Response to Reviewer 2

Our responses (R) are marked in red below each comment. In our revision, we implemented the following Specific Comments (SC):

SC1: Result section is still unclear for me and should be reorganized. I am still unclear whether the measuring time span the whole ice-free period of the two lakes. The author should also show the result of both lakes one by one, so the readers can be easy to follow.

RSC1: The eddy-covariance measurements were collected on two lakes in two different experiments in the years 2017 – 2018 on Lake Zub and in 2019 – 2020 on Lake Glubokoe. We measured evaporation during the ice-free period for the first lake (Zub), and it was planned that the measurements for the second lake (Glubokoe) will cover the whole summer (ice break-up and free periods). However, from mid-January 2020 our instrumentation was technically broken, and the measurements only covered the ice break-up period for Lake Zub. The results for the first experiment (Lake Zub) were published in Shevnina et al. (2022), however, they lack deriving site specific transfer coefficients for the bulk-aerodynamic method. This study fills the gap, and also targets (a) to estimate evaporation from the direct measurements collected in the second experiment (Lake Glubokoe), and (b) to test the empirical coefficients for the bulk-aerodynamic and combination formulas developed out of the measurements collected in the two experiments. We added new text after line 62: "Also, site-specific transfer coefficients for the bulk-aerodynamic method have not yet been suggested, but this study fills the gap."

SC2: Section 3.1, the authors should clarify whether it is the whole ice-free period or not for both lakes. If the EC system was only operated only part of the ice-free period, the authors should also clarify. For example, Figure 5 shows that the lake was still ice-free on Feb 25, 2020, but the evaporation result only covers the period from 7 December 2019 to 8 January 2020 (Line 183). The authors should give clarify this in the revision.

RSC2: The second experiment was planned to cover the whole summer period (ice-break-up and ice-free stages on Lake Glubokoe), but the logging system of IRGASON was broken in the middle of the season without possibility of being repaired in the field. We rewrote the text on lines 99–106 as follows: "The air temperature, barometric pressure, wind speed/direction and water vapour concentration were measured on a tower equipped with the EC open-path system IRGASON by Campbell Scientific. These measurements were collected on two lakes (Fig. 2 a) in two different experiments covering 38 days in 2018 and 33 days in 2019 – 2020. In the first experiment on Lake Zub/Priyadarshini, the evaporation was measured during the period from 1 January to 8 February 2018 when the lake was free of ice. The second experiment on Lake Glubokoe covered the period from 7 December 2019 to 8 January 2020. The experiment was planned to be carried out over the duration of the austral summer, but our eddy-covariance instrumentation was damaged in mid-January. Hence, the actual measurements on Lake Glubokoe only represented its ice break-up period."

SC3: Line 101-103, lake water temperature should be addressed in the next paragraph. Please reorganize this section and the following.

RSC3: The text about the lake water temperature was moved to the next paragraph.

SC4: Section 4.2, The EC system was operated at both lakes. Evaporation over Lake Glubokoe was addressed, but the result of Lake Zub is not mentioned, why?

RSC4: This manuscript does not include the results for Lake Zub because they have been published previously in Shevnina et al. (2022). This previous paper, however, did not include (a) derivation of site-specific bulk-transfer coefficients and (b) performance of the empirical formulas evaluated against independent data. The present manuscript addressed these issues using the measurements collected on both lakes. All the above is clarified in the revised manuscript.

SC5: Figure 1, it is difficult to read. I can not find where are year round (red) and seasonal (blue) settlements from the Figure.

RSC5: Figure 1 and its legend were modified as follows: "

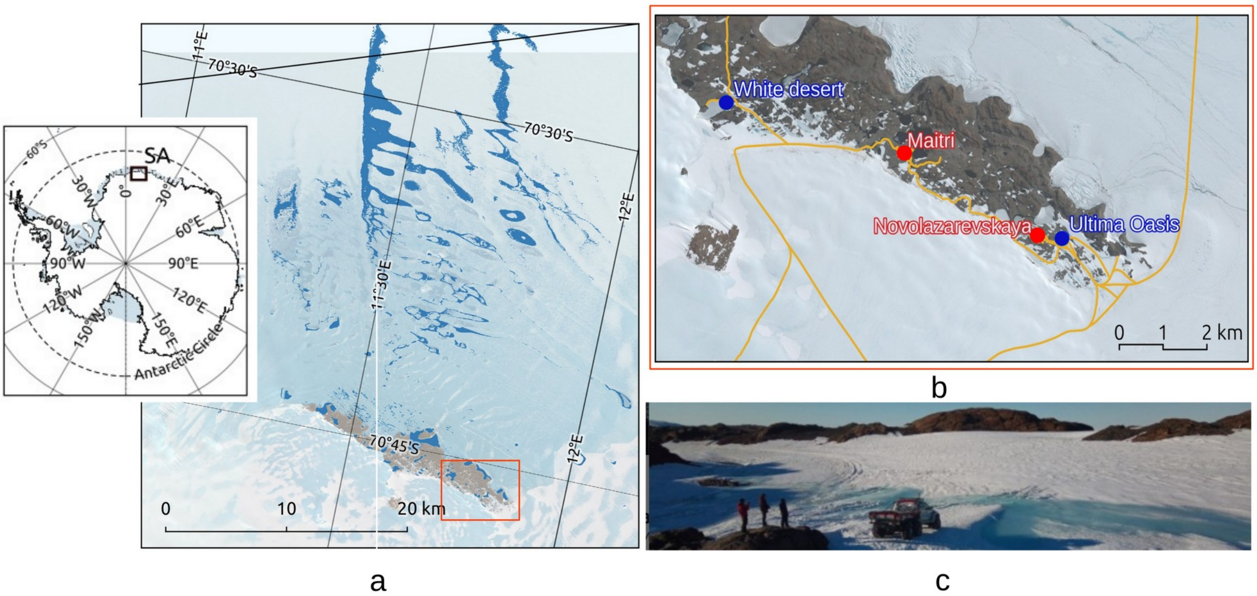

Fig. 1. Location of the Schirmacher oasis (SA) (a) and its infrastructure (b): year round (red dots) and seasonal (blue dots) settlements connected by roads (yellow lines, © Humanitarian OpenStreetMap Team (HOT), 2020. Distributed under the Open Data Commons Open Database License (ODbL) v1.0.). © Google Maps, 2019. The

red boxes in (a) and (b) outline the area with the main infrastructure in SA, and the image (c) shows the melted road to the White Desert Camp, December 2019 (photo D. Emelyanov).”

We replaced the text in lines 73-76 with the following text: “The oasis shelters two scientific bases operated year round since the 1960s (red dots within the red box in Fig. 1 b), and two tourist camps occupied seasonally (blue dots, Fig. 1 b). The scientific bases are occupied by 25–30 overwintering personnel, and up to 50 personnel during summer seasons. Up to 200 people can visit the tourist camps during summer. Two ice runways support transportation of people and cargo. Fuels are mostly delivered by ships to coastal bases located on the ice shelf, and then transported by vehicles to the settlements. The settlements, ice runways and coastal bases are connected with year-round ice roads (yellow lines in Fig. 1 b). In summertime, the transportation along the ice roads suffers from melted lakes and temporal streams formed over the ice surface. Figure 1 d shows the melted ice road to the White Desert Camp in December 2019.”

SC6: Figure 4, what do the vertical dashed lines mean? The start and end of ice should be marked in the Figure

RSC6: We improved Figure 4 and its legend in lines 162 – 170 as follows:

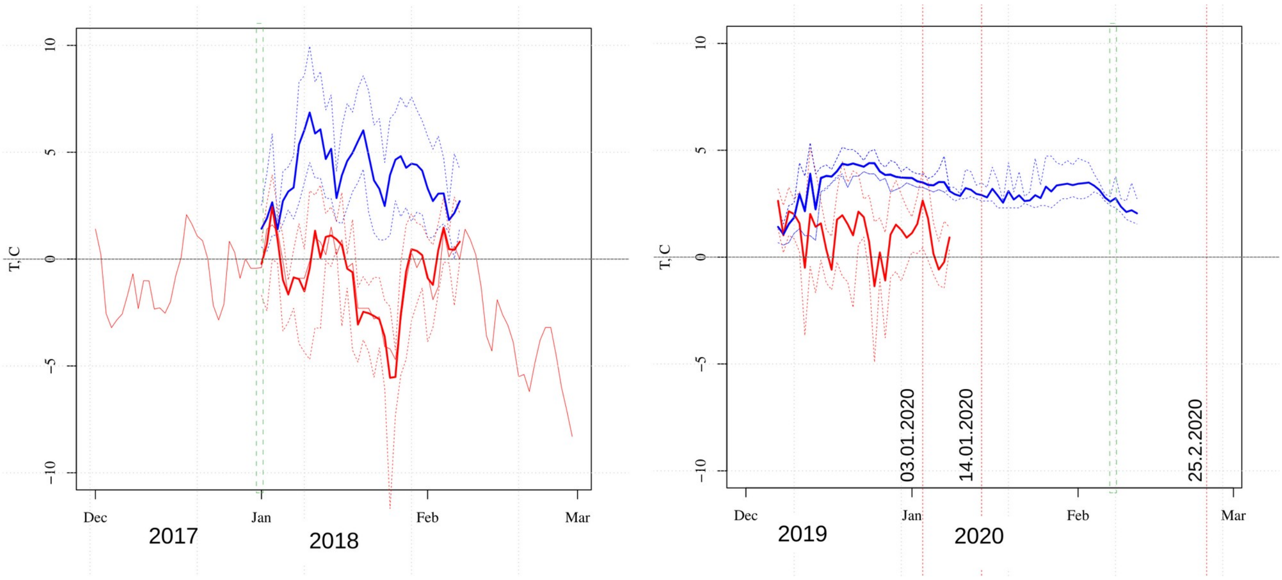

Figure 4. The daily minimum, average and maximum for the air temperature (red lines) and LSWT (blue lines) measured on the shore of Lake Zub/Priyadarshini. The greed dashed lines show the beginning of the ice free period; the red lines on (b) show the dates of the lake images given in Fig. 6 b-d.

We added the following text on line 171: “During most of the days in both experiments, Lake Zub/Priyadarshinis and Lake Glubokoe were warmer than the ambient air. During the period from 30 December 2018 to 9 February 2019, the mean daily LSWT in Lake Zub/Priyadarshini was 3.9 ºC, which was 4.7 ºC higher than the mean air temperature (Fig. 4 a). The difference between the

LSWT and air temperature varied from –0.5 ºC (2–3 January, 2018) to 10 ºC (25–26 January, 2018). From 7 December 2019 to 15 February 2020, the mean daily LSWT of Lake Glubokoe was 3.1 ºC, ranging from 0.6 to 5.3 ºC. During this period, the lake was 2.4 ºC warmer than the air on average (Fig. 4 b). The largest difference between the LWST and air temperature was observed on 25–26 December 2019, when also the relative humidity was the highest, exceeding 90 %."

SC7: Figure 5, The middle picture is taken from a different site compared with the other two.

RSC7. We changed Figure 5 and its legend on lines 172–180 as follows: "

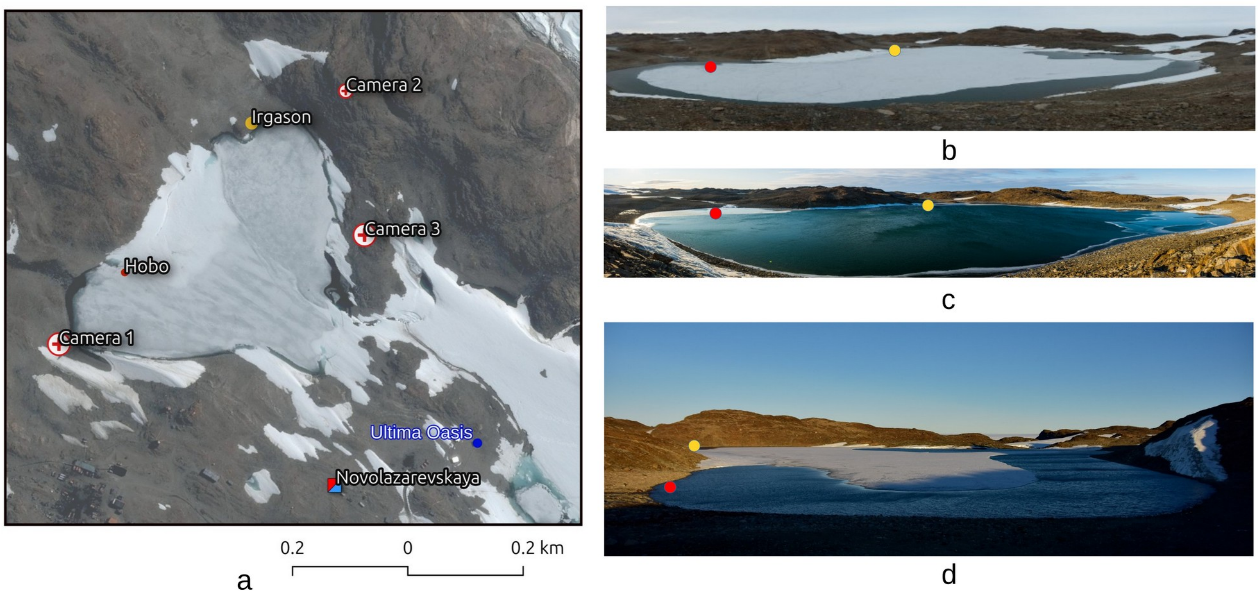

Figure 6. The instrumentation installed on Lake Glubokoe (a), © Google Maps, 2019; (b, c and d) show the panoramic images of the lake location of the HOBO logger (red dot) and the EC system (yellow dot) on 3 January, 14 January and 25 February 2020 (photos D. Emelyanov)."

We added the on line 181: "On Lake Glubokoe, the ice break-up period lasted from 8-12 December until 12-15 February, and the ice-free period lasted for approximately two weeks. The lake-ice cover was documented in a series of digital images taken from the three positions marked as Camera 1, Camera 2 and Camera 3 in Fig. 6a. Fig. 6b and 6c show the examples of the lake images taken on 3 January 2020 and 25 February 2020 using Camera 3 in different stages of the ice cover: the ice break-up (b) and the ice free (c). Fig. 6d was taken 14 January 2020 from the position of Camera 2. The EC measurements were taken during those 33 days when the ice had melted from 30–35 % of the lake surface. The fraction of lake ice was evaluated by processing the digital images of the lake ice cover (taken every 5-10 days in the period of December 2019 – February 2020)."

In the revised manuscript, we implemented the modifications following the comments of three reviewers. Also, besides of the modifications suggested by the reviewers, we implemented the following changes:

Fig. 8 became new Fig. 5 and its legend was modified.

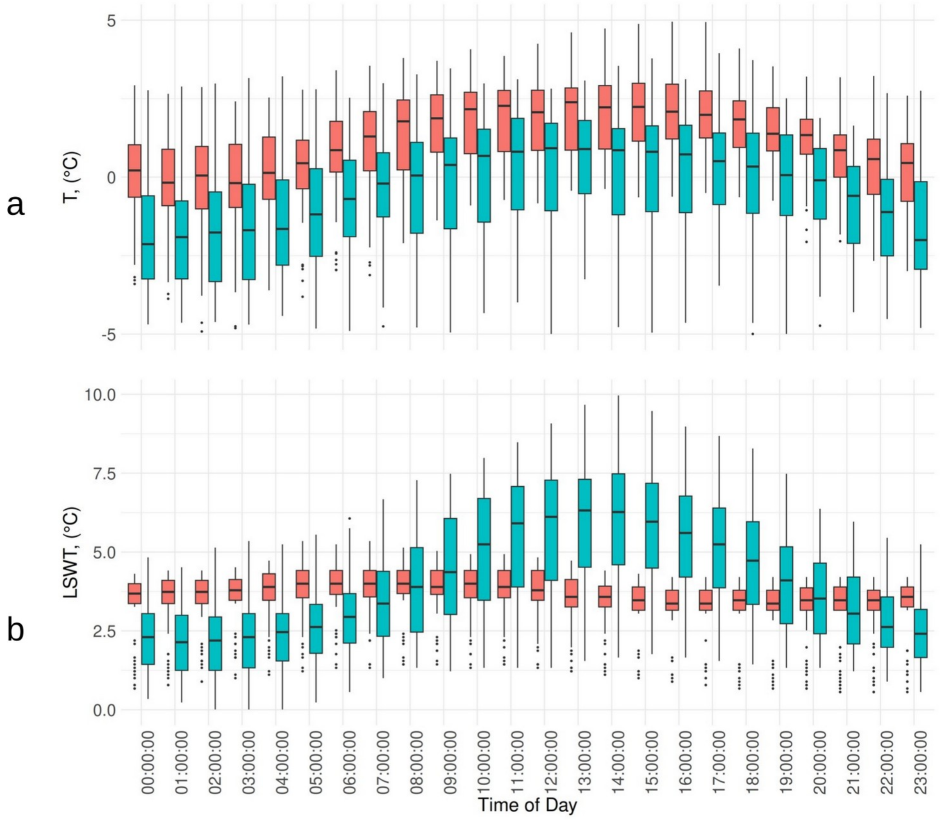

Figure 5. The diurnal cycles of air temperature (a) and the lake surface water temperature (b) measured on Lake Zub/Priyadarshini (light blue) and Lake Glubokoe (coral).

The diurnal cycle of the air temperature is qualitatively similar for both experiments: it reaches the maximum at the mid-day hours and the minimum at midnight. The average temperature was, however, higher in December 2019 – January 2020 (Fig. 5 a, coral boxplots) than in January – February 2018 (Fig. 5 a, light blue boxplots). The diurnal cycle of the LSWT differs for two lakes: on Lake Zub/Priyadarshini LWST shows the nighttime (23:00–02:00) minimums of 3.0 ºC and daytime (12:00–14:00) maximums up to 6.0 ºC (Fig. 5 b, light blue boxplots), whereas on Lake Glubokoe, the LSWT showed a weaker diurnal cycle, LWST remaining close to 4.0 ºC (Fig. 5 b, coral boxplots).

The Fig. 9 and its legend were modified as follows:

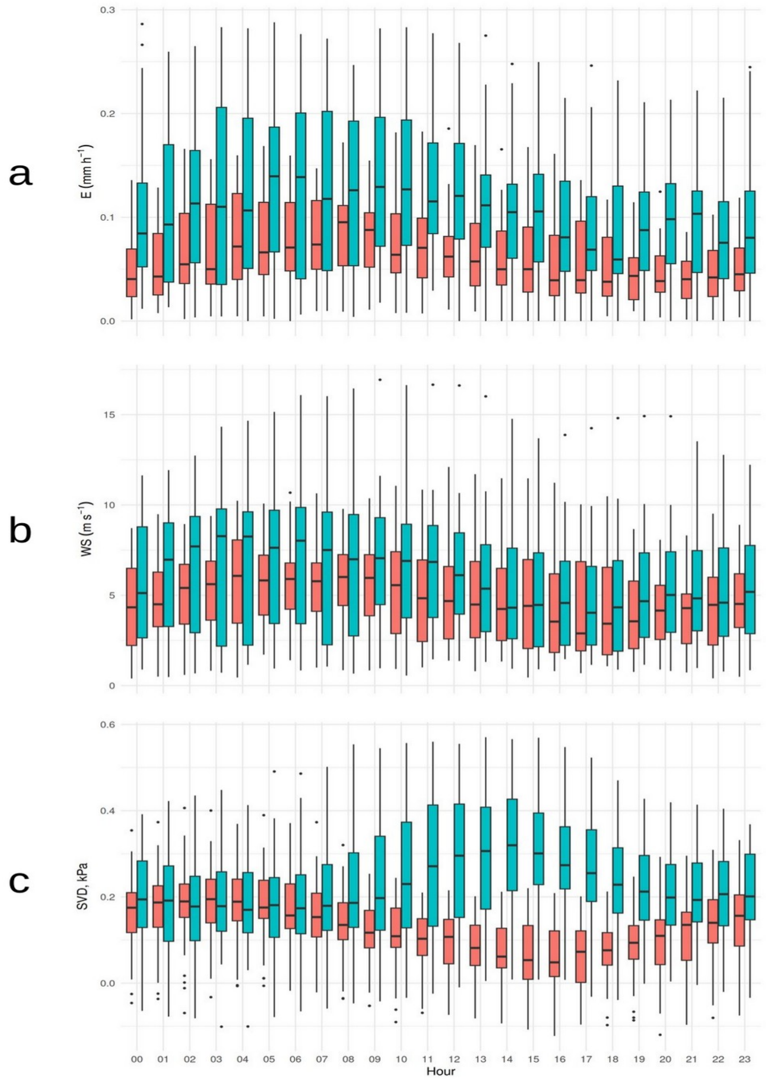

Figure 9. The diurnal cycle of the evaporation (a), wind speed (b) and saturation vapor pressure deficit (c) for two experiments on Lake Zub/Priyadarshini (coral) and Lake Glubokoe (light blue).

The text on lines 213-225 was modified as follows: "The diurnal cycle of evaporation over the lakes depends on the ice cover: the cycle is large during the ice-free stage on Lake Zub/Priyadarshini, and evaporation reaches its maximum (0.2 mm h^{-1}) between 11:00 AM and 01:00 PM (Fig. 9 a, light blue boxes). Its diurnal cycle is similar to the cycle of saturation vapor pressure deficit (Fig. 9 c, light blue boxes). The strongest wind speed was observed at nighttime (03:00 – 04:00 AM) reaching up to 10 m s^{-1}, while wind was often lower at daytime (04:00 – 05:00 PM). The diurnal cycle of evaporation over the partly ice-covered Lake Glubokoe showed maximum (0.15 mm h^{-1}) in the early morning at 06:00–8:00 AM (Fig. 9 a, coral boxes), then reducing to even near-zero values in the late evening hours (09:00 – 11:00 PM) and night. It was in the opposite phase relative to the diurnal cycle of the wind speed, demonstrating that the saturation deficit dominated over wind speed as the primary driver of evaporation (Fig. 9). These different patterns in the diurnal cycle of evaporation over the lakes reflect the complex interplay of factors (air-water temperature gradient, air humidity, wind speed, solar radiation) that vary throughout the day."

On lines 246 – 249 we added the text reads as follows: "We also calculated the transfer coefficient of moisture on the basis of the measurements on Lake Glubokoe following Andreas (1986), Arya (1988) and Fedorovich et al. (1991). The coefficient varied between $1.46 \cdot 10^3$ and $2.10 \cdot 10^3$ depending on the parameterization (Table 2). In Table 2, the transfer coefficients are presented for the measurement heights (different in the two experiments) and, to compare our results, also for the standard height of 10 meters (C_{EN10})."

We modified the text on lines 319-320: "The evaporation over lakes is often evaluated applying combination formulas, and we found five combination formulas (Penman, 1948; Doorenbos and Pruitt, 1975; Odrova, 1979; Shuttleworth, 1993; and Shevnina et al., 2022) that have been applied over the lakes in Antarctica. "

We added the text after line 362: "We did not present the estimations of the lake ice cover fraction from the digital images collected in the experiment on Lake Glubokoe, which may be a topic of the next study."

We added the text after line 349: "Lakes affect formation of fogs: passing of warm and moist air from lakes moves over colder ice covered surfaces cools the air to its dew point, leading to local fog (Gultepe et al., 2003) and precipitation (Su et al., 2020). In the Schirmacher oasis, the fog and "white rainbow" were observed in the early morning on 26 December 2020 (Fig. 12) when the relative humidity was over 95 %, the difference between the temperature of air and the lake water was close to –10 °C and wind speed was less than 1.0 ms^{-1}. Fogs may foster the surface melt, decrease visibility and make danger for the transport operations between the settlements, ice runways and coastal bases."

Fig. 12. The fog and "white rainbow" was observed on the early morning 26 December 2020 in the Schirmacher oasis (photo D. Emelyanov).

New references: "Gilson, G.F., Jiskoot, H., Cassano, J.J. *et al.*: The Thermodynamic Structure of Arctic Coastal Fog Occurring During the Melt Season over East Greenland. *Boundary-Layer Meteorol* 168, 443–467,https://doi.org/10.1007/s10546-018-0357-3, 2018

Su, D., Wen, L., Gao, X., Leppäranta, M., Song, X., Shi, Q., Kirillin, G.: Effects of the largest lake of the Tibetan plateau on the regional climate. J Geophys Res: Atmos 125, e2020JD033396, 2020."

We modified the text on lines 91-96: "This lake often stayed free of ice during 6–8 weeks during the austral summer (Khare et al., 2008), and it was ice free from 29–31 December 2017 to 8–12 February 2018 and from 22 – 25 December 2019 to 10 – 14 February 2020. Lake Glubokoe is of a maximum depth of 34.5 m (mean of depth is 13.1 m) and the surface area of 147000 m (Loopman et al., 1988). The lake is normally ice-covered year round (Kaup, 2005), but in recent years the lake has been ice free almost every summer (Sharov and Tolstikov, 2020). In February 2018 and 2020 the lake was ice free for 2 – 3 weeks."

We modified the text on lines 295 – 303: To our best knowledge, the direct (EC) observations on lake evaporation have been done in Antarctica for the lakes in the Schirmacher oasis. Ones, however, can be found for the regions with the polar desert climate, like the high-altitudes lakes located in the Qinghai-Tibet Plateau (36°N, 3194 m asl). Applying two years of observations, Li et al. (2016) found that the evaporation over the ice-free Lake Qinghai reaches up to 12 mm d-1 during wind storms, and days with wind speed stronger than 4 ms^{-1} contribute up 22 % to annual lake evaporation. Lately, Shi et al. (2024) found that the evaporation over the ice free lake is controlled by wind based on the EC observations collected in 2014 – 2019. The authors suggested that the ice sublimation takes 23 % of annual evaporation over Lake Qinghai."

We changed the text on lines 362-370: "The method used in calculation of the evaporation is important for shallow coastal lakes whose volume changes very little over an austral summer (Shevnina and Kourzeneva, 2017). Gopinath et al., (2020) affirmed the importance of the summertime evaporation from shallow lakes in the Schirmacher oasis applying the information on water isotope composition. Lake Zub/Priyadarshini is one of such shallow lakes whose water is used to supply the Maitri station and the new Maitri-II site (planned to open in 2029). The lake's water balance equation includes the precipitation, inlet river runoff (as inflow/positive component) and outlet river runoff, evaporation and water withdrawal (as outflow/negative component). The lake volume is 1032500 m^3, and in January-February 2018 it decreased by 40.3 m^3, and the discrepancies of the water balance equation was 670.6 m^3 (Dhote et al., 2021). The lake evaporation of 58.5 m^3 was calculated after Odrova (1979), which underestimated the evaporation for 72 % according to our results. In absolute values it corresponds to 42.1 m^3 (58.5 multiplied by 0.72), which represents approximately 6 % of the discrepancy of the water balance equation. It can be reduced by using a better indirect method while calculating the evaporation."

We added the reference: Gopinath, G., Resmi, T. S., Praveenbabu, M., Pragath, M., Sunil, P. S., Rawat, S.: Isotope hydrochemistry of the lakes in Schirmacher Oasis, East Antarctica. Indian Journal of Geo Marine Sciences Vol. 49 (6), 947-953, 2020.

We also try our best to smooth the language of the overall narrative and prepare new supplements with the modified code used for plotting the figures.

Elena Shevnina from behalf of co-authors