Geophysical Research Abstracts,
Vol. 11, EGU2009-10166, 2009
EGU General Assembly 2009
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Satellite-based monitoring of air quality within QUITSAT project

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Satellite remote sensing of both trace gas constituents and Particulate Matter (PM) can be profitably exploited in Air Quality (AQ) assessment. The actual potential role of satellite observations is here highlighted combined with regional meteorological and Chemical Transport Models (CTM) in the context of air quality monitoring as experienced in QUITSAT Project over Northern Italy (from 43:09 to 46:39 N, from 6:19 to 14:23 E).
QUITSAT (2006-2009) is a pilot project funded by the Italian Space Agency (ASI) in the framework of its institutional priorities for the Natural and Technological disaster management programme. AQ monitoring is in general based on local ground measurements. In recent years, this issue has been inserted in a more extended frame, in which CTM have joined ground-based data and satellite observations to provide a better characterization of AQ monitoring, forecasting and planning on a regional scale.
In particular, two satellite-based products arisen from analysis methodologies developed in QUITSAT and relative to significant pollutants as PM2.5 and NO2 are presented within this work.
The MODIS sensors capability (Terra and Aqua/NASA platforms) to retrieve Aerosol Optical Properties (AOP) has been used in a semi-empirical approach to estimate PM2.5 content at the ground.
At first, PM2.5 concentration sampled in several sites over Northern Italy are employed in order to infer AOP to PM conversion parameters. A spatial-temporal coincidence procedure has been performed amongst EO and non-EO data. To take into account the aerosol columnar dispersion and the AOP dependence on the relative humidity (RH) meteorological fields (Planetary Boundary Layer and RH) simulated by MM5 are considered. MODIS aerosol level 2 products (MOD04 and MYD04 collection 5, 10x10 km2 spatial resolution) and PM2.5 samplings performed by Regional Environmental Agencies (ARPA Emilia Romagna and ARPA Lombardia) and carried out over further 6 measurements sites (located in Milano, Bologna, S. Pietro Capofiume, Oasi Bine, Monte Cimone e Bormio) relative to 2004, summer 2007 and winter 2008, are employed to derive the best regression parameters for AOD to PM2.5 conversion relationship. The conversion parameters have been grouped on a monthly basis and spatially interpolated over the whole domain.
Thus, daily maps of satellite-based PM2.5 concentrations over Northern Italy are derived. Monthly averaged values have been compared to in-situ PM2.5 sampling providing a good agreement.
OMI (Aura/NASA platform) NO2 tropospheric column (spatial resolution 13x24 km2) are merged with the simulations of the Transport Chemical Aerosol Model (TCAM) performed at resolution of 5x5 km2. The method used is a weighted rescaling of the model column in the troposphere according to the OMI observations, where the weights are the measurement errors and the model column variances within the satellite ground-pixel, respectively. Nitrogen dioxide above the TCAM maximum modelled altitude (that is about 4 km) are considered as negligible in our approach. Actually this is a good approximation when medium and high polluted regions are observed (as Northern Italy) while further analysis could be required over low polluted regions to exclude any significant NO2 amount in the middle and upper troposphere. The obtained ground concentrations of NO2 have been compared with in-situ observations performed by the Regional Environmental Agencies (ARPA Emilia Romagna and ARPA Lombardia) showing good agreement either over rural area or over urban region where horizontal gradient in NO2 concentration could be relevant.

The work is part of the pilot project QUITSAT, funded by the Italian Space Agency (ASI), contract I/035/06/0, http://www.quitsat.it.