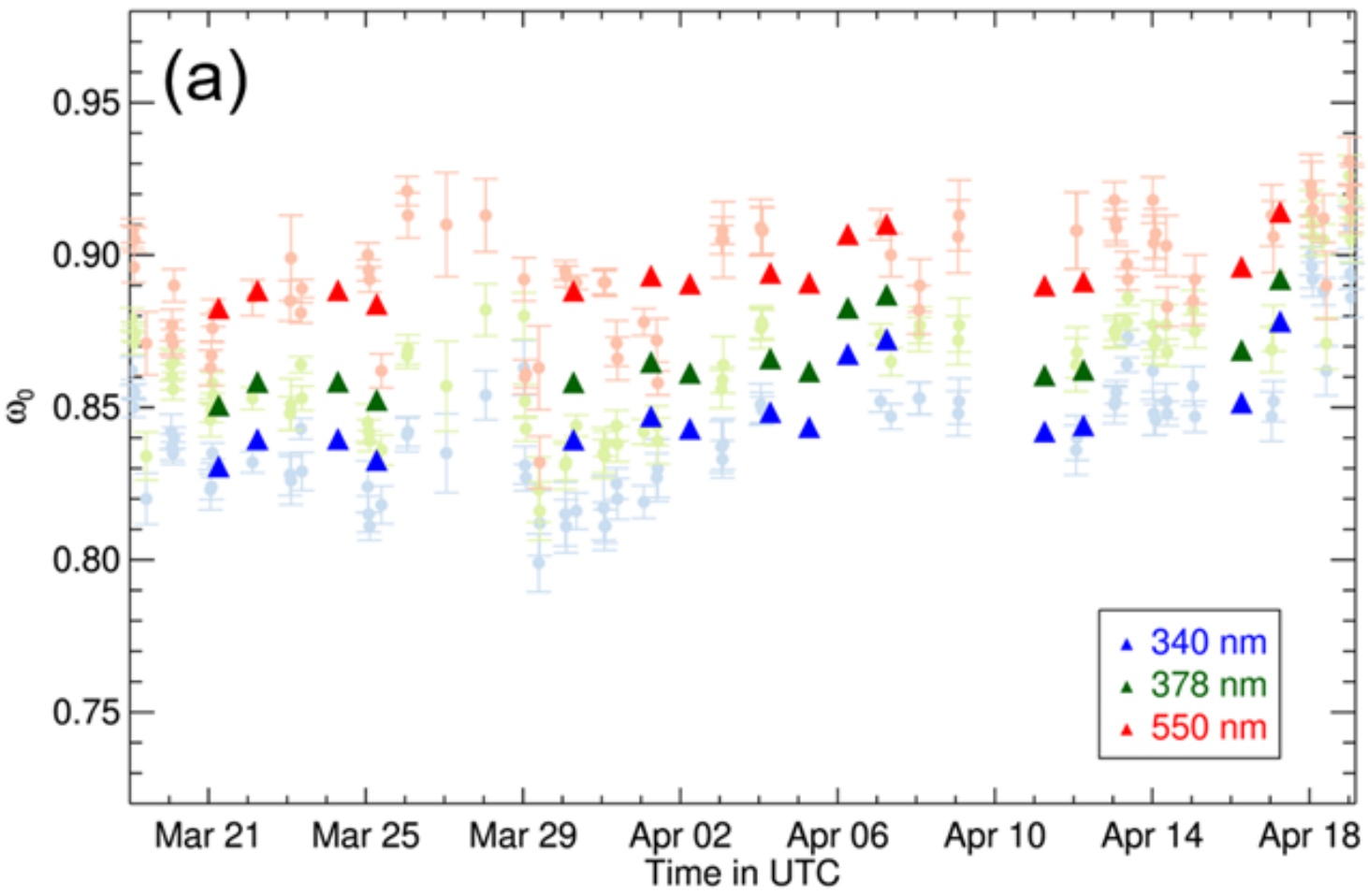
Comparison of aerosol single-scattering albedo with satellite products

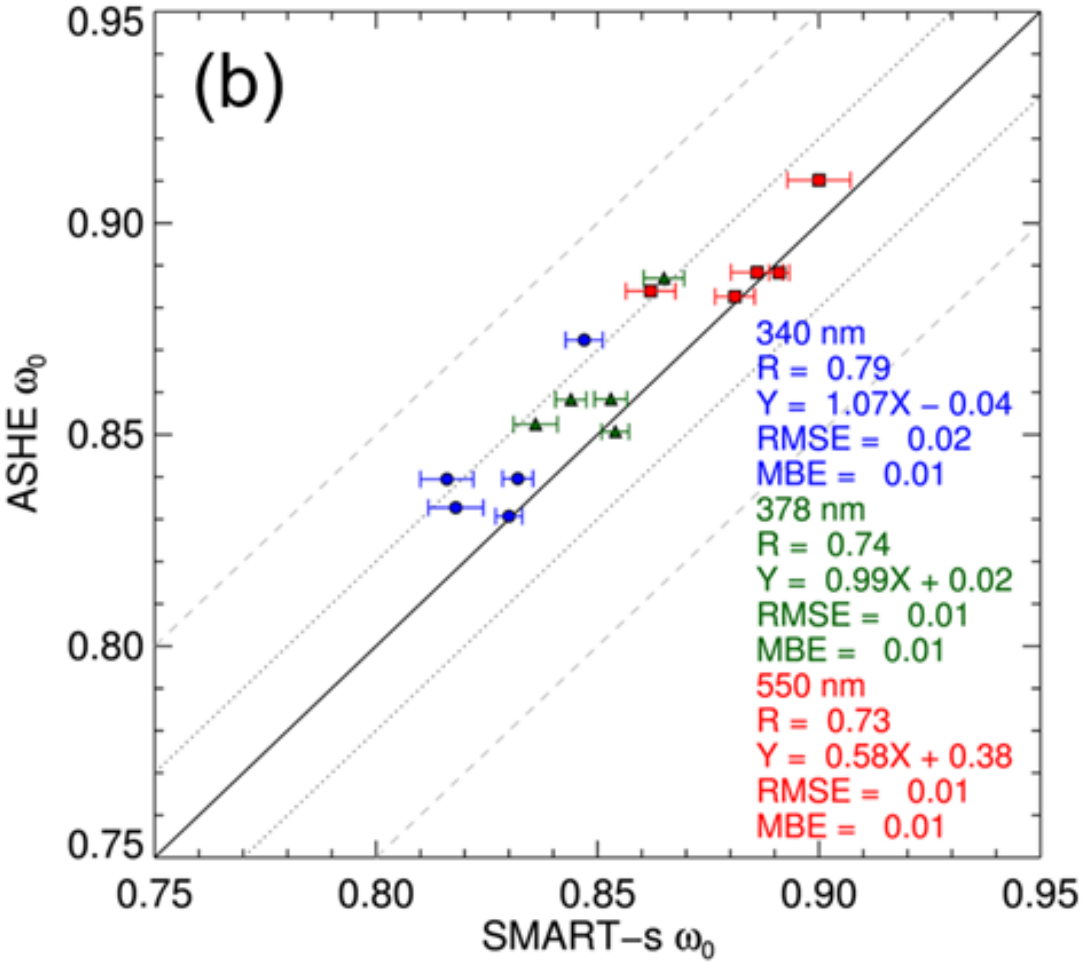
ASHE: Deep Blue's Aerosol Single-scattering albedo and Height Estimation algorithm (Lee et al., 2021 and references therein)



Comparison of aerosol single-scattering albedo with satellite products

Comparison and validation

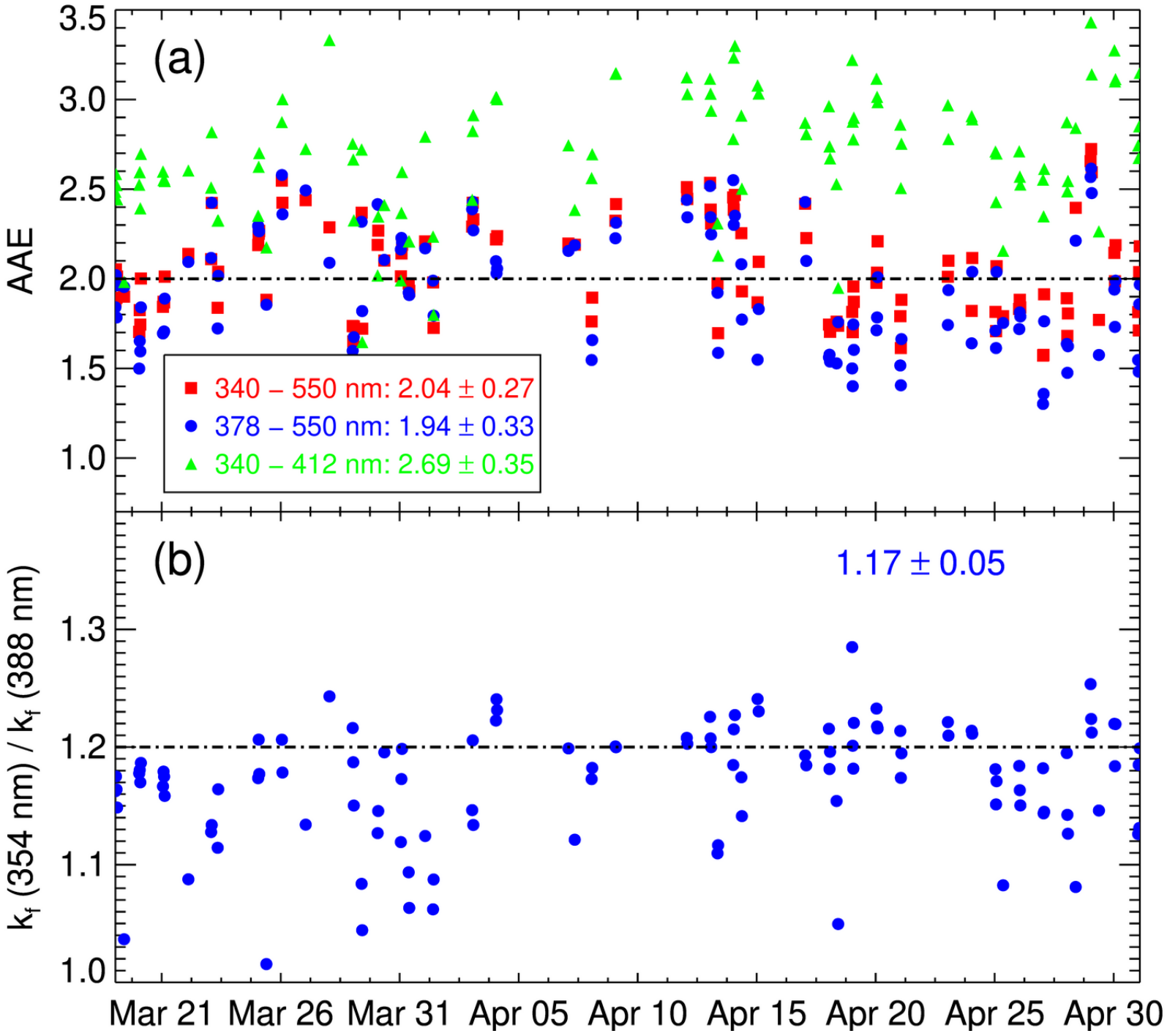




Evaluation of satellite's aerosol models in the UV

TOP: assumed value in the ASHE algorithm (Lee et al., 2021)

Bottom: Assumed value in the OMAERUV algorithm (Torres et al., 2013)



Thank you for your attention

Key References

Ukkyo Jeong, Si-Chee Tsay, N. C. Hsu, David M. Giles, John W. Cooper, Jaehwa Lee, Robert J. Swap, Brent N. Holben, James J. Butler, Sheng-Hsiang Wang, Somporn Chantara, Hyunkee Hong, Donghee Kim, and Jhoon Kim, 2022, Simultaneous retrievals of biomass burning aerosols and trace gases from the ultraviolet to near-infrared over northern Thailand during the 2019 pre-monsoon season, Atmos. Chem. Phys., 22, 11957-11986, doi:10.5194/acp-22-11957-2022.

Ukkyo Jeong, Si-Chee Tsay, David M. Giles, Brent N. Holben, Robert J. Swap, Nader Abuhassan, and Jay R. Herman, 2020, The SMART-s trace gas and aerosol inversions: I. Algorithm Theoretical Basis for column property retrievals, Journal of Geophysical Research: Atmospheres, 125, doi:10.1029/2019JD032088.

Ukkyo Jeong, Si-Chee Tsay, Peter Pantina, James J. Butler, Adrian M. Loftus, Nader Abuhassan, Jay R. Herman, Alexander Dimov, Brent N. Holben, and Robert J. Swap, 2018, Langley calibration analysis of solar spectroradiometric measurements: spectral aerosol optical thickness retrievals, Journal of Geophysical Research: Atmospheres, 123, 4221-4238, doi:10.1002/2017JD028262.

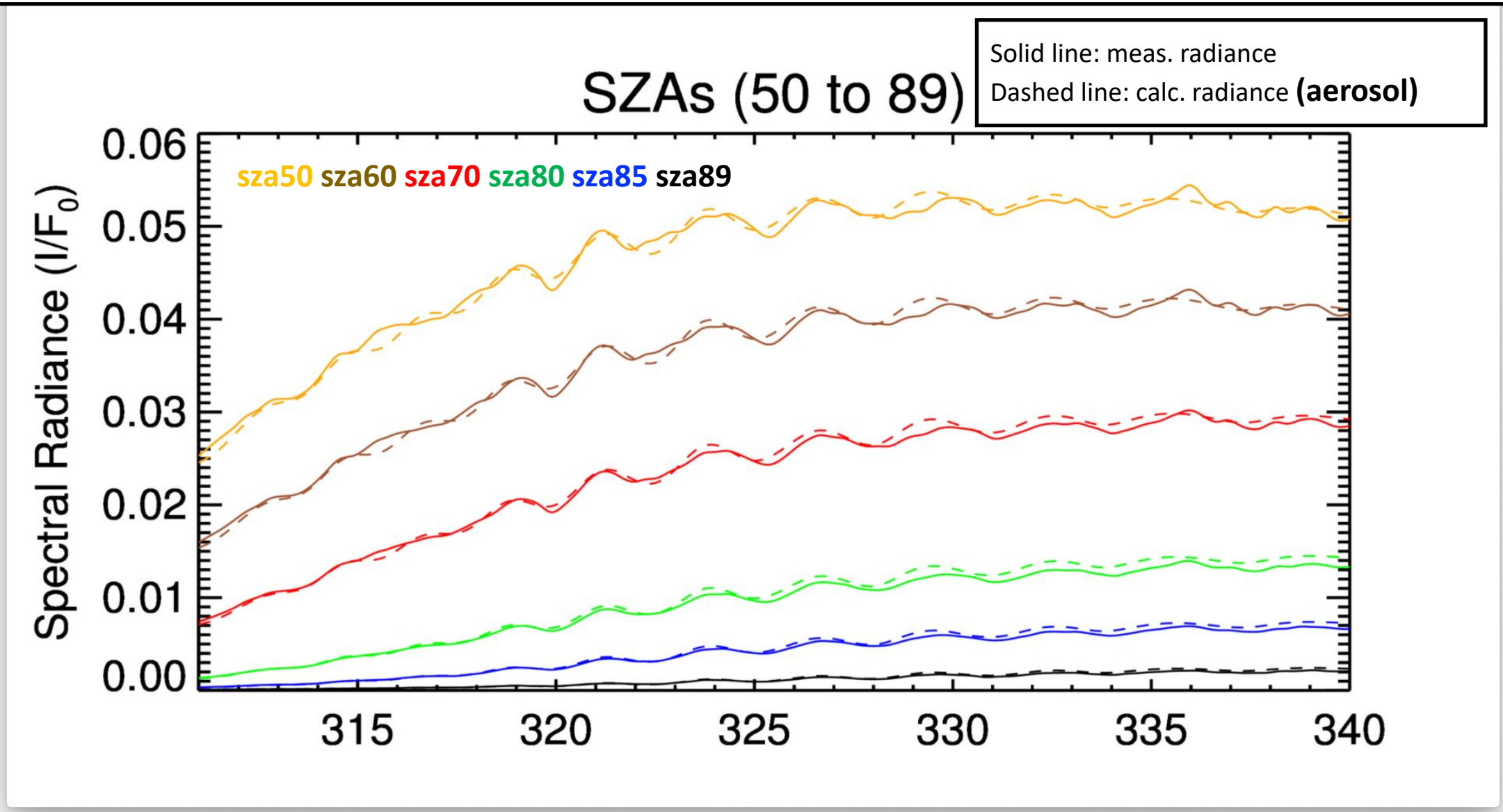
Data Sources and acknowledgment

The SMART-s serves as network units of NASA/GSFC's SMARTLabs (Surface-based Mobile Atmospheric Research & Testbed Laboratories; https://smartlabs.gsfc.nasa.gov/). The AERONET data are Version 3, level 2 inversion products using sun and almucantar radiances (https://aeronet.gsfc.nasa.gov/). This research was supported under the project *Understanding Changes in High Mountain Asia*, as part of NASA's Cryosphere Program. We gratefully acknowledge the continuous support of NASA's Radiation Sciences Program (RSP), managed by Hal B. Maring, on the research development of SMART-s, deployments of the SMARTLabs, and the execution of this study. NASA Earth Observing System and RSP provide facility support of AERONET. We also acknowledge Barry L. Lefer, Program Manager of the NASA Tropospheric Composition Program, and his support of NASA/GSFC's Pandora Project (https://pandora.gsfc.nasa.gov/). The data sets presented can be found at the above websites.

Thank you

During the UN/ESCAP Capacity Building Training at Bangkok, Thailand, in September 2022

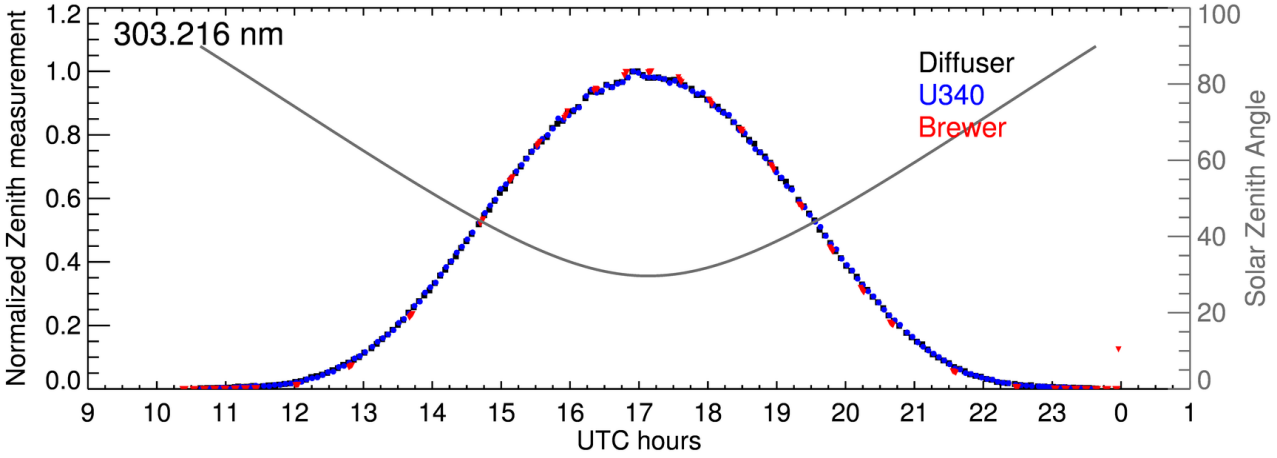
Comparison of Spectral Radiance (I/F_0)

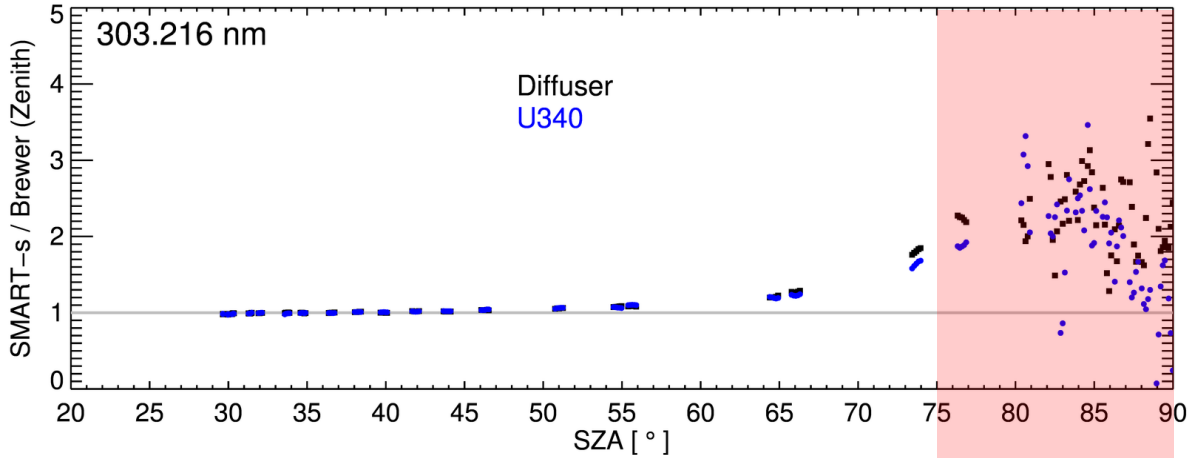


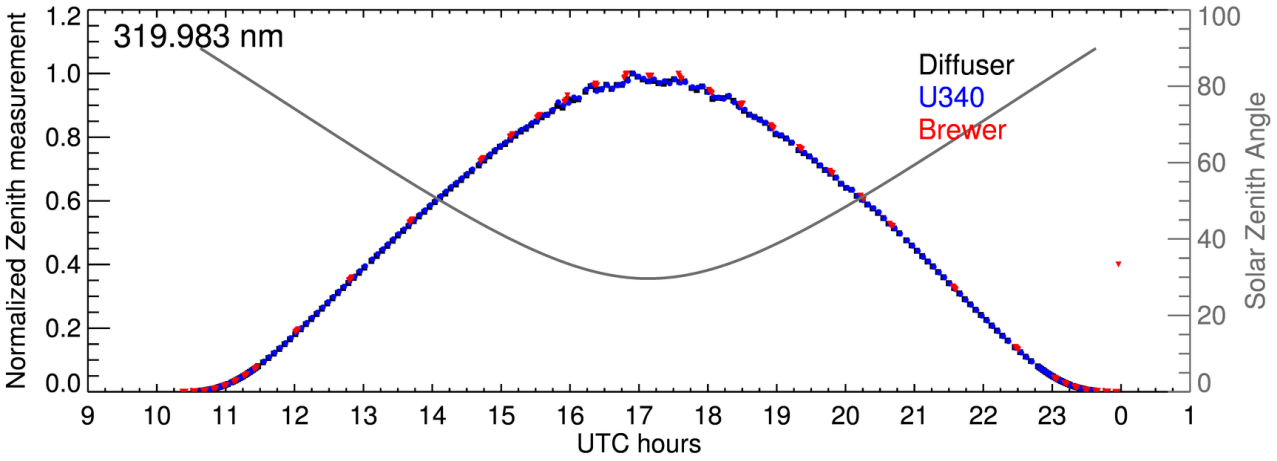
Example of UV measurements for Ozone retrieval

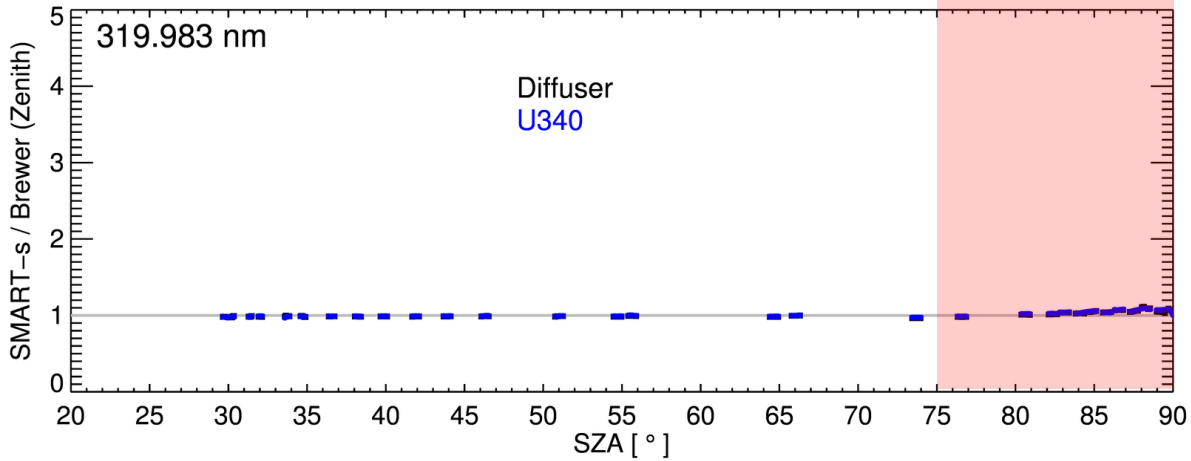
UV measurements for O_3 research

- Brewer is double spectrometer (significantly reduced stray light)
- Zenith measurements are often used to retrieve O_3 profile, which requires accurate radiances in the UV
- Zenith measurements have higher information contents at higher solar zenith angle

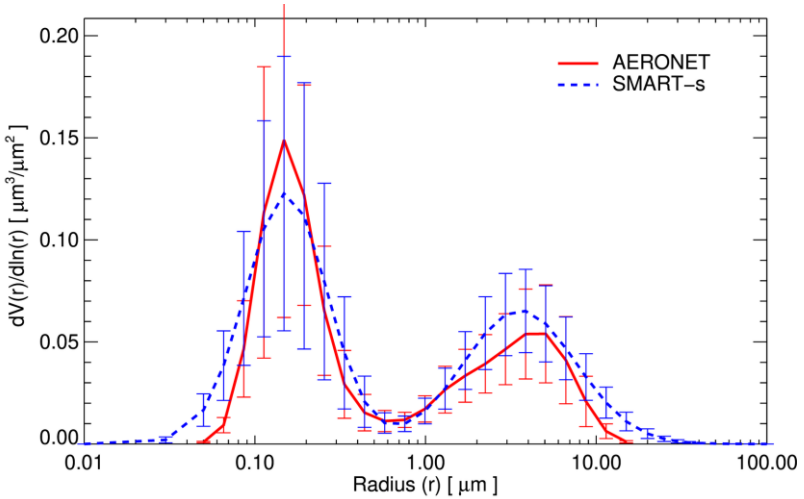


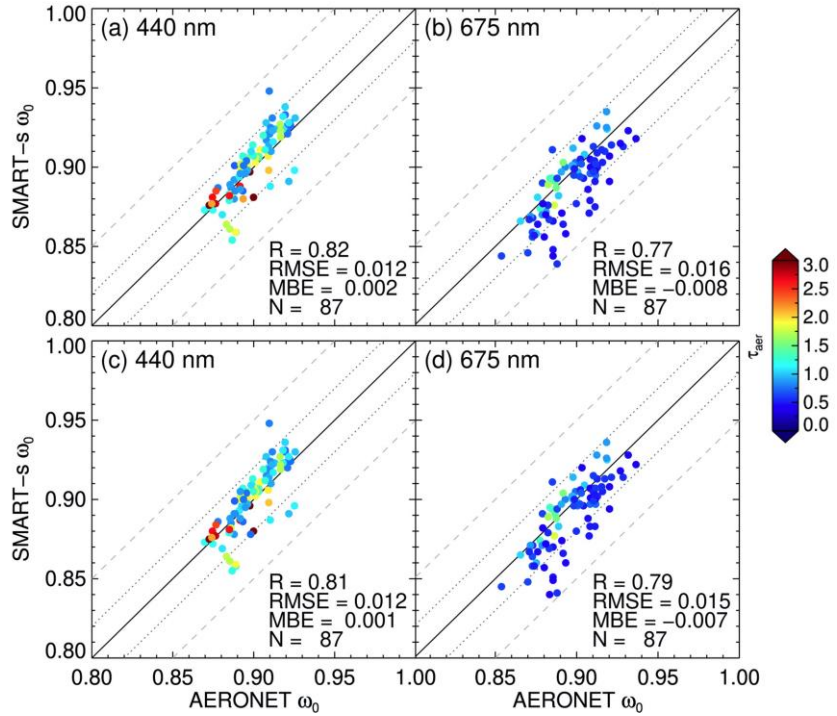


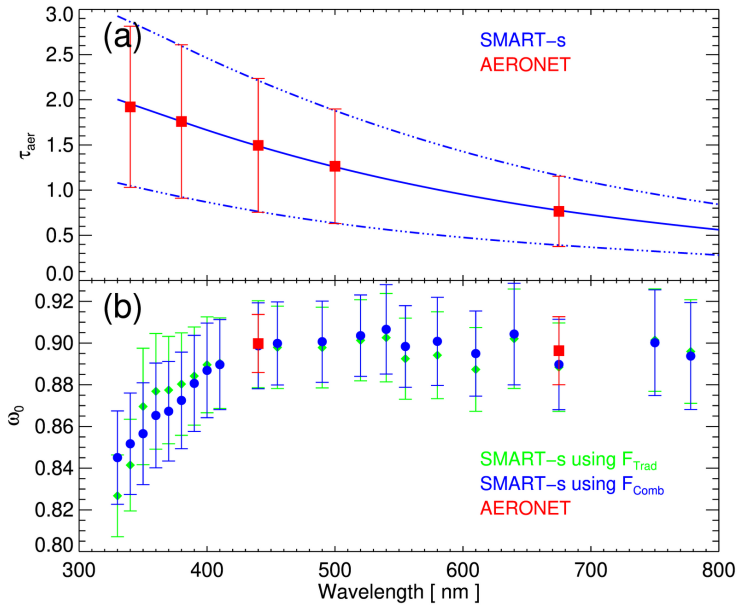


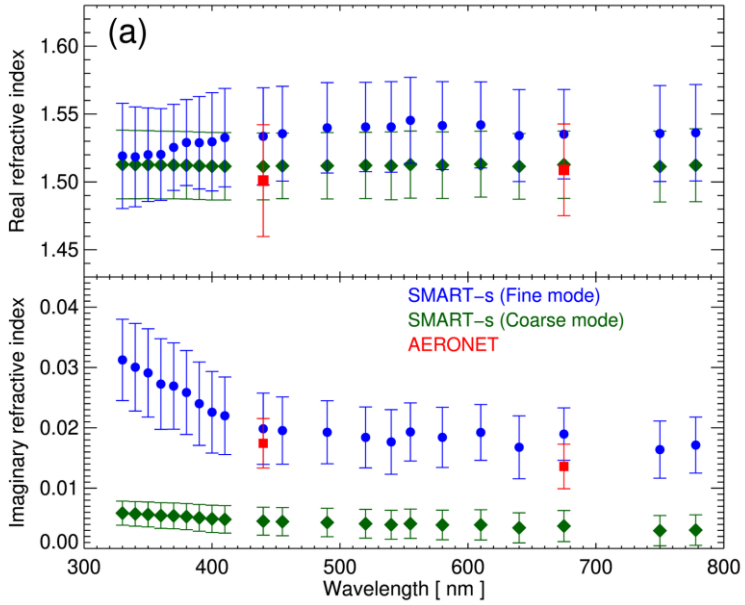


에어로넷 산출물과의 비교









에어로넷 및 위성 산출물과의 비교