DATA ASSIMILATION IN AIR QUALITY MODELLING OVER PO VALLEY REGION

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Data Assimilation (DA) integrates measured data (observations) and "a priori" information (background) provided by a numerical model. In air quality modeling, this methodology can be used to integrate the concentration fields of secondary atmospheric pollutants simulated by a chemical transport model with the information measured from monitoring stations or satellite sensors. In this work, the Optimal Interpolation (OI) algorithm has been used to separately assimilate O3 ground level data, NO2 ground level data and NO2 column data into CTM simulations over the North Italy domain. Results show that O3 assimilation highly improves the estimation of O3 concentration fields, while NO2 assimilation from both monitoring stations and OMI sensor has no significant impact.

METHODOLOGY

An on-line assimilation scheme is used to integrate observations and simulations of hourly O3 concentrations. Observations are provided by O3 monitoring stations, NO2 monitoring stations or OMI sensor. Background data are provided by simulations performed by the deterministic chemical and transport model TCAM (Carnevale et al., 2008).

ASSIMILATION SCHEME

Scheme variables

x_0 = TCAM IC

x_a = analysis

x_b = background

y = observations

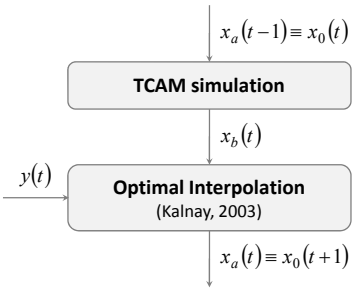

Fig. 1 – Assimilation scheme

TCAM MODEL

TCAM is part of the GAMES modeling system (fig. 2). It is a 3D Eulerian chemical transport model able to simulate secondary pollutants over a regional domain.

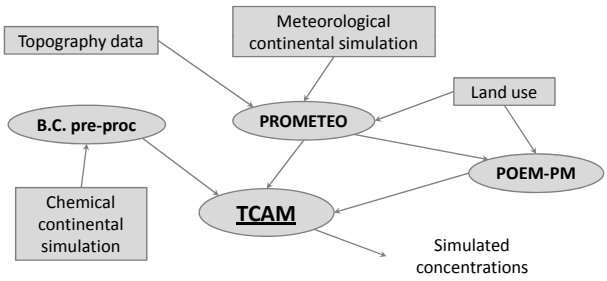

Fig. 2 – Scheme of GAMES modeling system

CASE STUDY

The study area covers the North of Italy. This domain is divided in 64x41 cells with a 10x10 km^2 spatial resolution. The simulation period ranges from 15th May to 15th July 2007. Data from 26 and 32 ground stations were used for the assimilation of O3 and NO2 respectively (fig. 3). Measurements of the tropospheric NO2 column provided by the OMI sensor were available for 20 days during the simulation period.

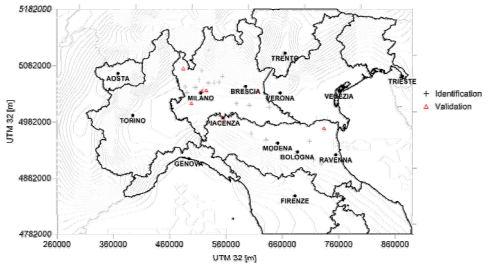

Fig. 3 – Study area with stations used for assimilation (black crosses) and validation (red triangles) of O3.

RESULTS

The validation is carried out comparing the results of the model simulations ($x_b(t)$) with the values measured by the stations chosen for the validation ($y(t)$). The box plots show the comparison between the case with the assimilation (OI) and without the assimilation (TCAM). Figures 4-6 show the comparison of the three different assimilations: 1) O3 ground level data measured by monitoring stations; 2) NO2 ground level data measured by monitoring stations; 3) NO2 column data measured by OMI sensor.

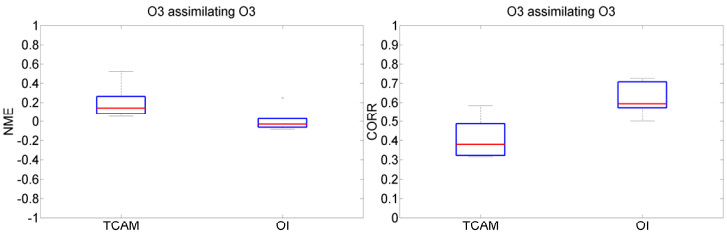

Fig. 4 – Case 1: impact on the O3 concentrations due to the assimilation of O3 data measured by monitoring stations. Box plots show: NME; Correlation.

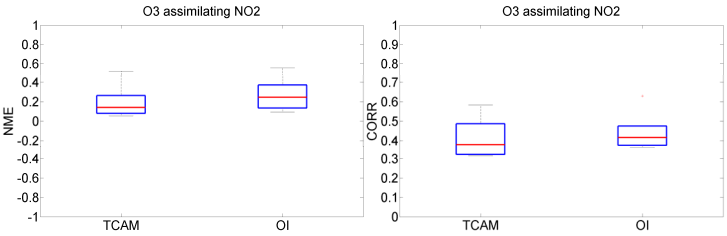

Fig. 5 – Case 2: impact on the O3 concentrations due to the assimilation of NO2 data measured by monitoring stations. Box plots show: NME; Correlation.

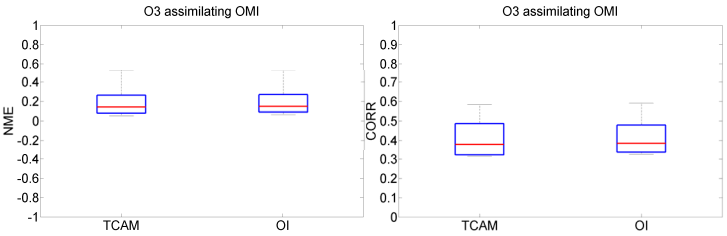

Fig. 6 – Case 3: impact on the O3 concentrations due to the assimilation of NO2 data measured by OMI sensor. Box plots show: NME; Correlation.

CONCLUSION

In this work, the impact on the O3 fields estimated over the North Italy domain for the period from 15th May to 15th July 2007 is evaluated for three different assimilations: 1) O3 ground level data measured by monitoring stations; 2) NO2 ground level data measured by monitoring stations; 3) NO2 column data measured by OMI sensor. The data assimilation is performed using the OI algorithm. The statistics show that the assimilation of O3 significantly improves the estimation of ozone concentrations, while NO2 assimilation does not seem to give benefit to the estimate of ozone fields, for both the data measured by ground stations and the OMI sensor.

C. Carnevale, et al., 2008. **Design and validation of a multiphase 3D model to simulate tropospheric pollution**. *Science of the Total Environment*, vol. 390, p. 166-176.

E. Kalnay, 2003. **Atmospheric modelling, data assimilation and predictability**, *Cambridge University press*.

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