We sincerely thank the editor for the constructive comments provided. We have carefully amended our manuscript accordingly, please see below.

Abstract

Question 1: The true novelty of this manuscript lies in the study area. Therefore I suggest that rather than the rather bland opening statement, the abstract opens with something in the following format: 'The Tibetan Plateau is important because…. There is little data available….. The snowpack supplies water and potentially nutrients to xxx downstream systems.' This makes the in situ dynamics on the plateau the subject, not the nutrient export story, which, while fascinating, is not really the central feature of your study.

Response:

We thank the editor for this comment. We have modified the beginning of the abstract to emphasize the value of the present study to Tibetan glaciers and the downstream ecosystems.

Amended manuscript:

The Tibetan Plateau harbours the largest number of glaciers outside the polar regions, which are the source of several major rivers in Asia. These glaciers are also major sources of nutrients for downstream ecosystems, while there is little data available on the nutrient transformation processes on the glacier surface. Here, we monitored the carbon and nitrogen concentration changes in a snowpit following a snowfall in the Dunde Glacier of the Tibetan Plateau. The association of carbon and nitrogen changes with bacterial community dynamics was investigated in the surface and subsurface snow (depth at 0-15 and 15-30 cm, respectively) during a nine-day period.

Introduction

Question 2: I suggest that the introduction also opens with a sentence similar to that suggested above to get your readers interested. Perhaps the paragraph beginning L70 would be better to lead with? I would also recommend highlighting the difference between papers that are on other cryosphere systems (e.g. Arctic glaciers) vs. those more local to your study site. I recommend this strategy to demonstrate that this is a problem that has received insufficient attention in the literature, and thus justify your study.

Response:

We thank the editor for this suggestion. We have reconstructed our introduction and it now opens with the importance of Tibetan glaciers. We also presented the available literature on the microbial and nutrient dynamics in other cryosphere ecosystems, including the glaciers of the Arctic, Antarctic, and the Alps. We then emphasize the lack of similar knowledge in Tibetan glaciers, which is the centre of the present study.

Amended manuscript:

The Tibetan Plateau (TP) is the world's third-largest ice reservoir, after those in Antarctica and Greenland (Qiu, 2012). These glaciers are the source of several large rivers in Asia, such as the Yellow, Yangtze, Mekong, Salween, Brahmaputra, and Indus rivers (Immerzeel et al., 2010). Glaciers are major sources of nutrients (carbon and nitrogen) for downstream ecosystems (Singer et al., 2012; Hood et al., 2015; Liu et al., 2021). It has been estimated that 80 gigagram of dissolved organic carbon and 27-43 gigagram of nitrogen are exported from the Greenland Ice Sheet (Bhatia et al., 2013; Wadham et al., 2016). These nutrients are subjected to complex accumulation and transformation processes in the glacier snow before being released into downstream ecosystems, and microorganisms are the drivers of these processes (Anesio and Laybourn-Parry, 2012; Hell et al., 2013; Hodson et al., 2008). Several studies on snowpacks revealed vital knowledge of the nutrient and microbial community dynamics in the Arctic (Hell et al., 2013; Larose et al., 2013a; Larose et al., 2013b; Maccario et al., 2014; Maccario et al., 2019), Antarctic (Antony et al., 2016), and Alps (Lazzaro et al., 2015). However, such knowledge is rarely available in the Tibetan Plateau, constraining our understanding of the nutrient accumulation, transformation, and release processes, which is urgently needed under the enhanced warming and glacier retreat in the Tibetan Plateau.

Question 3: In the introduction, it would also be worth highlighting when papers are quantifying snowpack exports vs. whole glacier system exports. Again, it might be that there are few snow studies to highlight, in which case: your study is ever more important.

Response:

We appreciate the editor for this comment. We have added additional sentences on the quantity of carbon and nitrogen exported from glaciers, then used this as a background for the value of understanding the accumulation and transformation processes of these nutrients.

Glaciers are major sources of nutrients (carbon and nitrogen) for downstream ecosystems (Singer et al., 2012; Hood et al., 2015; Liu et al., 2021). It has been estimated that 80 gigagram of dissolved organic carbon and 27-43 gigagram of nitrogen are exported from the Greenland Ice Sheet (Bhatia et al., 2013; Wadham et al., 2016).

These nutrients are subjected to complex accumulation and transformation processes in the glacier snow before being released into downstream ecosystems, and microorganisms are the drivers of these processes (Anesio and Laybourn-Parry, 2012; Hell et al., 2013; Hodson et al., 2008). Several studies on snowpacks revealed vital knowledge of the nutrient and microbial community dynamics in the Arctic (Hell et al., 2013; Larose et al., 2013a; Larose et al., 2013b; Maccario et al., 2014; Maccario et al., 2019), Antarctic (Antony et al., 2016), and Alps (Lazzaro et al., 2015). However, such knowledge is rarely available in the Tibetan Plateau, constraining our understanding of the nutrient accumulation, transformation, and release processes, which is urgently needed under the enhanced warming and glacier retreat in the Tibetan Plateau.

The following sentences describe the knowledge status quo on the carbon and nitrogen dynamics in glacier surface across a long period of time (such as the ablation period or across a whole season), and then emphasize the lack of knowledge on nutrient dynamics in snowpit (i.e., from single precipitation across a short temporal scale), which is more relevant to microbial transformation processes.

Autochthonous (microbial origin) and allochthonous (wet and dry atmospheric depositions) are the major sources of nutrients on supraglacial snow, and the contribution of allochthonous sources was much greater in Arctic glaciers (Larose et al., 2013a). Microorganisms are highly involved in the transformation of both autochthonous and allochthonous nutrients. Several studies investigated the dynamics of nutrient and bacterial changes in supraglacial snow during the ablation period. Larose et al. (2013a) revealed that the form of nitrogen varied as a function of time in supraglacial snow during a two-month field study in Svalbard, and fluctuations in microbial community structure were reported with the relative abundance of fungi and bacteria (such as Bacteroidetes and Proteobacteria) increased and decreased, respectively. Seasonal shifts in snowpack bacterial communities were reported in the mountain snow in Japan, where rapid microbial growth was observed with increasing snow temperature and meltwater content (Segawa et al., 2005). However, the results of these studies are likely the consequence of several precipitation events due to the long study period. During precipitation, a new snow layer forms above the previous ones, which is responsible for the stratified snowpack structure. These different snow layers have distinct physical and chemical characteristics and their age also differs substantially (Lazzaro et al., 2015). Thus, while the microbial process across the aged snowpack can be complex, focusing on supraglacial snow from a single snowfall event could provide unique insights into the bacterial and nutrient dynamics. For instance, Hell et al. (2013) reported bacterial community structure changes during the ablation period across five days in the high Arctic, but the bacterial and nutrient dynamics during the snow accumulation period remain elusive.

Question 4: L72: 'Glacier melting increases the discharge of microorganisms and nutrients in meltwater into downstream aquatic ecosystems (Kohler et al., 2020), which substantially impacts the bacterial community and biogeochemical processes (Liu et al., 2021)'. The way this sentence is structured makes it seem that the Kohler paper is discussing export from Tibetan Plateau systems – it is not. Please make clear that the Liu paper is directly applicable to your study area, whereas the Kohler paper is about potentially similar processes occurring in Arctic systems.

Response:

We appreciate the editor for raising this concern. Due to the modification on the introduction structure, this sentence has been removed.

Question 5: L324: add 'with time' i.e. 'showed a weak increasing trend over time in the surface snow'

Response:

We have revised the sentence accordingly.

Original manuscript:

Both ammonium and nitrate concentrations showed a weak increasing trend in the surface snow (Fig. 1).

Amended manuscript:

Both ammonium and nitrate concentrations showed a weak increasing trend with time in the surface snow (Fig. 1).

Question 6: L387: suggest replacing 'the present study' with 'this study'

Response:

We have revised the sentence accordingly.

Original manuscript:

Nitrogen is traditionally recognized to be released from the supraglacial environment due to photolysis, whereas the present study hints that nitrogen assimilation and denitrification could be alternative routes.

Amended manuscript:

Nitrogen is traditionally recognized to be released from the supraglacial environment due to photolysis, whereas this study hints that nitrogen assimilation and denitrification could be alternative routes.