

Remote Sensing and GIS as Pollution Model Validation and Emission Assessment Tools

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Satellite Advantages

- Broad and homogenous geographic coverage
- Short repeat period (a few days)
- Variety of geometric resolutions (local to global scale)
- Direct and complementary information on air pollution
- Measurements of the total or partial column concentration of certain pollutants, depending on the technique (nadir or limb measurements)

Satellites & Urban Air Quality

- Indirect measurements of pollutant concentrations by high-spatial resolution instruments
- Assessment of the optical atmospheric effects (OAE) induced by certain pollutants that influence the satellite image radiometry
- Mapping of urban air-quality indicators, e.g. Aerosol Optical Thickness (AOT), indicative of Particulate Matter (PM) loading in the atmosphere

Aims and Objectives

- to examine Envisat MERIS and Terra MODIS data for monitoring air pollution in terms of AOT in the lower troposphere
- to validate the results against PM₁₀ ground-based measurements

Study areas: Greater Athens area
Greater London area

Study periods: May - August 2003
February - October 2003

Instrumentation and Data

- Envisat MERIS Level-2 full resolution images
 - quarter scenes: 300km x 334km
 - ground sampling distance: 300m x 300m
 - cloud-free (as much as possible)
- Terra MODIS Level-2 granule based images
 - pixel resolution: 10km x 10km
 - cloud-free (as much as possible)
- Ground-based PM₁₀ measurements
 - on an hourly basis, provided from the Pollution Monitoring Networks of Greece and London

MERIS Image Analysis

- Image classification: highly, moderately, and slightly polluted
- Geo-referencing: UTM WGS 84 projection system, Ground Control Points, BEAM software
- Image processing: ERDAS Imagine software, cloud mask
- Derivation of spatial distribution of AOT values: Differential Textural Analysis (DTA) code, band 5 (560nm), rolling window of 13 x 13 pixels

The DTA Code

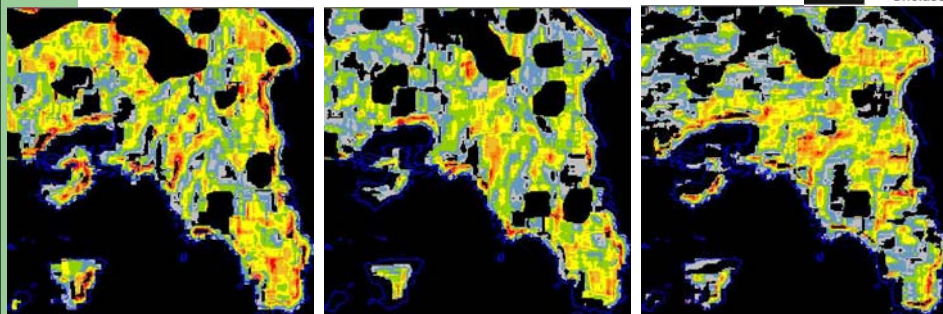
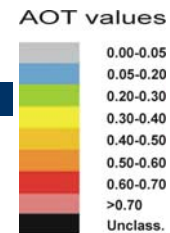
- Radiometric comparison of multi-temporal satellite data sets of the same area, allowing to locate, identify and assess variations of the magnitude of OAE
 - acquired by the same sensor
 - geometrically corrected
 - during different pollution conditions
- 2 tests on the MERIS images (1 “reference” image and 3 “polluted” images each time)
 - spatial resolution of 3.9km x 3.9km

MODIS Image Analysis

- AOT derived from the MODIS aerosol properties reported in level-2 products at 10km x 10 km
- MODIS AOT derived with an error of $\Delta\tau = \pm 0.03 \pm 0.05\tau$ (Chu, D.A. *et al.*, 2002)
- Geometric correction
- Appropriate colour palette for categorisation of the AOT values and for better interpretation purposes

AOT maps - Athens

- MERIS band 5
- Reference image 22/06/2003



11/05/2003

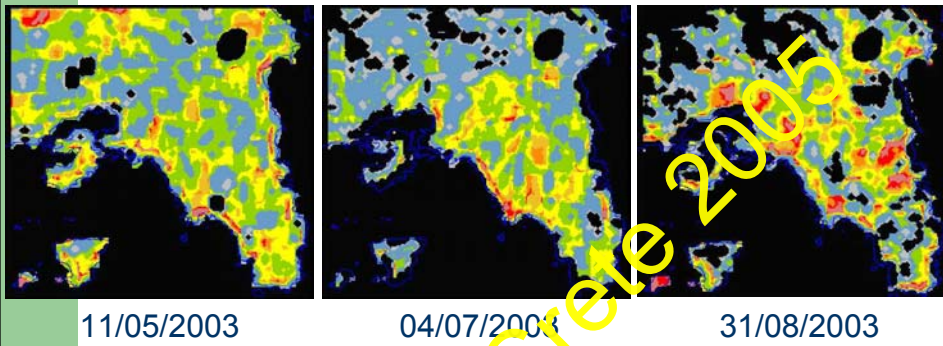
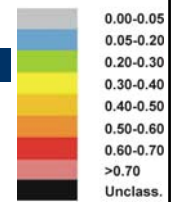
04/07/2003

31/08/2003

AOT maps - Athens

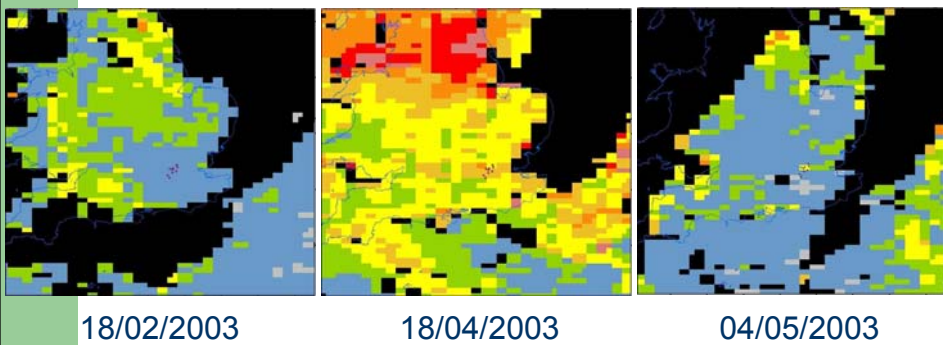
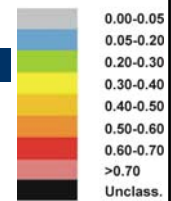
- MERIS band 5
- Reference image 15/06/2003

AOT values



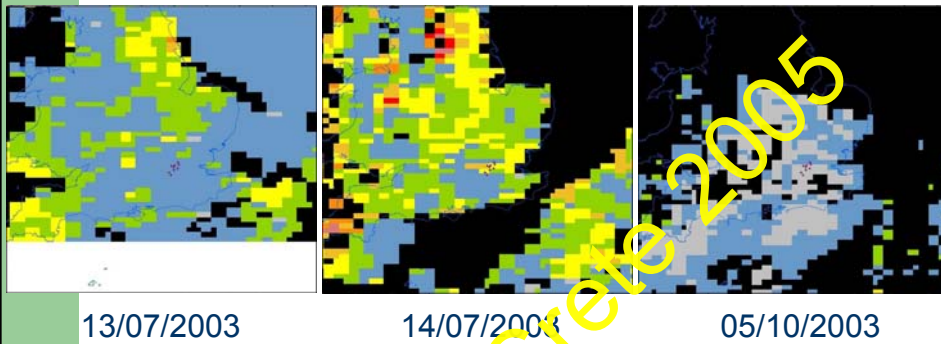
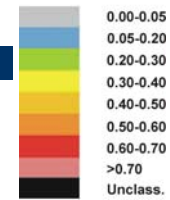
AOT maps - London

AOT values



AOT maps - London

AOT values



Scatter Plots for Athens

Ref. image 22/06/2003

- Correlation coefficient high ($R^2=0.70$)

Ref. image 15/06/2003

- Correlation coefficient improved ($R^2=0.73$)



Potentiality of using Envisat MERIS observations
for obtaining AOT maps

Limitations

- Accuracy of method (DTA code)
 - limited by the moderate resolution of MERIS data
 - determined by the selection of a rigorously clean image to be considered as the “reference” image
- Assessment of OAE (and consequently AOT)
 - influenced by variations over time of the underlying Earth surface

Conclusions

- Satellites: powerful tool for air pollution mapping
- DTA code + MERIS (whenever available and cloud-free) ⇒ Reliable AOT maps over Athens area
- Accuracy of method: quite limited
- Future work
 - AOT map production on an operational basis
 - Extension of the current monitoring network with new satellite observations

Questions?

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