ISSN 2070-2582
Key title: Newsletter (European Association for the Science of Air Pollution. Online)
Abbreviated key title: Newsletter (Eur. Assoc. Sci. Air Pollut., Online)
Parallel title: EURASAP newsletter

Articles, Letters and other Contributions
for the EURASAP Newsletter
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ISSN 2070-2582

EURASAP

Newsletter **69**
October 2009

European association for the science of air pollution

EURASAP GOVERNING BODIES

CONTENTS

Front cover: Vrataruša, Croatia (photo by Z.B. Klaić)

EDITORIAL

Dear EURASAP members,

In this issue you will find contributions of two young scientists and their collaborators, Dr. Eleni Katragkou and Kornelija Špoler Čanić, who recently obtained EURASAP travel grants.

If you have any information which you would like to have published in the Newsletter and posted at the EURASAP web site http://eurasap.gfz.hr/, please forward it to zklaic@rudjer.irb.hr.

The Newsletter Editor

Scientists' Contributions

TROPOSPHERIC OZONE IN REGIONAL CLIMATE-AIR QUALITY SIMULATIONS OVER EUROPE: FUTURE CLIMATE AND SENSITIVITY ANALYSIS.

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Abstract. In this work we present results of regional climate-air quality simulations over Europe performed for the future decade 2041-2050 (2040s) and the control decade 1991-2000 representative of the present climate. Summer ozone mostly decreases in the mid-century decade by about 0.8 to 1.2 ppb over continental Europe and the Mediterranean Basin, with the exception of the Balkan Peninsula, Adriatic and Black Sea and southern Iberian Peninsula in the area around Gibraltar, where average surface ozone increases by about 0.5 to 0.8 ppb. Ozone decrease can be mainly attributed to decreasing incoming solar radiation, which is mostly seen over France, England and northern continental Europe. Average temperature increases in the southern and northern parts of Europe, but not more than 1 K, and remains unchanged or even slightly decreases over France and England. Temperature change spatial patterns follow closely the changes in atmospheric circulation as indicated by 500 hPa geopotential height differences. Biogenic

emissions follow temperature and radiation changes, thus increasing in Mediterranean countries and decreasing over northern Europe. However, sensitivity studies in our simulations suggest that ozone formation is not sensitive to organic compounds of biogenic origin; therefore, changes in biogenic emissions due to climate change do not impact on surface ozone.

INTRODUCTION

Tropospheric ozone (O3) is an important trace gas with well documented adverse effects on human health, agriculture and natural ecosystems. Global change, including change in climate and anthropogenic emissions, is expected to impact on many key atmospheric species and tropospheric ozone is certainly one of them (IPCC, 2007). Most modeling studies agree that the 21st century climate change will increase regional ozone pollution. The basic reasons were reported to be the increase in frequency of stagnation episodes and robust increase of temperature which affects ozone either through PAN chemistry or through increased biogenic emissions (Jacob and Winner, 2009). Ozone increases are found to be mostly in the range of 1-10 ppb depending on the future decades and the region examined, the climate scenario which is adopted and the model system used. It is not easy to separate the effects of different meteorological parameters on air quality in the real atmosphere because the interaction between them is complex and there are several feedback mechanisms. A holistic approach is to study the impact of climate change on air quality which is a far more complicated task involving climate change, feedbacks with climate-dependent biogenic emissions and changes in future anthropogenic emission trends.

This paper presents a modelling system of a regional climate model off-line coupled to a regional chemistry transport model used for the assessment of present and future air quality. In the current study it is assumed that there are no changes in future emissions and the background species. Constant anthropogenic emissions and chemical boundary conditions are used for the present and future decades. Differences in tropospheric surface ozone can thus attributed only to climate change.

MODELING SYSTEM

The modelling system applied to simulate climate/air quality over Europe is RegCM/CAMx. RegCM was originally developed at the National Centre for Atmospheric Research (NCAR) and has been mostly applied to studies of regional climate and seasonal predictability. The air quality model simulations were performed with the Comprehensive air quality model with extensions (CAMx) version 4.40 (www.camx.com). CAMx is off-line coupled to RegCM with a Fortran-based code we developed, reading the basic meteorological parameters from RegCM (wind, temperature, water, cloud/rain, pressure and vertical diffusivity) and exporting them to CAMx-ready format. The spatial resolution of CAMx was set to 50 km x 50 km. The domain's vertical profile contains 12 layers of varying thickness. Layer 1 is 36 m deep and the uppermost layer is 1.2 km thick and extends to about 6.5 km. Top and lateral boundary

conditions were kept constant corresponding to a clean atmosphere.

The chemistry mechanism invoked is Carbon Bond version 4 (CB4). This mechanism includes 117 reactions – 11 of which are photolytic - and up to 67 species (37 gasses, 12 radicals and up to 18 particulates). Calculation of emissions is presented in detail in Krueger et al. 2008. We shortly mention that biogenic emissions are calculated on-line using temperature and radiation data from RegCM and anthropogenic emissions are taken from the EMEP database for the reference year 2000.

The runs presented in this work cover the time slice 1991-2000 and 2040-2050. RegCM was forced by the ECHAM5 global circulation model for the simulations covering the two time-slices. ECHAM5 run under the IPCC A1B scenario to provide forcing for the future decade.

RESULTS

Figure 1 shows changes in surface ozone and various meteorological parameters between the future and the present simulation. The results are averaged over the whole decadal time slice and are presented only for the summer season. Changes in ozone are depicted in Figure 1a: ozone mostly decreases over Europe with the exception of the Balkan Peninsula, Adriatic Sea and the area around Gibraltar. Decrease of ozone can be, at least partly, explained by the decrease of solar radiation which is shown in Fig. 1b. The most intense decrease is seen over France, eastern Atlantic and the Baltic Sea, where ozone is mainly lower.

Changes in solar radiation can in turn be explained by changes in cloudiness (Fig 1c). Cloud liquid water path is used here as an index of cloudiness. A qualitative comparison of Fig 1b and 1c shows that in regions where cloudiness increases, solar radiation mostly decreases. Temperature increases are in the range of 1 to 1.5 K (Fig. 1d). The areas mostly affected are south and north Europe while central Europe remains relatively unaffected. The temperature in France and England even decreases slightly. The spatial patterns of temperature change follow closely those of the changes in 500 mb geopotential height (Fig. 1e). The later forms a low over England and the North Sea where the minimum of temperature is also located. The geopotential height is used as an index of atmospheric circulation and seems to be strongly modulating the temperature fields.

Finally, Fig. 1f shows changes in biogenic emissions, which in our calculations are temperature and radiation dependent. Biogenic emissions increase in the mid-century decade over the Balkan Peninsula and southern Iberian Peninsula, but decrease over the rest continental Europe. Organic compounds of biogenic origin, the most important being isoprene, are known ozone precursors. Normally, it is expected that change in emissions of organic compounds of biogenic origin affect ozone production. However, sensitivity studies (not shown here) suggest that O3 formation in our modeling system is NOx sensitive, thus such small changes of biogenic emissions are not affecting surface ozone.

Acknowledgments. This work has been funded by the European Community's Sixth Framework Programme as a part of the project CECILIA (Central and Eastern Europe Climate Change Impact and

Vulnerability Assessment) under Contract No. 037005. This work was presented in the 30th ITM NAT/SPS International Technical Meeting on Air Quality Modeling and its Applications and awarded with the 1st EURASAP Award.

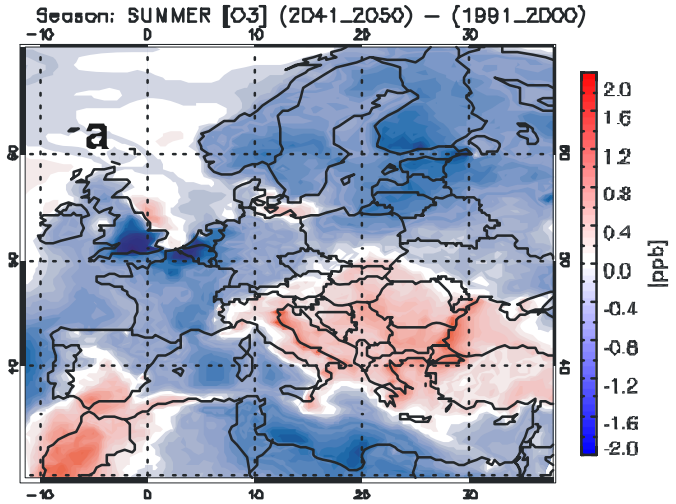
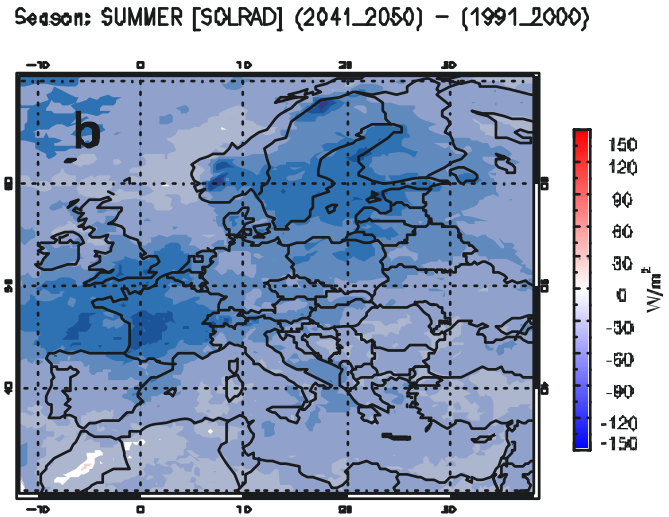


Figure 1. All panels show averaged differences between the future (2041-2050) and present decade (1991-2000) corresponding to the summer season.

a. Differences of average surface ozone;
b. Differences of average incoming solar radiation;
c. Differences of average cloud liquid water path;
d. Differences of average surface temperature;
e. Differences of 500 hPa geopotential height;
f. Differences of biogenic emissions.



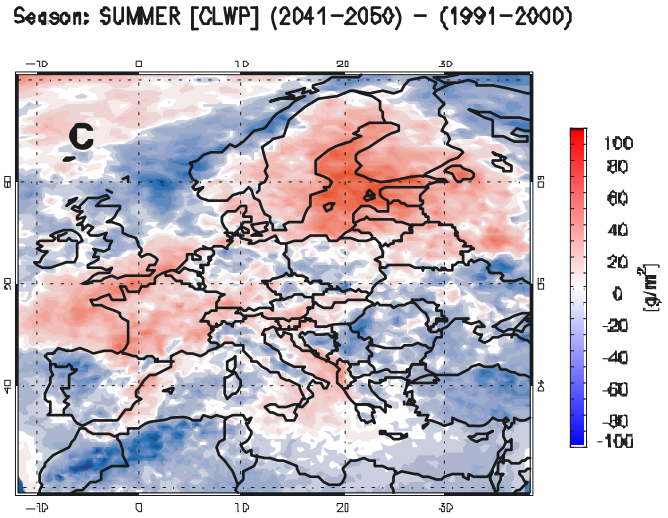
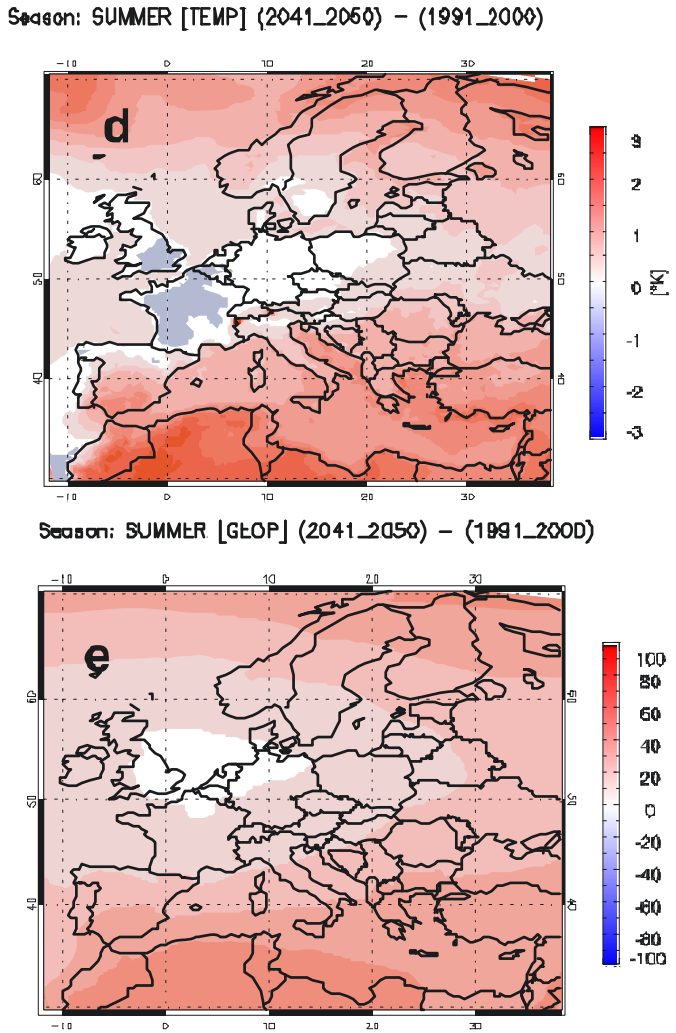


Figure 1. Cont.



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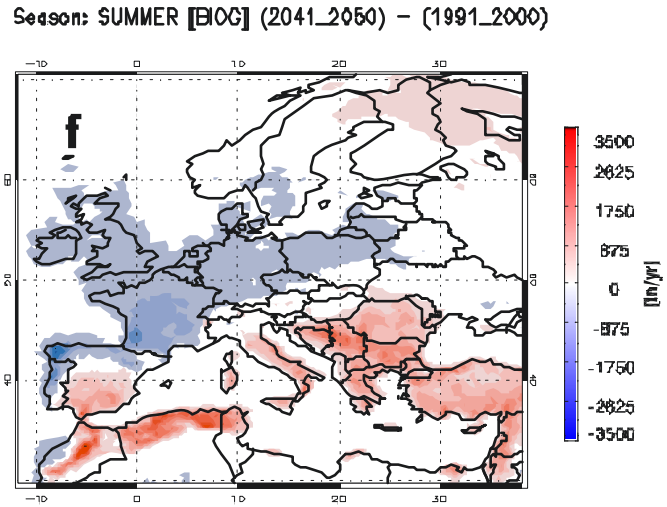

Figure 1. Cont.

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AN EPISODE OF SAHARAN DUST OVER CROATIA

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INTRODUCTION

In recent years the role of the desert dust in the global system has become increasingly apparent (Goudie 2009 and the reference therein). The world's largest source of desert dust is the Sahara with about half of the total global dust emission. The dust can be transported over thousands of kilometres and is deposited downwind by wet (i.e. mud rain) and dry processes. Mud rains are frequent over southern Europe and they have been reported since ancient times. In spite of that only few investigations have dealt with this phenomenon in Croatia (e.g. Lisac 1973).

In this work we analysed one mud rain episode, with the highest TOMS (Total Ozone Mapping Spectrometer) aerosol index over Croatia during the period 2001-2005. This episode was connected with strong Saharan dust outbreak which occurred over Mediterranean Sea from 8th to 14th April 2002. The synoptic situation over Croatia was analysed for the episode, as well as AI images, backwards trajectories and precipitation chemistry.

DATA AND METHODS

We analysed the precipitation chemistry data from 14 monitoring sites in Croatia (Fig. 1). Sites 12 and 14 are mountainous, background sites and they are parts of Co-operative Programme for the Monitoring and Evaluation of the Long-Range Transmission of Air Pollutants in Europe (EMEP) network. In daily bulk precipitation samples were determined: pH values, electrical conductivity and concentrations of main ions (i.e. SO_4^{2-}, NO_3^-, Cl^-, NH_4^+, Ca^{2+}, Mg^{2+}, Na^+ and K^+). Further analysis details can be found in Špoler Čanić et al. (2009).

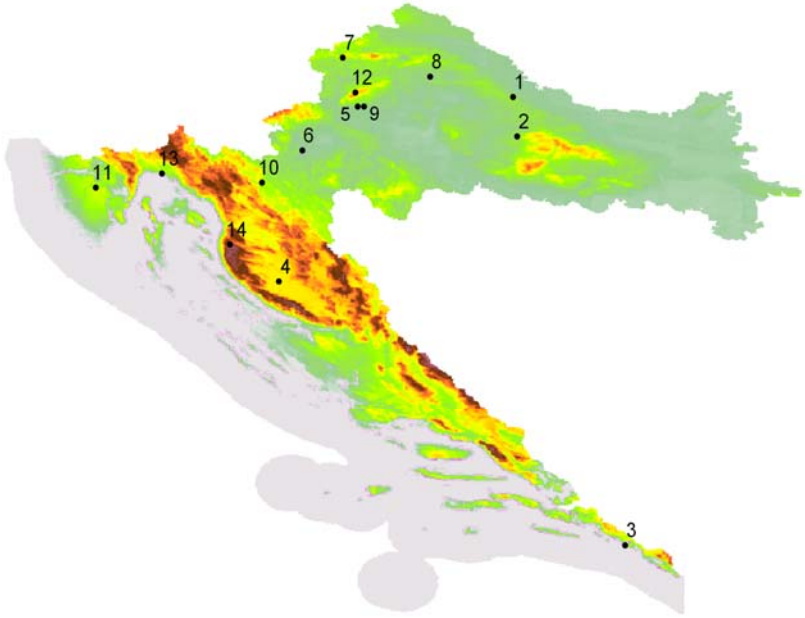

Figure 1. Sampling sites

Aerosol index

The analysed mud rain episode was identified using TOMS aerosol index (AI). The AI is defined as a measure of how much the wavelength dependence of backscattered UV radiation from an atmosphere containing aerosols differs from that of a pure molecular atmosphere. Herman et al. (1997) have shown that AI is a useful tool for monitoring intensity and pathway of desert dust on daily basis. In this work the daily maps and data of AI from TOMS Earth Probe were used (http://toms.gsfc.nasa.gov).

Backwards trajectories

Backwards trajectories are useful tools for tracing source regions of air pollution and determining transport patterns at receptor sites in general. Source regions of air parcels that arrived at the two receptor points (site 12 and 14) on April 2002 have been identified using the two dimensional backwards trajectories (www.emep.int). EMEP backwards trajectories are calculated by tracking an air parcel every two hours for 96 hours backwards in time, four times per day (at 00, 06, 12 and 18 h UTC).

SYNOPTIC SITUATION

From 7th till 9th of April there was a small cyclone over Croatia, with circulation of moist and unstable air along the vertical. It was rainy in plains and valleys and snowy in mountainous areas. Over the Adriatic Sea severe gusts of jugo were recorded first and, as the cyclone was moving, severe gusts of bura later. The next day (10th of April) was less rainy due to the influence of branch of the anticyclone over northern Europe. However, a new large cyclone, originated from the western Mediterranean, approached from the south-western Mediterranean (Fig. 2). The high altitude wind was southwest. Due to this synoptic situation it was mainly cloudy from 11th till 15th of April, with severe jugo in some places. Frontal passages brought heavy rain and thunderstorms, especially in the night from 12th to 13th of April. The greatest amount of precipitation fell over northern Adriatic Sea and mountainous areas.

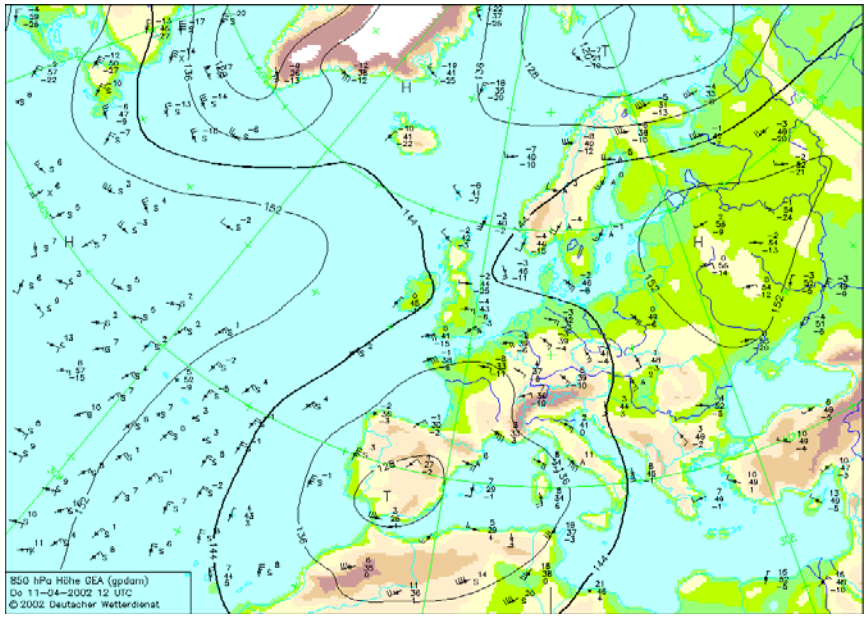

Figure 2. The synoptic situation at 850 hPa over Europe on 11th April 2002 at 1200 UTC (from the Europäische Wetterbericht, 2002)

RESULTS AND DISCUSSION

The AI was highest at 12th April 2002 (Fig. 3) and Fig. 4 shows Saharan dust transport over Mediterranean towards Croatia on that day. The TOMS data provide AI values higher then 4 during the main streamline of the outbreak over Croatia. For the same day AI values were between 1.2– 2.2 over the south-eastern coast of Italy (Blanco et al. 2003). The backwards trajectories (Fig. 5 a and b) for Site 12 and 14 also indicated Sahara Desert as a source region.

The Table 1 shows the ions concentrations and pH values at measurement sites over Croatia with precipitation on 12th April 2002. Comparing to annual volume weighted averages (VWA) for 2002 ions concentrations were highest at Site 14, the highest Croatian measurement site. Ion concentration of SO_4^{2+} was almost 15 times higher and concentration of Ca^{2+} was almost 12 times higher then VWA at Site 14. The only exception was NH_4^+ which was highest at Site 5. Ions concentrations were the lowest at Site 13 which was the site with highest amount of precipitation. The exceptions were Ca^{2+} and K^+, which were lowest at Site 3 and Site 12 respectively. Site 3 was in area with very low AI (Fig. 4). The pH was elevated (pH > 5.0) at all sites. The highest pH change was at Site 5 and the lowest at Site 10. According Löye-Pilot et al. (1986) only calcium concentration and pH value are consistently affected by Saharan dust in rain water.

Correlation analysis is useful technique to characterize relations among the ions present in precipitation. The Table 2 shows correlation between ions from all measurement sites at 12th April 2002. The highest correlation coefficient was between Na^+, Cl^- and Mg^{2+} which imply strong sea salt component in rain composition of this event. The ions: SO_4^{2-}, Mg^{2+} and K^+ are also highly correlated, as well as SO_4^{2+} and NO_3^- and NO_3^- and Ca^{2+}.

Table 1 Precipitation amount, ratio of concentrations of base ions at 12th April 2002 and VWA for 2002 at the monitoring sites.

ID	Site	mm	SO_4^{2-}	NO_3^-	NH_4^+	Na^+	Mg^{2+}	Ca^{2+}	Cl^-	K^+	pH
1	Bilogora	9.7	5.75	0.88	1.17	6.22	2.86	10.50	5.18	2.19	1.39
2	Daruvar	7.4	3.52	0.68	0.32	3.35	1.44	6.63	4.27	1.17	1.26
3	Dubrovnik	10.8	5.49	1.02	0.90	3.90	1.77	3.94	3.94	1.44	1.28
4	Gospić	14.8	7.13	1.16	-	5.06	1.75	4.37	4.23	1.98	1.47
5	Grič	20.6	4.11	0.98	1.28	5.97	1.91	6.71	4.94	2.26	1.69
6	Karlovac	17.6	6.48	1.11	0.55	8.51	3.03	9.42	6.84	2.59	1.51
7	Krapina	22.0	5.24	0.78	1.10	7.07	1.35	7.02	5.45	2.52	1.50
8	Krizevci	9.8	3.53	0.83	1.04	5.58	1.78	4.09	2.62	0.75	1.28
9	Maksimir	14.0	4.15	1.04	0.69	3.49	1.51	4.82	3.01	1.02	1.28
10	Ogulin	21.0	7.32	0.99	0.25	5.86	2.57	7.64	5.44	2.25	1.05
11	Pazin	12.2	4.17	1.10	0.74	3.55	2.56	5.06	3.32	2.73	1.67
12	Puntijarka	33.3	3.35	0.78	0.22	1.37	1.86	4.66	3.15	0.56	1.66
13	Rijeka	59.6	1.61	0.64	0.41	1.23	1.17	4.59	1.15	1.65	1.66
14	Zavižan	11.9	14.70	1.79	0.49	9.25	4.78	11.89	9.14	7.19	1.54

Dash represents no analysis for samples.

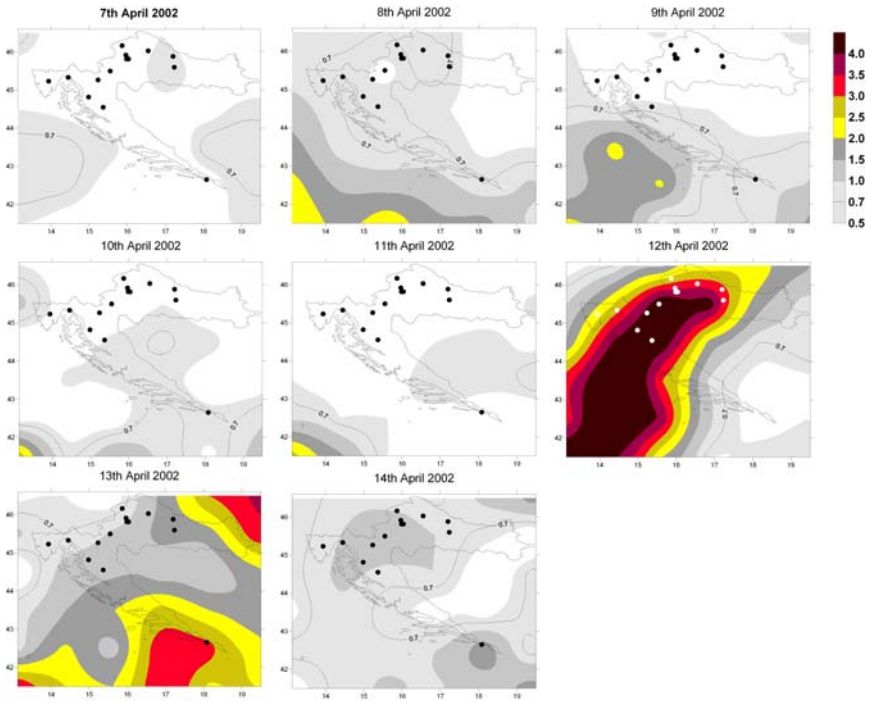

Figure 3. Evolution of AI over Croatia during Saharan dust outbreak which occurred over Mediterranean Sea from 8th to 14th April 2002. The threshold value AI =0.7 (Prospero et al. 2002) is emphasised.

CONCLUSIONS

Mud rain episode in April 2002 was the episode with highest AI over Croatia during the period 2001-2005. The spatial changes of precipitation chemistry were influenced by topography and distance from the Sahara as well as with the "AI plume" shape. The pH was elevated at all sites. Further, all ions at all sites had greater concentrations comparing to VWA for analysed episode and the highest ratio was mainly for Ca^{2+}.

Acknowledgments

Our work was supported by the Croatian Ministry of Science, Education and Sport (grants No. 004-1193086-3036, No. 037-1193086-2771 and No. 119-1193086-1323) and EMEP4HR project number 175183/S30 provided by the Research Council of Norway. We thank the NASA/GSFC/TOMS group for the use of aerosol index data.

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Table 2 Correlation coefficients among ions concentrations from all measurement sites at 12th April 2002

	H^+	SO_4^{2+}	NO_3^+	NH_4^+	Na^+	Mg^{2+}	Ca^{2+}	Cl^-	K^+
H^+	1,00	0,19	0,11	-0,21	0,05	0,02	0,19	0,05	0,00
SO_4^{2-}		1,00	**0,81**	0,17	0,61	**0,78**	0,59	0,59	**0,87**
NO_3^-			1,00	0,17	0,20	0,43	**0,70**	0,18	0,68
NH_4^+				1,00	0,04	0,14	0,54	0,03	0,57
Na^+					1,00	**0,95**	0,15	**1,00**	0,60
Mg^{2+}						1,00	0,10	**0,95**	**0,77**
Ca^{2+}							1,00	0,17	0,67
Cl^-								1,00	0,58
K^+									1,00

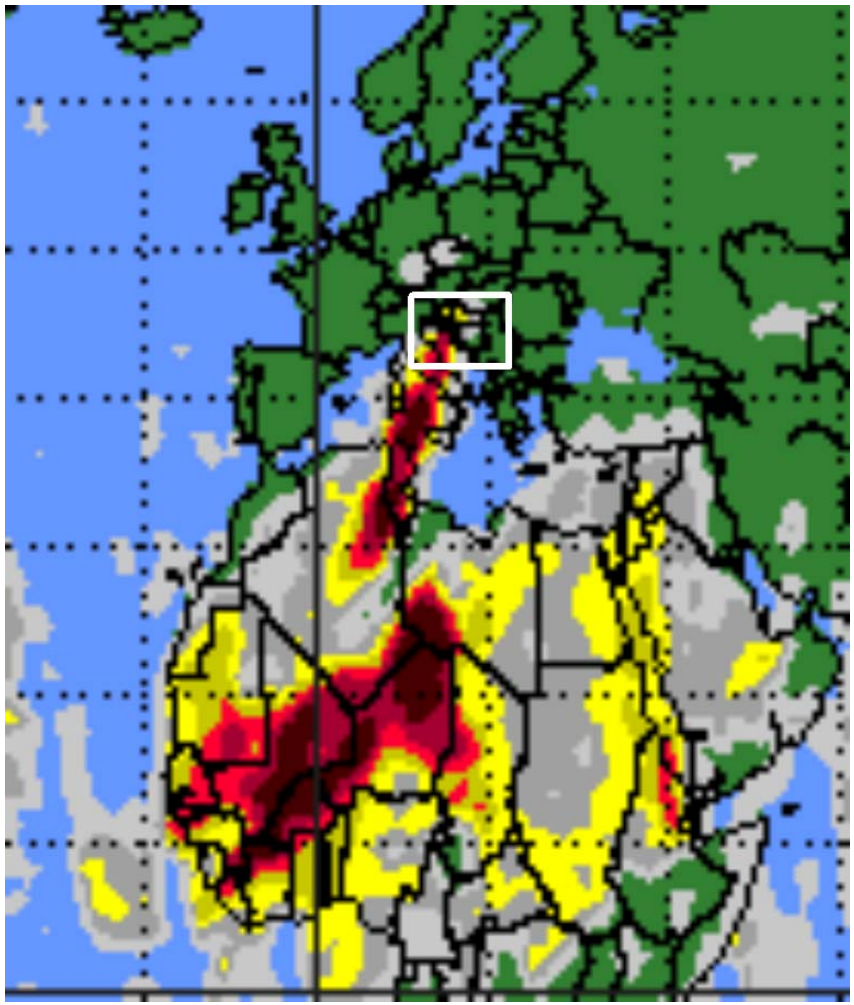

Figure 4. TOMS map of AI for 12th April 2002. A white square indicates strong Saharan plume over Mediterranean towards Croatia.

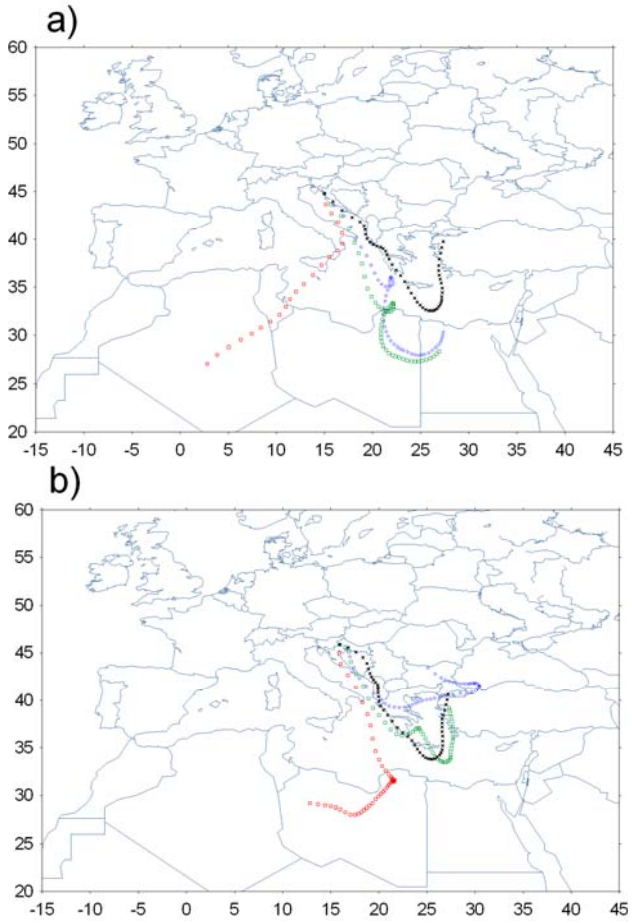

Figure 5 Backwards trajectories for Site 14 (a) and 12 (b), respectively for 12th April 2002. Trajectories are calculated four times per day at: 00 (black), 06 (blue), 12 (green), and 18 h (red) UTC.

Future events

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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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.

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EUROPEAN ASSOCIATION FOR THE SCIENCE OF AIR POLLUTION MEMBERSHIP FORM 2009

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