Urban aerosol concentrations from MERIS/AATSR synergy: a preparatory study for Sentinel 3

Beloconi Anton[1], Kamarianakis Yiannis[2] *and* Chrysoulakis Nektarios[1]

[1] *Foundation for Research and Technology Hellas (FORTH), Greece*
[2] *Arizona State University, USA*

Abstract

Particulate Matter (PM) concentration is used as an air quality indicator in urban areas; therefore it is highly important for urban planning. Furthermore, numerous studies, analyzing the impacts of PM on human health, have found associations of PM with increased morbidity and mortality. Monitoring of PM concentrations is primarily based on ground measurements. Despite the fact that dense station networks exist, in large cities like London, in situ measurements do not provide detailed information on the spatial distribution of PM at local scale. This reason has prompted an ongoing effort for PM estimation using satellite observations. This study evaluates alternative spatio-temporal approaches for quantitative estimation of daily mean PM concentrations. Both fine (PM2:5) and coarse (PM10) concentrations were estimated over the area of London (UK) for the 2002-2012 time period, using Aerosol Optical Thickness (AOT) derived from MERIS (Medium Resolution Imaging Spectrometer) / AATSR (Advanced Along-Track Scanning Radiometer) synergistic analysis at 1 km x 1 km resolution. High-resolution (100 m) local urban surface cover and morphology datasets were incorporated in the analysis in order to capture the effects of local scale emissions and sequestration. Spatial (2D) and spatio-temporal (3D) kriging were applied to in situ urban PM measurements to investigate their association with satellite-derived AOT while accounting for differences in spatial support. Linear mixed-effects models with day-specific and site-specific random intercepts and slopes were estimated to associate satellite derived products with kriged PM concentration and their predictive performance was evaluated. The developed method will be adapted to Sentinel 3 series, the first of which (Sentinel 3A) is expected to be launched in late 2015: the synergistic use of the Sea and Land Surface Temperature Radiometer (SLSTR) and the Ocean and Land Color Instrument (OLCI), on board Sentinel-3, is expected to provide improved AOT and thereby to increase its potential to support local scale studies related to urban planning and public health. The statistical models produced in the present study will contribute to the development of an operational tool capable of producing high-resolution PM concentration maps using Sentinel-3 observations. Since all covariates used in the predictive models are satellite-derived products, the methodology can be transferred to other urban areas, to estimate both PM10 and PM2.5, depending on the availability of in situ measurements to calibrate satellite observations. Furthermore, additional location-specific covariates can be included in mixed effect models, in order to explain part of the variability of random effects terms. While the MERIS and AATSR 11-year data set is suitable for investigating past PM changes and trends in urban areas, the forthcoming SLSTR and OLCI sensors offer the possibility of downscaling, if combined with the high spatial resolution MSI (Multispectral Instrument) onboard Sentinel-2 series. The common spectral channels of MSI, OLCI and SLSTR provide unique capabilities for synergistic use of observations from these sensors. Such synergistic use is expected to lead to daily PM concentration maps of high spatial resolution, which are necessary in urban air quality studies.