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Biogeosciences
Discussions

Interactive comment on "Plant responses to volcanically-elevated CO_2 in two Costa Rican forests" *by* Robert R. Bogue et al.

Anonymous Referee #2

Received and published: 3 May 2018

This paper tries to use volcanically elevated CO2 as a substitute for artificially added CO2 gas in FACE experiments. FACE experiments are expensive, because it uses CO2 from gas cylinders to elevate atmospheric CO2 concentrations in the tree canopy. The paper also explores the possibility of using wood carbon-13 isotope to reconstruct past volcanic activity. These ideas seem attractive but unfortunately this paper suffers from serious flaws in the methods applied to draw their conclusions, as pointed out below. Authors have to deal with issues before publication can be considered.

Major concerns:

1) Growth rates of tropical trees can be very different and I do not understand why authors think the wood from the outermost 5cm represents recent growth of 2-3 years. As reviewer #1 suggests, perhaps authors should have tried to analyze 13C of wood in

a chronological way.

Growth rates of tropical trees, as far as I know, can range from 0.6 mm per year (Kurokawa et al 2003) to 100 mm per year (fast-growing Falcata tree (Paraserianthes falcataria), for example). Which means radial growth of 5cm may represent growth increment from less than 1 year to 83 years. Over the past 83 years, influence of anthropogenic CO2 on wood d13C (Suess effect) can be as large as 4 permil (McCarrol & Loader 2004) and the Suess effect can have variable influence on wood d13C.

Kurokawa et al. The age of tropical rain-forest canopy species, Borneo ironwood (Eusideroxylon zwageri), determined by 14C dating. Journal of Tropical Ecology 19(1) 1-7.

McCarroll D., Loader NJ. (2004) Stable isotopes in tree rings. Quaternary Science Reviews 23 771-801.

2) Carbon isotope ratio of -26 peril is within the normal natural range and I still suspect that if there was significant contribution of volcanic CO2 to the wood. Even when large amount of 13CO2 (or 14CO2) is added to the crown, often it is blown away by wind and you do not see any trace of such carbon in the wood (for example, please read: Leavitt, S.W. and Long, A., 1989. Accelerator-measured 14C activity in tree rings from the vicinity of the first atomic bomb test. Radiocarbon 31:762-765.) If other environmental parameters such as radiation happen to have the same increasing patterns with Soil CO2 flux, then you may observe a pseudo-correlation between volcanic CO2 and wood d13C. To prove d13C increase is really caused by the volcanic CO2, authors should analyze 14C and 13C/14C ratio should be plotted against mean soil CO2 flux to prove the incorporation of volcanic CO2 into the plants. Volcanic CO2 is old and therefore 14C (half life of ca. 5300 years) concentration should be almost zero, I assume. Higher incorporation of volcanic CO2 means higher 13C concentration and lower 14C concentration, i.e. higher 13C/14C ratio. It is expensive to analyze 14C of wood (costs about 900 USD per sample in my country) compared to 13C (10 USD per sample). But there

are many companies that offer such services. If you measure 14C concentrations of 12 data points in Fig.4, then it would be about 10800 USD. Is this possible?

Minor comments:

Line 44. “including other gas species that accompany CO2 emissions at these springs” There are some studies that show effects of acidic deposition (SO2 and other pollutants) on leaf d13C.

Santruckova et al. 2007 Carbon Isotopes in Tree Rings of Norway Spruce Exposed to Atmospheric Pollution. Environ. Sci. Technol., 2007, 41 (16), pp 5778–5782.

Are effects of SO2 gas on leaves really absent? Acidic pollutants such as SO2 are known to affect stomata, hence, d13C of trees. Authors should analyze SO2 concentration in the air at the crowns/the leaf surfaces, then compare these concentrations with those of other literature so that they can be sure that effect of SO2 gas on d13C is absent.

Lines 133-134 “It averages 4-15 m in height” Was there any difference in tree heights in the three species studied? It is important because it affects how strongly the tree crowns are affected by volcanic CO2, which comes up from the ground. I suspect it is related to the different slopes of the two species in Fig.4.

Line 186 “which we estimated to be representative of roughly the last 2-3 years” You may be able to prove this, for example, by analyzing oxygen isotope cycles at high resolution or finding 14C bomb spike peak around 1964.

Line 199-222 Why you did not measure SO2 (and CO2) concentrations at the canopy? The model estimates may not reflect the concentrations of these gases surrounding the leaves.

Line 263 Average d13C values of -26 permil are observed in trees unaffected by volcanic CO2.

Lines 319 “Tree ring 14C content in volcanically active areas has been linked to variations in volcanic CO2 emissions, and comparing patterns of d13C to 14C measurements for the same wood samples provide additional confirmation of this finding”

I can not understand why you did not measure 14C, especially after reading this sentence in your paper.

Line 352 “Additionally, none of the trees displayed obvious signs of stress” This part seems to contradict with the following part: Line 195 “during analysis we excluded all trees that were observed in the field to have significant stress. . .” By the way, how many trees were excluded?

Fi.g 4, Why are the slopes of the two regression lines are different? Is it related to the difference in tree height between Oreopanax xalapensis and Buddeleja nitida?

Line388 “but 14C is relatively expensive and a limited number of labs are capable of making these measurements”

Now there are lab services that offer 14C analysis and I don’t know if “limted number of labs are capable of making these measurements” is true now.

Line 426 “Confounding factors that are known to influence d13C values in wood appear not to have affected our measurements, indicating that the heavier wood isotope values are most likely caused by photosynthetic incorporation of volcanic excess CO2”

I disagree with this statement and strongly feel that authors should measure 14C of the wood powder at least for the wood samples plotted in Fig.4.

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