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Vertical profiles of pollutant gases measured with passive DOAS in the Po Valley devoted to satellite and chemical model data comparison

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In the frame of QUITSAT Italian pilot project (Air QUality with InTegration of ground-based and SAtellite measurement and chemical Transport model), two field campaigns were made in S.Pietro Capofiume (44.65° N; 11.37° E) and Bologna (44.52° N; 11.34° E) to provide concentration of ground particular matter and gaseous pollutants, namely nitrogen dioxide (NO_2), formaldehyde (HCHO), sulphur dioxide (SO_2) and ozone (O_3). The aim of the campaigns was to provide experimental data need for tests and improvement of algorithms developed for integration of satellite and ground-based data together with chemical transport model data in order to retrieve air quality in the QUITSAT domain.

Ground based measurements were carried out within a network of in-situ analyser in the Po Valley and with a scanning multi-axis DOAS (Differential Optical Absorption Spectroscopy) spectrometer system developed at ISAC-CNR institute [1], in collaboration with Geophysics Center of Evora [2]. TropoGAS (TROPOspheric Gas Analyser Spectrometer) spectrometer permits active and passive DOAS measurements at the chosen angles: α =1,2,3,6,10,15,20,90 and another measurement was taken along the sun direction.

A Xenon lamp installed at 1km of distance from spectrometer was used as a reference concentration measured in the same place, and these values shows good agreement with in-situ analyser concentration. Gas spectral absorption was evaluated with DOAS [3] algorithms from 430 to 500 nm in two different windows: first from 436 to 460 nm for NO_2 retrieval; second from 460 to 500 nm for O_4 (best line at 477 nm) and NO_2.

Air Mass Factor (AMF) was calculated using PROMSAR (PROcessing of Multi-Scattered Atmospheric Radiation) model [4], that is a backward Montecarlo Radiative Transfer Model (RTM). An apposite inversion method [5][6], was applied to retrieve profiles of the target gases from their Slant Column Densities (SCD), using advanced approaches involving measurement of the atmospheric O_4 whose profile depends strongly on altitude [7][8]. Due to this it is also possible gain information about the atmospheric aerosol profile to set better the parameters in AMF Calculation, and then retrieve gas concentration's profiles. The NO_2 concentrations measured were in the range of 0.5-25 ppb, as we expect for summer periods in rural area.

GAMES (Gas Aerosol Modelling Evaluation System) model [9] was used in this work to have a reference about vertical distribution of gases (the model provides concentration profiles along 4km of altitude, with 11 growing thickness levels). Result of comparison with profile caculate by the model and profile calulate by the Multi-axis DOAS technique, is presented and then it is compared with Satellite column retrieved (with our satellite Data processor) from SCIAMACHY sensor (onboard on ENVISAT platform) and (directly NO_2 Tropospheric Vertical Column provided by KNMI) from OMI (onboard on AURA platform).

Good agreements between used series are shown and improvements for this methodology are discussed.

One month of measurement has been taken in consideration starting from 15 May to 15 June of 2007. Vertical structure of most important trace gases calculated with model has strong correlation with the off-axis DOAS one (in some cases with R^2=0,8), so better understanding of profiles and chemistry behaviour can be studied.

The experience acquired within QUITSAT activity appears valuable contribution for enlargement of the DOAS applications what concern atmospheric chemistry studies, operative monitoring of the air quality over regional scale as well as satellite data validation. Deployed approaches are not restricted to NO_2 but could be applied to

other gases e.g. ozone, formaldehyde etc..

Key words: Off axis DOAS, NO_2, CTM, AMF, gas profiles, satellite data validation,

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