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Articles, Letters and other Contributions
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to
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June 2009

European association for the science of air pollution

EURASAP GOVERNING BODIES 2005-2007

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Front cover: Gorski Kotar, Croatia (photo by B. Rožman)

EDITORIAL

Dear EURASAP members,

In this issue you will find contributions of a scientists Burçak Kaynak, who recently obtained EURASAP travel grant as support to participation in the 7th International Conference on Air Quality – Science and Application, 24-27 March 2009, Istanbul.

I would like to remind you that as of 2009 the EURASAP web page is updated continuously. Thus, for current information on jobs, Ph. D. positions and future events please refer to http://eurasap.gfz.hr/. If you have any information which you would like to have published in the Newsletter and posted at the EURASAP web site, please forward it to zklaic@rudjer.irb.hr.

Wish you all pleasant summer vacations!

The Newsletter Editor

News

New Science for Environment Policy website and archive

Science for Environment Policy' is a free news alert from the European Commission's DG Environment. It is designed to help policy makers and industry by providing relevant, up-to-date and easy-to-read information on environment-related studies. To access and search the online archive of articles, visit: http://ec.europa.eu/environment/integration/research/research_alert_en.htm. To subscribe for a free weekly news alert delivered by email , please email: sfep@uwe.ac.uk with the subject line 'SfEP subscription request'.

Scientists' Contributions

INTERCOMPARISON AND ASSIMILATION OF NO2 RETRIEVALS OBTAINED FROM SATELLITE (SCIAMACHY), AIRCRAFT AND GROUND OBSERVATIONS INTO A REGIONAL SCALE AIR QUALITY MODEL (CMAQ-DDM) FOR THE CONTINENTAL U.S.

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ABSTRACT

NO2 levels simulated using CMAQ were compared with satellite, ground-based and aircraft observations for August 2004. Two model simulations, one with and one without lightning emissions and a sensitivity simulation were performed. Both simulations generally have lower NO2 columns than the retrievals, especially in rural areas but CMAQ usually has higher simulated levels in urban areas. Land use specific (urban, rural and rural-point) comparisons found that satellite NO2 tropospheric columns correlate well with simulated NO2 concentrations for rural regions but less so for urban and rural-point regions. Simulated NO2 columns in Los Angeles are significantly lower than satellite observations indicating either a retrieval/analysis error or a problem in emission estimates specific to that region. These results suggest that using satellite retrievals can give useful information for improving emission inventories, though, reasons for the discrepancies between model results and satellite observations should be reconciled, and biases should be identified.

1. INTRODUCTION

Nitrogen oxide (NOx) emissions are one of the most important processes influencing tropospheric chemistry, impacting ozone, nitric acid, aerosol nitrate formation, and hydroxyl radical levels, which directly affects lifetime of many air pollutants. NOx mainly originates from anthropogenic activities (fossil fuel combustion), but also comes from biogenic sources (biomass burning), as well. Accurate estimates of emissions are very central to developing strategies to effectively improve air quality. However, emissions estimates from many sources are viewed as quite uncertain, and current and future reductions in power plant emissions which are viewed as relatively well known and the increasing fraction of emissions coming from vehicular emissions and biomass burning combined with their larger uncertainties (Miller et al., 2006) increase the importance of better quantifying rates from the more uncertain sources.

Model use for policy purposes requires performance evaluation - comparing simulated concentrations with observations- to increase the confidence, to understand model weaknesses and to improve the emission inventories. Ground-based observations which have been used traditionally have incomplete spatial coverage because of limited number of stations. Aircraft measurements, on the other hand include multiple species which are helpful but are temporally- and still spatially-limited. Satellite retrievals, as an addition to already existing resources, give on-going global coverage and include remote areas like rural regions where not many observations are available. Combining of these measurements together, taken during the summer of 2004 provides an opportunity to improve our scientific understanding of atmospheric processes by integrated analysis of satellite, aircraft, and ground-based observations with a regional air quality model. This will require both an extensive comparison of measurements and model results, and will entail

assimilation of the observations to the model by an iterative, inverse modelling technique.

Comparing model simulations to satellite retrieved tropospheric NO2 columns has been investigated by several researchers (Jaegle et al., 2005; Leue et al., 2001; Martin et al., 2003; Müller and Stavrakou, 2005; Toenges-Schuller et al., 2006). Significant quantitative differences have been found even though there is qualitative agreement in space. Most of these studies are on the global scale and more spatially and temporally detailed regional scale research is still limited (Kim et al., 2006; Konovalov et al., 2006; Napelenok et al., 2008), particularly for comparison with detailed emission inventories which is performed in our study.

In this study, direct comparison of simulated and observed NO2 column data, and use of aircraft and ground-based monitoring, helps fill information gaps by accounting for chemistry and meteorology. In addition, this comparison can also help identify reasons for discrepancies between retrievals and measurements. Additionally, this work provides information on use of the satellite retrievals in data assimilation for regional air quality models and their potential to further improve the emission inventories by assessing the accuracy and consistency of current estimates of United States.

2. METHODOLOGY

2.1. Model Description

The regional air quality model used in this study is EPA's Community Multi-scale Air Quality Model (CMAQ) (Byun and Schere, 2006) with the SAPRC99 Chemical Mechanism (Carter, 2000) which is widely used for both research and regulatory applications. The domain in focus has a 36x36 km horizontal grid resolution covering the continental United States, Southern Canada and Northern Mexico with 13 vertical layers (up to ~ 15km). CMAQ inputs are prepared by the Fifth-Generation NCAR/Penn State Mesoscale Model (MM5) (Seaman, 2000) (meteorological fields), and the Sparse Matrix Operator Kernel Emissions (SMOKE) (Houyoux and Vukovich, 1999) (emissions). The 2004 emission inventory obtained by projecting the Visibility Improvement State & Tribal Association of the Southeast (VISTAS) 2002 emissions inventory (MACTEC, 2005) to the simulation year with growth factors obtained from the Economic Growth Analysis System (EGAS) Version 4.0, and control efficiency data available from EPA for the existing federal control strategies. In addition, 2004 US electricity generating unit (EGU) NO_x emissions which are available through the continuous emissions monitoring (CEM) database from EPA website (E.P.A., 2008a) are integrated into the emission inventory. The episode is August 2004. Two simulations are performed: one with base case emissions and another with addition of lightning emissions which are typically not included in regional inventories but important source of NO_x in upper troposphere (Kaynak et al., 2008a).

The sensitivities to different emission sources are calculated with the Decoupled, Direct Method in Three Dimensions (DDM-3D) which is coupled with CMAQ. It is a method to directly and efficiently calculate the sensitivity of model outputs to model inputs which will be used in inverse modelling. Five emission sources that are selected for sensitivity study are (1) stationary, (2) mobile and (3) lightning NO_x emissions and (4) biogenic and (5) anthropogenic VOC emissions.

2.2. Observations

Satellite retrievals:

Scanning Imaging Absorption Spectrometer for Atmospheric Chartography (SCIAMACHY) instrument onboard the ENVISAT satellite measures atmospheric NO_2 columns (molecules/cm^2) with a typical U.S. observation time of 10:30 am and has a typical spatial resolution of 30 km along track by 60 km across track in the nadir view. The global coverage is achieved over 6 days. More information is available on algorithms used for retrieval of tropospheric NO_2 columns, along with uncertainty estimates (Martin et al., 2002; Martin et al., 2003; Martin et al., 2006). The scans with a cloud radiance fraction less than 0.5 are intersected with CMAQ grid cells and then averaged using intersected areas as weighing factors for comparison with corresponding CMAQ NO_2 columns which are integrated concentrations from the surface to the top layer accounting for temperature, pressure and terrain height using information from MM5.

Ground-based observations:

NO_2 measurements from EPA's AIRS network are also compared with model predictions. More information can be obtained from elsewhere (E.P.A., 2008b).

Aircraft observations:

The International Consortium for Atmospheric Research on Transport and Transformation, Intercontinental Chemical Transport Experiment-North America, (ICARTT INTEX-NA) P-3 flights consists of 18 flights, 16 of which have NO_2 measurements over the Eastern United States in July-August 2004 (Fehsenfeld et al., 2006). Model simulations are compared with ICARTT measurements by averaging the aircraft measurements within a model grid cell within an hour to give one average measurement for one simulated value. NO_2 performance is good with occasional large discrepancies and vertical profile comparison is very good with slight underestimation on the surface (Figure 1). The large discrepancies are explained, in part, by the aircraft sampling directly in power plant plumes, or storm events which makes it harder to capture by the model because of the grid size.

2.1. Inverse Method Description

The details on the inverse method will be used can be seen elsewhere (Mendoza-Dominguez and Russell, 2001).

3. RESULTS AND DISCUSSION

Comparison of modeled and observed NO_2 columns indicated an overall low negative bias in simulated levels. Lightning emissions were significant where high intensity lightning events occur, but the overall effect is minor. Both simulations generally have lower NO_2 columns than the retrievals, especially in rural areas. On the other hand, simulated levels are higher in urban areas (Figure 2). Possible reasons are diagnostic biases in the SCIAMACHY retrieval analyses, biases in the emissions estimates, or chemistry and/or transport problems in the model. Over Los Angeles, retrievals consistently show more NO_2 than simulations. This area has very low lightning activity and low wind speeds which reduce the uncertainty in meteorological inputs so these can not be the reasons. Comparison of simulated concentrations with ground observations around Los

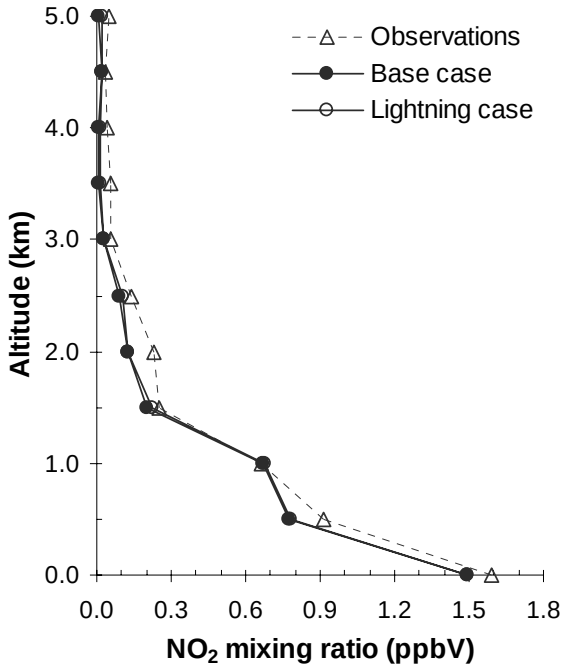

Figure 1. *NO_2 vertical profiles obtained from ICARTT INTEX-NA P-3 flights and CMAQ for August 2004*

Angeles are relatively unbiased overall, finding both lower and higher levels, unlike satellite retrievals high values. However if only the ground observations at 10:00 AM local time -satellite crossing time over US- are compared, there is a negative bias in the simulated results for Los Angeles as well as some other western cities, similar to that suggested by the satellite observations.

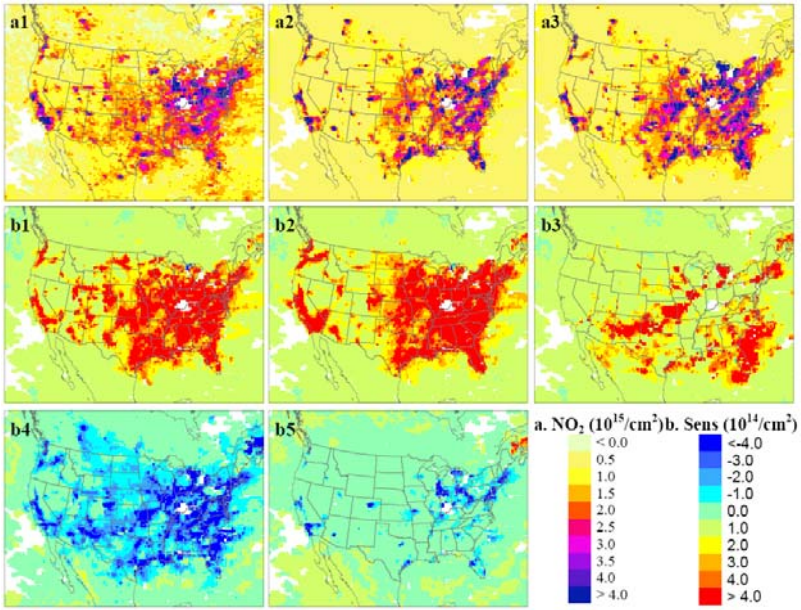

Figure 2. a) NO2 tropospheric columns from 1) SCIAMACHY, 2) CMAQ base and 3) CMAQ lightning case and b) NO2 tropospheric column sensitivities to 1)stationary, 2)mobile and 3)lightning NOx and 4)biogenic and 5)anthropogenic VOC emissions averaged for August 2004. (SCIAMACHY Monthly mean errors are 5□1014+0.3C where C is the tropospheric column)

Land use specific comparisons (Kaynak et al., 2008b) showed that, except for Los Angeles, all urban regions are correlated. Rural regions have the highest correlation and retrievals shows reasonable agreement, though with some outliers for rural-point regions (Figure 3). The poorer comparison for the rural-point regions is unexpected coupled with their relatively well-known emissions. The possible

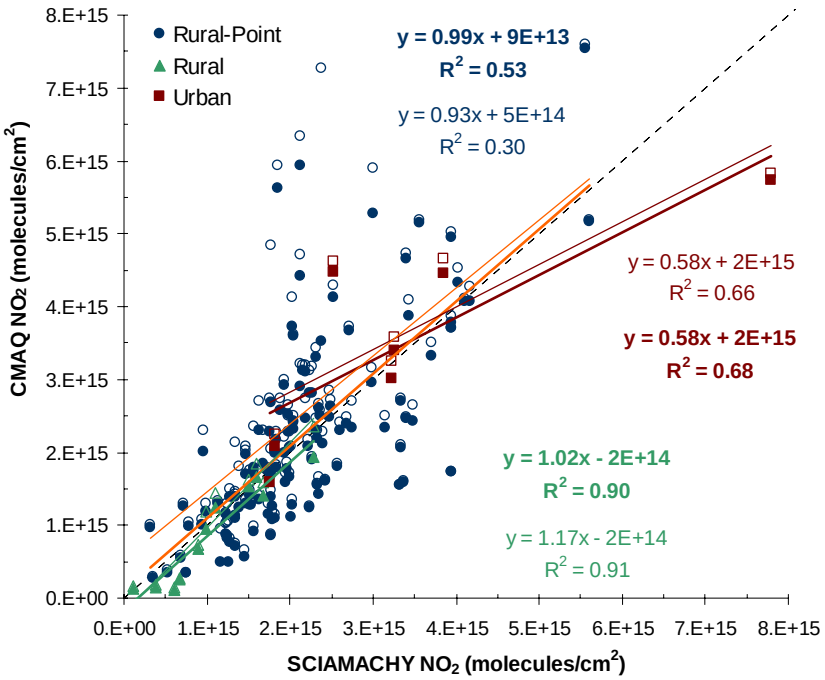

***Figure 3**. SCIAMACHY vs. CMAQ derived tropospheric NO_2 columns for urban, rural and rural-point regions for August 2004 (Bold fonts, thick lines and filled symbols indicate base and regular fonts, thin lines and void symbols indicate lightning case).*

reasons for lower correlation of rural-point could be the transport of NO_2 out of the small scan area or insufficient time for conversion of NO to NO_2 in power point plumes. The high correlation of rural regions indicates its potential for using the satellite retrievals to obtain emission estimates for area sources that are low in amounts but are sparse and hard to capture otherwise (i.e. fire emissions). Results also indicate correlations increase if satellite retrievals are averaged over larger areas, which may be related to NO_2 lifetime.

4. CONCLUSIONS

The contradiction between the biases observed between the simulated and observed NO_2 columns, versus little bias between the simulated and in-situ NO_2 measurements indicates that either the ground-based observations have somewhat limited utility for model evaluation and assessment of emission estimates, or that there may be biases in the satellite retrievals that need to be identified and corrected for further use of such measurements for emissions and model assessments. In addition, there appears to be somewhat less correlation between simulated and observed columns in areas containing relatively well known emissions. In part, this can be a result of data availability. On the other hand, the good correlation found for other areas suggests that the satellite retrievals can provide useful information for evaluating model performance and enhancing emission assessments within limitations in such retrievals are understood, and biases, errors and uncertainties quantified.

Overall comparisons are promising; even though there are discrepancies, using satellite retrievals for data assimilation can give insightful information for improving emission inventories. However, reasons for the discrepancies between model results and satellite observations should be reconciled, and biases should be identified.

ACKNOWLEDGEMENTS

NLDN data provided by the NASA Lightning Imaging Sensor (LIS) instrument team and the LIS data center via the Global Hydrology Resource Center (GHRC). This work was supported by NASA Project SV6-76007 (NNG04GE15G), and EPA grants (RD83096001, RD83107601 and RD83215901).

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Jobs and PhD Positions

Two PhD Positions at the Environmental Wind Tunnel Laboratory – EWTL of the Meteorological Institute at Hamburg University

Open call can be found at:
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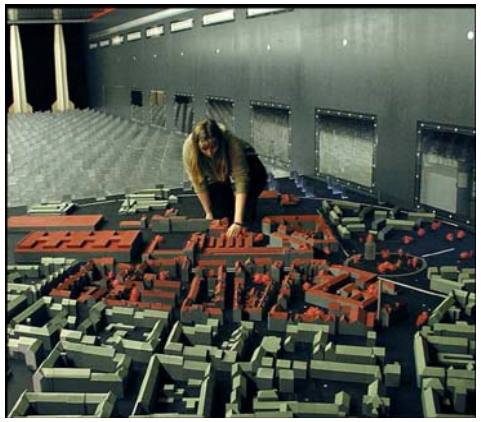
(A):Geo_Windkanallabor_09-03-26.pdf
(B):Meteorologischen_Instituts_09-03-26.pdf
Closing date: April 30th, 2009

One post will focus on "Climate Change and Wind Climate in Urban Areas" (A), the second research project focuses on "Efficiency of Wind Power Systems"(B). The job holders will be involved in / responsible for planning, realization and scientific analysis of data from systematic scale model tests in modern boundary layer wind tunnels. We are searching for motivated colleagues with interest in primarily experimental work, willingness to explore new research areas and with capacity for teamwork. A successfully finished MSc/Diploma degree is required for PhD enrollment (preferably background in Physics or Engineering).

We will provide an interesting and cooperative working environment. For further information please contact Prof. B. Leitl (bernd.leitl@zmaw.de). Information on the Environmental Wind Tunnel Laboratory can be found at www.mi.uni-hamburg/windtunnel.



PhD scholarship on mesoscale modelling at VITO, Mol, Belgium

VITO (Mol, Belgium) is inviting applications for a PhD scholarship on the topic "Value of mesoscale meteorological modelling for urban/regional-scale air quality simulations". More information is available on http://wwwb.vito.be/vitodocwebcms/lijst/MeerInfo.aspx?lang=EN&ID=183.

The application procedure for the scholarship is based on a written application and an oral presentation. Interested persons are invited get in touch with me as quickly as possible.

Kind regards,

Koen De Ridder
VITO - Flemish Institute for Technological Research
Mol, BELGIUM

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Future events

10TH URBAN ENVIRONMENT SYMPOSIUM - URBAN FUTURES FOR A SUSTAINABLE WORLD, GOTHENBURG, SWEDEN, JUNE 9-11 2010

Dear Colleagues,

We would like to inform you that the 10th Urban Environment Symposium will be held in Gothenburg, Sweden on June 9-11 2010. This symposium is broad in scope and covers all aspects of the urban environment.

The first symposium was held is London in 1983 and was a meeting place for researchers interested in urban pollution. Since the beginning, there has been an increasing interest for other aspects of the urban environment and the symposium got an increasingly broader scope. Topics at recent symposia in Nicosia in 2006 and Madrid in 2008 included air quality, urban water, climate change, contaminated sites, transportation and mobility. The aim of the 10th Urban Environment Symposium is to provide a forum for recent research and development on all aspects of the urban environment.

Paper submissions are welcomed on any of the following topics. Prospective authors wishing to present papers are invited to submit, by November 30, 2009, an abstract of no more than 300 words via the conference website (http://www.hues.se). The official language is English.

Topics

- Air and noise pollution

- Contaminated soils and waters

- Transport and mobility

- Greenhouse gases and climate change

- Resources and urban ecology

- Land use and spatial planning

Detailed information, including a pdf flyer, is available on the conference website http://www.hues.se For additional information, please contact Maria Svane (secretariat@hues.se).

We hope to see you in Gothenburg.

Sebastien Rauch

Gregory Morrison

Maria Svane

Alexandra Priatna

ACCENT/GLOREAM2009 WORKSHOP ON TROPOSPHERIC CHEMICAL TRANSPORT MODELLING, BRESCIA, ITALY, 26 - 27 NOVEMBER 2009

ACCENT/GLOREAM2009 Workshop on tropospheric chemical transport modelling, taking place in Brescia, Italy. The workshop will start on Thursday, 26 November 2009at 9.00 a.m. and will end on Friday, 27 November 2009 at 4.00p.m.

The aim of ACCENT/GLOREAM is to investigate the processes and phenomena which determine the chemical composition of the troposphere by means ofadvanced and integrated modelling, both on regional (over Europe) and global scale.

Please have a look at the website (http://automatica.ing.unibs.it/gloream/index.html) for more information on the workshop venue, call for abstracts, workshop registration, accommodation and contact information.

Giovanna Finzi and Marialuisa Volta

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