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Interactive comment on "Nutrient and mercury deposition and storage in an alpine snowpack of the Sierra Nevada, USA" *by* C. Pearson et al.

Anonymous Referee #1

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A review of "Nutrient and mercury deposition and storage in an alpine snowpack of the Sierra Nevada, USA" by Pearson et al.

General comments: This is a well constructed paper that provides a wealth of information on nutrient and Hg deposition to the Lake Tahoe watershed snow pack. It will be of interest to biogeochemists, snow scientists, and hydrologists. The paper is generally well written. I have identified a few typos and have a recommendation to change "snowpack" into "the snowpack" at multiple locations. The authors do this at some instances and not at others.

The methods are well explained and the results and conclusions are strong. I recommend accepting this paper after minor reviews. Some of the comment I provide may strengthen the work but they may be out of the bounds of what the authors wish to ac-

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complish. The only strong suggestion I have is that the authors have to provide more information on how, when, and where rain on snow or thermal melt events could have affected their samples. Perhaps these events were not an issue at all- particularly if the melt events never made it to the bottom or out of the base of the snow. But I suspect they could play a role. For Hg or other species for which there is a focus on surface snow samples the potential for rain or melt events to affect snow pack concentrations is strong.

Specific comments keyed to the text:

Abstract 7: list the “chemicals”

15: deposition and dynamics within the snowpack Here and in many other places I strongly recommend terming the snow pack “the snowpack” as if to say “the soil column”, “the outcrop”, “the organic surface layer”, etc. In many places the authors do say “the snowpack” but in others they do not. I recommend being consistent and using “the snowpack”

17: in the snowpack

22: snow. Spatial

26: the snowpack

Introduction p. 595 12: The Sierra Nevada

23: The snowpack

26: the developing

27: , the snowpack Instead of “collects” perhaps use “receives” as “collects” might imply an active process while “receives” is passive?

Somewhere in here perhaps just come out and say that “the seasonal snow pack is a spatial and temporal passive sampler of atmospherically derived particles, aerosols,

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and compounds”

p. 596 6: While the snowpack

19: the seasonal

p. 597 8: the Sierra Nevada snowpack

p.599 5-8: I understand why the sites were chosen as such. But how representative of the watershed is this? Ie how much of the snow pack is typically open, free of canopy, etc.?

A second way to ask: is the study missing potential physical, chemical or other processes that are common in the forested areas by only focusing on snow from the open areas?

Since SWE is used later on to make basin scale calculations is the SWE in the open areas different than that of the forested areas? The forests likely have greater interception, lower albedo, shallower snow, and less wind effects on post deposition snow. These characteristics could affect photochemistry, and nutrient dynamics.

A paragraph or at least a few lines explaining the potential limitations and presenting the % of area represented by the open snow pack could address this.

I also wonder about the occurrence of rain on snow events and/or large thermal melt events that would affect surface snow SWE, potentially build percolation columns that would smear the surface snow signal downward, and, if the melt features reached the bottom of the snow pack, move nutrients out of the collected snowpack? Again- perhaps some explanation of these events’ occurrence, whether they are common or were encountered, and the likelihood that the melt events reached the bottom of the s now pack.

p. 599 25: in the snowpack

p. 600 3: a NADP

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4: a glass. . .. . a glass. . .. . ..

23/24: “in” is repeated twice in a row

p. 601 8: I think the “um” should be a “micron” symbol?

21: The nitrate

p. 602 5: Fig. 3a is referenced here. Fig. 2 has not been referenced yet.

Figs. 2 and 4: I recommend adding air temperature from the sites or locations nearby for the winter season. At the least, times when the air temperature was above 0C for more than 24 hours or was above 0C and a rain even occurred should be noted. I suspect that over the three years of the study there were some rain on snow events or melt events in the middle of the winter? Maybe not- I do not know. But it would be important to mention if they had occurred.

This would be particularly important for Fig. 4 as some of the samples were at least collected after initiation of the spring melt. If the s now pack cores included the entire snow pack with little horizontal percolation or without the vertical percolation reaching the base of the snow pack.

For the Hg dynamics, for which the upper 10cm of the snow pack is deemed photochemical active and for which surface samples were employed the potential for melt events or rain in affecting Hg loading to the snow pack would be important. There are some studies showing an ionic pulse of nutrients, major ions, and Hg out of snow packs during spring melt (an “ionic pulse” to the base of the snow pack: Tranter et al., 1986; Bales et al., 1989; Harrington and Bales, 1998; Schuster et al., 2008).

Bales, R.C., Davis, R.E., Stanley, D.A. (1989) Ion elution through shallow homogeneous snow. Water Resources Research 25(8): 1869-1877. Harrington, R., Bales, R.C. (1998) Interannual, seasonal, and spatial patterns of meltwater and solute fluxes in a seasonal snowpack. Water Resources Research 34(4): 823–831. Schuster, P. F., J. B. Shanley, M. Marvin-Dipasquale, M. M. Reddy, G. R. Aiken, D. A. Roth, H. E. Tay-

lor, D. P. Krabbenhoft, and J. F. DeWild. "Mercury and organic carbon dynamics during runoff episodes from a northeastern USA watershed." Water, Air, and Soil Pollution 187, no. 1-4 (2008): 89-108. Tranter, M., Brimblecombe, P., Davies, T.D., Vincent, C.E., Abrahams, P.W., Blackwood, I. (1986) The composition of snowfall, snowpack and meltwater in the Scottish highlands-evidence for preferential elution. Atmospheric Environment 20(3): 517-525.

Fig. 4: 2011-2012: Snowpack values for all N species are diluted by late winter storms.

p. 607 4: This is where elution is mentioned but its occurrence has not been established.

27: from the early

p.608 9/10: in the late

25: to the Tahoe

p. 609 2: why the semicolon?

7: in the snowpack

15: to the snowpack

p. 610 4: remove “very” as it is vague

13: in the snowpack

14: in the snowpack

17: our measurements do not allow

20: Arctic is misspelled

24: in the Sierra

27: in the snowpack

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p. 611 13: site, also

p. 612 17: in the snowpack than in wet

29: “in the Sierra” is vague. Sierra what? Nevada mountains?

p. 613 10: The Tahoe Basin snowpack

15: the Tahoe snowpack

18: Hg in the snowpack

p.614 7: “with in” should be “within”

11: in the snowpack

18-21: is there information presented on the deeper, denser snow pack? Particularly in light of potential melt events at some elevations? And with respect to potential for bigger storm events at the higher elevation sites due to orographic effects.

She Hg versus SWE relationship: is that only for surface snow layers or the overall snowpack?

p. 615 7: storage, an increase

p. 606 12-13: much of the snowpack-

p. 618 6: in the snowpack

13: how about “more than” instead of “over”

20/21: in the Lake Tahoe Basin

p. 620 6: in the Lake Tahoe

9: the Tahoe snowpack

12: that the Lake Tahoe basin

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Fig 7. Potential for melt events to be represented or to have affected the snow chemistry?

Interactive comment on Biogeosciences Discuss., 12, 593, 2015.