Biogeosciences Discuss., 9, C5631–C5636, 2012
www.biogeosciences-discuss.net/9/C5631/2012/

Biogeosciences
Discussions

Interactive comment on "Isoprene emissions from a tundra ecosystem" *by* M. J. Potosnak et al.

Anonymous Referee #1

Received and published: 13 November 2012

This is a very interesting and quite comprehensive work. It is also very suitable for publication in Biogeosciences since the topic links vegetation processes to atmospheric and climate change research. The manuscript is generally well written albeit occasionally a bit lengthy. My main concerns are about the methods used for scaling the results. Rather than scaling isoprene emission linearly against light, I would prefer adjusting (decreasing) the alpha-parameter in equation 2 as has been done previously by Harley et al. 1996 (and 1997) and other authors and discussed in Monson et al. 2012. Generally, some references are certainly missing that have to be discussed (see below) but otherwise I have no objections against publication.

In the following, I elaborate a bit on questions or remarks related to specific text passages.

Abstract

L12: Note that it is not the algorithm but the standard parameters that are suitable/ unsuitable for use with the specific vegetation system. L14: The decisive conclusion in the comparison between sites would be if the emission per leaf area S. pulchra is approximately equal of if some other factors need to be considered. The absolute emission values are only of secondary importance. L18: clarify that the result of the simulations is a decrease of OH radicals when considering isoprene emission (with respective consequences on greenhouse gas concentrations).

Introduction

Please note that there are a couple of newer and more comprehensive reviews about BVOC emission sensitivity (Holopainen and Gershenzon 2010) and impacts generally (Sharkey et al. 2008, Harrison et al. 2012) and specifically on the leaf (Vickers et al. 2009, Niinemets 2010) ecosystem (Yuan et al. 2010, Clavijo McCormick et al. 2012) regional (Pinto et al. 2010) and global (Laothavornkitkul et al. 2009, Penuelas and Staudt 2010) scale. Modelling has been described in Grote and Niinemets 2008, Arneth et al. 2011, Monson et al. 2012. Also, the particular focus on isoprene should be more towards the end of this overview or in a separate paragraph. P13356, L10,11: Referring to Guenther et al. 2006 is a very general statement with global focus, while the arctic biosphere systems might require more specific. So, a shift between shrub species abundance might also lead to a decrease of emissions (Faubert et al. 2011) Also, a general statement about BVOC is hardly appropriate since birch for example (which emits no isoprene) has been shown to emit significant amounts of monoterpenes and sesquiterpenes (Tarvainen et al. 2007, Haapanala et al. 2009).

Methods

The description of measurements and modelling should be better separated. The measurement description is rather lengthy and should be shortened or put into an appendix. However, it should be clarified how the sites for chamber measurements are selected and what is in there. As pointed out in the general section, I would prefer a change in the alpha parameter to adjust the sensitivity to light rather than assume a simple linear dependency. There is also a small conception-error in equation 2 that has been pointed out by Monson et al. 2012 (which will not change the equation anyway). P13363, L20: If you use the canopy model that uses wind speed you should refer to Guenther et al. 1999. However, I doubt that the influence is large.

Results/Discussion

As indicated above, I would appreciate, if the alpha parameter could be adjusted to the results. P13367, L12ff: This has actually also been found in other studies (Copeland et al. 2012, Karl et al. 2009) although some studies indicate less emission capacity (Olofsson et al. 2005) P13368, L4ff: This reasoning is somewhat strange. If the plots had the same temperature they could hardly be used as warming references. For the seasonality impact, many references can be found but you can refer to the modelling reviews of Grote and Niinemets 2008 and Monson et al. 2012. P13368, L12: add the current replication number P13372, L11: this can be discussed a bit further. It seems to corroborate results from Tiiva et al. 2009 but contradicts Haapanala et al. 2009. Perhaps the findings of Ekberg et al. 2011 could serve for explanation? P13373, L2: versus P13375, L10ff: It really seems strange to me that the results in the two years were so different. Seasonality is certainly a factor but then the differences do not disappear in the MEGAN runs although you ran them considering the previous days (you did, didn't you?). To get a more complete picture I suggest adding a third line in Figures 5 and 6 with a pooled data set and an appropriate adjustment of the models (this would demonstrate the best model performance in a global application). P13376, L12: What is low? Either this should be given in the figure or indicated somewhere else together with further air chemical boundary conditions. The latter also includes the concentrations of other isoprenoids (probably 0 but should be stated and discussed later).

Conclusions

P13377, L14: simulated instead predicted P13378, L10ff: No. Due to the general exponential relationship the increase of isoprenoid emission is expected to rise much steeper than predicted for the rest of the earth. However, the big question is how the isoprene emission develope in response to the rising CO_2 concentrations (Arneth et al. 2007, Monson et al. 2012, Harrison et al. 2012). P13378, L16: drought stress instead of water stress. P13378, L24ff: Careful. As already mentioned other species might emit less isoprene but eventually other substances such as monoterpenes and sesquiterpenes. The differences and similarities in air chemistry and aerosol impacts could be briefly discussed. It should also be noted that there is difference in abundance and LAI increase that is also a possible effect of climate warming and CO_2 increase. This could mean that besides a loss in abundance, the total emitting foliage amount could still increase (at least theoretically).

References

Arneth A, Miller PA, Scholze M, Hickler T, Schurgers G, Smith B, Prentice IC (2007) CO_2 inhibition of global terrestrial isoprene emissions: Potential implications for atmospheric chemistry. Geophys Res Lett 34:doi:10.1029/2007GL030615

Arneth A, Schurgers G, Lathiere J, Duhl T, Beerling DJ, Hewitt CN, Martin M, Guenther A (2011) Global terrestrial isoprene emission models: sensitivity to variability in climate and vegetation. Atmos Chem Phys 11:8037-8052

Clavijo McCormick A, Unsicker SB, Gershenzon J (2012) The specificity of herbivore-induced plant volatiles in attracting herbivore enemies. Trends Plant Sci 17:303-310

Copeland N, Cape JN, Heal MR (2012) Volatile organic compound emissions from Miscanthus and short rotation coppice willow bioenergy crops. Atmos Environ 60:327-335

Ekberg A, Arneth A, Holst T (2011) Isoprene emission from Sphagnum species occupying different growth positions above the water table. Boreal Env Res 16:47-59

Faubert P, Tiiva P, Michelsen A, Rinnan A, Ro-Poulsen H, Rinnan R (2011) The shift in plant species composition in a subarctic mountain birch forest floor due to climate change would modify the biogenic volatile organic compound emission profile. Plant Soil DOI: 10.1007/s11104-011-0989-2:1-17

Grote R, Niinemets Ü (2008) Modeling volatile isoprenoid emissions - A story with split ends. Plant Biol 10:8-28

Guenther A, Baugh B, Brasseur G, Greenberg J, Harley P, Klinger L, Serca D, Vierling L (1999) Isoprene emission estimates and uncertainties for the Central African EXPRESSO study domain. J Geophys Res 104:30625-30640

Haapanala S, Ekberg A, Hakola H, Tarvainen V, Rinne J, Hellen H, Arneth A (2009) Mountain birch – potentially large source of sesquiterpenes into high latitude atmosphere. Biogeosciences 6:2709-2718

Harrison SP, Morfopoulos C, Srikanta Dani KG, Prentice IC, Arneth A, Atwell BJ, Barkley MP, Leishman MR, Loreto F, Medlyn B, Niinemets Ü, Possell M, Peñuelas J, Wright IJ (2012) Volatile isoprenoid emissions from plastid to planet. New Phytol doi: 10.1111/nph.12021:

Karl M, Guenther A, Köble R, Leip A, Seufert G (2009) A new European plant-specific emission inventory of biogenic volatile organic compounds for use in atmospheric transport models. Biogeosciences 6:1059-1087

Laothawornkitkul J, Taylor JE, Paul ND, Hewitt CN (2009) Biogenic volatile organic compounds in the Earth system. New Phytol 183:27-51

Monson RK, Grote R, Niinemets Ü, Schnitzler J-P (2012) Modeling the isoprene emission rate from leaves. New Phytol 195:541-559

Niinemets Ü (2010) Mild versus severe stress and BVOCs: thresholds, priming and consequences. Trends Plant Sci 115:145-153

Holopainen JK, Gershenzon J (2010) Multiple stress factors and the emission of plant VOCs. Trends Plant Sci 115:176-184

Olofsson M, Ek-Olausson B, Jensen NO, Langer S, Ljungstrom E (2005) The flux of isoprene from a willow coppice plantation and the effect on local air quality. Atmos Environ 39:2061-2070

Peñuelas J, Staudt M (2010) BVOCs and global change. Trends Plant Sci 115:133-144

Pinto D, Blande J, Souza S, Nerg AM, Holopainen J (2010) Plant volatile organic compounds (VOCs) in ozone (O3) polluted atmospheres: The ecological effects. J Chem Ecol 36:22-34

Sharkey TD, Wiberley AE, Donohue AR (2008) Isoprene emission from plants: Why and how. Ann Bot 101:5-18

Tarvainen V, Hakola H, Rinne J, Hellen H, Haapanala S (2007) Towards a comprehensive emission inventory of terpenoids from boreal ecosystems. Tellus Series B-Chemical and Physical Meteorology 59:526-534

Tiiva P, Faubert P, Räty S, Holopainen JK, Holopainen T, Rinnan R (2009) Contribution of vegetation and water table on isoprene emission from boreal peatland microcosms. Atmos Environ 43:5469-5475

Yuan JS, Himanen SJ, Holopainen JK, Chen F, Stewart CN (2010) Smelling global climate change: mitigation of function for plant volatile organic compounds. Trends Ecol Evol 24:323-331

Interactive comment on Biogeosciences Discuss., 9, 13351, 2012.