Atmos. Chem. Phys. Discuss., 4, S3969–S3977, 2004
www.atmos-chem-phys.org/acpd/4/S3969/
European Geosciences Union

Atmospheric Chemistry and Physics Discussions

Interactive comment on "A simple modeling approach to study the regional impact of a Mediterranean forest isoprene emission on anthropogenic plumes" *by* J. Cortinovis et al.

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Received and published: 3 May 2005

Letter to the referees

FIRST OF ALL THANK YOU FOR YOUR IN DEPTH REVIEW COMMENT AND SUGGESTIONS.

To Referee 1

General comments: 1. Abstract - The abstract has been partly rewritten and is more quantitative on the results obtained. Potential of the model application is mentioned. In order to give a concrete utilization, we have included the sentence following at the end of the abstract: "From this study, knowing the biogenic emissions can help urban planners and local air quality associations to control and to preview the total (anthropogenic + biogenic) VOC/NOx ratios in order to decrease the amount of the ozone produced in sub-urban or rural areas.";

2. Section 2 - "On line" calculation of emissions is mentioned in the second part of the article i.e., when the full coupling of BVOCEM and MesoNH-C is used: meteorological forcing, surface variables, biogenic emissions and chemistry are resolved simultaneously. In the literature, a lot of BVOC emission models have been proposed, based on canopy functioning scheme ranging from very complex (for local studies) to very simple (e.g. for global impact estimation). Our study is based on a scheme of intermediate to simple complexity. For surface energy budget, the radiation balance is calculated according to a "classical" big leaf approach: No vertically resolved leaf energy budgets (and so leaf temperatures vertical profiles) in the canopy are calculated. Unlike detailed micro-meteorological canopy model, the scheme requires a reduced number of canopy parameters which is essential for regional applications: this item is mentioned in the text. (préciser page + ligne) Nevertheless, because of its direct importance for biogenic emission and carbon assimilation, the radiation attenuation in the canopy is explicitly described assuming homogeneous layer of leaves. But it does not impact the energy balance scheme.

3. Section 4 - Others BVOCs emissions can be predicted in our modelling scheme. Monoterpenes fluxes can be simulated using the Guenther algorithm based only on leaf temperature. During the ESCOMPTE experiment, 85% of the study forest was composed of white oaks (Quercus Pubescens), only emitter of isoprene. There was no spin-up for these simulations (see the point on spin -up in the revised text page 8 - line 2). The model inputs comprise time evolutions for anthropogenic pollutants emissions and for meteorological data. The model was just run on one selected typical summer day.

This region was chosen for the ESCOMPTE experiment because of strong anthropogenic sources, and of meteorological conditions inducing recurrent problems of pollution (see Cros et al., 2004 for detailed explanations). The ESCOMPTE domain comprised the towns of Marseille and Martigues. The town sources are really contrasted. Marseille, with an area of 24000 ha and a population of ˜800 000 inhabitants, is clearly characterized by traffic emissions. Martigues covers an area of ˜7000 ha, and has a population of ˜45 000 inhabitants. With 4 refineries and 5 Seveso classified factories this town is under the influence of industrial emissions.

4. Section 4.5 - We thank the reviewer for his suggestion. The Wc and Wq have been normalised by the NOBIO results. They have now to be interpreted as the relative enhancement of O3 maximum concentration and in-plume production. Consequently, the magnitude of these indicators, the graphs and the discussion have been modified.

5. In the table, we have reported the maximum values for ozone concentration and ozone total amount (see the text for the table).

6. Comparisons with previous work: We thank the reviewer for his suggestion. References and discussion compared to these two papers, supporting experimentally what modelling tends to show, has been added in the text.

7. Figures. The quality of figures has been improved

8. Section 5 - Wc (the percent of the maximum plume ozone concentration contributed by the isoprene emissions) has been calculated considering the actual maximum ozone concentration (this one depending partly on the "offset" background level, see text). Wq represent the integrated in plume ozone production: the plume has been defined as "cells having a concentration exceeding the background level").

9. The wind speed was specified in terms of x,y components equal to 3m.s-1 resulting in a module of ˜ 4.2 m.s-1. The text is clearer now.

Technical/Editorial comments:

General comments: As proposed by the Referee 1, verbs such as "focus on", "investi-

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gate" or "address" are used instead of "deal with";.

Specific comments: Page 7696 - line 13: by "primary parameters", the authors mean surface parameters. Page 7701 - line 9-10: in this sentence, the authors compared the development the NOx and the ozone plumes in term of surface. When the surface of the ozone plume increases, at the same time, the surface of the NOx plume decreases.

Page 7703 - line 4: the biogenic and the anthropogenic sources are composed of 5 cells from the grid. In the d1, d2, d3 or d4 configurations, the distance between the two sources is taken between the centres of the squares defined by these cells.

The term "d configuration" has been removed from the text.

Page 7703 - line 4-6: when comparing figure 6a and 9a, there is a clear impact of the isoprene fluxes on the development of the ozone plume. Isoprene emissions induce a shift in the VOC/NOx ratios, from a "VOC-limited" to an optimum VOC/NOx regime for ozone formation. Page 7704 - line 8-12: see modifications in the text Page 7705 - line 3 and 5: see "specific comments" page 7703 - line 4.

For the others technical correction, see the text for the modifications.

To Referee 2

General comments:

We agree that in situ experimental measurement of ozone would have strengthened the results proposed in this study. Comparison with real case studies indicate nevertheless that the impact of biogenic isoprene obtained in our simplified configuration is consistent with experimental evidence of biogenic contribution to production of ozone (e.g studies in the Eastern US , Ryerson et al.). This point has been outlined in the corrected version. Over the ESCOMPTE domain, non published studies carried out in our group (Thesis) shows that ozone in anthropogenic plumes measured upwind and downwind a biogenic source (the Ste Victoire mountain) is significantly enhanced (up to 40 %), which is consistent with our modelling results. Concerning initial conditions, the purpose of our ideal study was to fix a maximum number of conditions to focus on certain point, namely the influence of the anthropogenic plume characteristics and the interaction distance between anthropogenic and biogenic sources. We chose standard "clean air" initial conditions. We agree that an in-depth study of the chemical background effect is of interest. However, some test showed that, in our ideal configuration, the in plume chemistry was at the first order determined by the sources. The ozone initial and background conditions act as an offset value. Our results are indeed presented in terms of "relative contributions". This has been precised in the revised version. (page 10, line 9) Concerning uncertainties analysis, we precised in the conclusion of the revised version that the main uncertainties on ozone formation will rely on both anthropogenic and emission uncertainties. For biogenic emissions, we have showed how the selected diurnal profile was relatively well validated and realistic for our specific studies. We agree that it is just representative of one specific white oak ecosystem at one specific period. More generally, uncertainties affecting the biogenic emissions over Mediterranean domain are in the range of the uncertainties admitted (cf GENEMIS report) on anthropogenic emissions: These uncertainties can reach a factor 2 (see also Solmon et al., 2004).

See the modifications in the text.

1. The town sources are really contrasted. Marseille, with an area of 24000 ha and a population of ˜800 000 inhabitants, is clearly characterized by traffic emissions. Martigues covers an area of ˜7000 ha, and has a population of ˜45 000 inhabitants. With 4 refineries and 5 Seveso classified factories this town is under the influence of industrial emissions. These differences induce quite variable VOC/NOx ratios at the emission.

2. See the text for the explanations.

3. See point 2. for the explanations.

4. In this study, we simulated isoprene emissions during a too short period to considered a canopy evolution (EP variation). As emission potential does not change during

these simulations, isoprene fluxes time dependence can only based on the variation of the canopy environmental factor (EC). EC(t) depends on the PAR and the leaf temperature Tl time variation. We could rewrite this equation as: F(t) = EP.EC[PAR(t),Tl(t)]. As suggested by the reviewer, the isoprene emission model has been described in a more detailed way. Confusion came from that (t) stood for a variable of time (t) and not temperature (T).

5. See the text for the corrections.

6. Estimating such uncertainty is difficult because EP depends on the canopy biomass evolution which can be assimilated to a low-frequency variation. If we consider a longer period (a season or a year), we would introduce a time evolution of EP, but the simulated period is too short for that. For this reason, we considered only the high-frequency isoprene fluxes variations. As outlined in the text, for the stand alone study, the uncertainty on EP due to seasonality is supposed to be reduced because emission factors and biomass measurement has been made on site and conjointly to flux measurements. However there are still uncertainties affecting the emission factor measurements and biomass heterogeneity effects (5-20%).

7. See the text for the definition.

8. Some surface parameter has been cited in the text (e.g. LAI, roughness, albedo, vegetation fraction), etc and the full description is given in Noilhan and Planton, 1989. For concision we are not to exhaustive in the description of the ISBA (soil biosphere atmosphere model functioning) which has been the subject of a number of publication. We tried to select the important aspect concerning directly the BVOC flux calculations.
Noilhan, J. and Planton, S.: A simple parameterization of land surface processes for meteorological models. Monthly Weather Review, 117, 536-549, 1989.

9. See the text for the correction.

10. In addition to the meteorological forcing (above canopy wind temperature humidity

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and direct radiation), all the surface parameter describing the soil canopy system and listed in Noilhan Planton,1989 and Calvet et al., 1998 has been provided for every specific site. Only the most current and important parameter for biogenic emissions have been reported.

11. ISBA is based on a "force restore" method including a set of coupled equation. Surface temperature is one of the prognostic variables. We have the feeling that describing the all ISBA system is out of focus here. We hope that the modification brought to the model description part in the revised version is now less confusing.

12. As proposed, this sentence is omitted.

13. A new equation explains how emitting biomass is calculated in the general method. For all the 4 tested ecosystems, one emitting species generally dominates in term of isoprene emission. The field experiment gives measurement or estimations of the key variables, like species cover rate, LAI, specific leaf weight (referred in cites publications) necessary to calculate the emitting biomass and further the emission potential.

14. With the PAR, the surface temperature assimilated to the leaf temperature is used to calculate isoprene emissions. In the MESO-NH-C model, this surface temperature is directly deduced from net radiations, latent and sensible heat fluxes. Validating these fluxes, in comparing with measurements, allows us to characterize as well as possible the canopy functioning and microclimate and to assume that the surface temperature is sufficiently realistic for the estimation of isoprene emissions.

15. See the text for the explanation.

16. As precised in the text, the surface temperature is basically used in the modeling to represent the vegetation temperature. However, on MEDiterranean ecosystem, the vegetation cover is more open compared to the other case, i.e with a fraction of bare soil not negligible which tends to warm up and enhance the value of surface temperature. The roughness of the MED forest is also quite large and favors heat exchange

between leaves and air. As a result, on this ecosystem, the actual leaf temperature is better approximated by the surrounding air temperature rather than by the surface temperature. This has been pointed out in the text.

17. The authors assess that, according to the simplicity of the scheme, the diurnal evolution and the magnitude of isoprene flux are well represented. On the test cases, fluxes are within the range on emission potential and measurements uncertainties (see text).

18. See the text for the definitions.

19. As better explained in the revised version, ISBA stands for soil plant atmosphere transfer. In the MesoNH system, ISBA is coupled to meteorological fields to provide the surface conditions. So does the BVOCEM biogenic emission, which is driven by ISBA.

20. As mentioned in the text (line 23-24 on page 7699), we selected a typical day of the year. Then, we only consider a diurnal evolution of the anthropogenic sources, characterized by a early and a later peak. However, we did not include a seasonal variation of these anthropogenic sources. The purpose of this article is to evaluate the impact of a biogenic source on a given anthropogenic source as a function of the plume degree of maturation (in increasing the distance between the two sources). For this reason, we only considered two anthropogenic sources with two VOC and NOx diurnal evolution and one biogenic source with one emission potential.

21. Marseille is représentative of a urban source widely dominated by transport emissions (strong diurnal modulation with 2 maximum in the morning-around 7a.m. and in the afternoon-around 5p.m.). Martigues is more characterized by industrial sources with a diurnal variation less pronounced.

Only one single day is represented in each simulation.

22. See the text for the correction. The 2-D simulations only represent the d1 for

two cases. The figure 6 represent the control run with the forest being physically at d1 distance but biogenic emission are here cut. Control runs for d2 d3 d4 are very close together in this idealized configuration (small dynamical differences induced by the position of forest). The figure 7 represent the same run but activating the biogenic emissions. This has been précised in the text and in the figure legend.

23. See the text for the correction.

Technical corrections:

Thanks to the referee for his numerous technical corrections. Refers to the text to read the technical corrections.

Interactive comment on Atmos. Chem. Phys. Discuss., 4, 7691, 2004.