NEAR REAL-TIME RETRIEVAL OF GROUND-LEVEL $PM_{2.5}$ CONCENTRATIONS FROM DIFFERENT FIVE MODIS AEROSOL OPTICAL DEPTH PRODUCTS OVER BANGKOK, THAILAND

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BACKGROUND

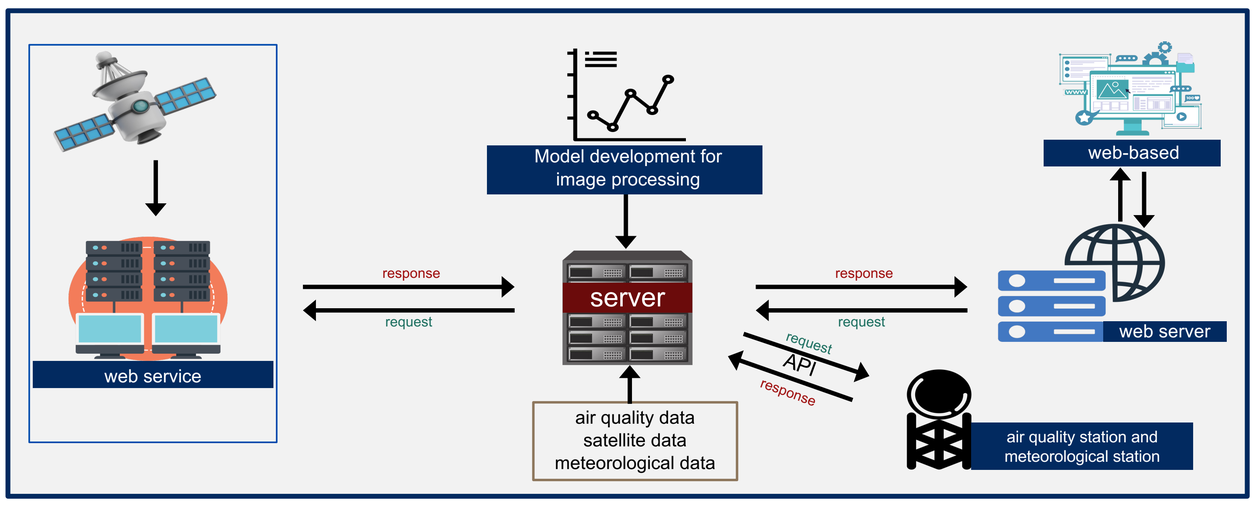
- Monitoring $PM_{2.5}$ concentration is crucial due to its potential to cause adverse health effects, including respiratory and cardiovascular diseases. However, the spatial availability of $PM_{2.5}$ monitoring stations is often limited in many cities.
- This limitation can be mitigated by utilizing satellite data processing applications, which can compensate for the lack of ground monitoring stations.

OBJECTIVE

To develop a more reliable broader spatial coverage of ground-level $PM_{2.5}$ concentration in ambient air for Bangkok, Thailand

MATERIALS & METHODS

Diagram of near real-time spatial $PM_{2.5}$ concentration processing



1. Collection of AOD Products

Different five products from the MODIS sensor were retrieved by developing Python programming for download and extraction. The ground-level $PM_{2.5}$ data from 14 ambient stations in the Bangkok area during high concentration episodes starting from December to March of 2018-2020 were collected and processed.

Satellites	Product Codes	Algorithms	Spatial Resolutions
Terra	MOD04_3K	DT	3x3 km²
Aqua	MOY04_3K	DT	3x3 km²
Terra	MOD04_L2	DT, DB, DTB	10x10 km²
Aqua	MOY04_L2	DT, DB, DTB	10x10 km²
Terra+Aqua	MCD19A3N	MAIAC	1x1 km²

Remark : DT = Dark Target, DB = Deep Blue, DTB = Combined,
MAIAC = Multi-Angle Implementation of Atmospheric Correction

2. Meteorological Data & Previous hour $PM_{2.5}$ Data Integration

Meteorological data and the air quality data from the previous hour's $PM_{2.5}$ concentration were integrated to improve the model performance.

3. Model Training & Validation

The collected data were divided into training (70%) and testing (30%) datasets. $PM_{2.5}$ estimation models were developed using the Multiple Linear Regression (MLR) approach. The accuracy and reliability of the models were assessed using the testing dataset.

4. Model Deployment

An Application Programming Interface (API) was developed to interface with the Thai Meteorological Department (TMD) and the Bangkok Metropolitan Administration (BMA) for data retrieval.

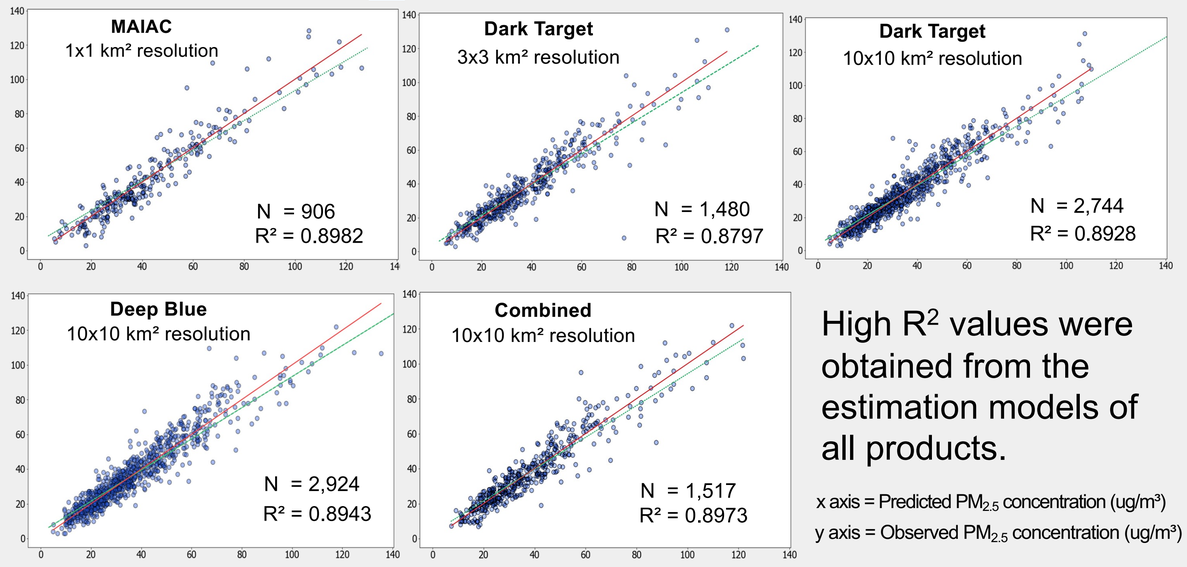
RESULTS

1. Coefficients of $PM_{2.5}$ Estimation Models

AOD Products	AOD	WS	T	RH	P	GR	PH $PM_{2.5}$
MAIAC	0.0921	-1.7397	0.0284	-0.2054	0.0211	-0.0042	0.7734
Dark Target (3x3 km²)	0.0543	-0.7528	0.1399	-0.1166	0.0064	-0.0030	0.8251
Dark Target (10x10 km²)	0.0340	-0.9262	0.1958	-0.0776	0.0034	-0.0031	0.8237
Deep Blue	0.0184	-1.0300	0.2455	-0.0625	0.0015	-0.0036	0.8392
Combined	0.0492	-1.0161	0.1757	-0.0888	0.0036	-0.0036	0.8312

Remark : WS = Wind Speed, T = Temperature, RH = Relative Humidity, P = Pressure, GR = Global Radiation
PH $PM_{2.5}$ = Previous Hour $PM_{2.5}$ data

2. Validation of $PM_{2.5}$ Estimation Models



High R^2 values were obtained from the estimation models of all products.

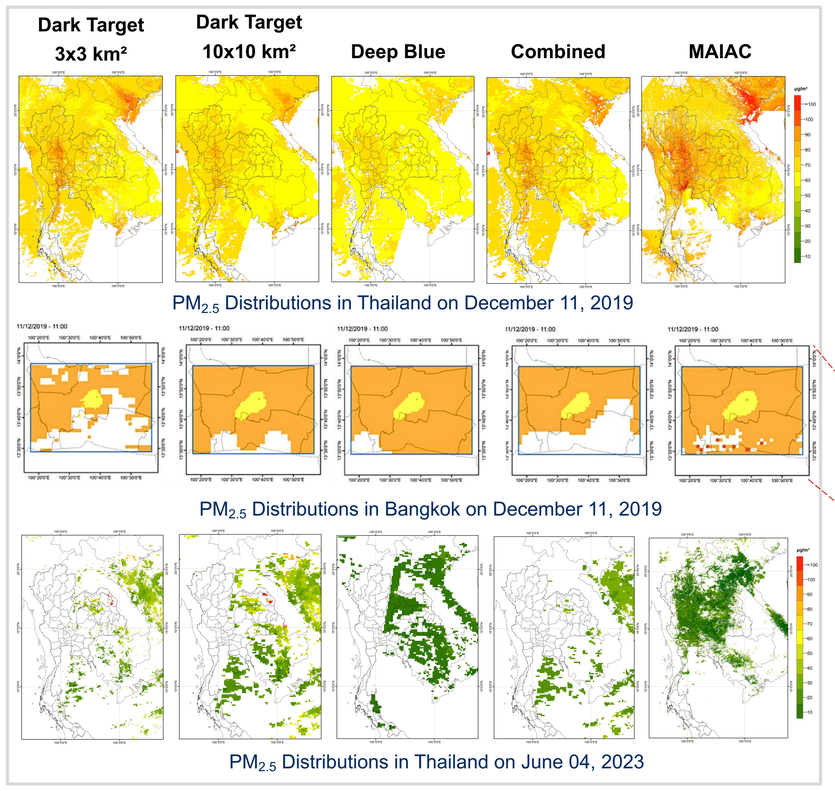
x axis = Predicted $PM_{2.5}$ concentration (ug/m³)
y axis = Observed $PM_{2.5}$ concentration (ug/m³)

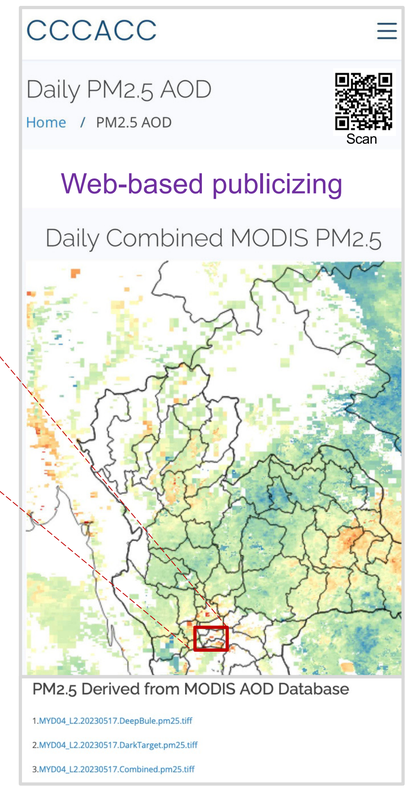
3. Statistical Analysis of Models

AOD Products	MBE (ug/m³)	MAE (ug/m³)	RMSE (ug/m³)	R^2	Cross-Validation
MAIAC	-0.56	5.49	7.82	0.90	0.87
Dark Target (3x3 km²)	0.18	4.78	7.18	0.88	0.87
Dark Target (10x10 km²)	0.25	4.55	6.59	0.89	0.88
Deep Blue	0.33	4.88	6.74	0.89	0.88
Combined	0.18	4.94	6.82	0.90	0.87

Remark : MBE = Mean Bias Error, MAE = Mean Absolute Error, RMSE = Root Mean Square Error

4. Spatial $PM_{2.5}$ over Thailand and Bangkok





CONCLUSIONS

A 10x10-km² Dark Target Product exhibited the highest correlation coefficient with ground-level $PM_{2.5}$ concentration over Bangkok, while the best R^2 from model validation was obtained from the MAIAC product with a value of 0.90. The five developed models showed a range of MBE from -0.56 to 0.33 μg/m³. Accordingly, these estimation models can effectively be used to estimate $PM_{2.5}$.

ACKNOWLEDGEMENT

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