

Classification of Urban Fine and Coarse Aerosol from January-October 2024 using Aerosol Robotic Network (AERONET) in Sarawak

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Structured Abstract:

Background: This study examines the characteristics of fine (PM_{2.5}) and coarse (PM₁₀) aerosols in Kuching, Sarawak. Aerosols play an important role in influencing urban air quality and regional haze events. In recent years, rapid urban development and recurring transboundary haze from biomass burning in Kalimantan have contributed to elevated aerosol levels. The objectives of this study are to analyse the trends in aerosol variation, to classify fine and coarse aerosols based on their optical properties, and to compare the classification performance between AERONET and MODIS datasets.

Methods: Aerosol data were obtained from the Aerosol Robotic Network (AERONET), providing Aerosol Optical Depth (AOD) and Ångström Exponent (AE) values. Time series analysis was used to identify seasonal patterns of aerosol loading. Threshold-based classification using AOD and AE was applied to determine aerosol type. In addition, MODIS satellite data were evaluated against AERONET data using statistical metrics such as the coefficient of determination (R^2) and root mean square error (RMSE).

Results: The findings show that fine-mode aerosols dominated most of the year except in February, when coarse-mode particles peaked with AOD₄₄₀ at 0.4389 and AE_{440–870} at 0.6614. Classification using AOD and AE values showed that urban aerosols were the most frequently detected, typically at AOD₄₄₀ between 0.2 and 0.4 with AE greater than 1.0, while biomass-burning aerosols with AOD greater than or equal to 0.7 and AE greater than 1.0 were less frequent. A comparison between AERONET and MODIS data indicated a weak correlation with R^2 of 0.1194, but a low RMSE of 0.0273 demonstrated close numerical agreement between the two datasets.

Conclusion: In conclusion, this study concludes that aerosol trends can be identified and fine and coarse particles can be classified using AOD and AE parameters. The results highlight the consistent influence of transboundary haze and urban emissions on aerosol characteristics in Kuching. The combined use of ground-based and satellite data offers better insight for monitoring air quality in tropical urban regions.

Keywords: Aerosol Optical Depth (AOD); Ångström Exponent (AE); Urban aerosols; Transboundary haze; Fine and coarse particles.

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