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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Assessment of high to low frequency variations of isoprene emission rates using a neural network approach" *by* C. Boissard et al.

C. Boissard et al.

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Reply to referee #1

General comments: As also suggested by the other referee, the following general changes were made: - the manuscript is now focusing only on isoprene emissions; therefore, comments and results on other BVOC, in particular those on monoterpenes, were removed. - the general outline was modified in order to include the former "review" section into the introduction - new references dealing with neural approach were included and are discussed.

Specific comments 1. As mentioned above, the manuscript is no more focussing on monoterpene.

2. As mentioned above, the manuscript is no more focussing on monoterpene.

3. As mentioned above, the manuscript is no more focussing on monoterpene.

4. Drought effect on monoterpene emissions is no more consider. Precision on short and long term effect were already presented for drought effect on isoprene emissions.

5. Thank you.

6. As mentioned above, the manuscript is no more focussing on monoterpene.

7. Monoterpene emissions are no longer considered and fewer details are now given in the introduction on isoprene variations.

8. We do agree that BVOC emissions are, by definition, mainly regulated by biological processes (but not only, as for VOC volatility) and we do agree that when they happen, they are relatively fast. However, such physiological adaptations can be a response to an environmental signal "threshold" received by the plant over a more or less long term. The overall strategy was rewritten and developed for a better clarity.

9. As suggested, we now get to this biochemical regulation discussion earlier in the manuscript.

10. The suggested information (species, Is(G95), …) is now added in the former Table 2 (now Table 1). As mentioned in former Table 2 caption, ISO-DB data (emission rates and environmental data) will be accessible at http://lisa.univ-paris12.fr/~boissard as soon as the manuscript is accepted for publication.

11. The overall outline of the manuscript was changed according to the referee's suggestions: - the former 'review' is now part of the introduction - the title of former section 4.2 was corrected and the section was modified for clarification. - appendixes A and B appear now as specific figure (Figure 3) and table (Table 2); only the description of ISO-LF (former appendix C) was kept as an appendix (now appendix A).

12. Non linear regression sensitivity tests are indeed difficult to interpret as it is now

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mentioned. Some care were taken in the interpretations of that section.

13. Data pre-processing was clarified. As it is now mentioned, the first step of this data processing consisted of course, for every input, to expressed/converted all values in a same unit (i.e. all precipitation in mm, all temperature in °C, …), as presented in the former Appendix B (now Table 2). Similarly, the network optimisation made sense only because every output values (isoprene emission rates) were converted into the same unit (gC gdwt-1 h-1, see for instance former Appendix A). Actually, most of the emission rates compiled into ISO-DB were mass based expressed. Only the Keller and Lerdau (1999) data were leaf area expressed. These authors were contacted and provided the appropriate leaf/mass conversion factor measured during in-situ during their experiment. Because each input varies over a wide range of values, depending on its specific unit, it was necessary to central-normalised all data (the inputs and the output) to get ride of any artificial weight that one particular regressor could have. For example L0 absolute values vary over a much larger range (from 0 to 2400 mole.m-2.s-1) than air temperature ones (5 to 40 °C). After their central-normalisation, both are varying within a much more comparable range (-3.2 to 2.4 and -1.3 to 3.2 respectively).

14. Mathematical expressions were corrected and are now expressed according to ACP rules.

15. NCEP and NCDC abbreviations were removed from the abstract, but ISO-LF, ISO-DB, T21, T0 and L0 were kept as they are used several times.

16. Paragraph on Ulex europaeus was removed from the abstract.

17. CTM abbreviation was removed.

18. VOC abbreviation was removed in the introduction.

19. The suggested change was made.

20. As mentioned in the original manuscript (page 12425, lines 19-20), this study is

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indeed not the first and only one using an ANN approach for biogenic emissions. A new paragraph is now added on that point at the end of the introduction (lines 5-13, page 3) and some new references added (Papale and Valentini, 2003; Simon et al., 2005; Delon et al., 2007).

21. Correction was made as suggested

22. The introduction focusing now only on isoprene emissions, this part has been deleted.

23. The introduction focusing now only on isoprene emissions, this part has been deleted.

24. The introduction focusing now only on isoprene emissions, this part has been deleted.

25. Correction was made as suggested

26. The sentence was indeed not clear and was modified.

27. The beginning of section 3.1 was removed since the manuscript is now focussing on isoprene emissions.

28. Former lines 2-6 P12426 were not removed as suggested as we did not compute at all the network program. However this paragraph was moved at the end of section 2.2. The bias is now properly defined (section 2.2) and the all paragraph reworded for a better description of the different parameters.

29. Of course, as it is now explained (section 2.2), the minimum of the least square error E does correspond to the point where the first derivative of E equals zero.

30. Former section 3.3 is not only an enumeration, but the description of ISO-DB. Because statistical methods strongly rely on the content and the characteristics of the data base, and because further precisions were required form the other referee, this section (now in 2.3) was not significantly shorten.

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31. Correction was made as suggested

32. This section was deleted.

33. The precision was removed. Integration time for emission sampling was not available for most of the references used for ISO-DB. This information could thus not be added in the appropriate table as suggested.

34. This section was deleted.

35. Soil water content (not soil humidity) is considered in this study.

36. This sentence was actually a (misleading) short way for a long story. Sorry about that! Here are some precisions. The emission rates used from Kuhn et al (2002, 2004) for ISO-DB were measured in 1999, on days 128, 129, 283, 284, 295 and 296. In-situ meteorological data are indeed available from the LBA-EUSTACH website. However, the PAR, air temperature and precipitation values were missing from day 280-1:30 p.m. till day 283-9:30 a.m. The desired cumulated values could thus not be calculated for days 283 and 284. Instead, they were assessed using the nearest NCDC met data available. On the days 128, 129, 295 and 296, the comparison between LBA and NCDC data showed that NCDC data were in relatively good agreement with LBA data (overestimation of 5 to 15%). In order to keep a consistency in the data, we decided to use only NCDC data rather than reduce the number of data of ISO-DB and not use some of the Kuhn data. The text was slightly rewritten.

37 ISO-DB data correspond to measurements carried out at the top of the canopy, except for some of the Liquidambar measurements (Harley et al., 1996) which were taken about 10 m under the top of the canopy in addition to those taken at the top of the canopy (22 m). This information is now given in point 1. of section 2.3.

38 A comparison with the G93 algorithm is now presented figures 4a and 4b and discussed in the text (section 3.3).

39 There was a mistake in the text. Indeed, MSEvalidation is always higher than MSE-

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traning. What we meant (and as it is now mentioned) was that MSEvalidation decreases with the number of neurons until it starts to increase again while the MSEtraining still decrease. The inflexion point on MSEvalidation gives the number of neurons from which the overtraining phenomena appears. This method used is called the early stopping criterion.

40 Correction was made as suggested

41 Correction was made as suggested

42 This section was changed and further conclusions are given.

43 Correction was made as suggested

44 Soil water contents are indeed expressed in fraction of volume. This precision was added to Table 2 caption.

45 The spelling was corrected.

46 The whole notation of the different weights was changed and homogenised.

47 Although most of the relevant information is mentioned in the text, this table format presentation is useful for a quick overview of the performances. As former Table 3 is not too long we decided to keep it as it is.

48 Former figure 4 is now divided into two separate figures in order to present a larger version of the results.

49 The mis-spelling was corrected.

50 The mis-spelling was corrected.

Reply to referee #2

General comments

As also requested by referee #1, the overall structure of the manuscript was clarified:

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- the former 'Review was moved into the introduction and is now focusing only on isoprene emissions - the overall strategy was rewritten (now section 2.1) as the ANN description (now section 2.2) - the results and discussion section (now section 3), was partly rewritten as well and a new paragraph was added (paragraph 3.3) to discuss ISO-LF performances. - some new conclusions were added - table and figures were simplified for a better understanding; only ISO-LF algorithm is now presented in an appendix. The origin of the data has been explained. This work is indeed based on Chervier 2005 thesis work. However, the database ISO-DB used for this presented study was changed from Chervier's work and the neural structure completely recalculated, in particular the number of the inputs considered in the final algorithm has been reduced. This is the reason why we did not mention this reference. New references of previous studies applying a neural approach to biogenic emissions are now presented and discussed in the introduction (Lasseron 2001, Papale et al. 2003, Simon et al. 2005, and Delon et al. 2007).

Specific comments

1. As mentioned above, the general structure of the manuscript was improved accordingly to the referee suggestions.

2. As mentioned above, figure and table presentation was improved for an easier reading. Former Table 1 is no longer presented (see further down, point 10).

3. As suggested, the indication of species type was corrected in tables and figures.

4. Only isoprene is now considered in the revised version. The suggested additional information was added in former Table 2 (now Table 1).

5. As mentioned above only the description of ISO-LF was kept in an appendix.

6. Former Table 4 confusion was due to the XL/Latex conversion. There is only one reference for Q. Coccifera, the other are for Q. Ilex. The table was clarified.

7. Symbols in the former Appendix A caption were corrected for Ulex Europaeus, as

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well as for Tsuga mertensiana and Q. pubescens.

8. The misspelling between ISO-DB and ISO-LF in former section 4.2 (now section 3.2) was corrected and the title simplified.

9. Former Section 4.3 (now section 3.3) was partly rewritten to improve its clarity.

ISO-DB description / data selection:

10. Former Table 1 was reviewing all seasonal studies of BVOC emissions found in the literature. Former Table 2 was presenting the data used in ISO-DB. Since ISO-DB data were not all extracted from seasonal studies (which is not a problem since the low frequency information comes from the fact that each regressor was cumulated over a certain time), not all Table 2 data were extracted from Table 1. In order to avoid further confusion between those two sets of data, and as suggested earlier by the referee (point 1), former Table 1 is no longer presented. However, as requested, some specific information given in the former Table 1 (the range of fluctuation of the measured isoprene emission rates, the G95 standardised emission rates, the original format of data …) was added (see new Table 1).

11. All the literature references used for this work do present measured emission rate data (in some cases, together with the corresponding calculated standardised values). As it is now mentioned (section 2.3, point 1), most of the data used for this study were presented under figures (not always diurnal graph). The corresponding values were digitally computed (this method was shown to produce no significant error). As explained in the former section 3.3 point 2 (now section 2.3, point 2), L0 and T0 were the only parameters which were not assessed from NOAA databases. Values of L0 and T0 were extracted from original reference, in a similar way than for the emission rates. When some values were missing or uncertain, the corresponding authors were contacted for clarification. If no response was obtained, the data were eventually not used in the final ISO-DB. About 40% of the pre-selected data were thus rejected. This is one of the reasons why the compilation of ISO-DB was such time consuming …

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but also a way to get some complementary raw data (not published) directly by the authors as it is now mentioned in the new Table 1.

12. One of our aims for publishing this work is to make the ISO-DB database freely accessible. However, it is quite understandable as well that we cannot do it before this work is accepted for publication. In the case this paper was accepted for publication in the ACP, we ask the publisher not to start the final publication process until the database is indeed freely accessible. However, if the referee does need the data for his (her) review, we would agree to provide ISO-DB directly to the publisher.

13. Presentation of former Appendix B (now Figure 3) and its caption was improved and clarified. D refers to the daylight duration as explained in the original manuscript (page 12429, lines 21-24). As it is now mentioned in the ISO-DB description (section 2.3, point 1), only daylight emission rates were used, as isoprene emissions are negligible at night. The smallest emission rates values shown in the former Appendix A correspond to winter values of Ulex europaeus. ISO-DB information concerning light intensity is indeed given in PPFD for L0 and in W.m-2 (for the visible band) for L1 to L21 inputs. Indeed, the use of different unit for L0 and L1-L21 would have been a problem if the inputs were not centrally normalised before use. As we did so, no conversion into one or the other unit was needed. Of course, some of our inputs are dependent, as more or less most (all?) environmental data are, in particular (but not only) because they are calculated using the same data. But, on the contrary to linear regressions, such co-linearities are not a problem in non linear regressions.

Conceptual issues

14. The manuscript title was changed as suggested.

15. The instantaneous variability of isoprene emissions is indeed well described by the G93 algorithm. However, as presented in the first part of the result section, all of the effects of L0 and T0 were not fully accounted by the G93 algorithm. This is the reason why raw emission rates were used and not basal emission potential; a

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same strategy was moreover employed by Simon et al. (2005) for isoprene and light dependent monoterpene emissions from Amazonian trees.

16. The revised manuscript is now only considering isoprene emissions. Note that Simon et al. (2005) did successfully consider both, isoprene and light dependent monoterpene emissions.

17. The revised manuscript is now only considering isoprene emissions.

18. For ISO-DB data access, see point 12. Although Q. ilex monoterpene emissions are no longer considered in the revised manuscript, the poor performance of the ISO-DB could also be attributed to the fact that none of the monoterpene data were used during the training phase. Indeed, the MTns-DB, on a statistical point of view, brings not only a new type of information in term of emitted compound, but unavoidably some new information in term of environmental conditions. As it is always the case with neural approach, if new data are used or added, the optimised neural network changes as well.

19. Different colours, different symbols (plain colour) are now used in Figure 5, and its labelling was widened for an easier reading. ST1u and T0 cannot fully reflect the same information, since they are integrated over different time scales (STIu represents the mean daily soil temperature and T0 the 'instantaneous' air temperature). ST1u impact may not be important but it can; above all, as it is now mentioned (section 3.4), this finding for temperate winter was indeed obtained only for one type of data (Ulex europaeus) which may, on a statistical point of view, not be representative enough.

20. The Dutot et al. (2007) reference was added in the reference list.

Interactive comment on Atmos. Chem. Phys. Discuss., 7, 12417, 2007.