

Interactive comment on “Biological proxies recorded in a Belukha ice core, Russian Altai” by T. Papina et al.

Anonymous Referee #3

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Overview

The Beluka ice core is the only ice core from the entire ~2000 km Altai mountain range. Papina et al. examine a suite of biological parameters including diatoms, hardwood and softwood pollen that are rarely studied in ice cores. For the novelty of these aspects alone, the paper deserves to be published. The authors attempt to determine source regions for each biological material by compiling daily precipitation data and comparing the biological material with the predominant atmospheric elementary circulating mechanisms (ECM). The author's crucial argument is that the biological proxies are deposited during periods of maximum wet precipitation and base all of their correlations on this assumption. As outlined in the general comments, I think that this fundamental assumption is flawed thus affecting their conclusions regarding source regions.

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Similar to suggestions by the other reviewers, the paper could be restructured where the authors present only the biological data in the results section, and then present the comparison with the ECMs in the discussion section, thus clearly separating the biological concentrations from assumptions that substantially alter interpretations of source regions.

General comments:

1. The goal of the paper is to compare the biological proxies with circulation patterns (especially with circulation patterns resulting in high precipitation) at the Belukha ice core site. I am not convinced by the authors' arguments that times of high precipitation are the times of the highest deposition of biological material. For example the authors mention that the highest percentage of diatoms are from bottom communities. The authors mention that the Aral Sea is a likely source of many of these biological products. However, during the 1981-2008 time frame, the Aral Sea has substantially decreased in size and exposed many of its sediments (including these bottom-dwelling diatoms) that are now available for transport. These sediments and associated diatoms could be deposited on the glacier surface through dry deposition. Is there a possibility that any of the diatoms and algae are from seasonal lakes in the surrounding arid areas? If so, then there is also the possibility that these biological materials could be deposited with dry deposition as during the dry season the lake bed sediments are entrained in the atmosphere and regionally transported.

The highest concentrations of both diatoms and coniferous pollen and one of the highest concentrations of hardwood pollen occur during 1983. Can this reflect increased wind speeds rather than increased precipitation? How much is known about wind speeds for each of the ECMs?

This examination of daily precipitation combined with ECMs cries out for a least some comparison with the stable isotopic information determined in the same core. Do times of increased precipitation result in relatively decreased stable isotopic ratios (ie amount

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effect)? Such a comparison could shed light on if the biological material are deposited by wet precipitation.

2. P. 2597: I agree with the approach that the authors use to separate their data by the two main circulation periods (1964-1980, and 1981 – 2008). However, if the maximum concentrations of all biological material occur during the 1980s and 1990s, I do not understand why the authors used 1981-2001 as their mean values. The arguments that the authors present in this section suggest that contrasting the results from the two dominant circulation regimes may be more valid than using 1981-2001 as a representative time period.

3. Methods section in general: I agree with Reviewer 1 that the methods section needs substantial clarification, especially regarding if the ECMs are defined elsewhere and the statistics linking the precipitation patterns and the biological data. Such clarification is essential before the paper is publishable.

4. Section 4.2 Figures 5, 6 and 7. The authors use one anomalous year to determine source regions. The highest amount of coniferous pollen occurs during 1983, and not 1986 as mentioned in the caption for Figure 7. 1986 contains the minimum coniferous pollen concentrations. Is this just a typo? If so, it needs to be clarified or these paragraphs and their associated figures do not make sense. Figure 7 does not show the main air masses arriving from West Siberia as the authors mention in the text. If the authors consider this area north of Belukha to be West Siberia, this needs to be explicitly stated. This is especially important if “We can conclude that the main sources of conifer pollen in layers of the Belukha glacier were taiga forests of North-West Siberia”.

Specific comments:

Abstract: Does the ice core record sub-annual differences? If you are comparing daily precipitation and synoptic meteorological data with annual ice core records, the abstract should contain a phrase demonstrating how the daily data were combined to allow such a comparison.

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P.2590 Line 19: “Different waterbodies”: Local waterbodies versus oceanic sources? Streams versus lakes?

P.2590 Line 10: “Coniferous tree pollen” not “coniferous trees pollen”

P 2590-2591 Lines 25 -5: Confusing word order. Why would the coincidence of seasonality in precipitation and pollen and algae production negate their deposition due to wet precipitation?

P 2590-2591 Lines 25 -5: The dominant atmospheric circulation pattern results in the most precipitation? This is taken as a given in this paragraph, but in p. 2592 Lines 9-10 the correspondence between atmospheric circulation patterns and precipitation is also outlined as one of the goals of the paper.

P. 2591 Lines 5-6: “Most typical inland glaciers” Of the region? For Central Asia? For inland glaciers anywhere in the world?

P. 2591 Lines 19-20: Why would moisture from the Mediterranean Sea be considered to be an “internal moisture source”? Do you consider any source that is not an open oceanic source as an internal moisture source?

P.2592 Lines 19-29: Confusing word order. How can the atmospheric circulation patterns providing the highest mounts of precipitation influence the minimum concentrations of biological proxies. The crux of the author’s arguments is that maximum precipitation = maximum biological proxies, and so this sentence does not support their main argument.

P. 2595 Lines 13-15: A figure with examples of the SEM images of different species would add to the scientific value of the paper.

The Table 2 summary of determined species should also define the concentrations. Are these mean concentrations? Is the units/L a mean count per liter?

P. 2595-6 Lines 14-5: Are the cyclones included in the ECMs? P. 2596 Lines 3-5

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suggest that they are. Do all cyclones arrive from the south? This paragraph is fundamental to the rest of the paper, but the meaning is unclear. The following paragraph (P.6 Line 26-P.7 Line 6) and associated tables helps clarify this section, but section 3.4 should be rewritten for clarity. For example, the 6 "areal sectors including the Siberian region" should be defined (although references are given). It is unclear from these paragraphs and from Figure 1 and Table 1 if the 13 ECM types are unique to this paper and these data or if they correspond with the types outlined by Kononova et al., 2009 (ie Figure 2).

P. 2598 Lines 7-9: What are the implications that most of the diatoms are from bottom communities? Does this imply that some of the lakes are seasonal? (Ie exposing their sediments at least part of the year). Could this reflect the dramatic drying of the Aral Sea during the 1980 -2000 time period?

P. 2599 Lines 24-25. What are the implications for the maximum precipitation occurring during the winter in 1986 and when coniferous trees are not emitting pollen?

Figure 10: Better to state "0 =lack of pollen" or "no pollen were present". With the current form it is unclear if you did not analyze these samples if you did not find any pollen.

Section 4.4 If 1981-2001 is dominated by zonal circulation, do you have an explanation for the years where pollen was not present in the ice core? Figure 10 is the only diagram where there is almost a complete step change in the presence of or lack of biological components in the ice core, and so separating 1981-2000 from appears to make sense. However, it would be interesting if you expanded your explanation in this section to look at the ECMs for 1982, 1987, 1990, 1995-1997 when no pollen was found in these samples but the circulation is still predominately zonal.

Interactive comment on Clim. Past Discuss., 9, 2589, 2013.

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