Reply to referees' comments on Jovanovska et al. discussion paper

The authors would like to thank both reviewers for the detailed and constructive comments on the manuscript. We took their suggestions into consideration and will incorporate them in the revised manuscript.
Below we list all comments and suggestions of the reviewers (in italics), together with our point-by-point reply.

Reviewer #1

General comments:

1. *"The characterization of Heinrich events as press events seems somewhat peculiar to me given that in the paleoclimate literature Heinrich events are viewed as relatively short term events, and H4 in particular is characterized as being abrupt and extreme…I think the paper would be better if it simply relied on contrasting the abrupt impacts of tephra with the longer-term impacts of climate variation, without the jargon".*
Response: We do agree with the reviewer that the used terminology might be inadequate from a geological viewpoint. However, biologically, the H-4 event is, indeed, a long period, especially when taken into account the biology of the diatom species studied (short generation time of ca. 1.1 divisions per day, Crawfurd et al., 2011). Moreover, this terminology is commonly accepted in ecosystems resilience/resistance studies, which are the main focus of this paper. We therefore would prefer to retain the term in the revised ms.

2. *"The paper concludes that the diatoms do show an abrupt response to tephra deposition but do not respond to the H4 event (but this latter statement is not consistently supported by the data - see my comments below). Differentiating the onset of these two "events", of course, hinges on chronology – as the Heinrich event precedes the tephra deposition by just 400 yr. Yet no comments are made on the errors associated with the chronology, so it is not clear how well supported this statement is … In addition, for Lake Ohrid, the sampling resolution prior to the onset and after the cessation of H4 is very low, so it is difficult to make a clear assessment of the impacts of H4, because of the changes in resolution … see comments below".*
Response: Thank you for raising this important point. However, our results in independency of the exact timing of the onset of the H-4 compared to Y-5, indeed, do not show an impact of H-4, which is as strong as the Y-5 impact. This, additionally, is supported by the previously published geochemical data (Wagner et al., 2010, 2012). Importantly, the sample resolution allows such interpretation, and therefore the impact of the H-4 seems to be relatively low compared to the impact of Y-5.

More importantly, the onset of the H-4 event has just been refined by Wutke et al. (2015). This new study specifies the timing of both events, H-4 and Y-5, based on sediment records recovered from Lago Grande di Monticcho in Italy. Accordingly, the timing of H-4 precedes the Y-5 event by ca. 800-700 years. In our revised ms, we will use this new chronological information.
However, it is important to note i) that this new information will not change the results and conclusions of our study and ii) that the primary aim of our study never was to precisely distinguish between Y-5 and H-4 events. Rather we are interested to see whether there is a differential response of lakes Prespa and Ohrid to these events.

3. *I also think the sampling resolution is a significant problem in the discussion of the extent to which the floras recover their pre-disturbance state, which is not acknowledged adequately in the discussion of the data. Based on Figure 3, for example, there are really only two samples above the gray Heinrich layer – how does one know what is signal versus what is noise?*
Response: Both reviewers pinpointed difficulties when comparing the recovery periods of lakes Ohrid and Prespa, mainly due to the uneven sampling resolution and the different timeframe observed. We fully agree with both reviewers and added 27 new sampling points to the Lake Prespa diagram and 9 to Lake Ohrid. Both diagrams now cover the same time frame and show a denser sampling. The refined analyses indicate that the overall diatom community in Lake Prespa, indeed, did recover (now supported by a total of 9 sampling points, instead of just 2 as in the original ms; see revised Fig. 3).
As for the signal-noise-ratio, the Y-5 impact (i.e., the signal) now shows a magnitude of change of ~0.6 units and a subsequently reduced variability of ~0.2 units. Therefore, the given variability of the sampling resolution should not blur the strong signal of the Y-5.

Specific comments:

4. Page 3, lines 13–15: *"This sentence should be less definitive. In both lakes, speciation patterns have been inferred for only one faunal group– hence there is not sufficient data to make generalizations, such as "the evolution of their species"…alternatively, it might be more appropriate to summarize what is observed in the diatom records of Lake Baikal and Lake E, for example, which arguably are more similar to Ohrid and Prespa than the two tropical lakes".*
Response: We accept the reviewer suggestion and will include in the revised ms information on diatom stratigraphic records from lakes Baikal (Russia) and Hövsgöl (Mongolia).

5. P. 7, l. 10: *It is not clear what is meant by "Until today." Recently? Please change the wording to be clearer.*
Response: Modified.

6. P. 13, l. 10: *As I indicated above, how good is your age model? How much error is associated with your characterization of the onset of H4?*
Response: Please see response #2.

7. P. 13, l. 17: *I think the basis for saying the Prespa community recovered is rather weak given that there are only 2 samples in the upper part of the diagram, and they are very widely spaced.*
Response: Please see response #3.

8. P. 13, l. 25: *Most of the prior discussion has centered on the impacts of the tephra deposition – Heinrich events are mentioned only briefly – so I think it would be better to start the discussion with a focus on the major theme (tephra deposition) – and later move into assessing how climate affected the flora.*
Response: In principle, we agree with this comment. However, as mentioned above, the primary aim of our study was not to precisely distinguish between Y-5 and H-4 events. Rather we are interested to see whether there is a differential response of lakes Prespa and Ohrid to these events.

9. P. 14, l. 23–26: *You start the Discussion section by saying that the Heinrich events had little effect on the diatom community – yet here you say that there is increased representation of benthic species, likely because of mixing at the onset of H4. The two statements are inconsistent.*
Response: We agree and will revise our discussion accordingly.

10. P. 15, l. 24: *Do you mean that climate may have delayed the recovery (rather than prolonged)? And again, saying that climate variation associated with the Heinrich event may have affected the rate of change in the diatom community structure is inconsistent with your statement that Heinrich events had little effect.*
Response: Our new analyses, indeed, suggest that climate change likely prolonged the recovery period. Moreover, the revised CONISS shows a mild influence of the H-4 event, particularly in Lake Prespa (see revised Fig. 3). We will discuss this in the revised paper.

11. P. 18, l. 20: *I think the variable sampling resolution, particularly the coarse resolution in some sections of each core, imposes some serious constraints on the ability to differentiate real trends versus sample to sample variation. This section should acknowledge this.*
Response: Please see response #3.

12. P. 19, l. 6: *The paper by Spanbauer (2014), which discusses long-term responses of diatom communities to perturbations, would be relevant to the discussion here. Spanbauer, T.L., C.R. Allen, D.G. Angeler, T. Eason, S.C. Fritz, A.S. Garmestani, K.L. Nash, J. R. Stone. 2014. Prolonged instability prior to a regime shift. PLoS ONE 9: e108936, doi:10.1371/journal.pone.0108936*
Response: The suggested paper will be included in the revised manuscript.

Reviewer #2

General comments:

1. *The concurrent/ongoing Heinrich "press" event (H4) did not have an impact on the diatoms, although the sampling around the initiation and termination of the evident (Lake Ohrid: pre- samples, post: 3 samples; Lake Prespa: pre- 13 samples, post 3 samples) was uneven and restricted for analysis. However, the degree of the impact by the Campanian Ignimbrite eruption was substantive, well beyond any hint of an impact from the Heinrich "press" event.*
Response: Thank you for pointing out this issue, which has also been raised by reviewer #1. For our response, please see comment #3 above.

2. *Lake Ohrid In the discussion it was implied that valve densities for C. ocellata and C. fottii increased, but the relative composition decreased. This can be deceiving because the reader thinks that numbers declined (based on figs 2 and 3) when in fact numbers (DC) increased for all the prominent taxa. Clarify differences between taxa relative abundance and taxa density changes.*
Response: We agree with the reviewer. As a pragmatic solution, we will remove diatom concentrations (DC) as a proxy for productivity from the revised ms. This proxy is not essential for reaching the goals of our study as it was only used as supporting data for the interpretation of the nutrient pool status.

3. *Lake Prespa is there a count at 36.5? If so it cannot be seen. The DC count graph indicates a count as well as the PAM data. Move the zone boundary line so we can see the data.*
Response: We revised the figure accordingly (see Fig. 3 below).

Specific comments:

4. *In the introduction there are a number of extended. Compound sentences, which make for difficult reading. Try to keep sentences to less than 35 words.*

Response: We will consider this point in our revised version of the ms.

5. *A picture of the core section including the tephra for each lake would be helpful (as a supplement figure).*
Response: We appreciate this suggestion, but, as we consider that this is not of crucial importance for the ms, we decided to not include pictures from the cores.

6. P. 16055, l.15: *Lisiecki spelling; P. 16056, l.08: Expand the explanation on how the samples were treated; P.16058, l.12: Expand the explanation on how cell densities were determined; Documentation of the taxa with images (supplemental) or archiving the samples for possible future referencing and validation should be included.*
Response: We appreciate the suggestions and will expand the information provided for the cleaning process and samples archiving in the revised version. As mentioned above we will exclude DC from the revised version of the ms.

7. "*Diatom concentrations are replicated figs 2 & 3 versus 4. I can see why this was done, but it may not be necessary. As listed below expand on the valve density changes for the prominent taxa after the tephra event…P. 16077&16078: Label: : :.. g ash free dry weight, text is very small, maybe exclude from the label and include in the legend".*
Response: We will apply the suggested corrections.

8. P. 16062, l. 16: *this sentence is repeating the results. Modify or remove.*
Response: The sentence will be modified.

9. P. 16062, l. 18: *This is the first time MIS 3 has been mentioned. This could be further defined/outlined in the Introduction or here.*
Response: In the revised ms, we will remove the statement about the potential influence of the MIS 3 climate conditions, since the Y-5 event occurs in the middle of the interstadial. Therefore, the communities should be already in equilibrium with the interstadial climate conditions of this period, and thus, MIS 3 unlikely influenced the recovery in lakes Ohrid and Prespa.

10. P. 16063, l. 03: *In Sulpizio et al. 2010, EDS data in the upper levels of the core would suggest that P levels were not altered that much during tephra events (?). If this is true, then P and possibly N were not significant. However the presence of A. formosa (in low numbers) does suggest P levels were changing? I would suggest adding more about the P and Si data from Sulpizio et al. paper in here. Your data is better than Barker et al. with respect to diatom proxies for TP. Limit the referencing to Barker et al. since they do not develop proxies for P & N. 20.*

Response: Thank you for these suggestions. Unfortunately, TP concentration data is not available from the bulk sediments for either lake. The low-resolution TN values (Wagner, unpublished data) show no significant change after the tephra influx. Therefore, we decided to tone down the respective interpretation and include suitable references.

11. P. 16064, l. 08: *Prespa and Ohrid had the same % SiO_2 tephra composition. I would add (either here or possibly in the methods) that you had similar "chemical" tephra compositions between the two lakes and reference Sulpizio et al. 2010. This further supports the idea that both lakes received the same impact.*
Response: We will consider this suggestion in our revised ms.

12. P. 16064, l. 10: *Since Barker et al. (2003) does not present chemistry/geochemistry data, but inference results for Conductivity and pH, I would suggest not using this reference to account for SI/P results.*
Response: Will be removed from the ms.

13. P. 16064, l. 16: "*The smaller graph interval is 50 years, not decades. 23. 16064-17: Benthic diatoms also "tended" to have an initial delay in response recovery but for a shorter period of time, which supports your argument of substratum availability…P. 16064, l. 26: Fig. 3 suggests that "recovery" of the benthics occurred in PZD 2a? Maybe stick to the planktonic forms for your discussion on return to pre-disturbance or use the MDS/PAM results".*
Response: We agree and will change the ms accordingly.

14. *Addition minor comments and suggested sentence format changes are found on the manuscript.*
Supplement: All changes will be taken into consideration and incorporated in the revised manuscript. We really appreciate the efforts made by the reviewer.

References

Crawfurd, K . J., Raven, J. A., Wheeler, G. L., Baxter, E. J., and Joint, I.: The Response of *Thalassiosira pseudonana* to Long-Term Exposure to Increased CO2 and Decreased pH, PLoS ONE, 6(10), e26695, doi:10.1371/journal.pone.0026695, 2011.

Wagner, B., Vogel, H., Zanchetta, G., and Sulpizio, R.: Environmental change within the Balkan region during the past ca. 50 ka recorded in the sediments from lakes Prespa and Ohrid, Biogeosciences, 7(10), 3187–3198, doi:10.5194/bg-7-3187-2010, 2010.

Wagner, B., Aufgebauer, A., Vogel, H., Zanchetta, G., Sulpizio, R., and Damaschke, M.: Late Pleistocene and Holocene contourite drift in Lake Prespa (Albania/F.Y.R. of Macedonia/Greece), Quat. Int., 274, 112–121, doi:10.1016/j.quaint.2012.02.016, 2012.

Wutke, K., Wulf, S., Tomlinson, E. L., Hardiman, M., Dulski, P., Luterbacher, J., and Brauer, A.: Geochemical properties and environmental impacts of seven Campanian tephra layers deposited between 40 and 38 ka BP in the varved lake sediments of Lago Grande di Monticchio, southern Italy, Quaternary Science Reviews, 118, 67–83, doi: 10.1016/j.quascirev.2014.05.017, 2015.

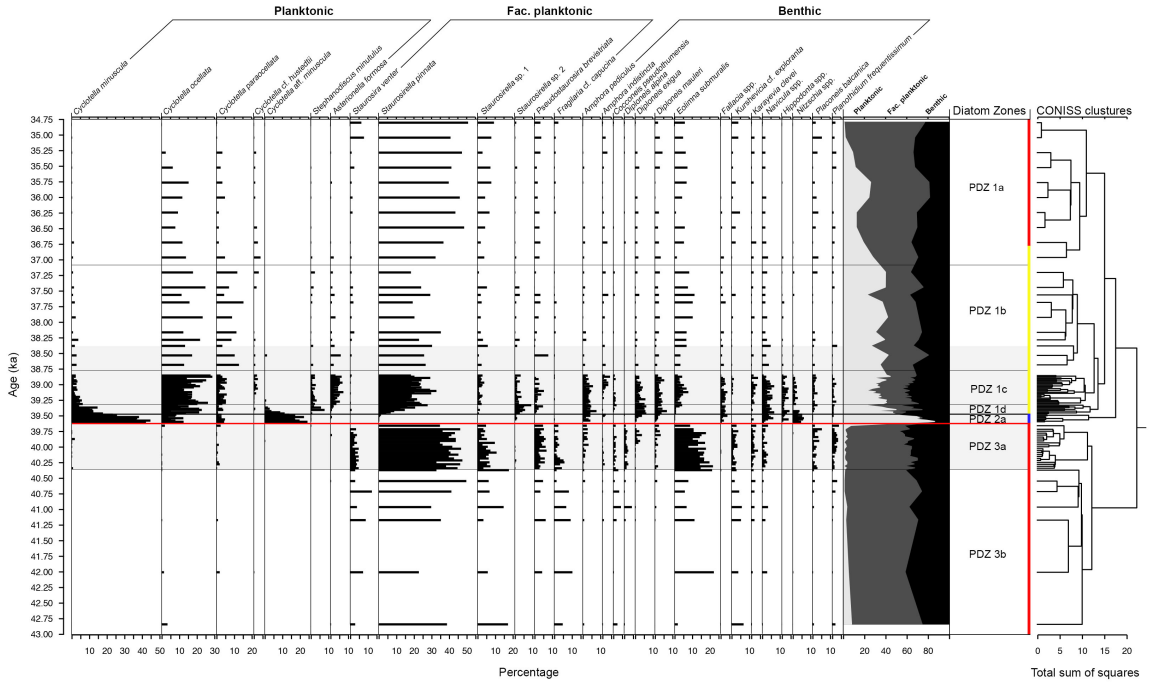

Figure 3. Summary diatom diagram for the Prespa core (Co1204). Only diatom taxa with a relative abundance of > 2% are shown. Diatom zones and subzones were defined by CONISS; zone boundaries are represented with thick solid lines, subzone boundaries with thin solid lines. PAM community clusters are color-coded according to Fig. 4B. The red line indicates the timing of the Y-5 eruption; the greyish area the timing of the H4 event. Note that the diatom communities had reached the quasi pre-disturbance state (upper red bar).