First of all we would like thanks a lot our Referee 2 for the great work and for the very constructive comments and remarks.

Answers on Referee 2 comments

We understand that in our paper the introduction, the goals of our work, and the description of the used methods are not satisfying (all three Referees have pointed it), so before answering on general and specific comments we would like to clarify the following:
The biological species in an ice core of inland glaciers as the biological species in a sediment cores of lakes are proxies for the paleo climatic changes at the adjacent territories (first of all they reflect a change of climatic zones). The high resolution of the ice core layers (up to one year) can provide additional possibility to use the biological species as proxies for estimation of other atmospheric characteristics. Glaciers located on the boundary between contrasting climatic and vegetation zones are of most interest in this context. The main goal of our work was to show that changes of concentrations of the biological objects in the layers of the Belukha ice core can reflect the changes in the structure of precipitation in Altai region (i.e. can reflect changes of the contribution of different EMC's to annual precipitation). In this case the biological objects (species) in the Belukha ice core can be the proxies for the changes in the structure of precipitation in Altai region. The second goal of our work was to identify the sources of biological objects discovered in the Belukha ice core. Additionally, results of our work can be used for the different aspects of the transboundary atmospheric transport of substances.
The main position based for our article was the common thesis that the vast majority of aerosols (about 80% of the total quantity) fall out to the ground surface with precipitation and only near 20 % fall out through dry depositions [Croft et al., 2010]. This thesis is a result of numerous investigations and measurements. The biological objects transported for a long distance as other aerosols being the nucleus of atmospheric moisture condensation can easy involve in precipitation.Therefore we can assume that the biological objects as a component of aerosols mainly enter to the glacier surface with precipitation and not through dry depositions. Dry condition (the occurrence of updrafts and strong wind) promote to enter the biological species in the atmosphere, but after transporting for a long distance precipitation (not dry depositions) determine their falling on the ground surface (in our case on the glacier surface).
The methodology used for performing the main goals of our work was the following (step by step):

1. We provide a high-resolution analysis of biological species in the Belukha ice core with annual resolution and get the records of the biological object concentration changes in the Belukha ice core for the period 1964-2000. The methods used for getting these results were described in section 3 “Methods” (in subsections 3.1 “Sampling” (unfortunately this subsection was wrongly named as “Methods” in our paper), 3.2 “Dating”, and 3.3 “Analyses of diatoms, spores, and pollen”).
2. Using the daily data on the frequency of synoptic patterns (daily calendar of successive change of ECMs - elementary circulating mechanisms) observed in the Northern Hemisphere [Kononova, 2009] and instrumental data of daily precipitation from the Kara-Tyurek weather station (located close to Belukha glacier) we calculated the contribution (in %) of each from 41 EMCs in annual precipitation in the study area for the period 1964-2000 (for each year and for period in whole). In other words, we calculated how much precipitation fall down in the Altai region at different types of ECMs during a year, and then calculated the percentages relatively the total annual precipitation.
3. To determine the atmospheric processes that contribute to the deposition of biological objects at the Belukha glacier in the period 1964-2000, we compared the changes in the amount of precipitation in the Altai region at different types of ECMs for years with maximum and minimum concentrations of biological proxies in the ice core. For this

purpose for years with the highest concentration of biological proxies, we identified the types of atmospheric circulation pattern providing in the period of flowering and sporulation the higher amount of precipitation **relatively to the average of these types** for the corresponding circulation period. For years with the minimum concentration of biological proxies, we identified the types of atmospheric circulation pattern providing the less amount of precipitation relatively to the average of these types.

4. If for years with the highest and the minimal concentrations of biological proxies we determined the same types of ECMs then it meant that these ECMs can define the deposition of biological objects at the Belukha glacier. For these ECMs we calculated pearson's correlation coefficient between concentrations of biological objects in the layers of the Belukha ice core and contribution (in %) of EMC in annual precipitation.

On the basis of the above we will completely revise the introduction and the description of goals and methods (methods especially for general methodology of the study and the Classification of circulation mechanisms by Dzerdzeevskii) at the revised version of the paper. Maybe it will be better to rename our paper as "Biological objects recorded in a Belukha ice core (Russian Altai) as proxies for atmospheric regional processes".

General comments

Statistic treatment of biological data is completely absent especially for diatoms where the total number is quite low and high risk for doubt conclusions. I mean there is a high risk that conclusions may be unreliable.

Answer: Absence of parallel samples is a common problem of the instrumental and other analysis of ice cores, because of the sampling stage (drilling of an ice core) is the most difficult part of the work and there is the hard limit on the mass of the sample for providing a high-resolution analysis of chemical and biological species.

There is some misunderstanding of what the source of the diatoms is? The authors mention (p. 2598) that the main source of diatoms are the nearest water bodies. But then in the last sentence they say that the Black Sea, the Aral and Caspian basins, and the water bodies of the southern Ural and northern Kazakhstan are the major sources of diatoms.

Answer: The main source of diatoms can be as the nearest water bodies (in the first place), as the Black Sea, the Aral and Caspian basins, and the water bodies of the southern Ural and northern Kazakhstan. Composition of diatoms in the core is the most common, these diatom species can be found as in the surrounding waterbodies, and as in the more remote, for example, in the waterbodies of the steppes of west Kazakhstan. We will clear this in the revised version of the paper.

It was not clear why for 1983, the authors took completely different types of ECMs with main precipitation to interpret diatoms data and then to interpret coniferous tree pollen, and even for the same month – May (diatoms – 2b; coniferous pollen – 7b(s)), April-May (diatoms – 10a; coniferous pollen – 8d(s), (Tables 3, 5). What is the reason for this? Based on this, the conclusions regarding the sources of biological proxies do not seem reliable.

Answer: On the base of 3 and 4 steps of methodology (see above) type 2b is determined as one of the main types controlling the supply of diatoms on the glacier surface since it provide the higher amount of precipitation at the maximum years (1982-1984) for the diatom and the absent of precipitation at the years (1995-1997) when diatoms are not identified. As for the type 7b (s) (controlling the supply of coniferous tree pollen) yes, indeed, the precipitations fall down at this type in 1983, when the maximum concentration of diatoms was observed, but this type of precipitation was observed also in 1995-1997, when the diatoms are not identified. For this reason type 7b (s) is not considered as the main type controlling the supply of diatoms in layers of the ice core. On the other hand the type 7b (s) is considered as the main type controlling the

supply of coniferous tree pollen on the glacier surface for the same reason as type 2b is determined as the main type controlling the supply of diatoms

The text is unclear in some places, it is difficult to read and understand, e.g. the last paragraph on page 2597.
Answer: We will completely revise the introduction and the description of goals and methods (methods especially for general methodology of the study and the Classification of circulation mechanisms by Dzerdzeevskii) and will add the discussions of the results at the revised version of the paper.

Specific comments:
Text P2590 L1: It is not clear to me, in this particular article, what these biological signatures are to be proxies for. The climatic data presented seems to be used to track the sources of the biological agents – so, the climatic data is already a given as far as I can tell. So, what is the biology a proxy for?
Answer: this is clarified in our above comments.

P2591 L1: I think there should be a citation, or some further discussion here, as I would argue that deposition with precipitation should be higher than dry deposition, but no dry deposition of biological agents on glaciers. Can't things be attached to dust particles?
Answer: this is clarified in our above comments

P 2592 L4: to end of paragraph: This sentence is very confusing. It understanding the atmospheric patterns is important, what are the biological markers proxies for? What is the interpretation?
Answer: this have been clarified in our above comments

P2592 L24-25: The section ends with the statement that the analyses of the results allowed the authors to identify the main sources of the biological signatures deposited on the glacier, but not the reader WHY they were identifying the sources. What is the goal hear? This would be a great time to make that clear.
Answer: We will completely revise the introduction and the description of goals and methods and will add the section “Discussions of the results” at the revised version of the paper.