Biogeosciences Discuss., 5, S465–S469, 2008
www.biogeosciences-discuss.net/5/S465/2008/

Biogeosciences Discussions

BGD

5, S465–S469, 2008

Interactive Comment

Interactive comment on "The effect of flooding on the exchange of the volatile C_2-compounds ethanol, acetaldehyde and acetic acid between leaves of Amazonian floodplain tree species and the atmosphere" *by* S. Rottenberger et al.

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Received and published: 5 May 2008

COMMENTS TO REFEREE 2

GENERAL COMMENTS

We thank the referee for his work on the manuscript and we are glad to be confirmed that this seems to be the first study on leaf emission of ethanol, acetic acid and acetaldehyde by flooded Amazonian tree species. However, with this background we do not agree with the phrasing that the paper is mostly of "confirmatory" character. Amazonian floodplains represent an important ecotype with regular flooding amplitudes of several meters of water level. Based on such seasonal events the biosphere adapted to the flood pulses with a lot of different adaptation features as reported in numerous publications. One of them was cited by the referee. Increased acetaldehyde and ethanol emissions caused by fermentation as a consequence of root hypoxia is only one potential adaptation and it is not clear how much plant species make use of this metabolic switch. We should not simply transfer interpretations from temperate species to the Amazonian case. Hence, we did not want to reinvestigate any earlier published work, but we wanted to check strategies of tropical floodplain species that seem to be specialists to grow under these conditions. We got the chance to have access on true Amazonian tree species being available though only for a limited time period (due to Brazilian legislation) and selected some of these species for a comprehensive set of measurements. Furthermore, these tree species were intensively investigated for their physiological and morphological adaptation strategies by earlier studies (De Simone et al. 2002). In addition to the cited publications, we would like to call attention to a summarizing report that is currently in press (Haase and Rätsch, 2008).

LOW NUMBER OF REPLICAS

The low number of replicas is a consequence of the limited access to the trees. We had to decide to measure one tree species with more replicas or try to get a first overview of the potential adaptation by screening more species assorted based on the knowledge gained from earlier work on the morphology and physiology of these Amazonian trees. Tree species were chosen along their adaptation capability as investigated and reported (cf. Haase and Rätsch, 2008), and gained consistent measurements over several days for each individual. We believe that the robust datasets accomplished by these decisions justifies our interpretations. We agree with the referee that there is need to perform more measurements, also for statistical reasons. We are aware that there is high uncertainty in the emission rates, but it was not the aim of our study to deliver robust emission rate numbers, but to demonstrate the VOC emission composition being in close agreement with the different morphological and physiological adaptation strategies in response to flooding. We will point this out more explicitly in a revised version.

DETERMINATION OF ETHANOL BY PTR-MS

We do not agree with the statement that the ethanol emission rates presented are useless. The PTR-MS is not the ideal instrument to measure ethanol, no doubt. As discussed above this study was aimed to give a first insight into the VOC emission quality caused by flooding an root anoxia. Within this set of data it was of great interest to see the general capacity of ethanol emissions in relation to acetaldehyde and acetic acid. For further experiments we will of course improve the measuring technique by further calibration tests.

SOIL OXYGEN CONCENTRATIONS

The oxygen content was measured sporadically and we observed a drop of O2 saturation from near saturation to levels of 40-50 % at 4-10 cm depth and to 20-30 % at 20 cm depth within the first 5 days. But we do not agree that the variation of the oxygen concentration in water is of significant relevance for our studies. The solubility of O2 in water is at least three orders of magnitude lower than in air. We regard this generally low solubility and availability to be the crucial factor, rather than the variation in the relative amount of solved O2. For plants not specially adapted to this situation this will cause an anoxic stress condition already. As demonstrated by De Simone et al. (2002) and Haase and Rätsch (2008) plants from Amazonian floodplain areas are adapted by internal transport of air and oxygen down to the roots, as demonstrated by a comparison of different tree species. There was nearly no oxygen deficiency detected in case of Salix martiana, whereas the oxygen concentration was low in case of Tabernemontana juruana and not detectable in case of Laetia corymbulosa. These data fit perfectly with our observations. Within this context we would like to point out a difference between potted trees and trees in their natural floodplain areas. The plants are highly flooded, sometime up to the crown. But in most of these floodplain areas a constant flow of water is observed indicating the steady exchange of water with more or less constant oxygen content. This leads to the conclusion that it is the generally limited oxygen concentration in water but not a further decreasing oxygen content which drives adaptation,

SUBSTRATE AVAILABILITY

We agree with the referee that substrate availability (soluble carbohydrates in the roots) may play a role in affecting the emission and even cause cessation. As such the emission rates may depend on this availability. But we think that this argument is challenged concerning the VOC emission composed of ethanol, acetaldehyde or acetic acid released from the leaves in correlation to the different adaptation strategies. It has been shown earlier (Haase and Rätsch, 2008) that S. martiana, T. juruana and L. corymbulosa clearly differ in their adaptation strategies by developing different amounts of alcohol dehydrogenase (ADH), e.g. Salix martiana having significantly lower amounts of ADH compared to the other tree species. For further information about metabolic adaptations we refer to the review Parolin et al. (2004).

RELATIONS BETWEEN EMISSION QUALITY AND ENZYME ACTIVITIES

We agree with the referee that our suggestion to interpret emission differences between species by assuming different leaf ethanol metabolism to be of special interest. We also encourage studying these relations by further investigations of responsible enzymes. But this is work for further studies. Within the same context we agree with the assumption that changes of the ratios between ethanol-acetaldehyde-acetic acid in the course of the experiments (Fig.4) might be caused by changes of the enzyme activities during the studies. We will stress this point in the revised version.

COMPENSATION POINTS

The data set for the other tree species was too limited as we did not adjust the atmospheric aldehyde concentrations and thus we were depending on the varying ambient mixing ratios. Therefore, we only explored the relation between atmospheric mixing ratios and exchange for those two of the tree species where sufficient data were available. The results were in close accordance with our earlier work on other tree species in Amazonia as well as in Europe. We would expect similar low values for the other species.

References

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Interactive comment on Biogeosciences Discuss., 5, 463, 2008.