October 4-6, 2010:
“Benefiting from Earth Observation: Bridging the Data Gap for Adaptation to Climate Change in the Hindu Kush-Himalayan Region, Nepal”

Assessment of aerosol influence on atmospheric properties using integrated ground- and satellite-based measurements

Mr. Thongchai Kanabkaew
Prof. Nguyen Thi Kim Oanh

Environmental Engineering and Management,
Asian Institute of Technology, Thailand

Outline of presentation

- Introduction
  - Background
  - Applications of satellites
- Methodology
  - Study area
  - Data collection: ground and satellite data
  - Data analysis
- Results and discussion
  - Relationship between ground- and satellite-based measurements
- Conclusions and recommendations

Introduction

- Atmospheric aerosols have been implicated in the adverse effect to human health, reduce visibility, and change in energy balances.

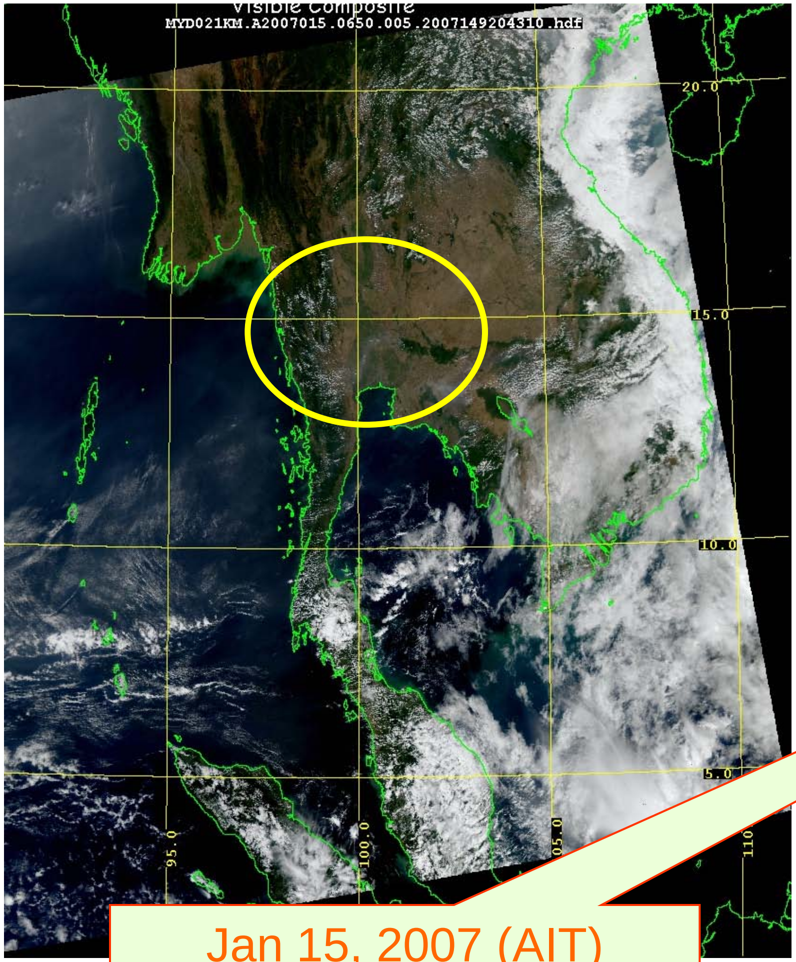
- Aerosol particles are measured as particulate matter mass for diameter less than 10 and 2.5 micron (PM_{10} and $PM_{2.5}$, respectively) and used as a standard to evaluate air quality at the ground level.

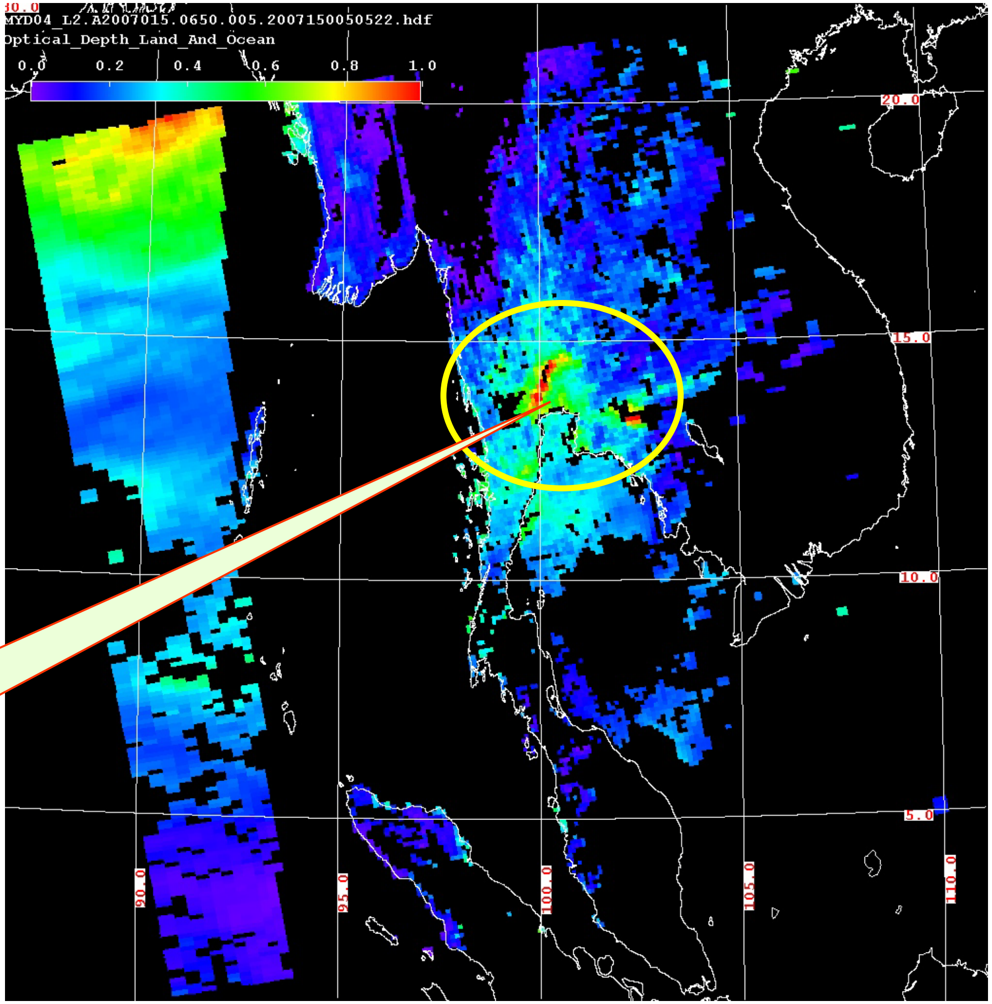
- Applications of satellite-based observation are attractive as an additional synoptic information and visualization to ground-based air quality data

- AOT = Aerosol Optical Thickness

MODIS-Aqua True color and AOT maps

January 15, 2007





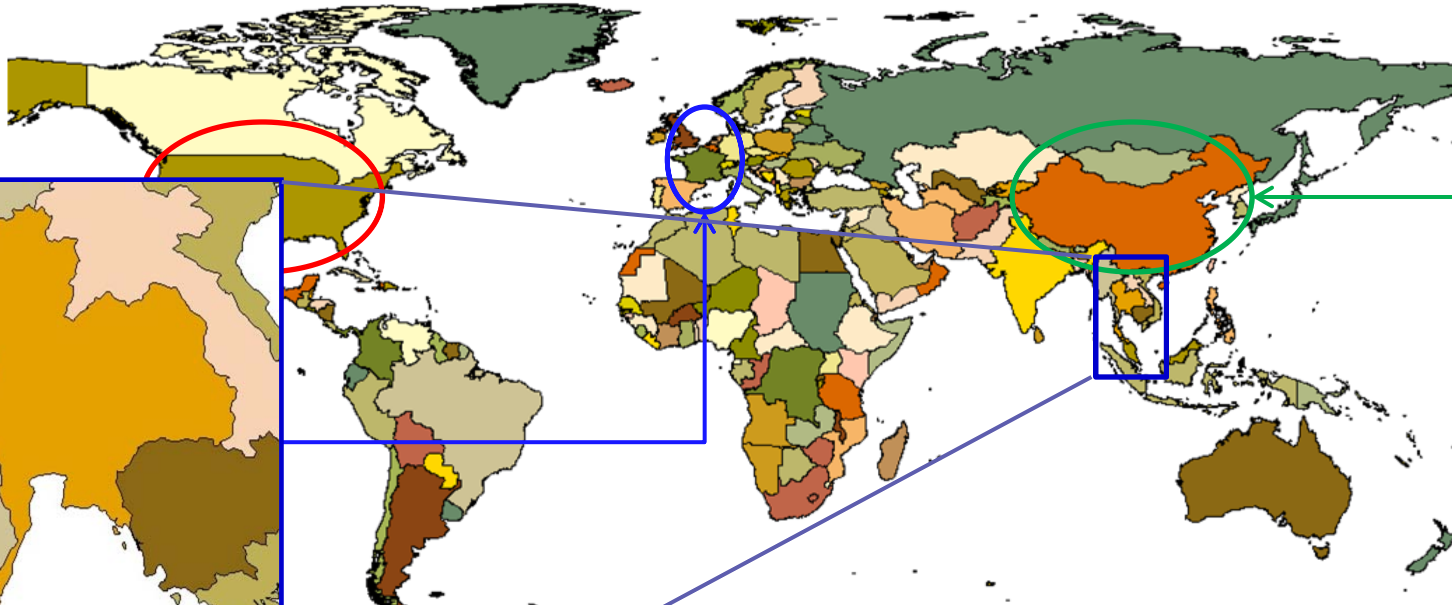
Jan 15, 2007 (AIT)

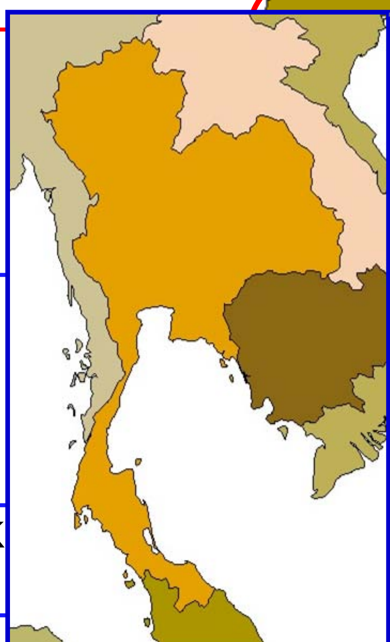
$PM_{2.5}$ = 71 μgm^{-3}

PM_{10} = 111 μgm^{-3}

Application

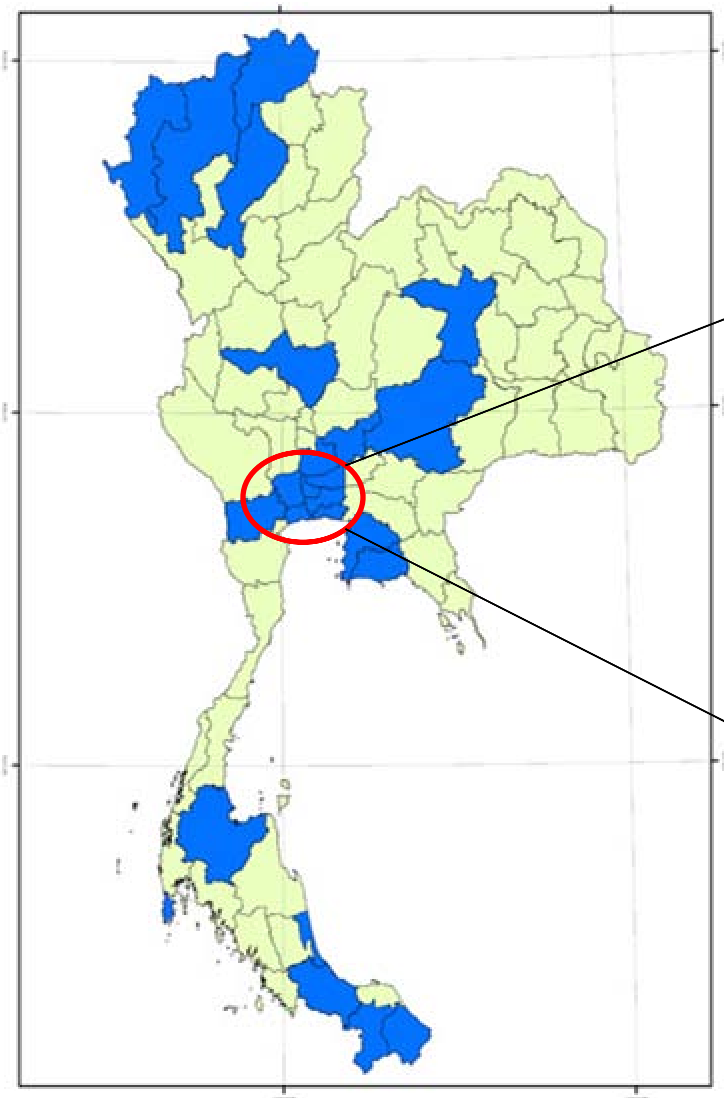
- Slater et al., 2004; Daily Average $PM_{2.5}$ ($\mu g/m^3$) = 100 × $AOT\text{-}550_{MFRSR}$ – 2, R = 0.87
- Engel-Cox et al., 2006; Daily Average $PM_{2.5}$ ($\mu g/m^3$) = 25.3 × $AOT\text{-}550_{MODIS}$ + 11.1, R = 0.57
  Hourly $PM_{2.5}$ ($\mu g/m^3$) = 31.1 × $AOT\text{-}550_{MODIS}$ + 5.2, R = 0.65
- Gupta et al., 2008; Daily Average $PM_{2.5}$ ($\mu g/m^3$) = 27.5 × $AOT\text{-}550_{MODIS}$ + 15.8, R = 0.52
  Hourly $PM_{2.5}$ ($\mu g/m^3$) = 29.4 × $AOT\text{-}550_{MODIS}$ + 8.8, R = 0.62



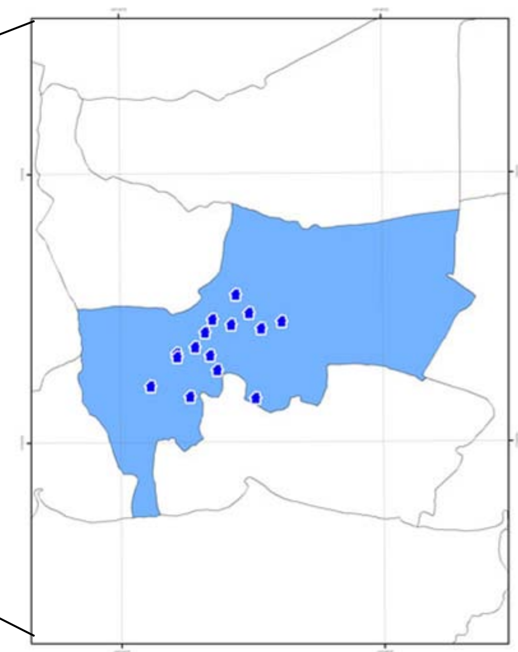


- K 2006; Daily Average $PM_{2.5}$ ($\mu g/m^3$) = 26.56 × $AOT\text{-}440_{POLDER}$ + 13.20, R=0.70
- Wang et al., 2010; Hourly PM_{10} ($\mu g/m^3$) = 99.96 × $AOT\text{-}550_{MODIS}$ + 22.67, R = 0.72
  Hourly $PM_{2.5}$ ($\mu g/m^3$) = 19.58 × $AOT\text{-}550_{MODIS}$ + 8.52, R = 0.69

Air Quality Stations in Thailand



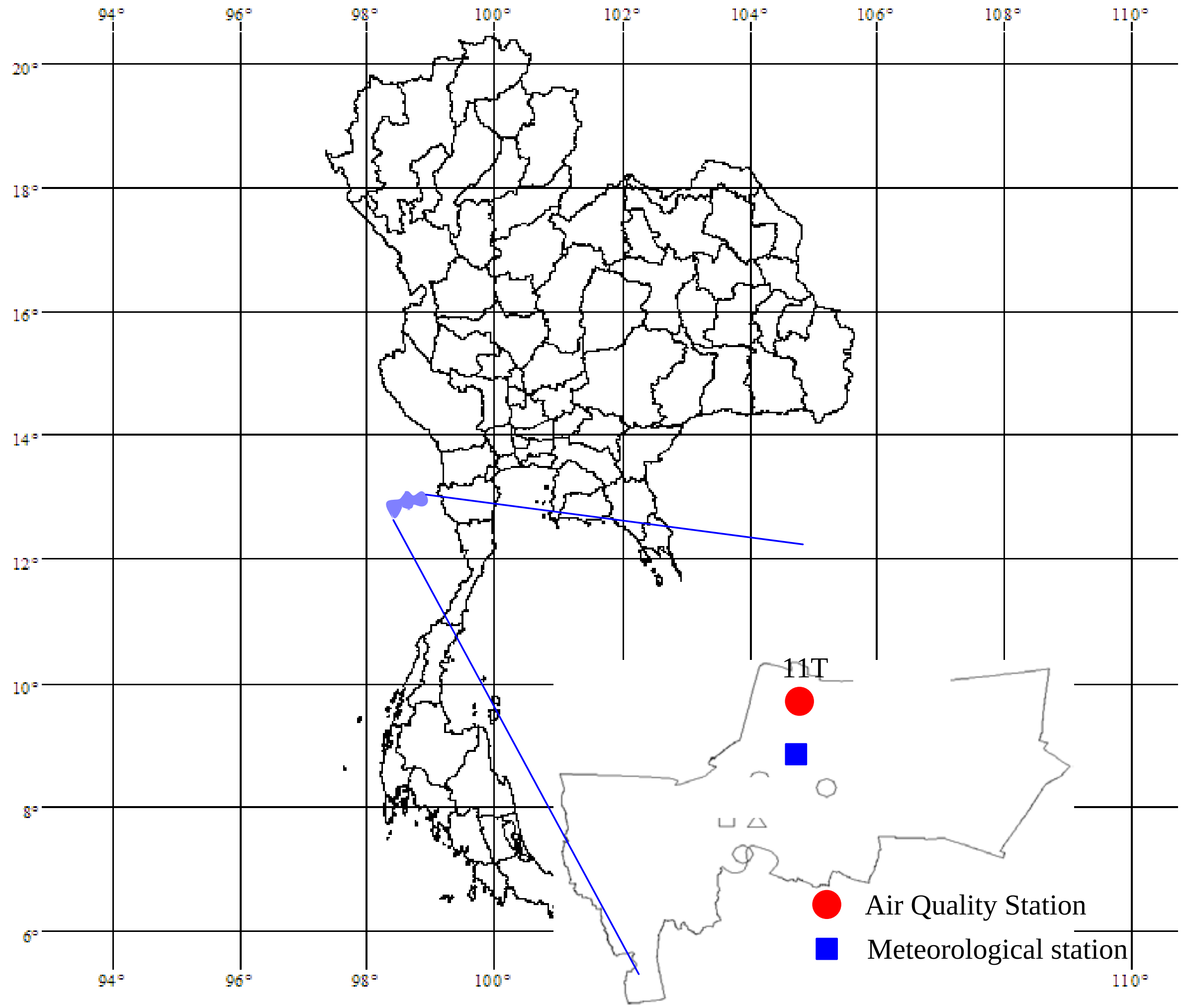
Totally, there are 53 permanent stations



17 stations are located in Bangkok, capital city

Source: Pollution Control Department (PCD); http://aqnis.pcd.go.th/station/allstation.htm

Methodology



Study Area

Methodology

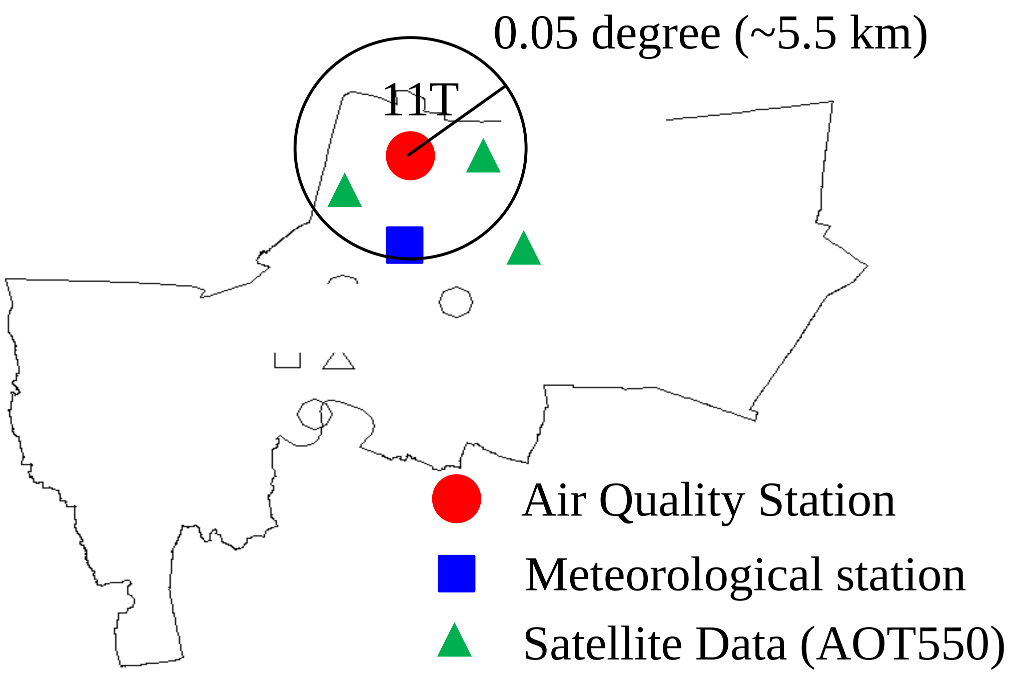
Data Collection

- **Ground data collection**
  - Air quality and Meteorological Data are from the Pollution Control Department (PCD) and Thailand Meteorological Department (TMD).
  - Parameters include PM_{10}; incoming net solar radiation (SR); cloud cover; horizontal visibility.

- **Satellite data retrieval**
  - MODIS-Terra
  - Parameter includes Aerosol Optical Thickness (AOT) at 550 nm

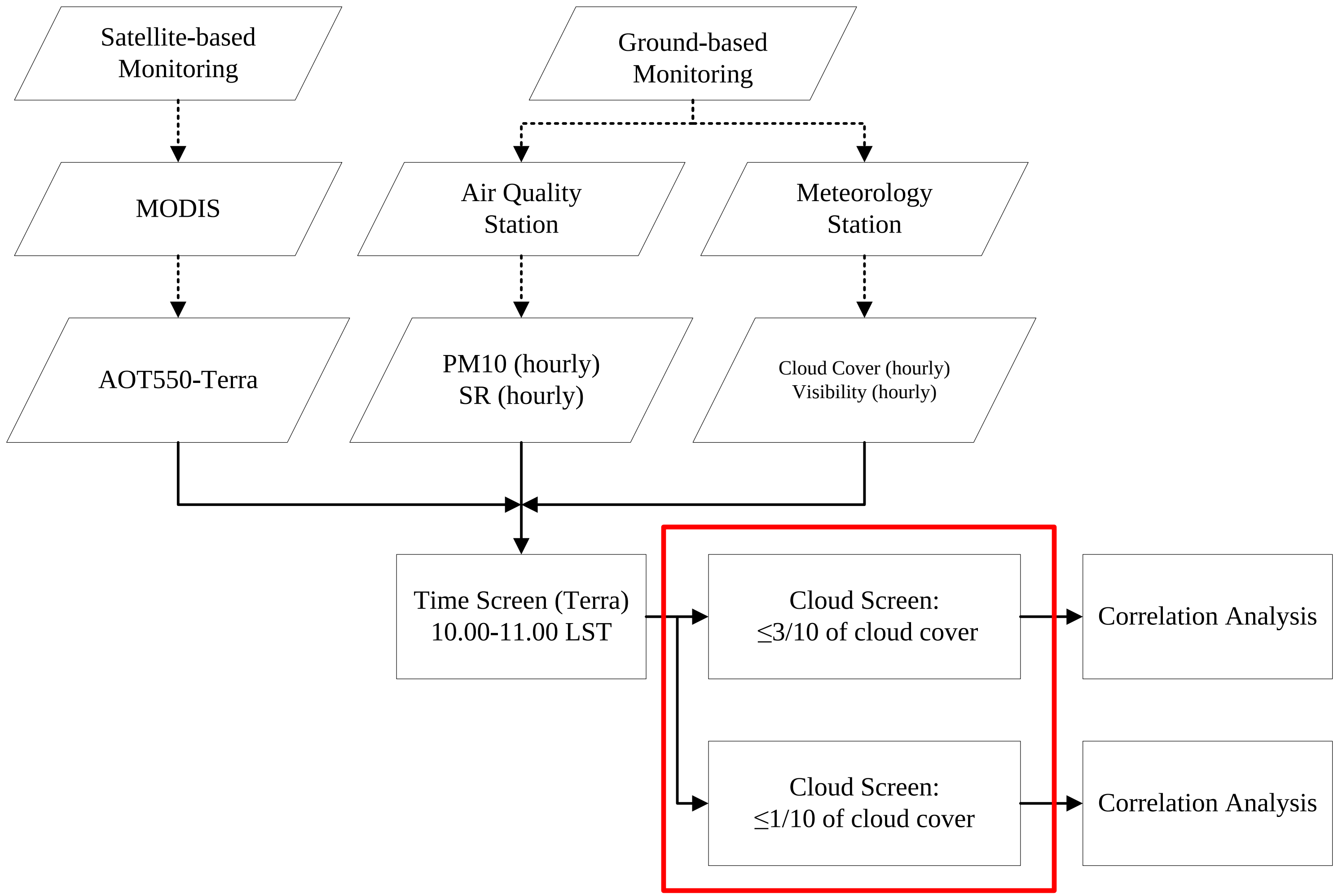
Satellite data retrieval
MODIS-AOT550 (Terra)
MOD04_L2 http://ladsweb.nascom.nasa.gov/data/search.html
HDF files
Text; Spreadsheet format
Geo-location selected

Methodology



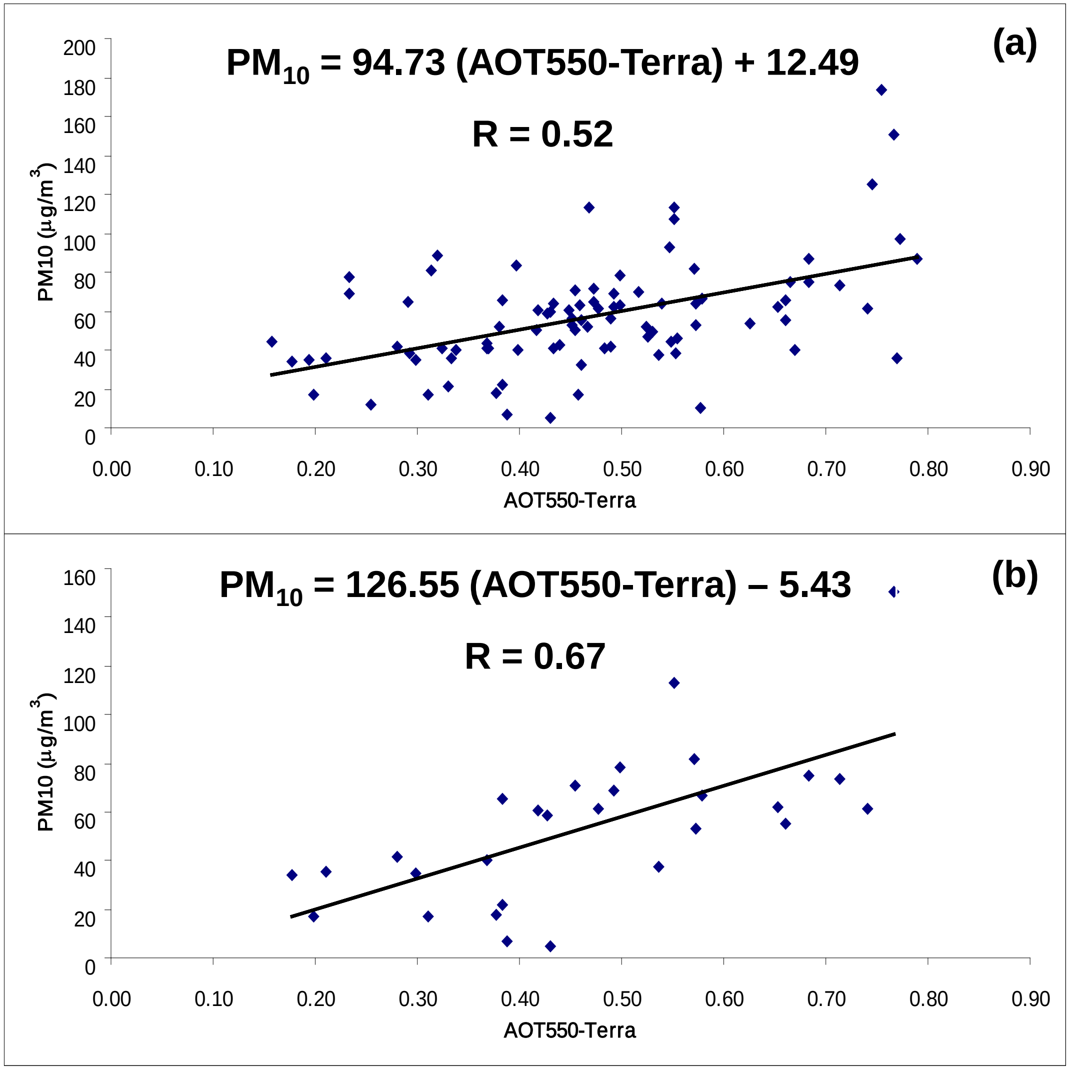
Area of AOT data retrieval

Methodology



Data Analysis

Results

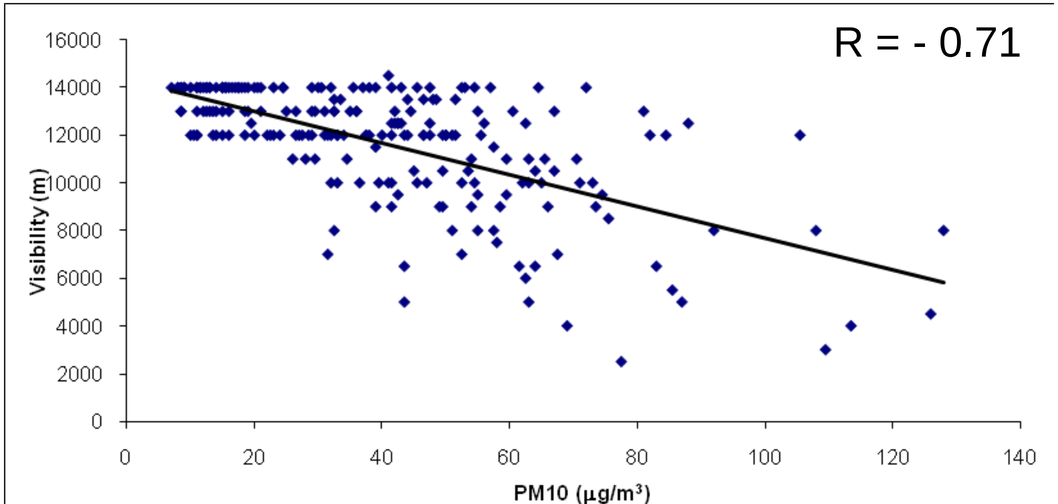


≤3/10 of cloud cover

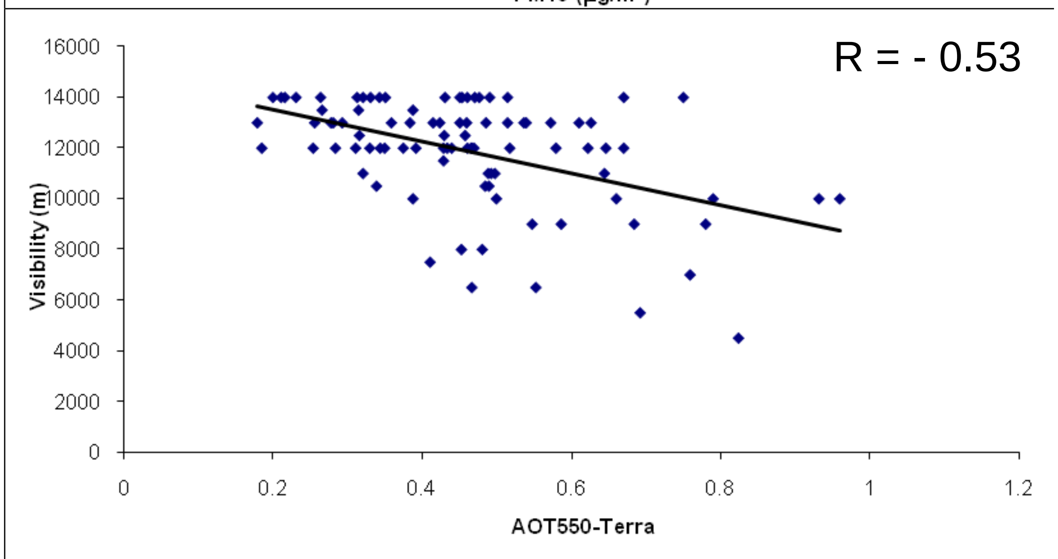
≤1/10 of cloud cover

Relationship between hourly PM_{10} (10.00-11.00 am) and AOT550 over Bangkok from 2002-2007: (a) ≤3/10 of cloud cover and (b) ≤1/10 of cloud cover

Results



PM_{10} versus Visibility



AOT550 versus Visibility

Relationship of hourly PM_{10} (10.00-11.00 am) and AOT550 on horizontal visibility over Bangkok from 2002-2007 with ≤3/10 of cloud cover

Correlation between aerosols on solar radiation and visibility at selected ambient air station

Parameters		Statistical parameters	Cloud screened method	
			≤ 3/10 of cloud cover	≤1/10 of cloud cover
PM_{10}	AOT550	Correlation	0.52	0.67
		N	91	29
	SR	Correlation	-0.19	-0.07
		N	218	67
	Visibility	Correlation	-0.71	-0.85
		N	218	67
AOT550	SR	Correlation	0.09	0.15
		N	91	29
	Visibility	Correlation	-0.53	-0.57
		N	91	29
SR	Visibility	Correlation	0.11	0.08
		N	221	67

Note N is number of analyzed data

Conclusions

1. Hourly PM_{10} and AOT550-Terra were negatively correlated with horizontal visibility observed in Bangkok.

2. High positive correlation coefficients between PM and AOT550 from MODIS indicated the capability of satellite for observing surface aerosol.

3. The study on atmospheric aerosols and its effects to environment toward satellite-based measurement would be applicable and alternative ways especially to the developing countries where the monitoring stations are sparse and limited.

Recommendations

For further study,

1. the correlation between AOT550-Terra and fine PM ($PM_{2.5}$) as well as PM compositions should be included.
2. meteorology should be appropriately classified into different classes to improve the relationships.
3. the AOT and PM relationships in different regions of sources would provide better picture of PM air quality using available satellite data

We would like to thank:

- Pollution Control Department (PCD)
-Thailand Meteorological Department (TMD)
- National Aeronautics and Space Administration (NASA)

Thank you very much