**Biogeosciences
Discussions**

Interactive
Comment

Interactive comment on "Tracing atmospheric nitrate in groundwater using triple oxygen isotopes: evaluation based on bottled drinking water" *by* U. Tsunogai et al.

U. Tsunogai et al.

urumu@nagoya-u.jp

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Dear Prof. Michalski,

Thank you very much for your kind comments and suggestions regarding our manuscript. Below are our responses to each of your comments.

> I think the authors should add a map showing the location of the drinking water origins, that would help put context for site.

We have added a map to the revised manuscript. The same one was attached to this comment as well.

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> One issue with the quantification of the atmospheric fraction is the uncertainty in how D17O differs depending on location. This must also be considered in the context of ground water age. Alexanders model is for modern atmosphere, as are the measurements of tropospheric atmospheric NO3-. Many ground waters are 100 to 1000's of years old and the NO3-atm inputs would likely have a vey different d17O value. This unfortunately can not be assessed until a pre-anthropogenic model is developed. Do the authors know which aquifers are modern versus ancient? I don't think these issues can be definitely resolved but might be qualitatively discussed.

We agree that the regional D17O differences are the major issue associated with quantification of the atmospheric fraction. This is the reason we set the large errors for D17Oavg (+- 3 per mil). We also agree that the D17O values could be different on days when NO3–atm was deposited, especially for that deposited during pre-industrial ages, when the emission flux of anthropogenic NOX was substantially smaller than that at present. Alexander's model also showed smaller D17O values in remote regions than in areas close to the source at the same mid latitude. However, the regional differences in the annual average D17O values within the same mid latitude were less than a few per mil in the model, while the highest deposition rate of NO3–atm was more than 10 times that of the lowest value. As a result, the differences in the D17O values from the present D17O values are included in the error of D17Oavg (+-3 per mil) used in this study. Of course we would like to revise the D17Oavg values in the future when a reliable model of the historical changes in the D17O values is developed. We have discussed this in the revised manuscript.

> 16495: Line 16 "for sampling ground water directly"

We have corrected this in the revised manuscript.

> Line 19. I'm not sure if this is true, I do not think drinking water company evaluate the status of the forests where they obtain their water.

Although there are variations among brands, many drinking water companies have paid

serious attention to the environment of each recharge area because consumers believe that the environmental qualities of these areas determines water quality. Thus, groundwater eluted from declining or damaged forested watersheds was naturally avoided as the source. Some large drinking water companies have even taken steps to protect the entire recharge area themselves. Detailed information pertaining to each recharge area is available on the websites. Some of the examples are shown below:

http://www.volvic.fr/une_source_unique/au_coeur_des_volcans_dauvergne/
http://www.perrier.com/en/discoverperrier.html http://www.acquaparadiso.it/eng/le_fonti.php
http://www.dobra-voda.cz http://www.tibetwater.com.cn/index_en.aspx

> 16501 "would be 0.03.." is this even relevant given the analytical uncertainty is 10 times higher and it would not even be a rounding factor? As discussed on p. 16502

As suggested, the differences would be around 1 per mil for the $D^{17}O$ values of NO_3–atm. Thus, when using the linearly approximated $D^{17}O$ values of NO_3–atm in the literature for the calculations conducted in this study, we recalculated the $D^{17}O$ values based on the power law. We have described this in the revised manuscript.

We thank you for your helpful comments and suggestions. We trust that our responses to your comments and questions are satisfactory.
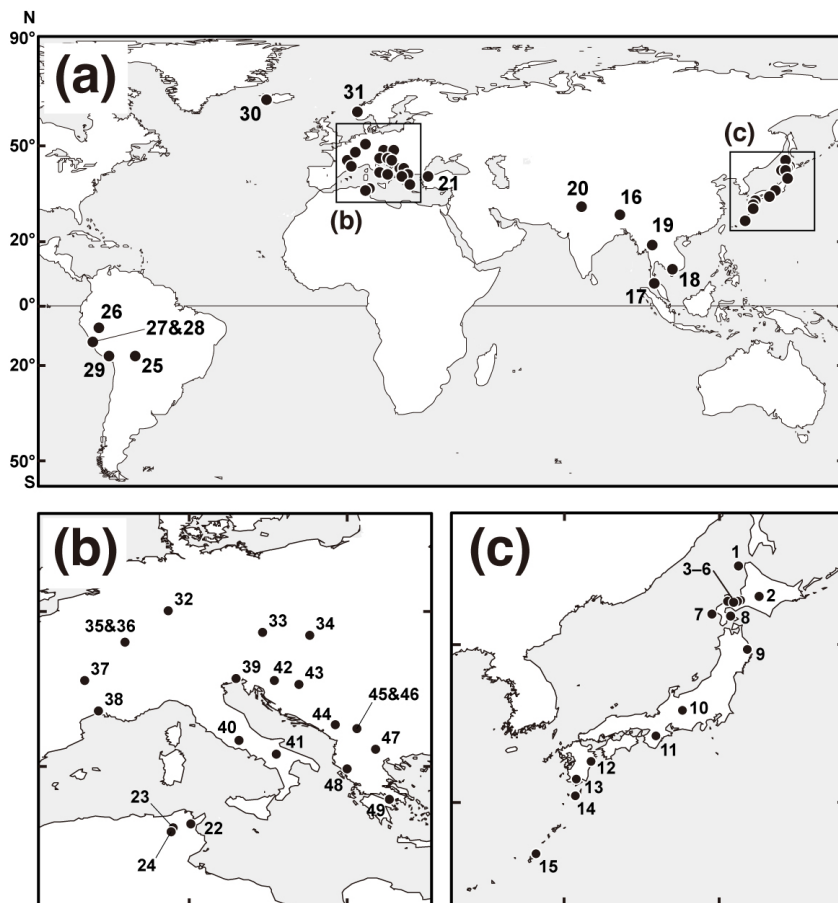
Sincerely, Urumu Tsunogai

Cc: Drs. A. Suzuki, S. Daita, T. Ohyama, D.D. Komatsu, and F. Nakagawa

Interactive comment on Biogeosciences Discuss., 9, 16493, 2012.

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Fig. 1. Maps showing the distribution of the source wells worldwide (a) and regionally (b) and (c).