



Technion-Israel Institute of Technology

Faculty of Civil and Environmental Engineering

Integration of satellite observations and ground monitoring data and its application for assessing exposure to PM in Israel

Meytar Sorek-Hamer

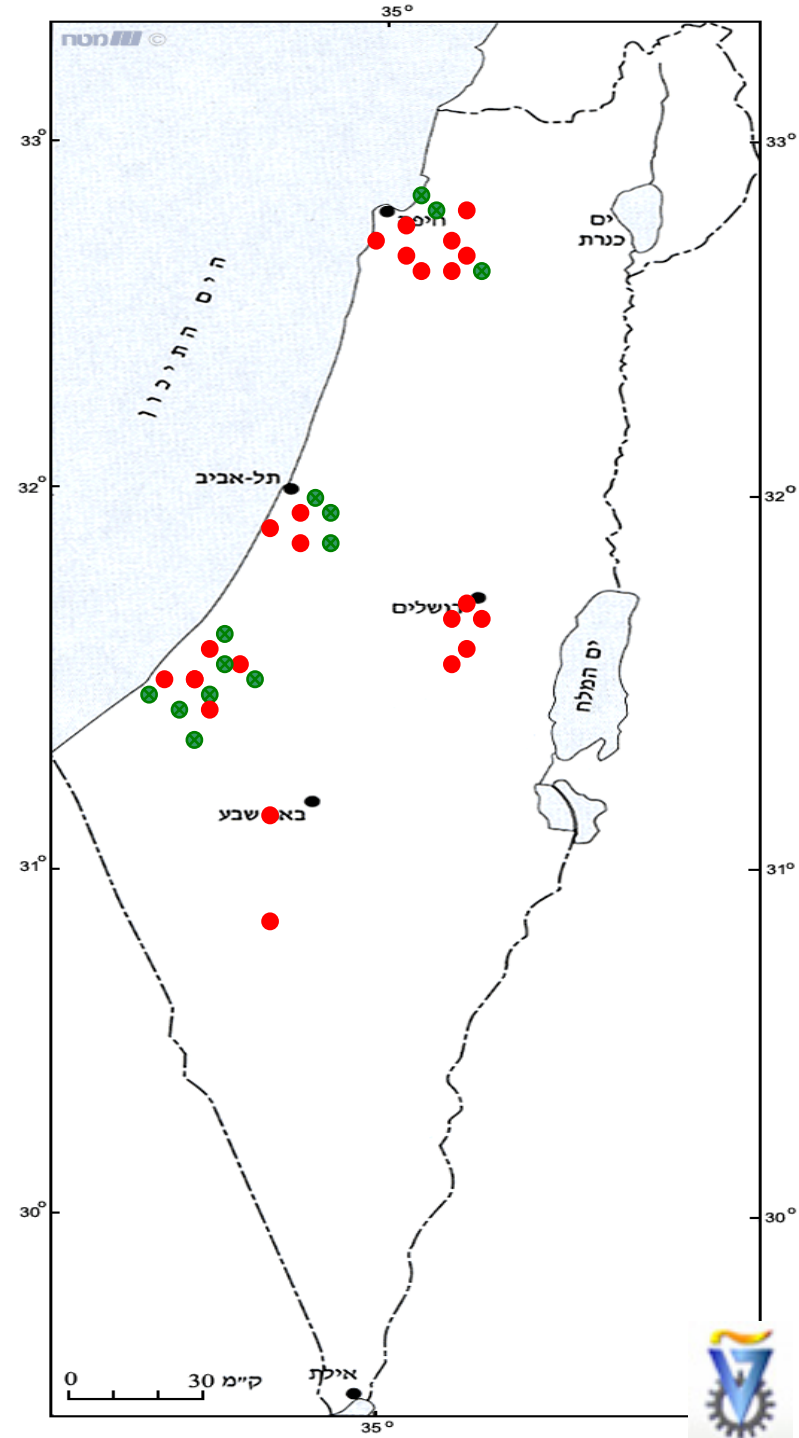
Dr. David Broday

IAAR 10.2.2010

Air quality monitoring system - Israel

	PM 10	PM 2.5
North	8	3
Center	3	3
Jerusalem	5	-
South	7	7
Total (36)	23	13

(MOE and Municipal Associations)

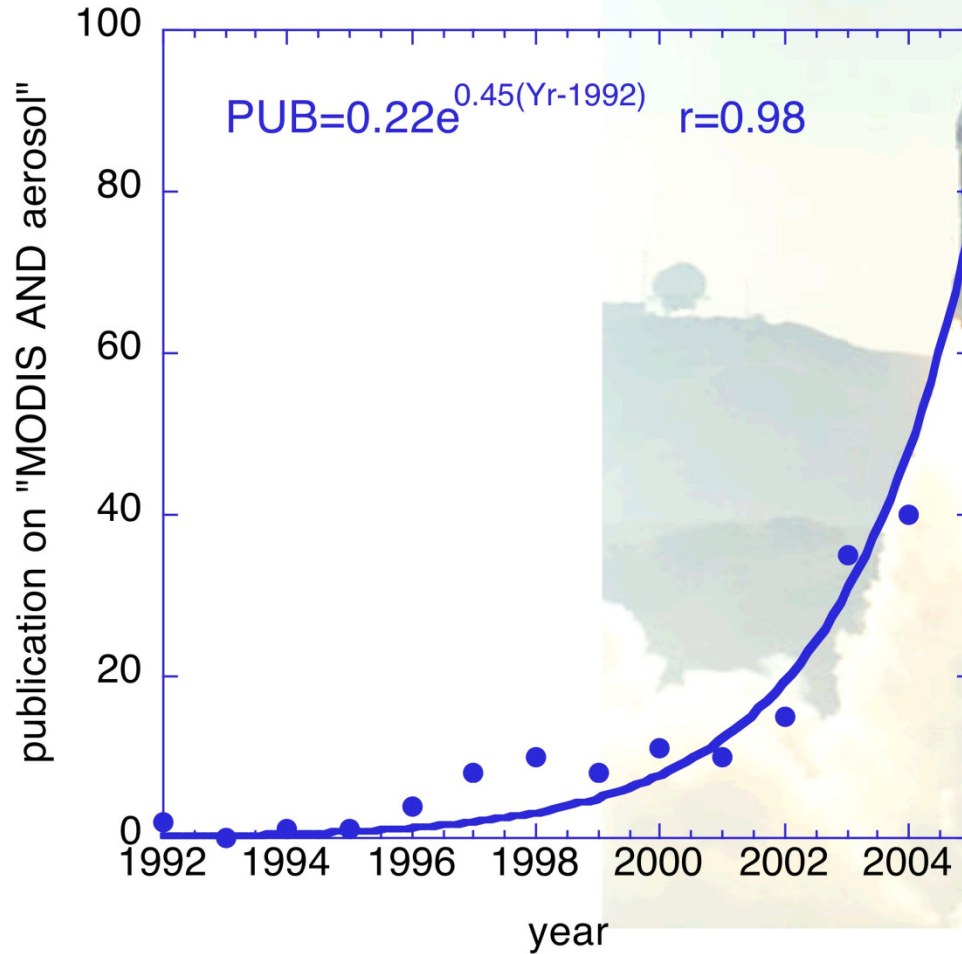


Satellite observations



- Large spatial coverage
- Global applications
(e.g. Climate change)
- Integration of the atmospheric column
- MODIS – 7 bands for aerosol data retrievals; $0.47\text{-}2.1\ \mu\text{m}$
- Frequency : 98.8 min
- Passes over Israel :
AQUA~ morning
TERRA~noon

Research status around the world



(Remer et al.,2005)



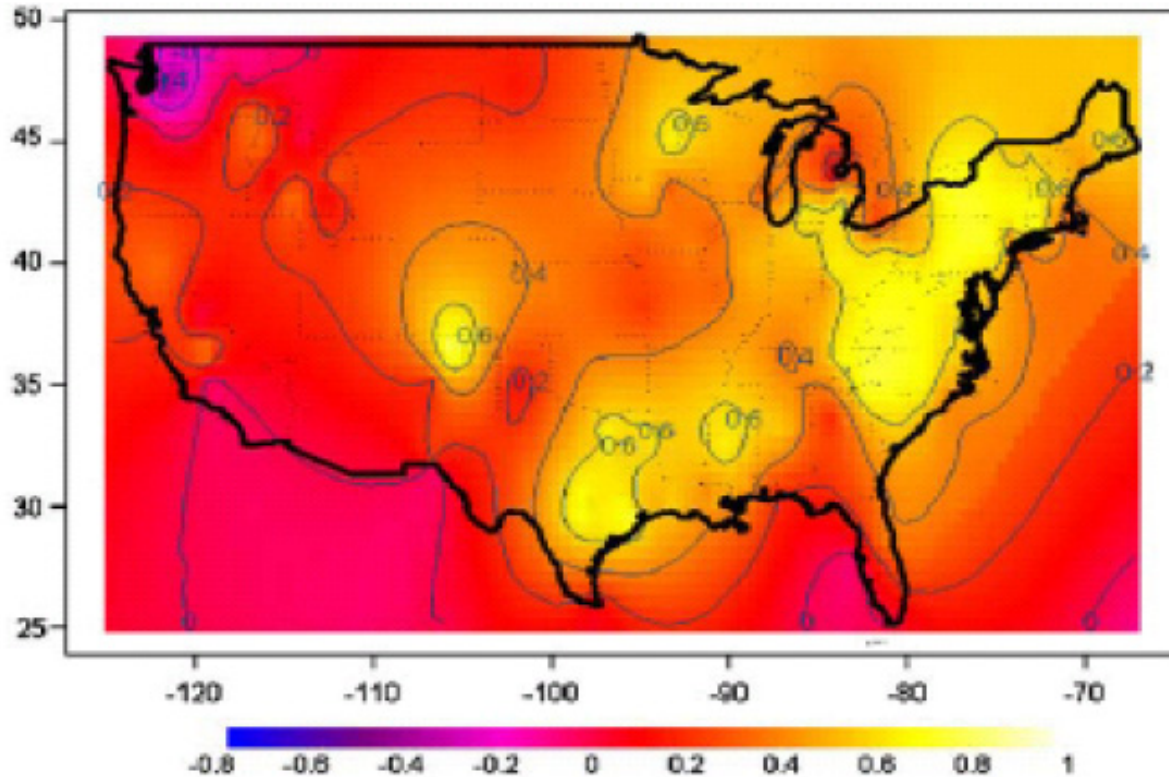
Research status around the world

- More than 30 studies – AOT vs PM
- All over the world – USA, Italy, India, Holand...
- Variety in results:
 - Better correlations in different seasons
 - Better correlations in different areas
 - (e.g. Eastern USA – better correlations than western USA)



Research status around the world

Correlations between AOD and PM_{2.5}(hourly)



(Engel-Cox et al., 2004)

- Surface reflectance calculations ?
- Aerosol characterization assumptions ?
- Relative humidity differences ?
- Aerosol vertical location ?

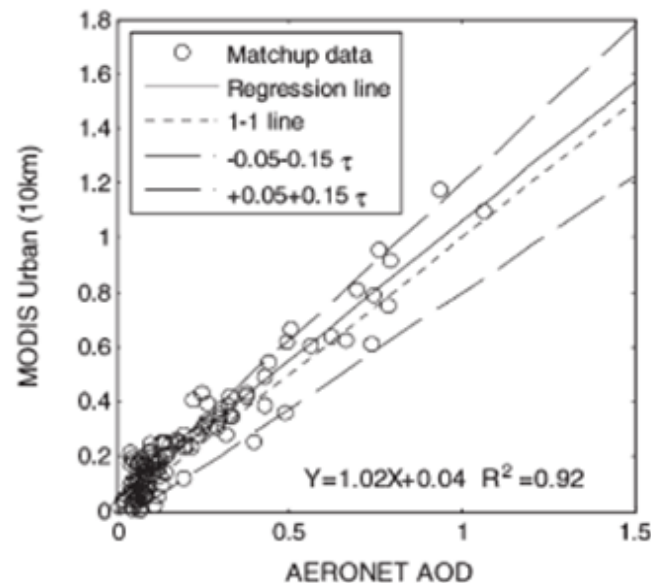
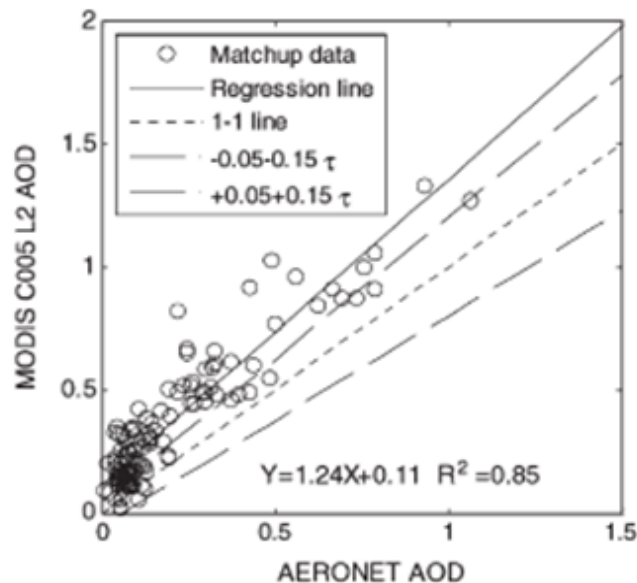


Surface reflectance modifications

Improved MODIS Aerosol Retrieval Using Modified VIS/SWIR Surface Albedo Ratio Over Urban Scenes

Min M. Oo, Matthias Jerg, Eduardo Hernandez, Ana Picón, Barry M. Gross,
Fred Moshary, and Samir A. Ahmed, *Life Member, IEEE*

2009 IEEE



Satellite-Borne data in Epidemiological studies

- **Spatial analysis of MODIS aerosol optical depth, PM2.5, and chronic coronary heart disease**

Zhiyong Hu

International Journal of Health Geographics 2009, 8:27

- **Particulate air pollution and chronic ischemic heart disease in the eastern United States: a county level ecological study using satellite aerosol data**

Zhiyong Hu and K Ranga Rao

Environmental Health 2009, 8:26

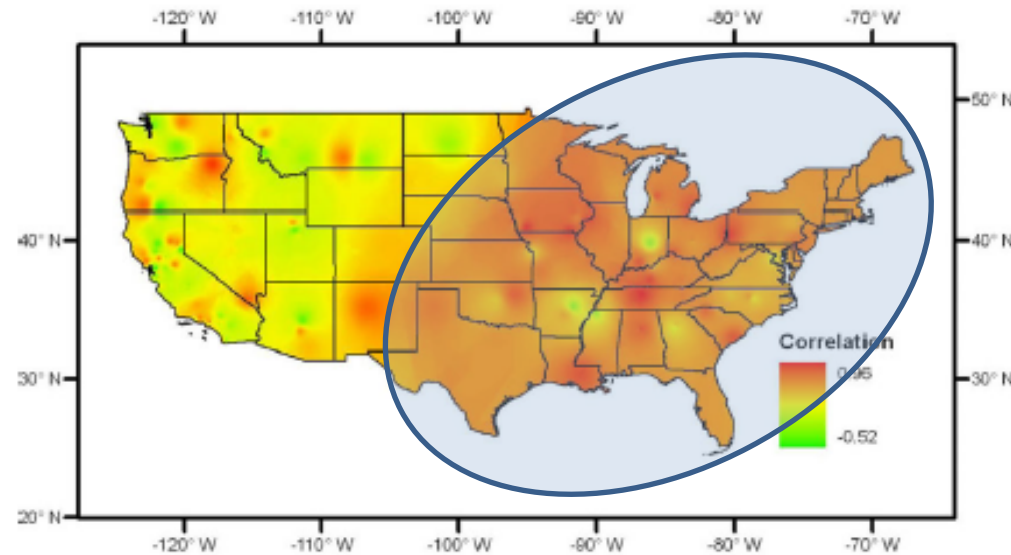


Satellite-Borne data in Epidemiological studies

- **Spatial analysis of MODIS aerosol optical depth, PM2.5, and chronic coronary heart disease**

Zhiyong Hu

International Journal of Health Geographics 2009, 8:27



- MODIS L2 AOT (Terra + Aqua)
- Cold months excluded
- Ground PM2.5 data – 877 sites
- Data area: USA
- Data period: 2003-2004

Ecological study:

Chronic coronary heart disease (CCHD)

mortality count and population at risk : county, race, age



Motivation

1. Correlation studies of satellite AOT vs ground PM concentrations aiming to improve the knowledge of air quality haven't been widely conducted in Israel.
2. Studies based on data from MODIS used the aerosol product with a spatial resolution of 10x10km whereas for air quality management as well as for environmental health applications a better resolution is required.
3. The MODIS aerosol data products over the ocean, which have a better reliability and accuracy, haven't been used for improving the PM retrieval over the land.

Integration of different data systems to improve the knowledge on the air quality in Israel.



Research Objectives

Develop a model that will be able to assess PM concentrations, based on the relationship between ground PM and satellite-borne aerosol data at a resolution compatible with environmental-health inference

Key questions:

- Can satellite observations over the land be used to estimate ambient PM concentration near the ground?
- How and when ?
- Can satellite data over the sea (i.e. Mediterranean) be used to assess a certain background level of ambient PM?



Research Methods

Raw Data (2002-2008):

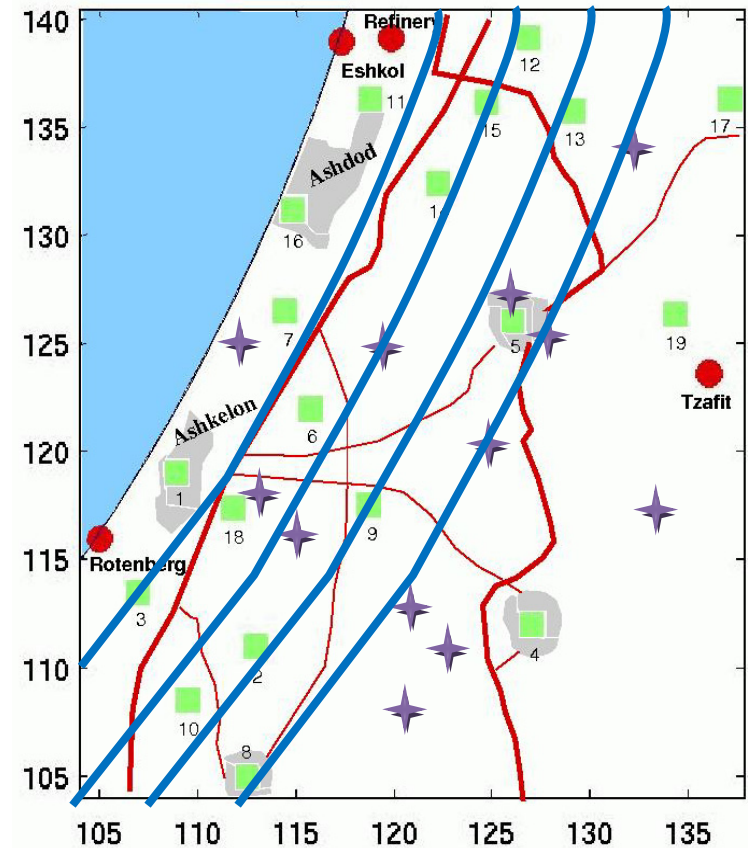
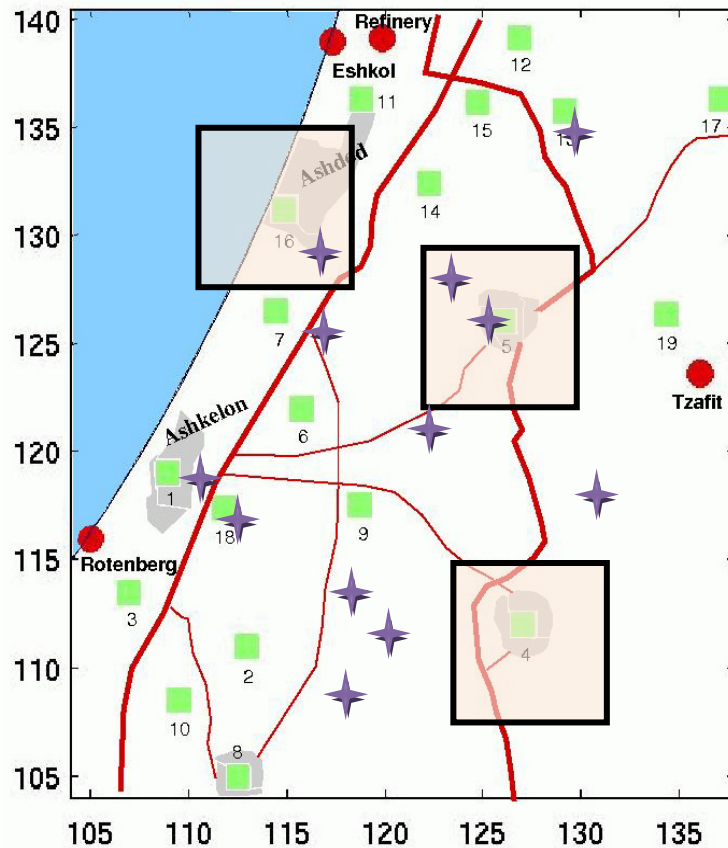
- MODIS – AOT, FMF
- Ground monitoring network - PM conc.
- MET. DATA – PBL, RH, WD

Spatio-temporal collocation



Initial data processing

Spatio-temporal collocation



(Ichoku et al., 2002)



PM ground monitoring station

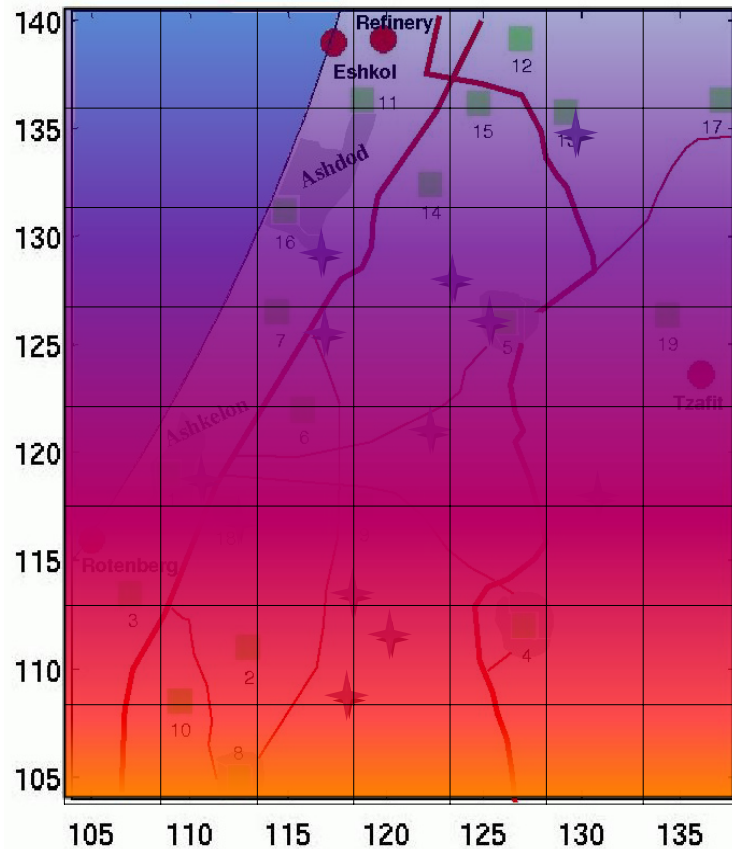


Satellite retrieval

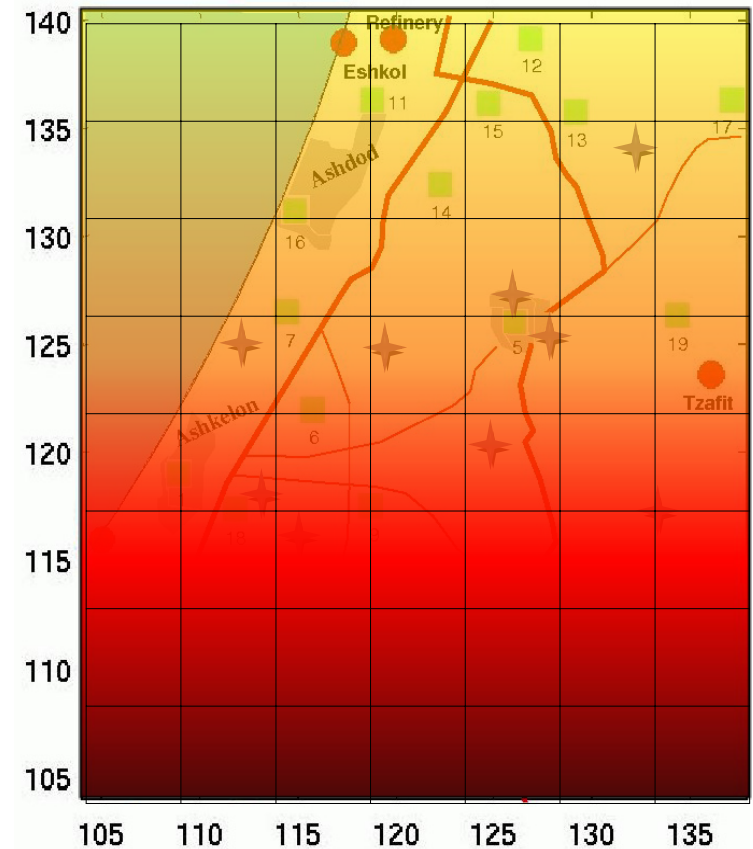


Initial data processing

Spatio-temporal collocation



PM



AOT



Research Methods

Raw Data:

- MODIS – AOT, FMF
- Ground monitoring network - PM conc.
- MET. DATA – PBL, RH, WD

Spatio-temporal collocation

Dust event – YES/NO ?

- Health effects
- Statistics
- Fine/Coarse

- Yuval and Broday (2006)
- HYSPLIT
- DREAM



Research Methods

Raw Data:

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- Ground monitoring network - PM conc.
- MET. DATA – PBL, RH, WD

Spatio-temporal collocation

Dust event – YES/NO ?

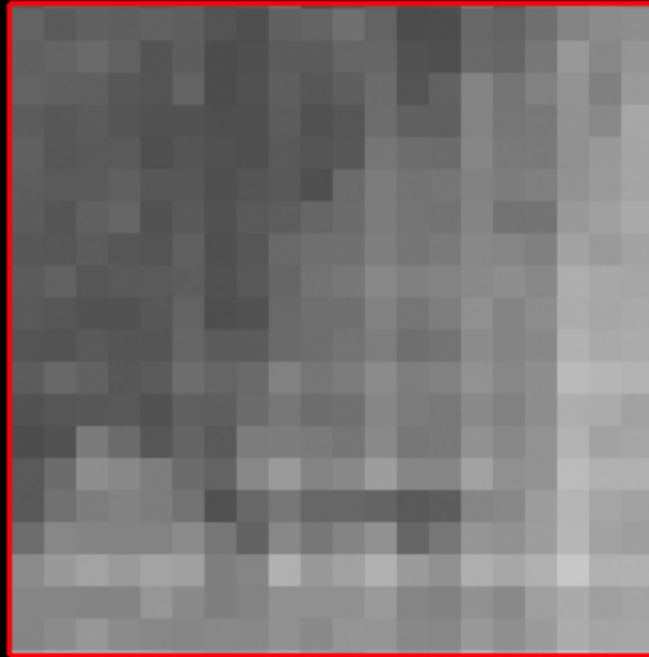
Satellite data –
Higher spatial resolution



Higher spatial resolution

10x10km

400
pixels



3x3km

36
pixels



Less pixels → More noise OR More data ???

Research Methods

Raw Data:

- MODIS – AOT, FMF
- Ground monitoring network - PM conc.
- MET. DATA – PBL, RH, WD

Spatio-temporal collocation

Dust event – YES/NO ?

Satellite data –
Higher spatial resolution

Utilizing Satellite Data
Over The Med. Sea



Utilizing Satellite Data Over The Med. Sea

- Rudich et al., 2008
- Is there a significant correlation between data over sea - over land when westerly winds are dominant ?

$$\tau_{L_1} = \tau_{L_{BG}} + \tau_{L_D} + \tau_{L_{SS}} + \tau_{L_A} + \dots + \varepsilon \quad (x > x_1)$$

$$\tau_{L_2} = \tau_{L_{BG}} + \varepsilon' \quad (0 < x < x_1)$$

$$\tau_{L_2} = \tau_S + \varepsilon_1 \quad (\text{Hypothesis})$$

$$PM = f(\tau_S) + f(\tau_L - \tau_S)$$

BG NOT-BG

τ_L = AOTland

τ_S = AOTsea

BG = Background from
Med. Sea

x_1 = Selected distance
from shore

**Distinguish between certain background
concentrations**

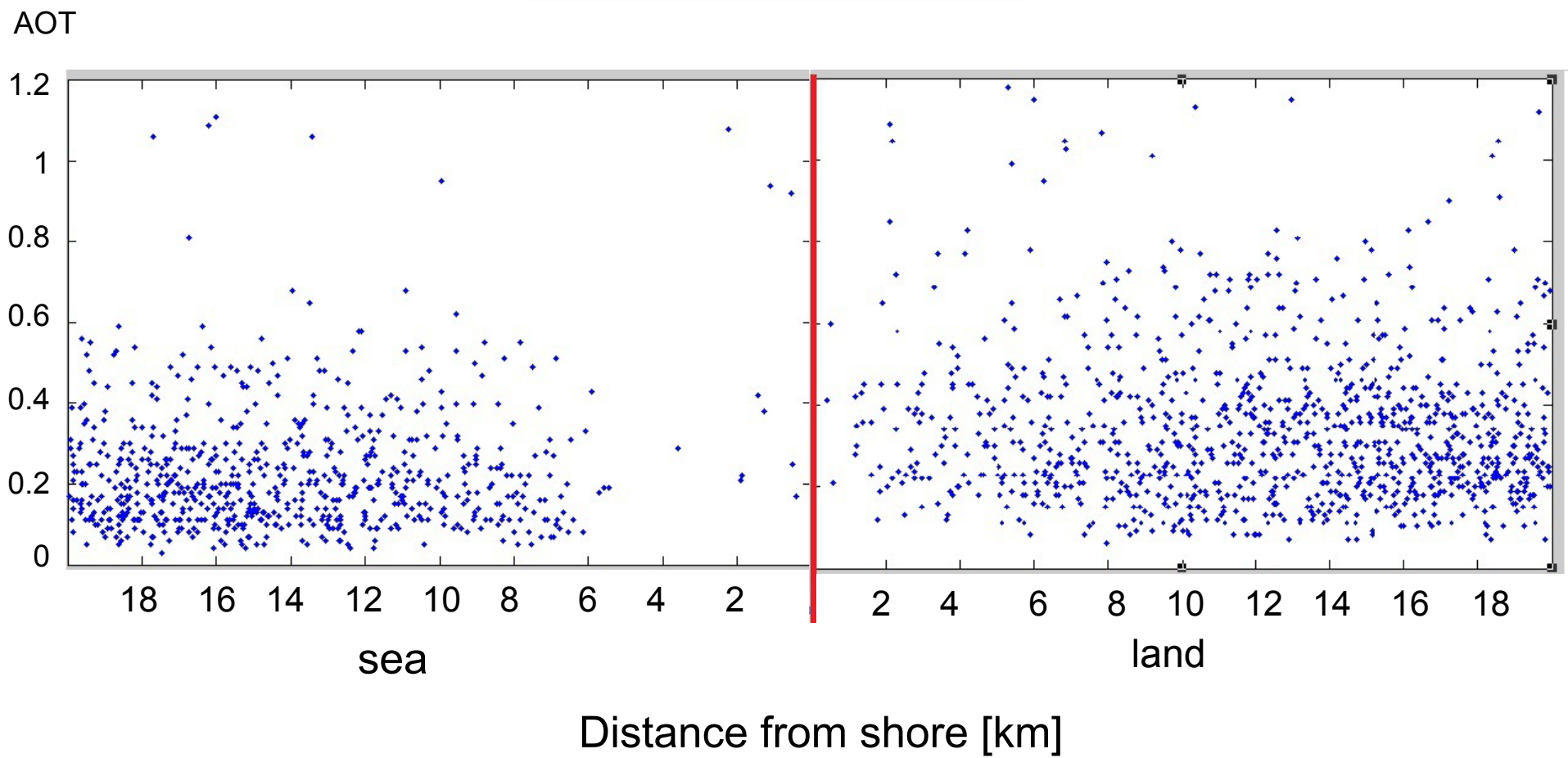


Model Evaluation

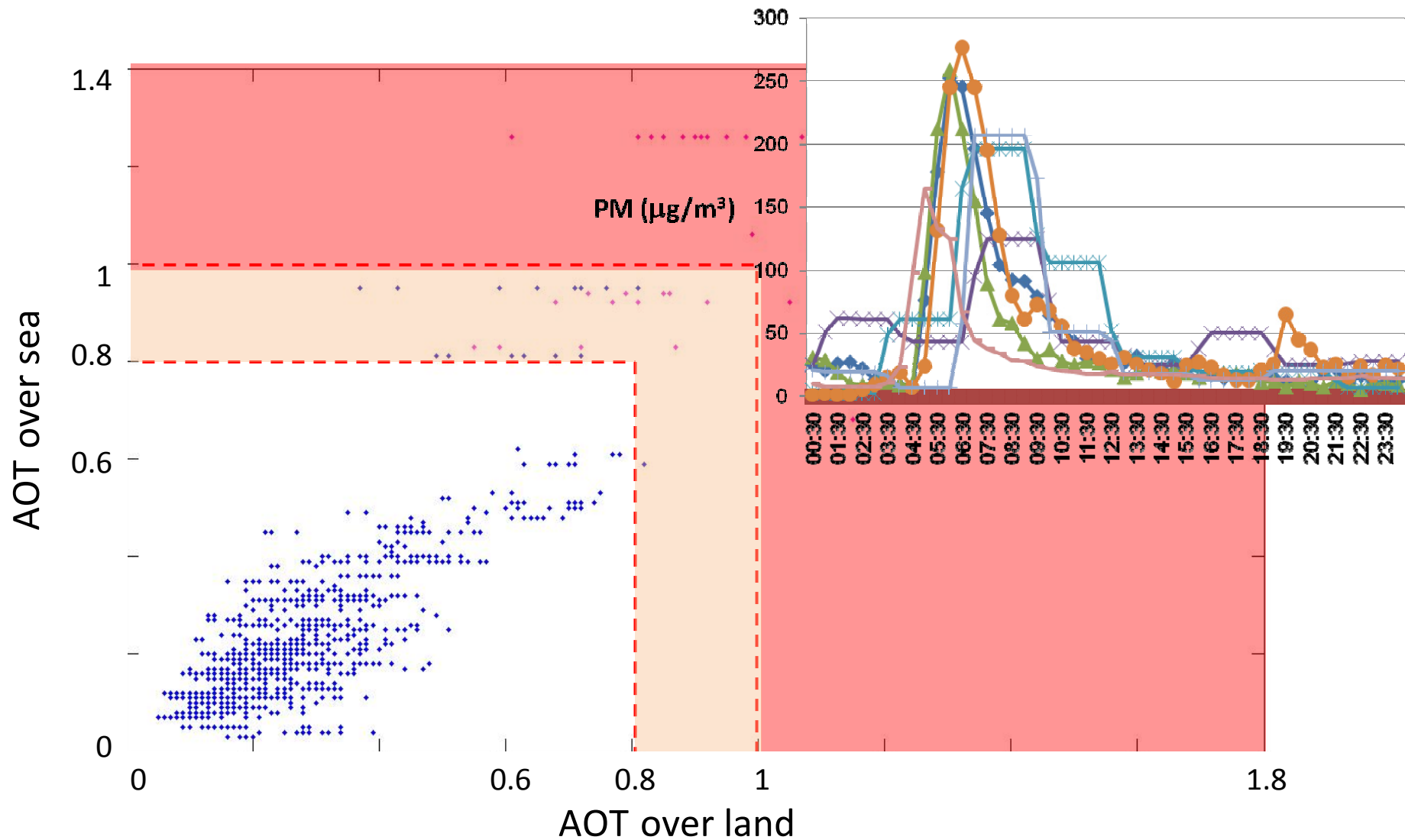
- Same area (i.e. Ashdod-Ashkelon) – different time period (i.e. 2009)
- Different area (e.g. Tel Aviv, California)
- CALIPSO aerosol vertical profile data



AOT Data – Sea/Land



PM events



Summary

- **Local contribution :**

- Development of a model - $\text{PM}_{\text{estimated}} = f(\tau_{\text{observed}})$
improve the knowledge on Israel's air quality
- Create spatial maps - assist environmental-health studies

- **Global contribution :**

- Utilizing satellite data with a higher spatial resolution
- Utilizing satellite retrievals over the ocean to assess background concentrations
- Identify capabilities and limitations of using satellite data in environmental-health studies



THANK YOU

