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Data fusion for assessment of urban air pollution

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Information from satellite observations, ground-based monitoring and numerical simulations of air pollution are integrated by the networked interactive computational environment ICAROS NET.

The new methodology provides information about air quality with a resolution of approximately 30 m x 30 m by using retrievals of optical depth (AOT) from satellite images in an area of approximately 100 km x 100 km (depending on the satellite sensor used, e.g. Landsat, SPOT).

The mixing layer height (MLH) is determined either by radiosondes, by remote sensing (SODAR, ceilometer, RASS, by numerical models of the boundary layer, or by aircraft sounding.

The optical depth from the satellite images can be interpreted as the particle mass concentration in the mixing layer.

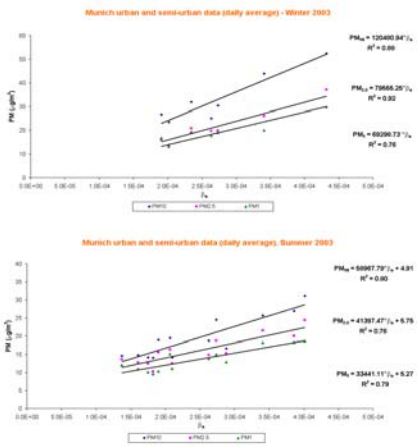


Fig. 3. Dependence of PM mass concentrations from particle scattering coefficient during the winter (above) and summer campaign (buttom). MLH was measured by a SODAR in Maisach.

Methodology

a) Acquisition of two-image multi-temporal sets
   (i) one image recorded under very clear atmospheric conditions and
   (ii) images of the same geographical area recorded during different pollution levels.
b) Pre-processing to render the images radiometrically comparable.
c) Application of the retrieval codes for optical depth on the basis of the blurring, screening, opacity and dark target effects.
d) Adaptation to selected region: Correlating measured AOT from sun photometers with local PM measurements (Fig. 1). Urban and sub-urban areas were investigated (Figs. 2 – 4).
e) Introducing population data in exposure-response relations from large epidemiological studies both in EU and USA. Health impact indices such as population vulnerability, mortality and morbidity were calculated.

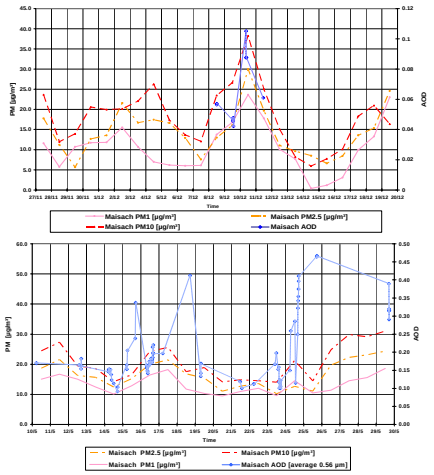


Fig. 2. AOT at 560 nm (average) and PM mass concentrations, measured at Maisach (sub-urban): winter (above) and summer campaign (bottom).

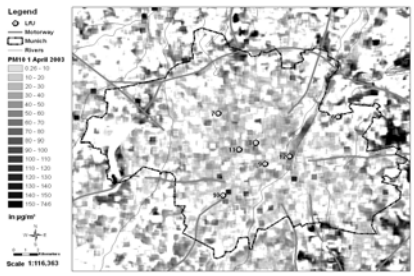
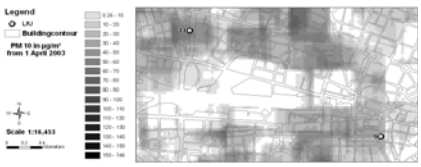


Fig. 1. Measurement devices: SODAR for mixing layer height and PM mass concentration sampler .

Optical depth and air pollution

Strong dependence of AOT from particle mass concentrations was found in the Munich area. The growing of particles with rising relative humidity is considered in the first layer data fusion module (Fig. 3). There is a high correlation of the retrieved PM10 concentration on 01 April 2003 (Fig. 4) with ground-based measurements (Fig. 5).



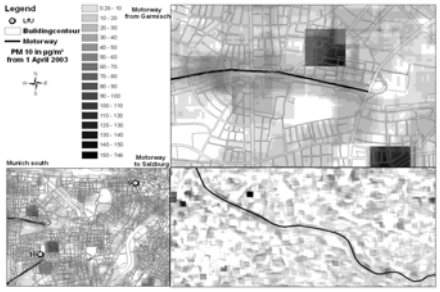


Fig. 4. Spatial distribution of PM 10 in µg/m³ retrieved from Landsat images in different areas (reference 16 April 2000). Measurement sites are indicated.

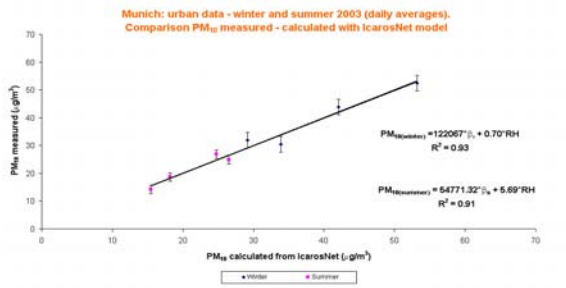


Fig. 5. Comparison of daily averaged PM10 concentrations measured in Munich and calculated by the ICAROS NET platform.