Response to Reviewer 3

Our responses (R) are marked in red below each comment. The manuscript got the revision by implementing the following Specific Comments (***SC***):

SC1: Listing the four combination formula simply may improve understanding of the precision of the used 6 methods.

RSC1: We added the following text on line 129: "To calculate the daily evaporation over Lake Glubokoe, we applied the combination equations, which read as follows: $E = 0.26(1 + 0.54\, w_2)(e_s - e_2)$ based on Penman (1948) and Tanny et al. (2008), $E = 0.26(1 + 0.86\, w_2)(e_s - e_2)$ according to Doorenbos and Pruitt (1975), and $E = 2.909A^{-0.05} w_2(e_s - e_2)$ according to Shuttleworth (1993). We also used the formula $E = 0.14(1 + 0.72w_2)(e_s - e_2)$ suggested for evaporation over lakes in northern Russia (Odrova 1979), and $E = -0.33(1 - 1.82w_2)(e_s - e_2)$ suggested based on the direct measurements over Lake Zub/Priyadarshini (Shevnina et al. 2022). In these equations, E is the evaporation in mm day^{-1} , A is the surface area in m^2, w_2 is the 2 m wind speed in m s^{-1}, es is the saturation water vapour pressure for the lake surface temperature, and e_2 is the air water vapor pressure at the height of 2 m. Both es and e_2 are in hPa, and calculated according to the Tetens's formula given in Stull (2017)."

SC2: In Section 3.1, it may be better to introduce all of the information one lake by one lake.

RSC2: We modified the text on lines 99–106 to read as follows: "The air temperature, atmospheric 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. 2a) 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 covers 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: The origin of the wind-dependent transfer coefficient (Eqs. 2-3, Fig. 10) is unclear. This is a critical part of the analysis and must be explicitly stated: are these relationships developed from the Zub 2017-2018 data in this manuscript, or are they presented as established relationships from a previous study? This has major implications for interpreting the validation results in Table 3 and Fig. 11.

RSC3: The text on lines 136-138 was modified to read as follows: "The transfer coefficient of moisture was calculated following the parametrization schemes suggested by Heikinheimo et al. (1999), Andreas (1986), Arya (1988) and Fedorovich et al. (1991). The new wind-dependent relationship was derived by applying Equation (1) on the basis of data on evaporation, wind speed, air specific humidity and surface saturation specific humidity from Lake Zub during 2017-2018."

C4: If the CEin equation (2) and (3) were obtained in the previous work (Shevnina et al., 2022), it may appear in Section 3.2 Methods. Table 2 may be moved to the section, too.

RSC4: As explained above, the equations were derived in this study. We also modified the text on lines 57 – 59: "The bulk-aerodynamic method is often used to assess evaporation/sublimation over lakes and glaciers in Antarctica (Clow et al., 1988; Bliss et al., 2011; Leppäranta et al., 2016). In this method, the turbulent exchange (mass-transfer) coefficients account for atmospheric stability, which is calculated through Monin–Obukhov framework, incorporating empirical dimensionless gradient functions (Brutsaert, 1982). The empirical gradient functions are site specific (Guseva et al., 2023), and they can be evaluated from the eddy-covariance (EC) measurements on lakes (Franz et al., 2018; Ala-Könni et al., 2022). These gradient functions, however, have not yet been suggested for lakes in coastal Antarctica. The bulk aerodynamic method where the empirical gradient functions estimated for a boreal lake site underestimated the summertime evaporation over an ice-free lake by over 32% in Antarctica, and it is not clear how good it is for the lakes during the ice break-up period (Shevnina et al., 2022)."

SC5: Is Figure 10 from the above mentioned previous work? If not, how to get it?

RSC5. Fig. 10 is a part of this work. We modified the figure legend on line 245 as follows: **Figure 10. Dependence of the 10-m neutral transfer coefficient for moisture (CEN10) on the 2-m wind speed (w_2, ms^{-1}) over Lake Zub/Priyadarshini in 2017-2018.**

SC6. The performance of the wind-dependent method needs explanation. If it was derived from Zub data, why does it not perform best for Zub? Why does the best parameterization differ between the two lakes? This warrants discussion on the site specificity of these coefficients.

RSC6. We added explanations after line 283: “It is indeed interesting that the new wind-dependent transfer coefficient, derived on the basis of Lake Zub/Priyadarshini data, has a smaller RMSE for Lake Glubokoe than for Lake Zub/Priyadarshini. This is, however, understandable because the transfer coefficient is only one of the factors that controls the evaporation calculated using the bulk-aerodynamic formula (Eq. (1)). In addition to the transfer coefficient, at least the following factors may generate inaccuracy in the estimated evaporation: (1) errors in the measurements of lake surface temperature (controlling the saturation specific humidity), air specific humidity, and wind speed, (2) contribution of spray droplets to evaporation, (3) role of waves in the lake surface, and (4) validity of the Monin-Obukhov similarity theory, which requires quasi-stationary, horizontally homogeneous conditions. Errors and uncertainties associated with (1) – (4) above may either increase the overall error or partially offset one another. Hence, it is reasonable that the performance of parameterization schemes varies among lakes, as factors (1) – (4) may be site-specific, and also depends on the metrics used (e.g., RMSE or SSC) to evaluate performance (Table 4).

SC7: Figures: Most of subfigures and legends are unclear. It is recommended that each subfigure of a figure be labeled as a, b, c, d, etc., instead of distinguishing subfigures by terms like "Figure 2 top" or "Figure 2 bottom". Additionally, each piece of information in the figures should be explained in the legends.

RSC7: We modified the legends of Figures 1, 2, 3, 4, 5, 6, 7, 8, 9 and 10.

SC8: The format of the numbering is inconsistent with that of other figures (e.g., Figure 2). It is suggested to unify the figure numbering format, such as using "Figure 1" consistently with "Figure 2".

RSC8: We unified the numbering format for all figures/subfigures in the revised manuscript.

SC9: Section 4.1: The descriptions in the text do not correspond to the figures, leading to confusion. It is suggested that the authors carefully check and revise this part.

RSC9. We corrected the text on line 152 as follows : “During the experiment on Lake Zub/Priyadarshini, the weather was colder and less windy than the climatology over 1961 – 2010, estimated according to the observations at Novo meteorological site (Shevnina et al., 2022). The daily air temperatures ranged between –8.3 and 2.8 °C. The wind speed varied between 1.5 to 14.3 ms-1, with the mean of 6.2 m s-1. The mean relative humidity was 54 %."

SC10. Figure 3: I only observed black and green colors in the upper subfigure. Where does "water vapour concentration (blue)" in the legend come from? Does "relative humidity" correspond to green or black? Are the data in the figure daily data or half hourly data? I assume they are half-hourly data, which would contradict the description in L152 that the range of daily air temperature is -4.9 to 5.1 °C. 11.

RSC10. We corrected Figure 3 and its legend on lines 159 – 160 as follows:

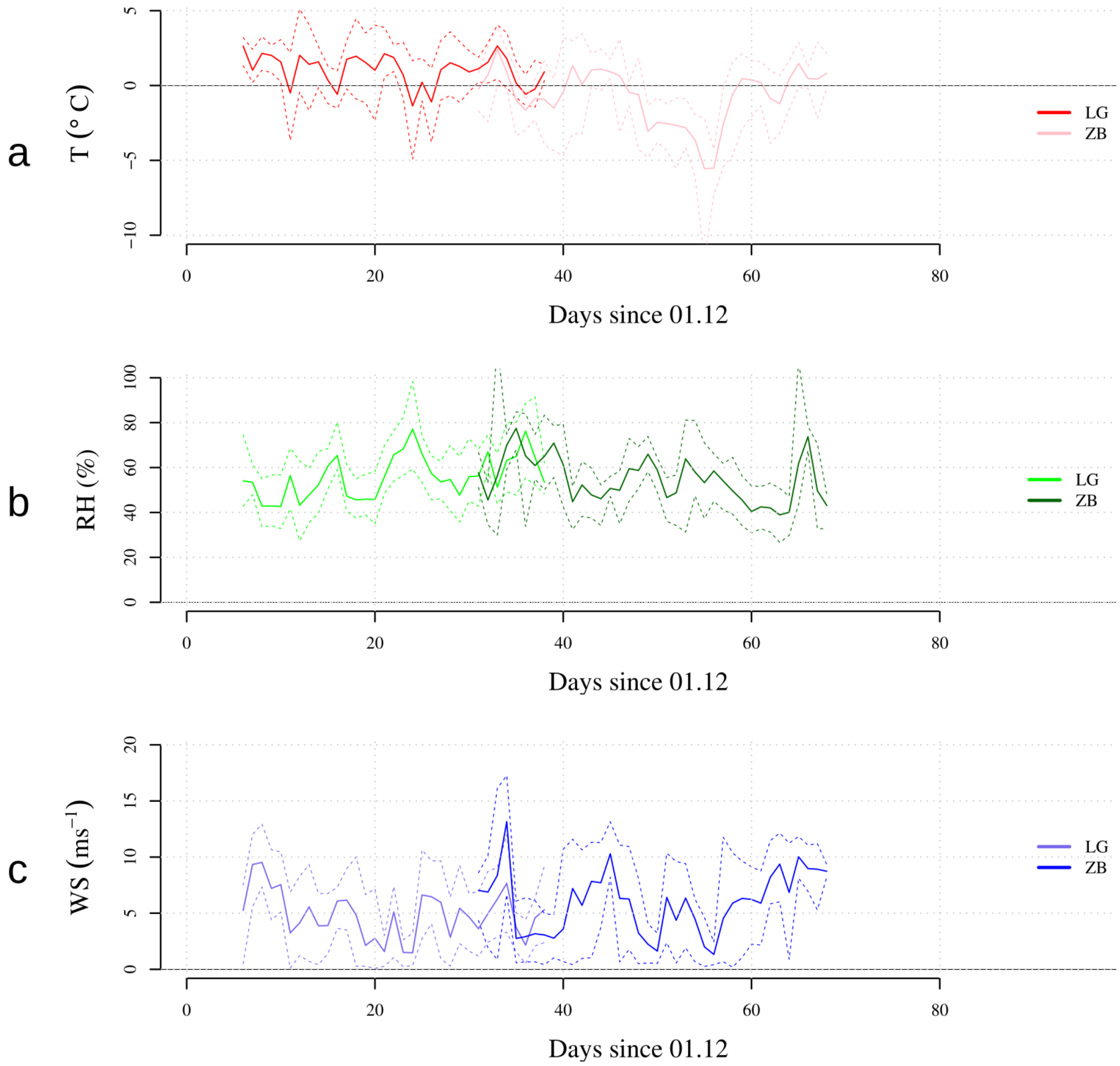

Figure 3: The mean (solid line), minimum and maximum (dashed lines) values for the air temperature (a), the relative humidity (b) and the wind speed (c) for the period of two experiments (y-axis is given in days starting from 1 of December). In legends: LG is Lake Glubokoe and ZB is Lake Zub/Priyadarshini.

SC1: L196-203: This section is analyzed based on Figure 7, yet there is no reference to Figure 7 at all. It is suggested that the authors add "(Fig. 7a)" and other corresponding references at appropriate places in the text.

RSC11. Figure 7 and its legend were modified on lines 194 – 203:

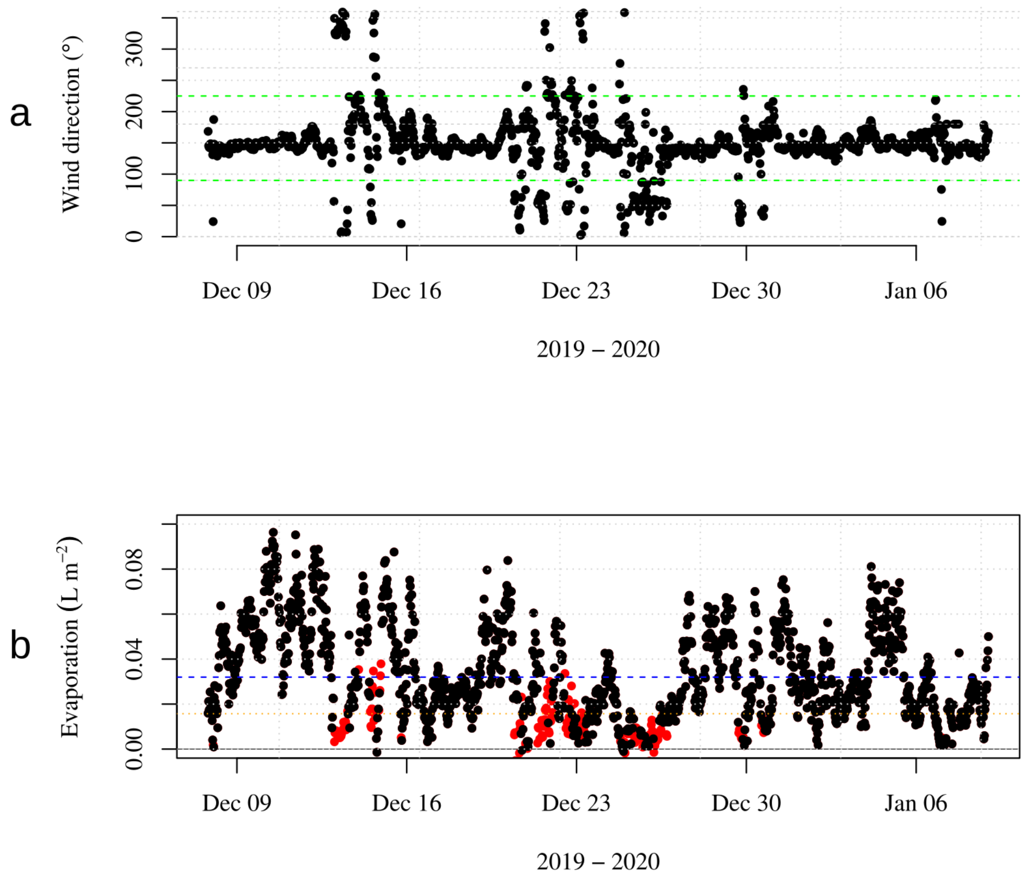

Figure 8. Time series of the 30-minute means of the wind direction (a) and evaporation (b) observed by the EC system on Lake Glubokoe. On (a): the green lines show the wind directions of 90 and 225 degrees (the footprint); on (b): the red dots indicate the measurements collected outside the footprint and the blue line shows the mean evaporation.

We added the text: “The raw 30-minute measurements were filtered by (a) the sensors’ signal strengths, (b) number of gaps in the observations, (c) the footprint, and (d) the sector of wind directions covering the lake (the green lines in Fig. 8a). The percentage of the filtered out (excluded) measurements did not exceed 20 % of total data (red dots in Fig. 8b);most of the excluded data corresponded to wind directions outside the footprint. These gaps were replaced by the mean of evaporation estimated for the period of the experiment (the blue line in Fig. 8b). Since most of the gaps are lower than the mean, we also replaced them by the 25 percentile evaporation (the orange line on Fig. 8b). The evaporation over each day was calculated from 30 minute measurements (with the gaps filled), and the total sum for the period of the experiment is

50 and 54 mm (per period of 33 days) being replaced by the mean and 25 percentile evaporation, respectively. The daily mean evaporation was 1.5 ± 0.1 mm d^{-1} and 1.6 ± 0.1 mm d^{-1}, and varied between 0.3 and 3.2 mm d^{-1}. These estimates show that filling the gaps either by the mean or 25 percentile evaporation gave almost the same results, and we further filled them by the mean evaporation. The largest evaporation (more than 2.5 mm d^{-1}) was observed on 9 – 11 December 2019 and 3 – 4 January 2020; and, the lowest evaporation (less than 0.9 mm d^{-1}) was observed on 6, 7 January 2020.

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

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

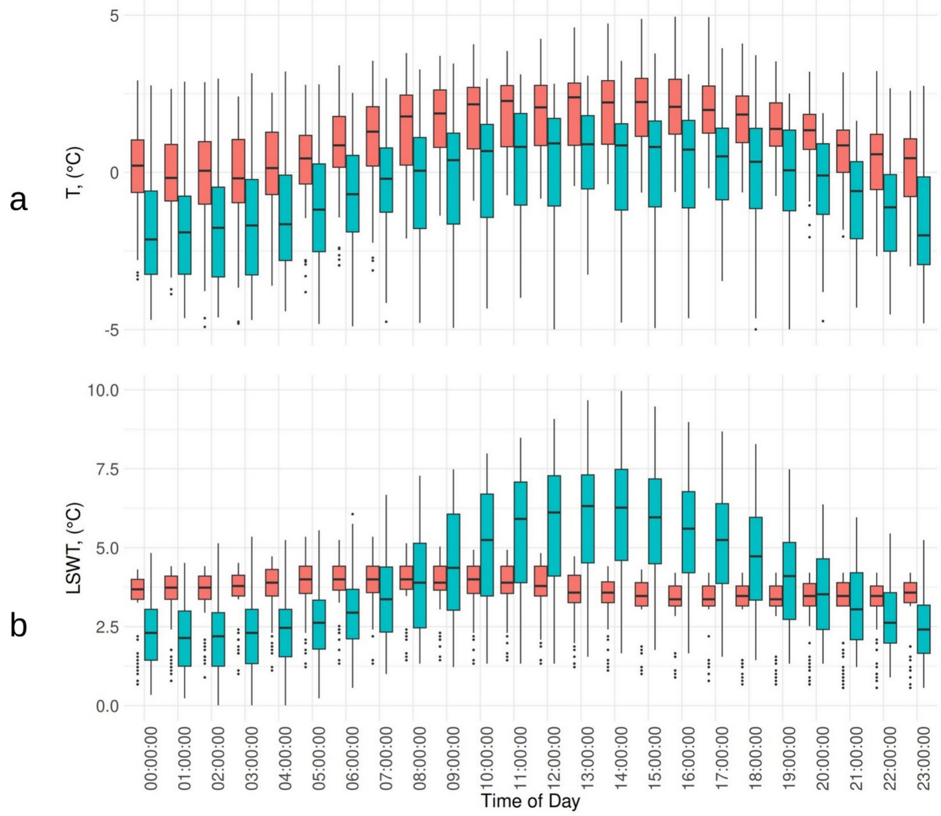

Figure 5. The diurnal cycles of air temperature (a) and the lake surface water temperature (b) measured on Lake Zub/Priyadarshini (light blue) and Lake Glubokoe (coral).

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:

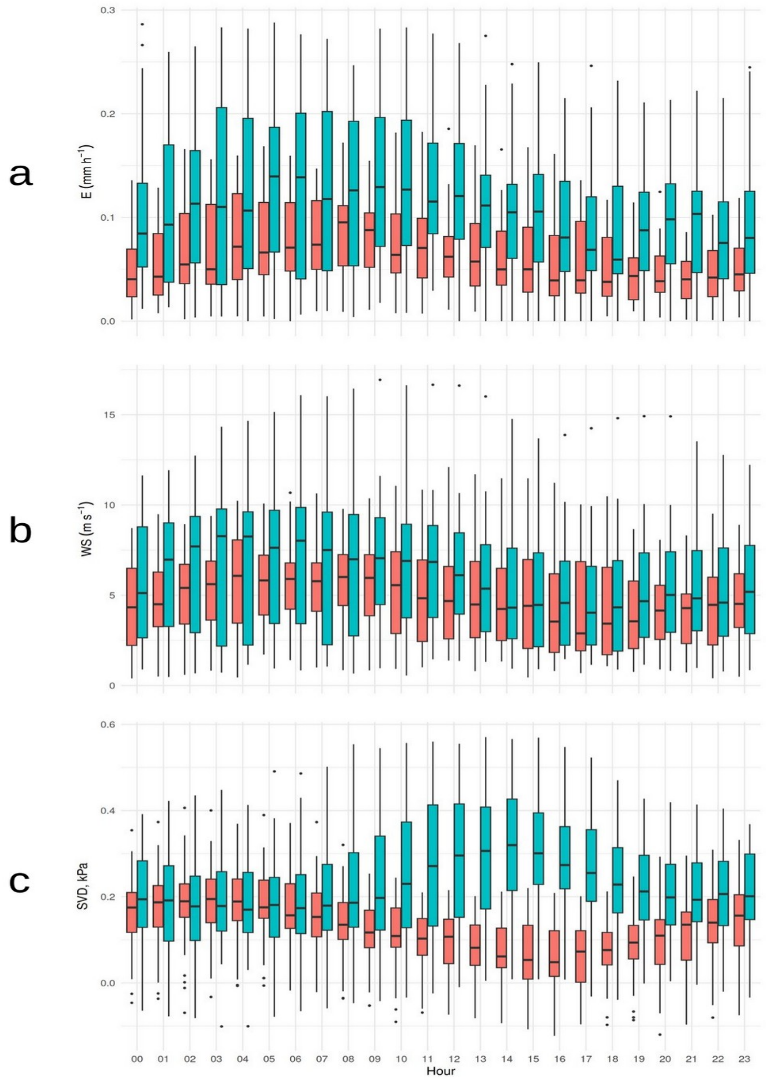

Figure 9. The diurnal cycle of the evaporation (a), wind speed (b) and saturation vapor pressure deficit (c) for two experiments on Lake Zub/Priyadarshini (coral) and Lake Glubokoe (light blue).

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