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## Aerosol Optical Properties at Four Sites in Thailand

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### Author(s)

S. Janjai, M. Nunez, I. Masiri, R. Wattan, S. Buntoung, T. Jantarach, W. Promsen

### ABSTRACT

This paper presents column integrated aerosol optical properties including aerosol optical depth (AOD), Angstrom wavelength exponent ( $\alpha$ ), single scattering albedo (SSA), and size distribution from ground-based measurements at four sites in Thailand: Chiang Mai (18.° N, 98.° E), Ubon Ratchathani (15.25° N, 104.87° E), Nakhon Pathom (13.82° N, 100.04° E), and Songkhla (7.2° N, 100.60° E). Results show a marked seasonal trend in AOD at 500 nm for the first three stations, with the monthly average maxima of 0.92, 0.78 and 0.61 for Chiang Mai, Ubon Ratchathani and Nakhon Pathom, respectively. These maxima occur in the dry season (November-April). Minimum values for these stations were recorded during the wet season (May-October). A similar pattern is exhibited in the  $\alpha$  for the three stations, with maxima in the dry season and minima in the wet season. The lowest SSA values occur at Chiang Mai, which means this station has the highest absorption, with the highest SSA values occurring at Songkhla which corresponds to the lowest absorption. The southern station at Songkhla differs from the other three as it has less local pollution sources and is subjected to the influence of the tropical maritime environment. AOD at Songkhla maintains a low and more constant value year round with the maximum monthly average AOD of 0.27 and the minimum of 0.16. Diurnal changes in AOD at the four stations are discussed and related to various external variables.

### KEYWORDS

Erosol Optical Properties; Measurements; Sunphotometers; Thailand; Tropical Environments

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### References

- [1] M. Iqbal, "An Introduction to Solar Radiation," Academic, New York, 1983.
- [2] V. Ramanathan, P. J. Crutzen, J. Lelieveld, A. P. Mitra, D. Althausen, J. Anderson, et al., "Indian Ocean Experiment: An Integrated Analysis of the Climate Forcing and Effects of the Great Indo-Asian Haze," *Journal Of Geophysical Research*, Vol. 106, No. D22, 2001, pp. 28371-28398. doi: 10.1029/2001JD900133
- [3] J. Xin, S. Wang, Y. Wang, J. Yuan, W. Zhang and Y. Sun, "Optical Properties and Size Distribution of Aerosols over the Tengger Desert in Northern China," *Atmospheric Environment*, Vol. 39, No. 32, 2005, pp. 5971-5978. doi: 10.1016/j.atmosenv.2005.06.027
- [4] Y. J. Kaufman and I. Koren, "Smoke and Pollution Aerosol Effect on Cloud Cover," *Science*, Vol. 313, 2006, pp. 655-658. doi: 10.1126/science.1126232
- [5] A. Angstrom, "On the Atmospheric Transmission of Sun Radiation and on Dust in the Air," *Geografiska Annaler*, Vol. 11, 1929, pp. 156-166. doi: 10.2307/519399
- [6] M. Masmoudi, M. Chaabane, K. Medhioub and F. Elleuch, "Variability of Aerosol Optical Thickness and Atmospheric Turbidity in Tunisia," *Atmospheric Research*, Vol. 66, No. 3, 2003, pp. 175-188. doi: 10.1016/S0169-8095(02)00175-8

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- [7] S. Ramachandran and A. Jayaraman, "Spectral Aerosol Optical Depths over Bay of Bengal and Chennai: I-Measurements," *Atmospheric Environment*, Vol. 37, No. 14, 2003, pp. 1941-1949. doi:10.1016/S1352-2310(03)00082-7
- [8] O. Dubovik and M. D. King, "A Flexible Inversion Algorithm for Retrieval of Aerosol Optical Properties from Sun and Sky Radiance Measurements," *Journal of Geophysical Research*, Vol. 105, No. D16, 2000, pp. 20673-20696. doi:10.1029/2000JD900282
- [9] S. Bhaskaran, N. Phillip, A. Rahman and J. Mallick, "Applications of Satellite Data for Aerosol Optical Depth (AOD) Retrievals and Validation with Aeronet Data," *Atmospheric and Climate Sciences*, Vol. 1, No. 2, 2011, pp. 61-67. doi:10.4236/acs.2011.12007
- [10] K. Praseed, T. Nishanth and M. Kumar, "Spectral Variations of AOD and Its Validation Using MODIS: First Cut Results from Kannur, India," *Atmospheric and Climate Sciences*, Vol. 2, No. 1, 2012, pp. 94-100. doi:10.4236/acs.2012.21011
- [11] D. Sharma, M. Singh and D. Singh, "Impact of Post-Harvest Biomass Burning on Aerosol Characteristics and Radiative Forcing over Patiala, North-West region of India," *Journal of the Institute of Engineering*, Vol. 8, No. 3, 2011, pp. 11-24.
- [12] F. Esposito, L. Leone, G. Pavese, R. Restieri and C. Serio, "Seasonal Variation of Aerosols Properties in South Italy: A Study on Aerosol Optical Depth, Angstrom Turbidity Parameters and Aerosol Size Distributions," *Atmospheric Environment*, Vol. 38, No. 11, 2004, pp. 1605-1614. doi:10.1016/j.atmosenv.2003.12.011
- [13] S. Dey, S. N. Tripathi, R. P. Singh and B. N. Holben, "Seasonal Variability of the Aerosol Parameters over Kanpur, an Urban Site in Indo-Gangetic Basin," *Advances in Space Research*, Vol. 36, No. 5, 2005, pp. 778-782. doi:10.1016/j.asr.2005.06.040
- [14] D. Six, M. Fily, L. Blarel and P. Goloub, "First Aerosol Optical Thickness Measurements at Dome C (East Antarctica), Summer Season 2003-2004," *Atmospheric Environment*, Vol. 39, No. 28, 2005, pp. 5041-5050. doi:10.1016/j.atmosenv.2005.05.010
- [15] M. R. Perrone, M. Santese, A. M. Tafuro, B. N. Holben, and A. Smirnov, "Aerosol Load Characterization over South-East Italy for One Year of AERONET Sun Photometer Measurements," *Atmospheric Research*, Vol. 75, No. 1-2, 2005, pp. 111-133. doi:10.1016/j.atmosres.2004.12.003
- [16] G. M. Giavis, H. D. Kambezidis, N. Sifakis, Z. Toth, A. D. Adamopoulos and D. Zevgolis, "Diurnal Variation of the Aerosol Optical Depth for Two Distinct Cases in the Athens Area, Greece," *Atmospheric Research*, Vol. 78, No. 1-2, 2005, pp. 79-92. doi:10.1016/j.atmosres.2005.03.003
- [17] X. Yu, T. Cheng, J. Chen and Y. Liu, "Climatology of Aerosol Radiative Properties in Northern China," *Atmospheric Research*, Vol. 84, No. 2, 2007, pp. 132-141. doi:10.1016/j.atmosres.2006.06.003
- [18] X. Yu, B. Zhu and M. Zhang, "Seasonal Variability of Aerosol Optical Properties over Beijing," *Atmospheric Environment*, Vol. 43, No. 26, 2009, pp. 4095-4101. doi:10.1016/j.atmosenv.2009.03.061
- [19] X. Yu, B. Zhu, Y. Yin, J. Yang, Y. Li and X. Bu, "A Comparative Analysis of Aerosol Properties in Dust and Haze-Fog Days in a Chinese Urban Region," *Atmospheric Research*, Vol. 99, No. 2, 2010, pp. 241-247. doi:10.1016/j.atmosres.2010.10.015
- [20] I. Behnert, V. Matthias and R. Doerffer, "Aerosol Climatology from Ground-Based Measurements for the Southern North Sea," *Atmospheric Research*, Vol. 84, No. 3, 2007, pp. 201-220. doi:10.1016/j.atmosres.2006.05.006
- [21] O. K. Nwofor, T. Chidiezie-Chineke and R. T. Pinker, "Seasonal Characteristics of Spectral Aerosol Optical Properties at a Sub-Saharan Site," *Atmospheric Research*, Vol. 85, No. 1, 2007, pp. 38-51. doi:10.1016/j.atmosres.2006.11.002
- [22] A. Saha, M. Mallet, J. C. Roger, P. Dubuisson, J. Piazzola and S. Despiou, "One Year Measurements of Aerosol Optical Properties Over an Urban Coastal Site: Effect on local Direct Radiative Forcing," *Atmospheric Research*, Vol. 90, No. 2-4, 2008, pp. 195-202. doi:10.1016/j.atmosres.2008.02.003
- [23] L. Alados-Arboledas, A. Alcantara, F. J. Olmo, J. A. Martinez-Lozano, V. Estelles, V. Cachorro, A. M. Silva, H. Horvath, M. Gangl, A. Diaz, M. Pujadas, J. Lorente, A. Labajo, M. Sorribas and G. Pavese, "Aerosol Columnar Properties Retrieved from CIMEL Radiameters during VELETA 2002," *Atmospheric Environment*, Vol. 42, No. 11, 2008, pp. 2654-2667. doi:10.1016/j.atmosenv.2007.10.006

- [24] N. Prats, V. E. Cadorro, M. Sorribas, S. Mogo, A. Berjon, C. Toledano, A. M. de Frutos, J. de la Rosa, N. Laulainen and B. A. de la Morena, "Columnar Aerosol Optical Properties during El Arenosillo 2004 Summer Campaign," *Atmospheric Environment*, Vol. 42, No. 11, 2008, pp. 2643-2653. doi:10.1016/j.atmosenv.2007.07.041
- [25] K. O. Ogunjobi, Z. He and C. Simmer, "Spectral Aerosol Optical Properties from AERONET Sun-Photometric Measurements over West Africa," *Atmospheric Research*, Vol. 88, No. 2, 2008, pp. 89-107. doi:10.1016/j.atmosres.2007.10.004
- [26] H. D. Kambezidis and D. G. Kaskaoutis, "Aerosol Climatology over Four AERONET Sites: An Overview," *Atmospheric Environment*, Vol. 42, No. 8, 2008, pp. 1892-1906. doi:10.1016/j.atmosenv.2007.11.013
- [27] Z. Cong, S. Kang, A. Smirnov and B. Holben, "Aerosol Optical Properties at Nam Co, a Remote Site in Central Tibetan Plateau," *Atmospheric Research*, Vol. 92, No. 1, 2009, pp. 42-48. doi:10.1016/j.atmosres.2008.08.005
- [28] X. N. Yu, B. Zhu, S. X. Fan, Y. Yan and X. L. Bu, "Groundbased observation of aerosol optical properties in Lanzhou, China," *Journal of Environmental Sciences*, Vol. 21, No. 11, 2009, pp. 1519-1524. doi:10.1016/S1001-0742(08)62449-3
- [29] L. Pan, H. Che, F. Geng, X. Xia, Y. Wang, C. Zhu, M. Chen, W. Gao and J. Guo, "Aerosol Optical Properties Based on Ground Measurements over the Chinese Yangtze Delta Region," *Atmospheric Environment*, Vol. 44, No. 21-22, 2010, pp. 2587-2596. doi:10.1016/j.atmosenv.2010.04.013
- [30] P. Wang, H. Che, X. Zhang, Q. Song, Y. Wang, Z. Zhang, X. Dai and D. Yu, "Aerosol Optical Properties of Regional Background Atmosphere in Northeast China," *Atmospheric Environment*, Vol. 44, No. 36, 2010, pp. 4404-4412. doi:10.1016/j.atmosenv.2010.07.043
- [31] J. Bi, J. Huang, Q. Fu, X. Wang, J. Shi, W. Zhang, Z. Huang and B. Zhang, "Toward Characterization of the Aerosol Optical Properties over Loess Plateau of Northwestern China," *Journal of Quantitative Spectroscopy and Radiative Transfer*, Vol. 112, No. 2, 2011, pp. 346-360.
- [32] Y. Xingna, Z. Bin, Y. Yan, F. Shuxian and C. Aijun, "Seasonal Variation of Columnar Aerosol Optical Properties in Yangtze River Delta in China," *Advances in Atmospheric Sciences*, Vol. 28, No. 6, 2011, pp. 1326-1335. doi:10.1007/s00376-011-0158-9
- [33] M. Kumar, K. Lipi, S. Sureshbabu and N. C., Mahanti, "Aerosol Properties over Ranchi Measured from Aethalometer," *Atmospheric and Climate Science*, Vol. 1, No. 3, 2011, pp. 91-94. doi:10.4236/acs.2011.13010
- [34] S. Bhaskaran, N. Phillip, A. Rahman and J. Mallick, "Applications of Satellite Data for Aerosol Optical Depth (AOD) Retrievals and Validation with AERONET Data," *Atmospheric and Climate Science*, Vol. 1, No. 2, 2011, pp. 61-67. doi:10.4236/acs.2011.12007
- [35] P. Chaiwivatworakul and S. Chirarattananon, "An Investigation of Atmospheric Turbidity of Thai Sky," *Energy and Buildings*, Vol. 36, No. 7, 2004, pp. 650-659. doi:10.1016/j.enbuild.2004.01.032
- [36] D. Sharma, M. Singh and D. Singh, "Impact of Post-Harvest Biomass Burning on Aerosol Characteristics and Radiative Forcing over Patiala, North-West Region of India," *Journal of the Institute of Engineering*, Vol. 8, No. 3, 2011, pp. 11-24
- [37] W. Von Hoyningen-Huene, T. Schmidt, A. K. Chan, J. Heintzenberg and C. Neusuess, "Climate-Relevant Aerosol Parameters of South-East Asian Forest Fire Haze," *Journal of Aerosol Science*, Vol. 29, No. S2, 1998, pp. 1259-1260. doi:10.1016/S0021-8502(98)90812-6
- [38] N. Nurhayati and T. Nakajima, "A Study of Aerosol Optical Properties at the Global Gaw Station Bukit Kototabang, Sumatra, Indonesia," *Atmospheric Environment*, Vol. 46, 2012, pp. 597-606. doi:10.1016/j.atmosenv.2010.10.057
- [39] B. Gadde, S. B. Bonnet, C. Menke and S. Garivait, "Air Pollutant Emissions from Rice Straw Open Field Burning in India, Thailand and the Philippines," *Environmental Pollution*, Vol. 157, No. 5, 2009, pp. 1554-1558. doi:10.1016/j.envpol.2009.01.004
- [40] S. Janjai, S. Suntaropas and M. Nunez, "Investigation of Aerosol Optical Properties in Bangkok and Suburbs," *Theoretical and Applied Climatology*, Vol. 96, No. 3-4, 2009, pp. 221-233. doi:10.1007/s00704-008-0026-4
- [41] B. N. Holben, T. F. Eck, I. Slutsker, D. Tanre, J. P. Buis, A. Setzer, et al., "AERONET—A Federated

- [42] T. F. Eck, B. N. Holben, J. S. Reid, O. Dubovik, A. Smirnov, N. T. O' Neill, I. Slutsker and S. Kinne, "Wavelength Dependence of the Optical Depth of Biomass Burning, Urban, and Desert Dust Aerosol," *Journal of Geophysical Research*, Vol. 104, No. D24, 1999, pp. 31333-31349. doi:10.1029/1999JD900923
- [43] A. Smirnov, B. N. Holben, T. F. Eck, O. Dubovik and I. Slutsker, "Cloud Screening and Quality Control Algorithms for the AERONET Database," *Remote Sensing of Environment*, Vol. 73, No. 3, 2000, pp. 337-349. doi:10.1016/S0034-4257(00)00109-7
- [44] A. Smirnov, B. N. Holben, T. F. Eck., I. Slutsker, B. Chatenet and R. T. Pinker, "Diurnal Variability of Aerosol Optical Depth Observed at AERONET (Aerosol Robotic Network) Sites," *Geophysical Research Letters*, Vol. 29, 2002, p. 2115. doi:10.1029/2002GL016305
- [45] J. T. Peterson and E. C. Flowers, "Atmospheric Turbidity over Central North Carolina," *Journal of Applied Meteorology*, Vol. 20, No. 3, 1981, pp. 229-241. doi:10.1175/1520-0450(1981)020<0229:ATOCNC>2.0.CO;2
- [46] R. B. Stull, "An Introduction to Boundary Layer Meteorology," Kluwer Academic Publication, Dordrecht, 1994.
- [47] M. I. Nodzu, S. Ogino, Y. Tachibana and M. D. Yamanaka, "Climatological Description of Seasonal Variations in Lower Tropospheric Temperature Inversion Layers over the Indochina Peninsula," *Journal of Climate*, Vol. 19, No. 13, 2006, pp. 3307-3319. doi:10.1175/JCLI3792.1
- [48] K. Kanokkanjana, P. Cheewaphongphan and S. Garivail, "Black Carbon Emission from Paddyfield Open Burning in Thailand," *International Conference on Environmental Science and Technology*, Vol. 6, 2011, pp. v2088-v2092.
- [49] O. Dubovik, B. N. Holben, T. F. Eck, A. Smirnov, Y. J. Kaufman, M. D. King, D. Tanre and I. Slutsker, "Variability of Absorption and Optical Properties of Key Aerosol Types Observed in Worldwide Locations," *Journal of the Atmospheric Sciences*, Vol. 59, No. 3, 2002, pp. 590- 608. doi:10.1175/1520-0469(2002)059<0590:VOAOP>2.0.CO;2
- [50] J. S. Schafer, T. F. Eck, B. N. Holben, P. Artaxo and A. F. Duarte, "Characterization of the Optical Properties of Atmospheric Aerosols in Amazonia from Long-Term AERONET Monitoring (1993-1995 and 1999-2006)," *Journal of Geophysical Research*, Vol. 113, No. D4, 2008, 16 pp. doi:10.1029/2007JD009319
- [51] C. F. Bohren and D. R. Huffman, "Absorption and Scattering of Light by Small Particles," Wiley-Interscience, New York, 1983.
- [52] Z. Li, P. Goloub, C. Devaux, X. Gu, X. Qiao, F. Zhao and H. Chen, "Aerosol Phase Function and Single Scattering Albedo Retrieved from Ground Measurements," *Atmospheric Research*, Vol. 71, No. 4, 2004, pp. 233-241. doi:10.1016/j.atmosres.2004.06.001
- [53] V. Estelles, J. A. Martinez-Lozano, M. P. Utrillas and M. Campanelli, "Columnar Aerosol Properties in Valencia (Spain) by Ground-Based Sun Photometry," *Journal of Geophysical Research*, Vol. 112, No. D11, 2007, 9 p. doi:10.1029/2006JD008167