by the referee 4 (CS):

R4: This paper summarizes research to determine evaporation rates from two Antarctic lakes. The energy dynamics of these lakes are poorly documented so it is good to see the effort to try to measure these fluxes and examine the mechanisms that control them. There are some interesting results. The winds are amazing. An average of 8 m/s in summer! There are many who would be surprised to see evaporation rates this high so early in an open water season from such a cold location. The novelty of these measurements makes me think the paper should be published. Before that, the story needs improving to ensure the paper is impactful as it could be. I understand that this version might be a revision and the authors have responded adequately to previous comments. There remain some large issues with presentation and scientific robustness (these problems are intertwined) and overall messaging. Some are relatively minor, such as those about phrasing, and some are major, such as those that concern how the results are presented and their broader significance. I realize that the depth of these comments may be disheartening at this stage, but I hope my comments come across as constructive. I have not separated my comments in major or minor, but present them sequentially.

Thank you for all your comments. It is not disheartening to get such a review. We implemented as many of them as possible in this revision and try our best in explaining what controls evaporation from these lakes, and how that compares and contrasts with other lakes around the globe. Thank you for inviting us to repeat some parts from the manuscript Shevnina et al. (2022). It, definitely, makes the data and methods clear. In the revised text, we (a) extended all sections, (b) modified figures and tables, (c) added new figures, tables and references, and (d) included new supplements with the python code (replacing R). We did not implement the comment suggesting to include the analysis of the panoramic images (lake ice cover fraction) because their authorship is not fully clear yet, and we hope to get a solution soon.

It can be that this text is not that perfect as it can be, however, it did not aim to tell the whole story about the lakes in Schirmacher Oasis. It will continue further with analysis of other hydrological measurements collected in two summers 2017 – 2018 and 2019 – 2020.

Elena Shevnina
On behalf of the authors

We further followed the comments to answer.

Line 22: change to “containing”

A: done

Line 32: change “often serve” to “provide”

A: done

Line 50: It is not quite correct that combination methods are empirical, but the ones the authors refer to use simplifications of combination methods which do involve empiricism. Perhaps it would be more correct to say "There are a wide diversity of approaches to estimate lake evaporation. Simplified, empirical, versions of combination methods (e.g., Shuttleworth; Borghini, etc.) have been applied to Antarctica lakes even though ...." Further to this point, there are numerous approaches to estimate lake evaporation. The authors would do well to dig deeper and mention these (e.g., Morton, Meyer, Priestley Taylor, Penman, Bowen, Dalton types). The two references currently used are older and very general. Some papers that would be valuable for the authors to read and incorporate:

Meng et al 2020. Water 12, 3491.

Morton, 1983. Journal of Hydrology 66, 77-100

Islam et al 2024. Proceedings of the Canadian Society of Civil Engineering Annual Conference 2022, Lecture Notes in Civil Engineering 367, https://doi.org/10.1007/978-3-031-35471-7_65.

Nordbo et al. 2011. Journal of Geophysical Research 116 D02119, doi: doi:10.1029/2010JD014542,

Spence et al., 2003. Journal of Hydrometeorology 4, 694-701.

Granger and Hedstrom 2011. Hydrology and Earth System Sciences 15, 167-277.

Gan and Liu 2020. Journal of Geophysical Research: Atmospheres 125, e2019JD032334.

Blanken et al 2003. Journal of Hydrometeororology 4, 680-693 (and references within)

Oswald and Rouse 2004. Journal of Hydrometeorology 5, 129-144

This list is not exhaustive. The authors could even mention lakes where evaporation has been measured in warm locales such as Australia and Israel. The authors need to place their results in the broader context of lake evaporation rates observed elsewhere on the planet. More could be done in the paper to show why Antarctic lakes are so distinctive from elsewhere. The same processes govern evaporation here as elsewhere (e.g., winds, vapour gradients), but the combination of local conditions is what results in evaporation so early after breakup. Other cold regions lakes take time to warm up because of the significant heat capacity needed to be overcome. The authors measurements imply these two lakes start evaporating immediately. On these Antarctic lakes, it seems the wind may be the explanation, even though the authors suggest it is the vapour pressure gradient. I suggest the authors dissect this some more because wind may play a bigger role than the paper suggests, and this is different than anywhere else. There is much research coming out of China on lakes on the Tibetan Plateau (a couple examples above), and Canada with their cold lakes (again, listed above) that should be included in this paper for context. Some of these are listed above. My advice for how to evaluate the importance of wind vs gradients is further explained below.

A: Thank you!

We corrected the text in the introduction, the following text replaces lines 50-67: "The lake water balance equation describes changes in a lake volume as the difference of inflow (surface/underground runoff, precipitation, etc) and outflow components (evaporation/sublimation, artificial water withdrawal, surface/underground runoff, etc). Depending on the specific case and the integration time scale—whether daily, seasonal, or decadal—the contribution of certain components may be negligible, while others remain essential (Chebotarev, 1975). Evaporation, in particular, is a crucial component of the water balance for lakes in polar regions (Le et al., 2016; Leppäranta et al., 2020; Wang et al., 2020; Shi et al., 2024). However, because evaporation is difficult to measure directly, it is often estimated using indirect methods that require only limited hydrometeorological observations (Morton, 1990; Finch and Hall, 2001; Spence et al., 2003).

A wide diversity of approaches exists to estimate lake evaporation indirectly from meteorological and hydrological observations (Spank et al., 2025; Keijman, 1974). The indirect approaches are divided into mass and energy balance, bulk aerodynamic (mass-transfer), combination, equilibrium temperature and empirical formulas, pans or sticks and tracers i.e. water isotopes (Finch and Hall, 2001; Finch and Calver, 2008; Abtew and Melesse, 2013; Bellagamba et al., 2021). The use of evaporation pans is a traditional approach that can provide high accuracy when properly calibrated (Stanhill, 2002). In the energy balance and mass (water) balance approaches, the evaporation is typically estimated together with discrepancies of a balance equation provided all other components are known (Singh and Xu, 1997; Stannard and Rosenberry, 1991; Abtew and Melesse, 2013).

The bulk-aerodynamic approach estimated the evaporation on the basis of data on a land surface properties (whether a land surface type is an ice or a lake or rock or a forest, surface temperature and surface roughness) and atmospheric variables (wind speed, specific humidity and air temperature) in the lowermost part of the atmospheric boundary layer (Brutsaert, 1982). It needs meteorological observations on the different levels above the land surface allowing it to calculate heat fluxes (sensible and latent) from their gradients. The latent heat flux divided by the latent heat of vaporization yields evaporation. The bulk aerodynamic approach employs the transfer coefficients (turbulence, heat and moisture) derived from flux-gradient relationships and semi-empirical profiles for wind, temperature and humidity (Yang and Bai, 2023); in particular situations, it adequately estimates the surface evaporation on daily or shorter timescales (Moore, 1983). Consequently, this method has been widely applied to assess evaporation and sublimation over lakes and glaciers in Antarctica (Clow et al., 1988; Bliss et al., 2011; Leppäranta et al., 2016).

Combination approaches integrate elements of both energy budget and mass-transfer principles (Penman, 1948). A more comprehensive form is the Penman-Monteith equation (Monteith, 1965), which was originally developed to describe evapotranspiration from vegetation. Simplified versions of the combination formulas have been applied to Antarctica lakes even though their uncertainties are unknown (Borghini et al., 2013; Shevnina and Kourzeneva, 2017; Dhote et al., 2021). In the empirical approach, daily and monthly lake evaporation rate is correlated with variables such as surface area, incoming solar radiation, diurnal minimum and maximum of air temperature (Zhao et al., 2013, Spank et al., 2025), or it may solely only the air temperature and relative humidity (Konstantinov, 1968). The disadvantage of the empirical, mass transfer and combination approaches is that their performance is restricted to the specific geographical locations where their empirical coefficients were originally derived (Finch and Hall, 2001). To overcome this, the mass transfer coefficients are often calibrated based on measurements from eddy covariance (EC) systems (Ala-Könni et al., 2022, Nordbo et al. 2011).

This study evaluated the evaporation over two lakes in Antarctica from direct (eddy-covariance) and indirect (mass-transfer and combination) methods. The study quantifies the uncertainties of five combination equations and bulk-aerodynamic formulae against the eddy-covariance measurement collected on two lakes in the Schirmacher Oasis in two austral summers in 2017–2018 and 2019–2020."

Line 57: This is not a complete sentence.

A: It was removed.

Line 58: It is more correct to say the mass transfer coefficients can be calculated by measuring hydrometeorological conditions coincident with latent heat fluxes with eddy covariance (EC) measurements.

A: We corrected line 58: "the mass transfer coefficients can be calculated by measuring hydrometeorological conditions coincident with latent heat fluxes with eddy covariance (EC) measurements."

Line 61: This sentence needs rephrasing.

A: It was modified.

Line 64: These two thoughts do not constitute a full paragraph and could be deleted or moved to other places in the paper.

A: They were removed.

Line 76: change "featured by the" to "often subjected to"

A: changed.

Line 102: change "has been" to "becomes"

A: changed.

Line 123: This paper would be better if the methods of Shevina et al were included here. There is room. The paper is not too long already. Further to this point, in order for the reader to have confidence in these surprising observations, the authors need to present more detail on how they were taken.

A: Thank you for inviting us to partially reprint our previous manuscript! We extended the explanation of EC measurements in the section 3.2 (methods):" The IRGASON raw data were measured with a frequency of 10 Hz, which were further processed following Potes et al. (2017). In the first step, bad data with less than 50 % of total 10 Hz measurements were excluded. In the second step, we excluded all data automatically flagged for low quality, and the data with a gas signal strength less than 0.7 (or 70 % of the strength of a perfect signal). The gas signal strength is usually lower than 0.7 during rain events, which are seldom observed in our study region in Antarctica. The raw data were processed in the third step to remove spikes using the method of Vickers and Mahrt (1997), with threshold window means set to 3.5 standard deviations for horizontal wind speed, CO_2 and H_2O, and 5.0 standard deviations for vertical wind speed. This procedure was repeated up to 20 times or until no more spikes were found. The spectral correction (Nordbo et al., 2011) was implemented because of no high frequency loss in the collected EC data.

The lake evaporation was calculated only by those values collected within a footprint, which is defined by a sector of wind direction covering a source area (Burba et al., 2016). It depends on the location of the EC station, the height of its sensors, the roughness of the upwind surface, and the stratification of the upwind atmospheric surface layer (Burba, 2013). We estimated the footprint according to Kljun et al. (2004) and filtered out data corresponding to wind directions outside the footprint. The resulting gaps were filled with the mean value calculated from the entire record. Using the mean value to fill the gaps did not significantly affect the results. The daily evaporation over a lake was estimated as the sum of 30-minute values in each day of the experimental period. We also evaluated the relative humidity from the water vapor concentration as given by Hoeltgebaum et al. (2020).

Uncertainties in the estimation of evaporation by any method include instrumental errors associated with the specific instrument, and we used the paired tower method to evaluate the instrumental errors of our IRGASON following Aubinet et al. (2012). The instrumental error does not depend on the region where the instrument will be used, and our instrument was intercalibrated between the field experiments in Alqueva Artificial Lake in October 2018 (Shevnina et al., 2022). ”

This text replaced the lines 128 – 134.

We also extended the section of Study area with the text:”The climate of the Schirmacher Oasis is characterized by low air humidity and temperature, and persistent (katabatic) wind blowing most of the year. There are two scientific observatories operating in the Schirmacher oasis (Fig. 1 a): Novolazarevskaya (Novo) observatory (70° 46′36″S, 11° 49′21″ E) starts the observations in 1961, and Maitri observatory (70° 46′00″S, 11° 43′53″ E) operates since 1989. They are located at a distance approx. 5.5 km, their meteorological measurements following the WMO’s standards (Turner and Pendlebury 2004). Table 1 shows the monthly air temperature, relative humidity, averaged over the period of 1961–2010 according to the observations at Novo site (the data given by the Arctic and Antarctic Research Institute at http://www.aari.aq/default_ru.html, last access 07.12.2021).

Table 1. The monthly minimum, mean and maximum values for the meteorological parameters calculated for the period of 1961 – 2010 (the values are separated by a slash).

Meteorological parameter	1961 – 2010		
	December	January	February
Air temperature, °C	–3.9 / –1.0 /1.5	–2.5 / –0.4 / 1.4	–4.7 / –3.3 / –1.0
Relative Humidity,%	47 / 56 / 69	49 / 56 /66	41 / 49 / 59
Atmospheric pressure, Pa	965 / 975 / 991	964 / 976 / 986	964/ 973 / 987
Wind speed, ms-1	4.3 / 7.4 / 10.3	3.1 / 7.0 / 10.4	5.8 / 9.4 / 13.1
Soil surface temperature, ºC	3.0 / 6.7 / 10.0	3.0 / 6.7 /11.0	–2.0 / 0.2 / 4.0
Precipitation, mm	0.0 / 5.3 / 54.8	0.0 / 2.6 / 38.0	0.0 / 2.9 / 25.9

The region of the study is featured with the persistent katabatic winds blowing from the continental interior (Bormann and Fritzsche, 1995). To fetch an area covering eddy-flux measurements, it is important to place an instrumentation toward prevailing wind directions (Burba, 2013). Fig. 2 shows the wind directions and wind speed anomalies for December and January for **the** period 1998–2016 calculated from the 6-hour synoptic observations at the Novo site available from the British Antarctic Survey Dataset (https://www.bas.ac.uk, last accessed 14.12.2018). The prevailing wind directions range from 110 to 140º (marked with the black arrows in Fig. 2), and these winds come from a direction that would be the direction of katabatic winds. However, it is not guaranteed that all these winds are entirely of katabatic origin, and some winds may be driven by a combined effect of katabatic and synoptic forcing. The wind speed anomalies were estimated for each 10 degree range in the wind direction, and they are given with the different colors in the legend to Fig. 2. The positive wind speed anomalies are often observed within the range of the prevailing wind directions (marked with orange, yellow, red, brown and black in the legend of Fig. 2). Therefore one can expect the majority of strong winds from these directions.

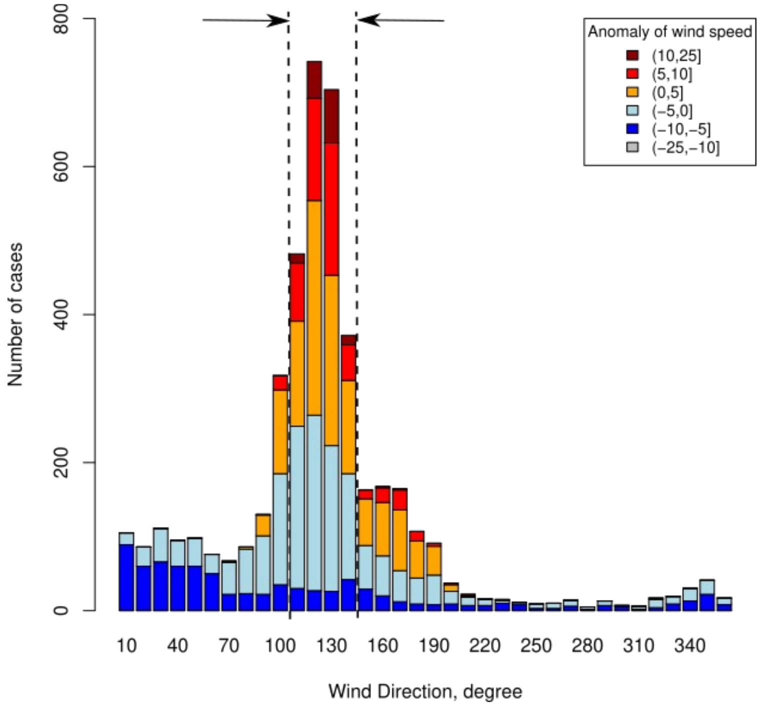


Figure 2: Wind direction and wind speed anomalies for two austral summer months (December and January).
"

Line 129: Please provide details of how these terms were measured. There is no mention of low frequency air temperature/vapour pressure measurements.

A: We replaced the text in lines 110 -126: "The measurements were collected on two lakes (Fig. 3 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 when the lake was free of ice. The second experiment on Lake Glubokoe covers the period of lake ice break-up; the experiment, however, was planned to cover the whole austral summer but was terminated due to the instrumentation failure in mid-January.

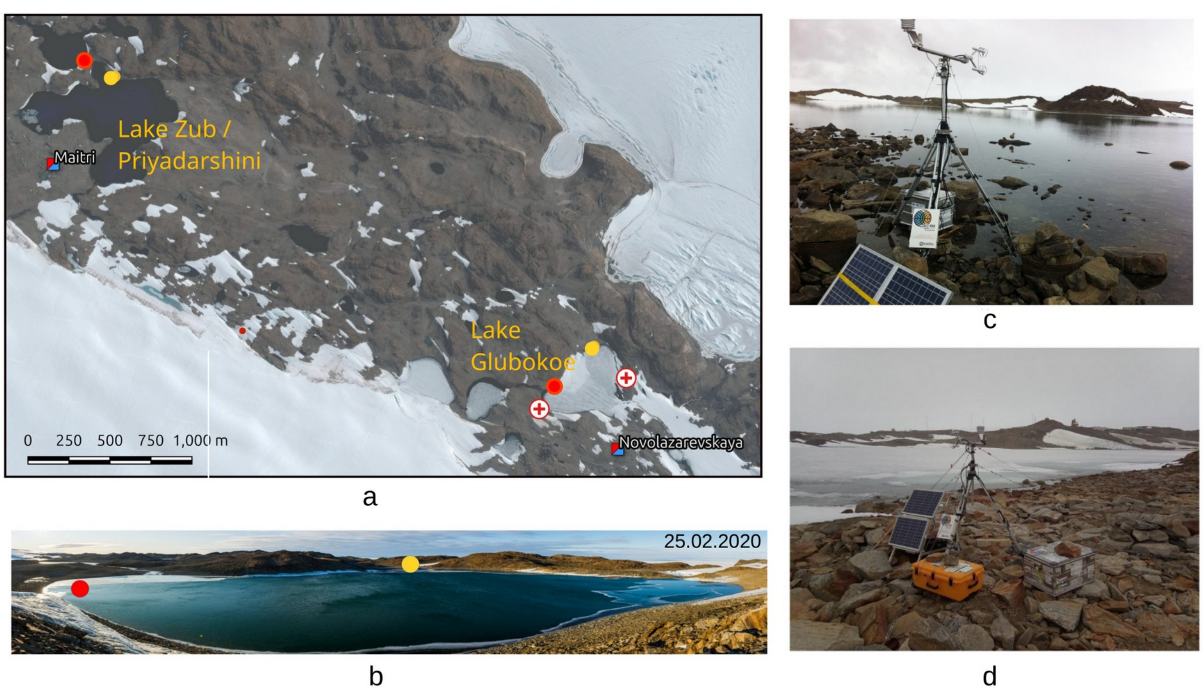


Figure 3: Location of the instrumentation on the shores of two lakes (a): temperature and water level logger (red dots), the EC system (yellow dots), and digital cameras collecting the panoramic images (rounded red crosses), © Google Maps 2019. The photo (b) shows the instrumentations installed on Lake Glubokoe on the panoramic image from 25 February 2020. The photos on (c) and (d) show the EC system installed on the shore of Lake Zub/Priyadarshini (6 January 2018) and Lake Glubokoe (12 December 2019).

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 (Table 2). The instrument consists of a 3D sonic anemometer and two gas analysers measuring CO_2/H_2O concentrations on a high frequency (10 Hz). It was placed 5–6 m from the lake shoreline and oriented toward the lake in the direction of the prevailing winds. The lake surface water temperature (LSWT) was measured by the HOBO instrumentation (red dots in Fig. 3 a) installed at a depth of 0.02 m. We used the meteorological measurements from the Novo and Maitri automatic weather stations for a 1–2 day intercalibration with our sensors prior to their installation (data not shown). The IRGASON was intercalibrated in October 2018 in the experiment in the artificial Lake Alqueva (Shevnina et al., 2022).

Table 2. The instrumentations used in the experiments on Lake Zub/Priyadarshini (LZ) and Lake Glubokoe (LG)

Sensor Site in (Fig. 3)	Elevation, m	Measured variables	Accuracy / (Resolution)	Raw data >> processed data
IRGASON ZB LG	 124 84	air temperature, ºC; H_2O concentration, g/m^3; wind speed, ms^{-1}	±0.15 / (0.025) ±0.037 / (0.00350)	10 Hz >> 30 min
HOBO ZB GL	 122 82	water temperature, ºC	±0.44 / (0.10)–	10 min >> 30/60 min and daily

Line 133: These equations need to be presented separate from the text, either as equations or in a table.

A: We added the table for the combination equations and text in the Methods section replacing lines 132-139: " The general form of combination and empirical relationships reads as $E = K\, w_z\, (e_s - e_z)$, where E is evaporation (mm period^{-1}), w is the wind speed (m s^{-1}), ($e_s - e_z$) is the water vapor deficit (kPa), z refers to height (m), and K is an empirical function approximated with a small number of coefficients. In this study, we evaluated evaporation over two glacial lakes with the formulas originally derived for tropical, temperate and cold climate regions (Table 3).

Table 3. The combination and empirical equations applied to evaluate the lake evaporation. Climate is following the Köppen climate classification.

Author(s) (year)	**formula**	**Climate**
Penman (1948) as given in Tanny et al. (2008)	$E = 0.26(1 + 0.54\, w_2)(e_s - e_2)$	Temperate
Doorenbos and Pruitt (1975)	$E = 0.26(1 + 0.86\, w_2)(e_s - e_2)$	Temperate
Odrova (1979)	$E = 0.14(1 + 0.72 w_2)(e_s - e_2)$	Cold
Shuttleworth (1993)	$E = 2.909\ A{-}0.05 w_2 (e_s - e_2)$	Tropical

In these formulas, E is evaporation (mm d^{-1}), w_2 is the wind speed at 2 m height (ms^{-1}), and A is a lake surface area (m^2). We also verified against the independent observations the formula $E = -0.33(1 - 1.82w_2)(e_s - e_2)$ suggested in Shevnina et al. (2022). "

Line 154: These are presumably the equations listed above. Perhaps a table is best, which can be referred to here.

A: We added the equations in the table (Table 3). Also, we modified the results (lines 256 – 262): The evaporation over the was estimated on the basis of four formulas: the mean daily evaporation varied between 0.4 ± 0.1 mm d^{-1} and 1.1± 0.1 mm d^{-1}, which represent 27 – 73% less than the evaporation based on the EC method (Table 4). The formula by Shevnina et al. (2022) gave the daily mean evaporation of over 1.5 ± 0.02 mm d^{-1} over the ice-covered Lake Glubokoe (independent data); it is only 6% less with respect to the evaporation rate calculated from the EC technique. The scores of all formulas (Table 5) are weak: $s/\sigma > 2$, and the RMSE is up to 1.6 mm d^{-1} .

Table 4. The evaporation over two glacial lakes on the basis of the combination formulas and their skill scores. The daily mean evaporation in mm d^{-1} , and the sum is given in mm $period^{-1}$

Author(s) in Table 3	Lake Zub/ Priyadarshini			Lake Glubokoe		
	Mean	Sum	*RMSE / s/σ*	Mean	Sum	*RMSE / s/σ*
Penman (1948)	1.3 ± 0.2	48	1.8 / 2.0	0.6 ± 0.1	20	1.3 / 2.1
Doorenbos and Pruitt (1975)	1.8 ± 0.2	68	1.3 / 1.6	0.8 ± 0.1	28	1.5 / 2.4
Odrova (1979)	0.8 ± 0.1	32	2.2 / 2.4	0.4 ± 0.1	13	1.3 / 2.2
Shuttleworth (1993)	1.0 ± 0.1	38	2.1/ 2.3	1.1 ± 0.1	37	1.3 / 2.1

In the section of discussion, the new text replaced lines 355–365: "The daily lake evaporation was underestimated after the five equations (Table 3): the Penman formula (1947) – by 60%, the formula of Shuttleworth (1993) – by 27%, the formula of Doorenbos and Pruitt (1975) – by 47%, and the formula by Odrova (1979) given the largest underestimate by 73%. The skill scores were low for all formulas ($s/\sigma >> 0.80$ and RMSE was 1.4 mm d^{-1} on average), and it does not allow using them for simulating the daily evaporation rates. The formula by Odrova (1979) has been used to estimate the summertime evaporation over 12 lakes in the Larsemann Hills Oasis and King George Island (69 °S, Antarctica); the daily lake evaporation rates vary between 0.8 and 1.7 mm d^{-1} depending on presence of ice cover (Shevnina and Kourzeneva, 2017). In the case of Lake Glubokoe, this formula yielded an average evaporation of 0.4 mm d^{-1}, and it is less than for the lakes in the Larsemann Hills Oasis. This difference may be explained by the fact that the dataset on Lake Glubokoe spanning the early stage of ice break-up period (December 2019) while the observations on the lakes in the Larsemann Hills Oasis were carried out when over 60–80% of the lake surface (January – February 2014)."

Line 154: It was not immediately apparent that these parameterizations were from Heikinheimo et al. (1999), Andreas (1986), Arya (1988) and the observations. I suggest a table for these and the equations.

A: We added the equations (1 – 13) to the Methods: "Evaporation is defined as the vertical surface flux of water vapor due to atmospheric turbulent transport. Lake evaporation is estimated from measurements of a lake water surface temperature, and relevant bulk properties of the air (Venäläinen et al., 1998; Brutsaert, 1982). We calculated the evaporation after the bulk-aerodynamic methods as follows:

$$E = \rho C_{Ez} \left(q_s - q_{az} \right) w_z \quad (1)$$

where, E is the evaporation (kg m^{-2} s^{-1}); is the air density (kg m^{3}), C_E is the turbulent transfer coefficient for moisture (Dalton number), q_s is the saturation specific humidity corresponding to the lake surface temperature, q_z is the air specific humidity, and w_z is the wind speed. The subscript z refers to the observation height. The actual values for the turbulent transfer coefficient of moisture for a reference level z (C_{EZ}) depend on the surface roughness and atmospheric stratification. The dependence is determined either from field experiments (eddy covariance, gradient measurements and radiation) or from values reported in the literature; both methods were applied in this study. From the literature, the C_E was taken as 0.00107 following Heikinheimo et al. (1999) and Venäläinen et al. (1998), who suggested the value based on measurements over a boreal lake. It allows us to better take into account the different regime of turbulent mixing over a small lake compared to the sea (Sahlee et al., 2014).

Since the atmospheric surface-layer stratification is not always neutral, the stratification effects on the turbulent transfer coefficient C_{EZ} were taken into account as follows:

$$C_{Ez} = \frac{C_{DzN}^{1/2} C_{EzN}^{1/2}}{\left[1 - \left(\frac{C_{DzN}^{1/2}}{k} \right) \psi_m \left(\frac{z}{L} \right) \right] \left[1 - \left(\frac{C_{EzN}^{1/2}}{k} \psi_q \left(\frac{z}{L} \right) \right) \right]} \quad (2)$$

where C_{DzN} is the drag coefficient for a lake surface (unitless), k is the von Karman constant (0.4), ψ_m and ψ_m are the stability functions for momentum and moisture, respectively, and L is the Obukhov length (metre). The subscript N in Eq. (2) refers to the neutral values of the transfer coefficients. The Obukhov length (Obukhov, 1946) allows adjusting the transfer coefficients (C_{Dz} and C_{Ez}) to actual stratification in the atmospheric surface layer. In our calculations, the neutral drag coefficient (C_{DN}) equals 0.00181 as suggested by Heikinheimo et al. (1999). The values by Heikinheimo et al. (1999) were given for z = 3 metres, and converted to our observation height (of 2 and 1.8 metres) using Launiainen and Vihma (1990), and the same algorithm was applied to iteratively solve the interdependency of the turbulent fluxes and the Obukhov length. For the stability functions, we used the classic form by Businger et al. (1971) for unstable stratification, and that of Holtslag and de Bruin (1988) for stable stratification. The actual values for the turbulent transfer coefficient (C_E) and the drag coefficient (C_D) were also defined on the basis of the eddy covariance measurements. The wind dependent value for the C_E was defined on the basis of the EC measurements on Zub/Priyadarshini (2017 – 2018), and applied in the calculation of evaporation using Eq. (1) from the independent observations collected on Lake Glubokoe (2019 – 2020).

The C_{Dz} and transfer coefficient (C_{Ez}) were also estimated on the basis of the EC measurements on Lake Glubokoe (2019 – 2020) and applied to calculate the evaporation from the observations on Lake Zub/Priyadarshini (2017 – 2018). Following Arya (1988) the coefficients were calculated as:

$$C_{Dz} = \frac{k^2}{\left[\ln \left(\frac{z}{z_{0m}} \right) * \Psi_m \left(\frac{z}{L} \right) \right]^2}. \quad (3)$$

$$C_{Ez} = \frac{k^2}{\left[\ln \left(\frac{z}{z_{0m}} \right) * \Psi_m \left(\frac{z}{L} \right) \right] * \left[\ln \left(\frac{z}{z_{0q}} \right) * \Psi_q \left(\frac{z}{L} \right) \right]}. \quad (4)$$

where z_{0m} is the momentum roughness length [m] and z_{0q} is the roughness length for water vapour [m] according Ferdorovich et al. (1991):

$$z_{0m} = \frac{0.135 v_a}{u_*}\ ; u_* \leq 10.856 \left(\frac{cm}{s} \right), \quad (4)$$

$$z_{0m} = \frac{u_*^2}{69 g}\ ; u_* > 10.856 \left(\frac{cm}{s} \right), \quad (5)$$

$$z_{0q}=\frac{9.072\times10^{-2}}{u_*}\text{ ; } u_*\leq 10.856\left(\frac{cm}{s}\right), \tag{6}$$

$$z_{0q}=8.357\times10^{-3}-1.904\times10^{-4}\left(u_*-10.856\right)\text{ ; } 10.856<u_*<26.622\left(\frac{cm}{s}\right), \tag{7}$$

$$z_{0q}=1.092\times10^{-4}u_*^{2}e^{-0.228u_*^{3/4}}\text{ ; } u_*>10.856\left(\frac{cm}{s}\right). \tag{8}$$

where u_* is the friction velocity (m= s[-1]). The stability functions ψ_m and ψ_m assume the following forms:

$$\Psi_m\left(\frac{z}{L}\right)=\ln\left[\left(\frac{1+x^2}{2}\right)\left(\frac{1+x}{2}\right)^2\right]-2\tan^{-1}x+\frac{\pi}{2}\quad\text{for}\left(\frac{z}{L}<0\right), \tag{9}$$

$$\Psi_q\left(\frac{z}{L}\right)=2\ln\left(\frac{1+x^2}{2}\right)\quad\text{for}\quad\left(\frac{z}{L}<0\right), \tag{10}$$

$$\Psi_m\left(\frac{z}{L}\right)=\Psi_q\left(\frac{z}{L}\right)=-5\left(\frac{z}{L}\right)\quad\text{for}\quad\left(\frac{z}{L}\geq 0\right), \tag{11}$$

where $x=\left[1-16\left(\frac{z}{L}\right)\right]^{\frac{1}{4}}$. The value of the transfer coefficient of moisture (C_E) was further referred to Arya 1988.

Also, we also estimated the transfer coefficient of moisture as suggested in Andreas (1986):

$$C_{Dz}=\frac{k^2}{\ln\left(r/z_0\right)}, \tag{13}$$

$$C_{Ez}=\frac{\alpha_E k C_{Dz}^{1/2}}{k C_{Dz}^{-1/2}-\ln\left(z_Q/z_0\right)}, \tag{14}$$

where, the values of the z_Q and z_0 were taken as the functions of the roughness Reynolds number, and were depended on the wind speed and on the surface roughness parameter." In the revised manuscript, this replaced the lines 143 – 155.

We also edited section 4.3 (line 155): "The estimated uncertainties of the indirect methods rely on the eddy-covariance (EC) technique (Tanny et al., 2008; Tran et al., 2023; Shi et al., 2024)."

We implemented the text in the section 4.3: (line 262): "We estimated the lake evaporation on the basis of the observed wind speed, lake surface temperature (controlling q_S), and air specific humidity, applying three literature based formulae for C_{ENz} (Heikinheimo et al., 1999; Arya, 1988; Andreas, 1986). In addition, the actual values of the transfer coefficient were derived from the direct observations on evaporation, wind speed, air specific humidity, and surface saturation specific humidity collected during the experiment on Lake Zub/Priyadarshini (2017 – 2018).

Applying Eq. (1), 30-minute mean values of C_{E2} were solved on the basis of the observed E, q_S, q_2 and w_2, and the results were converted to C_{EN2}. Finally, to allow comparison against relationships presented in the literature for the standard height of 10 m, the C_{EN2} values were converted to C_{EN10} values applying the iterative algorithm of Launiainen and Vihma (1990). The result demonstrated an approximately piecevise linear relationship between w_2 and C_{EN} (Figure 10). Linear regressions were derived for the wind regimes below and above 13 ms^{-1}), separately for C_{EN10} and C_{EN2} as follows:

C_{EN10}= 0.0000119 w_2 + 0.00114 (w_2 < 13 ms^{-1}), (14)

C_{E10}= 0.0013 (if w_2 >= 13 ms^{-1}). (15)

C_{EN2}= 0.0000193 w_2 + 0.00153 (if w_2 < 13 ms^{-1}), (16)

C_{E2}= 0.0018 (if w_2 >= 13 ms^{-1}), (17)

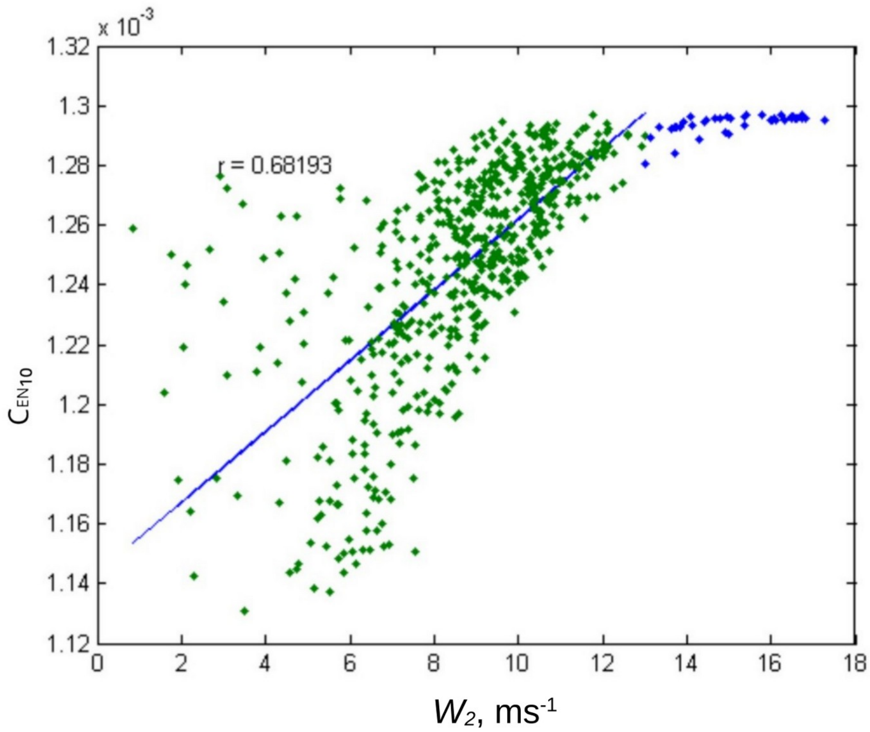


Figure 7. Dependence of the 10-m neutral transfer coefficient for moisture (C_{EN10}) on the 2-m wind speed (W_2) on the basis of 30-minute mean values observed over Lake Zub/Priyadarshini (2017–2018).

The actual values of the transfer coefficients (C_E and C_D) were estimated from the EC measurement on Lake Glubokoe (2019 – 2020) applying the methods referred to Arya 1988 and Andreas 1986 (Table 2). In the first method (Eqs. 3- 11), the actual values were estimated for the roughness lengths calculated with literature-based friction velocity (black dots in Fig. 8). In the second method (Eqs. 12–13), the actual values of the transfer coefficients were calculated with independence of stability and friction velocity (red dots in Fig. 8) .

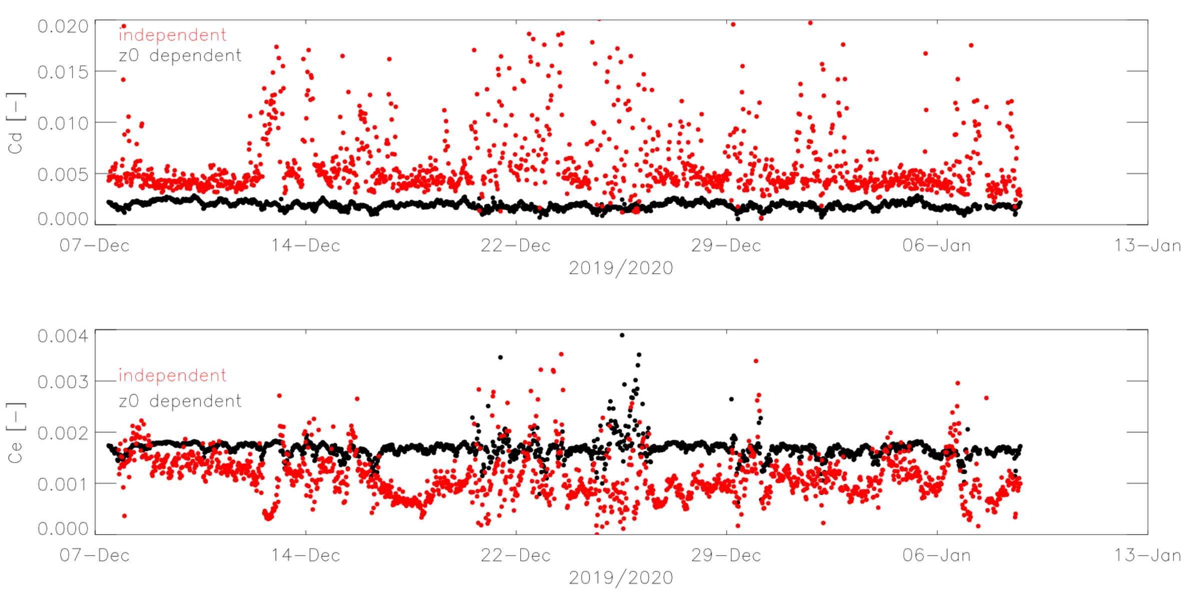


Figure 8. The actual values of the bulk transfer coefficients calculated following Arya 1988 (black dots) and Andreas 1986 (black dots) estimated from the EC measurement on Lake Glubokoe (2019–2020).

The actual values for the C_{E10} (for the standard height of 10 meters) varied between $1.1 \cdot 10^3$ and $2.1 \cdot 10^3$, in Table 5 they are given for the height of our instrumentation: 2 m for Lake Zub / Priyadarshini and 1.8 m for

Lake Glubokoe. The values of the C_{E2} were further used in calculations of lake evaporation with the Eq. (1), and estimations of the scopes for the bulk-aerodynamic method simulating the hourly, daily and seasonally cumulative sums of lake evaporation calculated from the 30 minute data.

Table 5. The equations applied in estimations the transfer coefficient (C_E) in the bulk-aerodynamic method. Notations: N refers to the neutral stratification, and z refers to the height of the instrument.

Lake	Eqs. for the C_E	Methods	$C_{E\ Nz}$	
			z = 10 m	z = [1.8 – 2] m
Lake Zub / Priyadarshini (2017 – 2018) Lake Glubokoe (2019–2020)	taken from literature	Heikinheimo et al., 1999	1.2×10^{-3}	1.1×10^{-3}
Lake Glubokoe (2019–2020)	Eqs. (17)	Wind dependent	–	–
Lake Zub / Priyadarshini (2017 – 2018)	Eqs. (3 – 11)	Arya, 1988	1.4×10^{-3}	1.2×10^{-3}
	Eqs. (12 – 13)	Andreas, 1986	2.1×10^{-3}	1.7×10^{-3}

Line 158: These equations too should be presented separate from the text. But, I suggest below that maybe this exercise is not necessary for the paper.

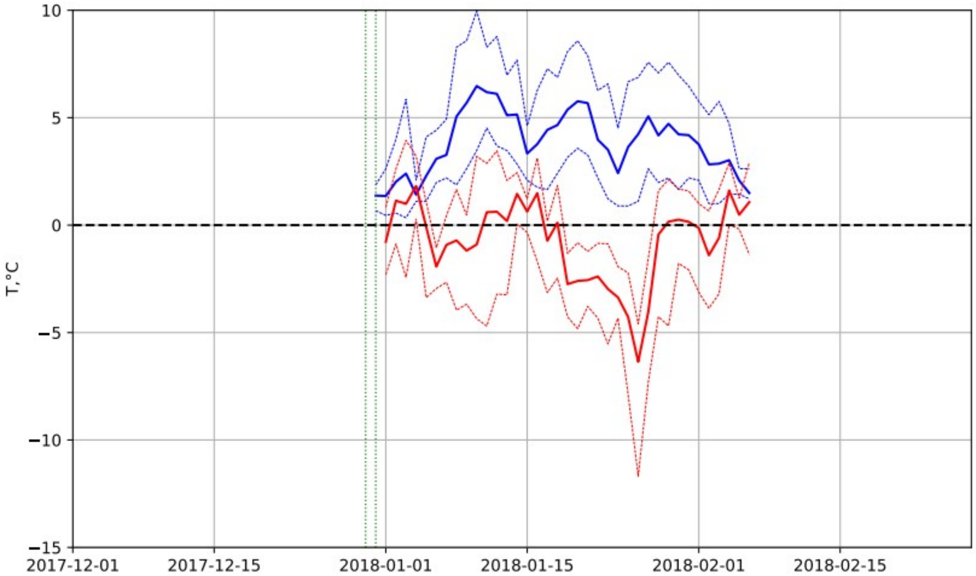
A: Thank you. We did not exercise.

Figure 3: The line width is different in the legend than in the graph. Because each lake was only instrumented for one summer, I suggest adding the year to the legend (e.g., ZB (2018) LG (2019-2020).

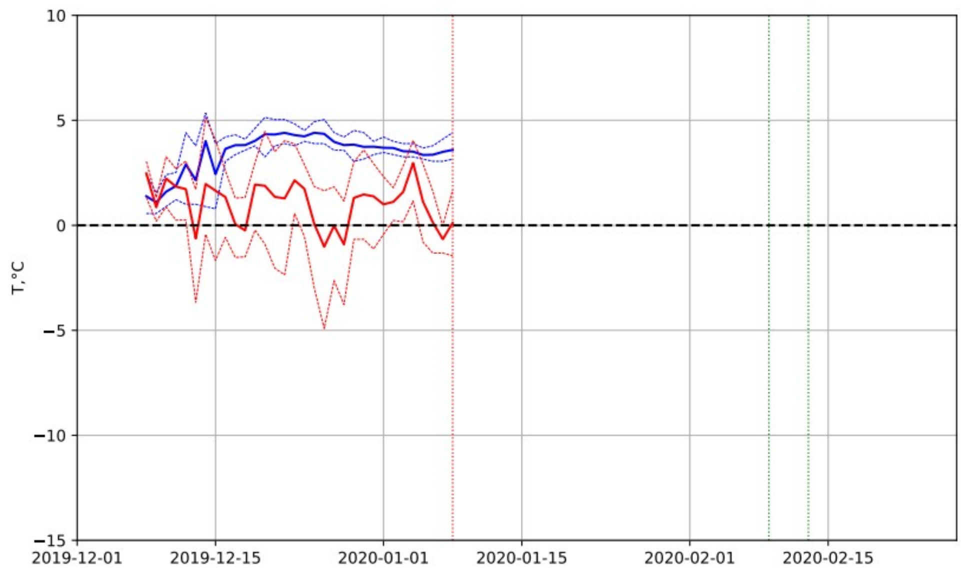
A: The figure 3 was removed. We added the text in lines 164–180: "In 2017 – 2018, the weather was colder and less windy than the climatology (Table 1): the daily mean air temperatures ranged between –5.6 and 2.4 ºC , and the daily mean wind speed varied between 1.3 to 13.2 ms^{-1}. In January – February 2018, the mean daily wind speed was 6.3 m s^{-1}, and the daily mean relative humidity was 54 %, (varied between 39 and 77 %). The highest relative humidity (up to 90%) was observed on 3 January and 2 December 2018. In 2019 – 2020, the daily mean air temperature ranged from –1.4 ºC to 2.6 ºC, with an average of 1.0 ºC. The daily mean of the air temperature varied between –4.9 ºC and to 5.1 ºC, and the warmest days were observed at the end of December 2019. The daily mean relative humidity was 56%, and it varied between 43% and 77%; and the daily maximums exceeded 90 % on 25–26 December 2019. The daily mean wind speed ranged from 1.3 to 9.5 ms^{-1}, and averaged as 5.9 ms^{-1} for the period of the experiment (Table 2). The strongest winds (weed speed reached up to 13.0 m s^{-1}) were on 9 December 2019 and 1 January 2020, and the weakest winds (wind speed was less than 0.5 m s^{-1}) were on 21–25 December 2019 and 3 January 2020."

Figure 4: Some of the temperature data extend off the graph. Perhaps only show data for the period described in Section 3.1. It would make it simpler on the reader.

A: We corrected the figure.



a



b

Line 200: “was” not “is”.

A: corrected.

Line 209 – 215. This would fit better in Methods.

A: moved.

Figure 5: Please state which camera's photos are in each of b), c) and d)

A: We removed this figure. We have not got the information on the camera type yet.

Line 221: This first sentence is not needed.

A: removed.

Figure 7: What are the percentages in the wind rose? Percentage of time from that direction? It is very difficult to see the green line on the east axis. Maybe make it thicker?

A: We removed this figure, and the new figure shows the wind rose and footprint estimates for both lakes. We added the following text (lines 217–225): “Direct measurements of evaporation were a key component of this study. The IRGASON raw data were measured with a frequency of 10 Hz, which were further processed following Potes et al. (2017). The EC system was installed on a location allowing it to cover the lake surface sector which was between 105 and 240 degrees for Lake Zub/Priyadarshini (green lines in Fig. 5 a and c), and between 90 and 225 degrees for Lake Glubokoe (green lines in Fig. 5 b and d). In Fig. 6 c and d, the X_{90} represents the horizontal distance over the lake surface that encompasses 90% of the flux footprint, and it ranged from 30 to 250 m. The percentage of the filtered data that was excluded did not exceed 20% of total data, and 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.

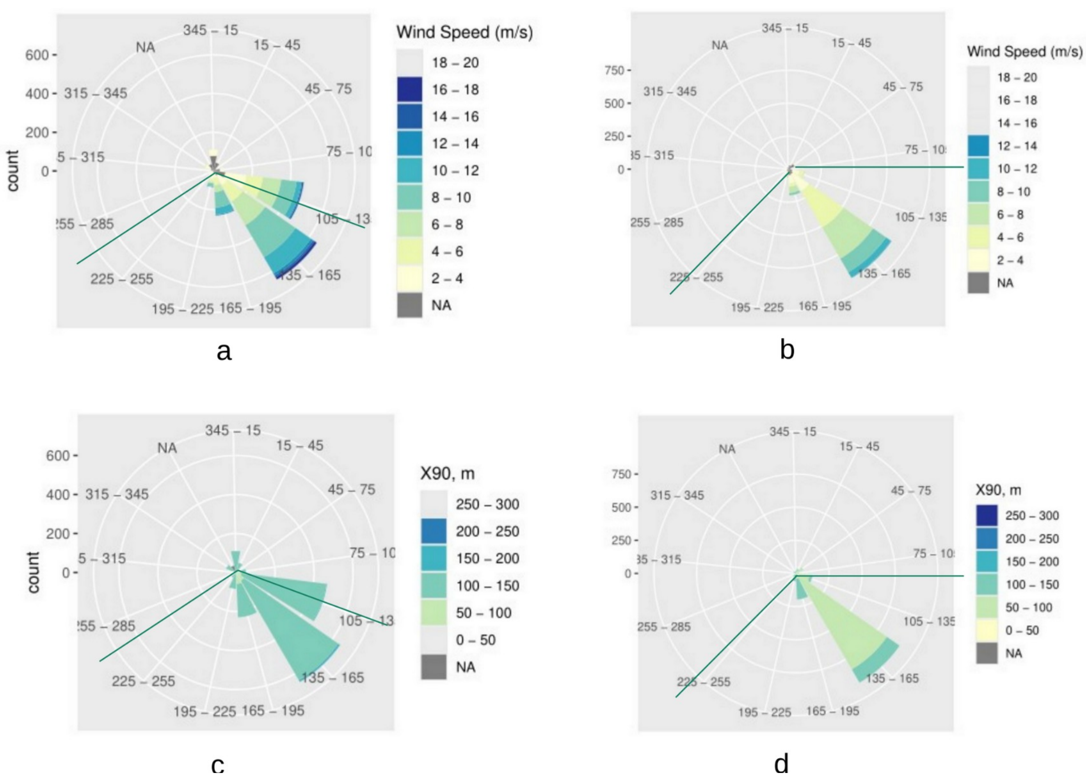


Figure 5. The wind speed and direction measured at Irason site (a: Lake Zub/Priyadarshini, and b: Lake Glubokoe) and the footprint length estimate (X90, m) (c: Lake Zub/Priyadarshini, and d: Lake Glubokoe). The green lines indicate the footprint sector.

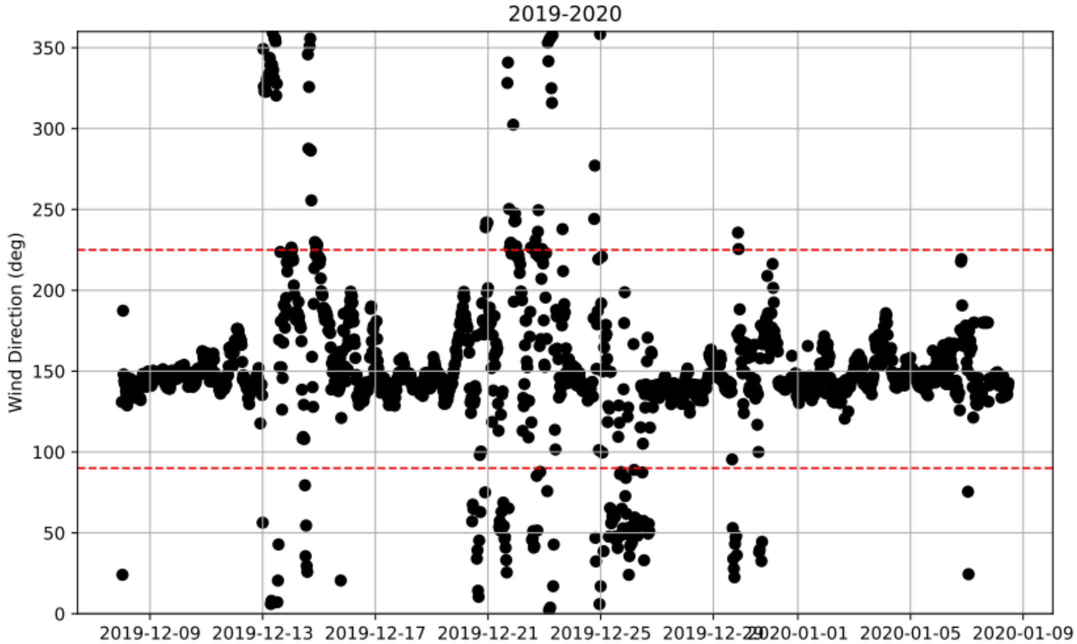
The IRGASON height of 1.8 – 2 m generates a blind zone near the instrument, so that the stones on the downwind shore do not affect the fluxes. The low height of the instrument also guarantees that the vertical divergence of the water vapour flux is negligible.

Line 229 – 234: Much of this too should be Methods.

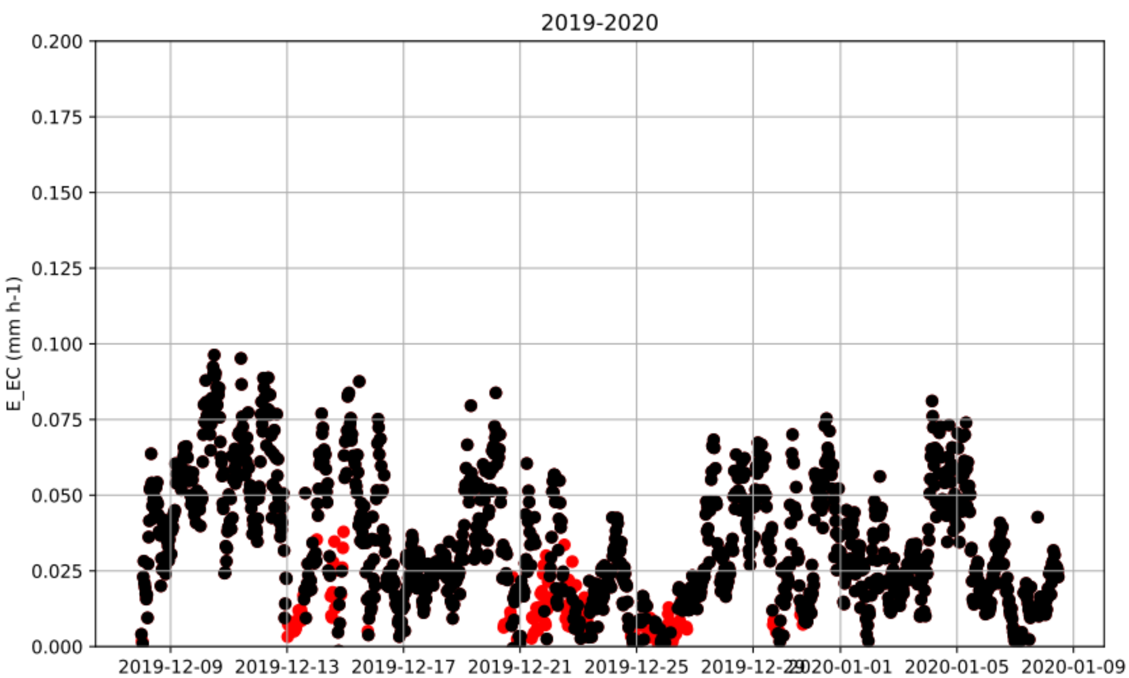
A: Moved and corrected as given in the answer to the comments for Line 154.

Figure 8: The units here are different than those presented in the text.

A: We modified Fig. 8 (new Fig. 6) and notations. We added the text (lines 226-230) : “The raw 30-minute measurements were filtered by the sensors’ signal strengths, a number of gaps in the observations, the footprint and the sector of wind directions covering a lake. The percentage of the filtered out (excluded) measurements did not exceed 20 % of total data, and most of the excluded data corresponded to wind directions outside a lake. The gaps were replaced by the mean of evaporation estimated for the period of the experiment, and the hourly and daily cumulative sum were calculated from the data with gaps filled. Figure 6 shows how the values of evaporation were filtered in the experiment on Lake Glubokoe (2019 – 2020): the red lines outline the sector of wind directions covering the lake surface (a), and the red dots show the filtered values (b).



a



b

Figure 6. The 30-minute means of the wind direction (a) and evaporation (b) measured by the EC instrumentation on Lake Glubokoe. On (a): the red lines show the limit of the wind directions within the footprint; on (b): the red dots indicate the measurements collected outside the footprint. "

Line 240: I think these data are from Glubokoe. It would be appropriate to include a paragraph on Zub.

A: We added the text for Lake Zub placing the line 240: "The daily mean evaporation rate as well as the cumulative sum for the whole period were calculated from high-frequency measurements. For Lake Zub/Priyadarshini, the daily mean evaporation rate varied from 1.5 to 5.0 mm day^{-1} and took an average

3.0 ± 0.3 mm day^{-1}. The average daily evaporation rate was calculated by dividing 114 mm of evaporated water (sum over the whole period of the experiment) by the number of days in the period (which is 38). The evaporation increased with wind speed, with the maximum of 5.0 mm d^{-1} observed during the storm on 2–3 January 2018. For Lake Glubokoe, the daily mean evaporation rate varied between 0.3 and 3.2 mm d^{-1}, and took on average 1.5 ± 0.1 mm d^{-1}. The total sum of the evaporation in this experiment was 54 mm. The largest evaporation (> 2.5 mm d^{-1}) was observed on 9–11 December 2019 and 3–4 January 2020. The smallest evaporation (< 0.9 mm d^{-1}) was observed on 6–7 January 2020."

Line 255: The authors need to provide some data of the ice covered fraction, as they mention this was calculated in the Methods section and it provides important context for the high evaporation rates.

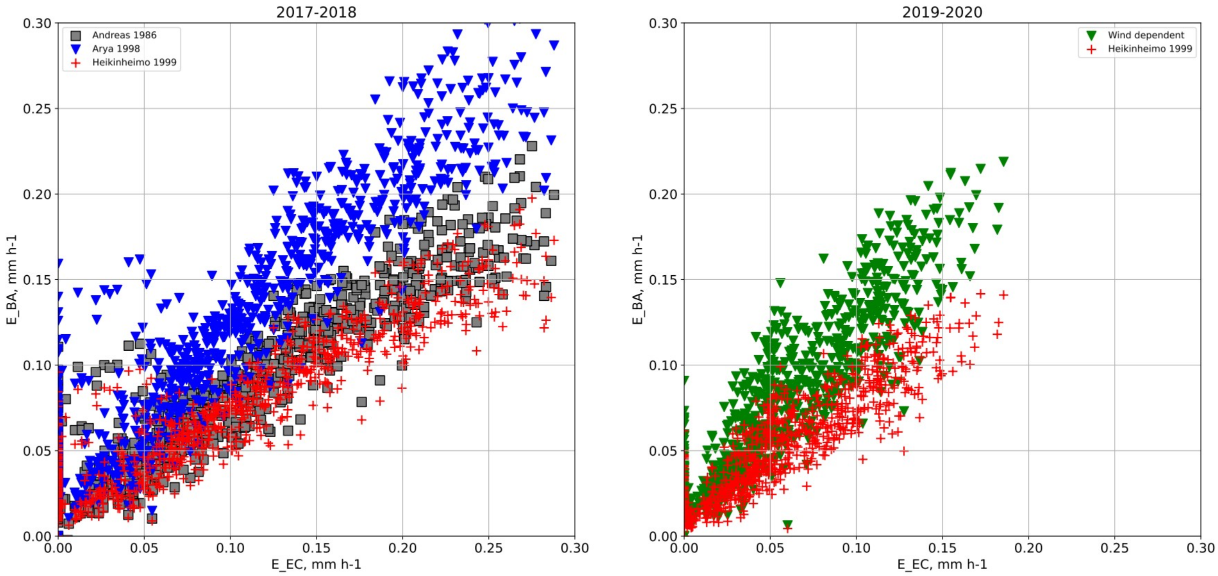
A: We removed the text about the ice cover fraction analysis. We refrain from including the panoramic images because their authorship is not fully clear yet.

Line 257: This interpretation of the data in Figure 9 is not correct. As VPD goes up, E goes down at Zub. But the relationship is less apparent than at Glubokoe, I admit. While I like Figure 9, another good way to show these relationships are in plots such as those in Peter Blanken's papers on Great Slave Lake and Lake Superior (Blanken et al 2000 Figure 6; Blanken et al 2003 Figure 5; Blanken et al 2011 Figure 9). Such figures would be very helpful here to dissect the major controls of evaporation form these lakes and compare them to other lakes. This goes for the bulk transfer coefficients as well. Guseva et al (2023), which the authors already cite, is a great resource the authors can use for comparing different lakes to their.

Blanken et al 2000. Water Resoures Research 36, 1069-1077.

Blanken et al 2011. Journal of Great Lakes Research 37, 707-716.

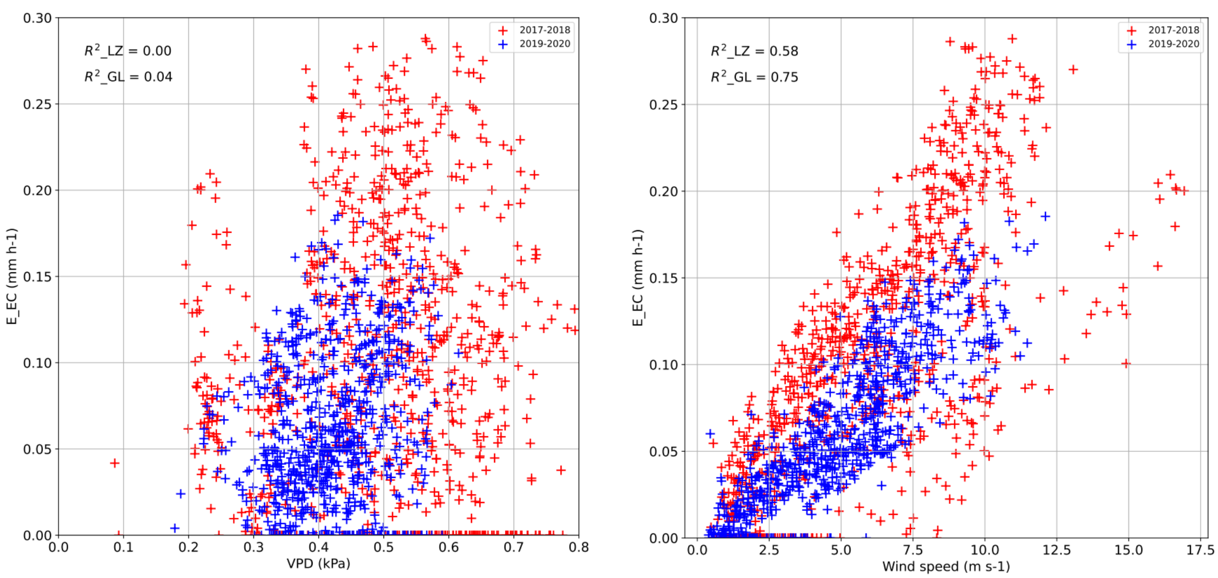
A: We modified Fig. 9, and text in Section 4.3 (lines 242 –255): " The hourly rate of lake evaporation was simulated with the bulk-aerodynamic method following the different actual values of the E_{C2} (Table 5). Figure 9 shows a good agreement between the bulk-aerodynamic simulations and independent measurements: the Pearson correlation coefficient is 0.92 for the data collected in the experiments on Lake Zub/Priyadarshini, 2017 – 2018 (Fig. 9 a) and 0.89 for Lake Gluboke, 2019 – 2020 (Fig. 9 b).



a b

Figure 9. The measured (x-axis) evaporation and simulated (y-axis) with the bulk-aerodynamic method applying different actual values for the E: (a) Lake Zub/Priyadarshini and (b) Lake Glubokoe. The red dots cross to Heikinheimo et al. (1999), grey box to Andreas (1986), blue triangle to Arya (1988), and green triangle to the wind-dependent coefficient.”

We added Figure 10 and new text in line 256: “There are two drivers forcing lake evaporation: the vapor pressure deficit (depends on a land surface-air temperature gradient) and wind speed. The results from two glacial lakes suggest no dependency between the lake evaporation and the vapor pressure deficit (Fig. 10 a) with the Pearson correlation coefficient is near zero in both experiments (2017 – 2018 and 2019 – 2020). However, the dependence between the lake evaporation and the wind speed is strong (Fig. 10 b), the Pearson correlation coefficient is 0.58 for the ice-free Lake Zub/Priyadarshini (2017 – 2018) and is 0.75 for the ice covered Lake Glubokoe (2019 – 2020). It implies that the wind speed is the major driver for the evaporation over the local lakes.



a b

Figure 10: The scatterplots of the vapor pressure gradient, (x-axis in a: VPD, kPa) and wind speed (x-axis in b: m s^{-1}) against the hourly rate of lake evaporation (y-axis in a and b) for Lake Zub/Priyadarshini (red) and Lake Glubokoe (blue).”

Table 3: Is the reference the same as "this study" in the last line? It is unclear what that is.

A: We changed Table 3 to Table 6 and added the text (line 286):

"The daily and seasonal rate of lake evaporation were calculated as a cumulative sum of the hourly rate after the bulk-aerodynamic method (with the various C_{E2}). For the ice free Lake Zub/Priyadarshini (2017–2018), the mean daily evaporation rate varied between 2.0 ± 0.1 mm d^{-1} and 3.0 ± 0.2 mm d^{-1} (Table 6). The best scores for the daily mean evaporation rate gives the C_{E2} = 1.7 x 10^{-3}, and it fits the estimates according to the EC technique (3.0 ± 0.2 mm d^{-1}).

Table 6. The lake evaporation estimated using the bulk-aerodynamic method used different actual values of the transfer coefficient (C_{E2}). The bold numbers indicate the indirect method that yielded the estimates closest to the reference, and the parentheses show the verification with the independent data. Sum is the cumulative value for the period of the experiment (Table 2).

Actual value the C_{E2} in Table 5	Lake Zub/ Priyadarshini (2017 – 2018)			Lake Glubokoe (2019 – 2020)		
	Mean mm d^{-1}	Sum mm	*RMSE / s/σ*	Mean mm d^{-1}	Sum mm	*RMSE / s/σ*
1.1 x 10^{-3}	[2.0 ± 0.2]	[78]	[1.0 / 1.1]	[1.3 ± 0.1]	[42]	[0.5 / 0.8]
Eqs. (17)	2.6 ± 0.2	100	0.7 / 0.7	[1.9 ± 0.2]	[63]	[0.5 / 0.9]
1.2 x 10^{-3}	[2.1 ± 0.2]	[79]	[0.9 / 0.9]	**1.5 ± 0.1**	**50**	**0.4 / 0.7**
1.7 x 10^{-3}	**[3.0 ± 0.2]**	**[114]**	**[0.7 / 0.7]**	2.2 ± 0.2	71	0.8 / 1.2

For Lake Glubokoe (2019 – 2020), the best estimate for the evaporation being 1.5 ±0.1 mm d^{-1} (on average) is obtained with the transfer coefficient C_{E2} = 1.2 x 10^{-3} with the daily lake evaporation of 1.6 ± 0.1 mm d^{-1}; it is approximately 8% less than the reference method. Depending on the value of transfer coefficient (C_E), the bulk-aerodynamic method either underestimated the evaporation up to 20% (1.1 x 10^{-3}) or overestimated it up to 38% (Eqs. 17). The RMSE varied from 0. 4 to 0.8 mm d^{-1}, and the s/σ criteria was 0.7 when the C_E was 1.2 x 10^{-3} and 1.7 x 10^{-3}, and the scores are acceptable for an indirect method (s/σ < 0.8). "

Line 298-301: This can be deleted because it is already in the figure caption.

A: Deleted.

Line 330: The word "lake" appears twice.

A: Deleted.

Line 394: I am not sure if you mean lake stratification here or not. But that also brings up the subject of lake heat storage - which should be discussed in the context of the combination methods that do not account for it. I know the authors did not measure it, but some discussion on the matter is needed in the paper.

A: No, we did not mean stratification, however, it worths to mention the lake heat storage in line 394: "In Antarctica, the summer thermal stratification has only been reported for saline lakes in the Larsemann Hills Oasis (Kaup etal., 2001), while the freshwater lakes stay mixed during the whole summer (Shevnina and Kourzeneva, 2017). In the Schirmacher Oasis, Lake Zub/Priyadarshini was reported to be thermally homogeneous during the period spanning from mid-January 1996 to mid-February 1997 (Sinha and Chatterjee, 2000)."

Line 409: More context is needed for the reader about why this water balance estimate is important.

A: We corrected the text as follows (line 409): " Gopinath et al. (2020) found that summertime evaporation is a significant component in the water budget of shallow lakes in the Schirmacher Oasis. Lake Zub/Priyadarshni supplies freshwater to the Maitri research station which is crewed with approximately 60 people at maximum during summers. A new Maitri-II research station is planned to open in 2032; expanding the investigation of Antarctica, it will accommodate up to 140 people (10 October 2025, https://timesofindia.indiatimes.com/). To plan the water supply/utilisation system of the stations, one should investigate (model) the water budget of Lake Zub/Priyadarshni. Dhote et al. (2021) evaluated the component of this lake water balance equation, namely the precipitation, inlet river runoff and wastewater return (as positive); and the outlet river runoff, evaporation and freshwater withdrawal (as negative).

The volume of Lake Zub/Priyadarshini is 1.03×10^6 m^3, and in January – February 2018 it decreased by 40.3 m^3; the discrepancies of the water balance equation was 670.6 m3 (Dhote et al., 2021). The lake evaporation of 58.5 m^3 was calculated following Odrova (1979), which underestimated the evaporation by72 % 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 the bulk-aerodynamic method with the neutral 10-m turbulent transfer coefficient of moisture (C_{ENz}, z = 10 m) equaling 2.1×10^{-3}. The volume of precipitation over the surface of Lake Zub/Priyadarshini was 5.3 m^3 in January – February 2018, and it is 0.05% of the lake volume. The rest of discrepancy is likely contributed by methods used to evaluate the inlet/outlet river runoff. "

Line 420: I am not sure what this paragraph provides for the paper. I recognize the portion about solar radiation was in response to a reviewer comment. It may have been better placed in the Methods section.

A: We removed the paragraph.

Line 436: This is very important. I apologize if I am wrong, but *wasn't the coefficient calculated with the same data used to test it?* This is inappropriate and brings into question conclusions that a bulk aerodynamic method would be more accurate than others approaches. I recognize that this is large part of the interpretation and outcome of the work. That said, I feel the paper would be more impactful if there were more explanation of what controls evaporation from these lakes, and how that compares and contrasts with other lakes around the globe. I am not suggesting removing the comparisons with the combination methods, but don't make the outcome of the paper an evaluation of methods. Instead, use those estimates (i.e., when they work and when they do not) to interpret what is necessary and what is not when it comes to predicting lake evaporation in Antarctica. Again, compare this to the results found elsewhere on the planet. Then the authors could bring in the content discussing solar radiation, as recommended by a previous reviewer. Which is important, because it controls the surface temperature of the water. However, if one looks at the bulk transfer relationship:

incoming solar radiation is nowhere to be seen. Incoming solar radiation is important at a seasonal or annual scale, but with the large heat capacity of lakes, there are only specific situations where incoming radiation is the main driver, and that tends to be in shallow warm lakes. Which these are not. Finally, the authors could then bring the discussion back to the local situation of what is important to predict conditions around these lakes.

Again, compelling work. I hope these comments are useful for improving the paper.

A: Thank you! We answered the question "Wasn't the coefficient calculated with the same data used to test it?": NO. The indirect methods were verified with the independent data.

We modified the text in lines 22–67 (**Introduction):**

Antarctica hosts numerous water bodies that store meltwater within a complex hydrological system of lakes and streams. Every summer, approximately 60,000 supraglacial lakes are formed on the ice shelf (Corr et al., 2022; Dirscherl et al., 2021), the largest lakes found in East Antarctica are up to 80 km long (Shen et al., 2025; Stokes et

al., 2020). These lakes accelerate the marginal glacier calving (contributing to the global sea level rise), and increase risk of hydrofracture-induced collapse of ice shelves (Rignot et al., 2004; Banwell et al., 2013; Arthur et al., 2022). Providing a moisture source to the atmosphere through evaporation, lakes affect local weather by increasing the precipitation and fostering fog formation (Blanken et al., 2003; Gultepe et al., 2003; Rouse et al., 2005; Su et al., 2020).
Antarctica hosts approximately 120 permanent settlements in Antarctica, most of them located along the continental coast, in rock oases and sub-Antarctic islands (Antarctic station catalog, 2025). Since the COVID-19 pandemic, the number of people visiting Antarctica has increased by 40%, and is expected to grow further by approximately 12.5% per year (Bastmeijer et al., 2023). The nearest lakes provide a freshwater supply for the settlements, and evaluation of their water resources is a crucial task for their managers (Kaup, 2004; Sokratova, 2011). The managers plan on the maintenance and infrastructure investments based on assessment of freshwater resources and hydrological risks (Lan et al., 2025). This assessment requires reliable hydrometeorological observations and robust models to evaluate hydrological stability. Furthermore, the Antarctic lakes house unique lifeforms (Rothschild and Mancinell, 2004; Andersen et al., 2011; Keskitalo et al., 2013). Understanding the lake hydrological regime is important to save these ecosystems (Faucher et al., 2019)."

Modified text in lines 69-95, **(**study area**):** The Schirmacher oasis (70°45′ S, 11°38′ E) is situated approximately 80 km from the coast of Lazarev Sea, Dronning Maud Land (SA, Fig. 1 a). The oasis is an ice-free rock outcrop approximately 20 km long and 3 km wide (Fig. 1 a), elongated in the west–northwest to east–north-east direction (Simonov and Fedotov, 1964). The relief is hillrocks with absolute heights up to 228 m above sea level (asl). The rock hills mostly consist of gneiss mixed with basalts (Sengupta, 1991).
The Oasis was discovered in 1939, and first settlements emerged primarily for science in the late 1960s. Now, the oasis now shelters two scientific observatories operated year round and two tourist camps occupied seasonally (Fig. 1 b). The observatories are crewed by 25–30 overwintering personnel, and up to 50 personnel are visiting the site during summers. Two tourist camps accommodated up to 20 people, and operated from November to February. Two ice runways support transportation of people and cargo. Fuel and goods are mostly delivered by ships to coastal bases located on the ice shelf, and then transported to the settlements by vehicles. 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 is hindered by meltwater lakes and streams formed over the ice. Figure 1 c shows the melted ice road to the White Desert Camp in December 2019."

We replaced the lines 96-105 with new text: "Lakes have existed since the Late Quaternary in the Schirmacher Oasis (Phartiyal et al., 2011), and today, the oasis is home to approximately 300 lakes (Gerrish et al., 2008). Most of these are freshwater waterbodies, nourished by ice melt and seasonal snow cover, and remain ice-free for 6 – 12 weeks in summer (Simonov, 1971). The largest lakes are attached to the ice sheet (glacial), and are connected by temporary streams into chains that end up in epishelf saline lakes (Loopman et al., 1988). Lakes with no connection to ice are landlocked: they are fed by only snow melt, and evaporate through time forming hollows and dry beds (Fedorova et al., 2011). This study focuses on two lakes differing in volume and depth, and both becoming ice free almost every summer for 2–8 weeks (Khare et al., 2008; Tolstikov et al., 2018). Lake Zub/Priyadarshini is the second largest lake in the Oasis with a volume of 1.02 $x10^6$ m^3. Its maximum depth is 6.0 m (mean depth is 2.9 m), and a surface area of 35,000 m^2 (Dhote et al., 2021). The lake was ice free from 29–31 December 2017 to 8–12 February 2018. Lake Glubokoe is the deepest lake in the Oasis with a maximum depth of 34.5 m (mean of depth is 13.1 m), a surface area of 147,000 m^2, and a volume of over 1.93 $x10^6$ m^3 (Loopman et al., 1988), Until the late 1990s, it was ice-covered year round (Kaup, 2005). This lake was free of the ice from 26 – 28 January 2019 to 23 – 25 February 2020."

We added the following text instead of lines 318–395 (discussion): The EC technique has been recognized as the most precise for directly measuring the evaporation over inland water (Eugster et al., 1997; Spank et al., 2020; Rodrigues et al., 2020), and has taken as a reference to quantify various indirect methods (Wang et al., 2019; Tanny et al., 2008). Its accuracy is, however, sensitive to how a measuring system has been deployed and postprocessed (Spank et al, 2025; Burba, 2013). In our experiments, the EC system was deployed to measure fluxes over the lakes on low heights (1.8 – 2m), and the data got low gaps. The system was deployed with accounting the prevailing winds, and during the experiments the instrumentation fetched up to more than 80 % fluxes from the footprint covered by a lake surface. The EC measurements were processed following the standard routine (filtering, gap filling, footprinting). Therefore, we considered the EC measurements given the reference to compare the lake evaporation calculated with the indirect methods.

We estimated evaporation from the EC measurements collected in two lakes in the Schirmacher Oasis. Two field experiments covered the break-up and ice-free periods on the lakes differing in depth, volume and thermal regime. For Lake Zub/Priyadarshini, the direct estimates give the average daily evaporation rate as 3.0 ± 0.2 mm d^{-1} in January – February 2018 when the lake was ice-free. The daily evaporation varied from 1.5 to 5.0 mm day^{-1}; and the cumulative sum of lake evaporation was 114 mm for the period from 1 January to 7 February 2018 (38 days). The evaporation increased with the wind speed, and took the maximum of 5.0 mm d^{-1} observed during storms. The highest evaporation was measured on 2 – 3 January 2018. For Lake Glubokoe, the daily evaporation rate varied between 0.3 and 3.2 mm d^{-1}, with an average of 1.6 ± 0.1 mm d^{-1} during the ice break-up period. The cumulative sum of evaporation is 54 mm of evaporation over the 33-day period in December 2019 – January 2020. The largest evaporation rate (up to 3.0 mm d^{-1}) was observed during the storm 13–15 December 2019. The EC measurements imply the lakes start evaporating immediately after the break up, and this effect is likely caused by the strong winds resulting in the high evaporation rate even in days with low vapour pressure gradient.

To the best of our knowledge, the measurements of lake evaporation in Antarctica with the EC technique were done only on two lakes in the Schirmacher Oasis. However, these measurements are available for natural and artificial lakes globally (Guseva et al., 2022; Liu, 2023). While many studies analyse the surface energy budget of lakes, they typically report evaporation as a latent heat flux expressed in W m^{-2} or J cm^{-2} day^{-1} (Stewart and Rouse, 1976; Stannard and Rosenberry, 1991; Marsh and Verseghy, 2000; Oswald and Rouse, 2004; Blanken et al., 2011; Mamarella et al., 2015). These energy-based units are often impractical for hydrological (water balance) applications, and are difficult to compare directly with depths measured by other techniques (for example, evaporation pans). To ensure comparability of our results, we converted the reported latent heat fluxes (W m^{-2}) into equivalent depths of evaporated water.

The EC measurements remain rare on the lakes located north of 60° latitude. Ala-Könni et al. (2022) measured the evaporation over Lake Kuivajärvi (61°N, Finland) during the ice free period, and yielded the mean evaporation rate 1.5 – 2.5 mm d^{-1} during July – August; the evaporation up to 5 mm d^{-1} were observed in days with strong winds, or periods when dry and cold synoptic fronts pass. Blanken et al. (2000 and 2003) measured the evaporation over Great Slave Lake (62 °N, Canada) during the ice free period from June to September (1997, 1998, and 1999) when the evaporation rate reached 2.8 mm d^{-1}. The results imply that both (wind speed and vapor pressure gradient) control the evaporation over an ice free lake. Granger and Hedstrom (2011) estimated that 4–9 day-averaged evaporation rate reaches 3.2 – 3.9 mm d^{-1} during an ice free period for small lakes located next to Lake Great Slave. The northernmost EC measurements were obtained from a small Arctic thermokarst lake (72°N, Russia) during an experiment spanning from April to August 2014 (Franz et al., 2018). The lake evaporation rate was estimated to be near zero from April through the mid June (covering the ice-covered and break-up periods), subsequently averaging 2.5 mm d^{-1} and peaking at 6 mm d^{-1} during the ice free period from July to September. These estimates of the lake evaporation are comparable with the evaporation over the ice-free Lake Zub/Priyadarshini measured with the EC technique (2017 – 2018).

Evaporation of the high-altitude lakes in the Qinghai-Tibetan Plateau (36°N, 3200 – 4700 m asl, China) has been extensively studied in last decades with the EC measurements spanning more than 5 years (Shi et al. 2024; Gan and Liu, 2020; Meng et al 2020; Wang et al., 2019; Li et al. 2016). Li et al. (2016) found that evaporation over the ice-free Lake Qinghai reaches up to 12 mm d^{-1} during storms, and windy days (wind speed > 4 m s^{-1}) contribute up to 22 % of the annual lake evaporation, and this contribution is comparable for the ice sublimation (23 %). Shi et al. (2024) conclude that evaporation over the ice-free Lake Qinghai is controlled by wind rather than by vapor pressure gradient or solar radiation. It is in accordance with our results shown that wind is the primary factor driving the evaporation over two lakes in Antarctica. We did not measure the radiation during the experiments, however, it is routinely measured with instrumentation installed at Maitri and Novo observatories. It opens opportunities for a new study on the lake surface energy balance.

Faucher et al. (2019) measure the ice sublimation over the surface of perennially frozen glacial Lake Untersee (71° S, Antarctica) with sticks during two years (), and estimate the sublimation (evaporation) between 400 to 750 mm $year^{-1}$ which gives the mean daily rate 1.1–2.1 mm day^{-1}. It is very close to the estimates obtained for the ice-covered Lake Glubokoe (2019 – 2020). Dugan et al., (2013) estimate the lake ice ablation (sublimation) of 5–31 mm d^{-1} for the lake in Tailor Valley (77°S, Antarctica); the authors, however, did not have means to distinguish between the contributions of surface melt and sublimation to ablation during summer. For winter, Dugan et al. (2013) found sublimation values ranging from 0.2 to 0.7 mm d^{-1}, and these values are naturally much smaller than our results obtained for the fully or partially ice-free lakes.

Leppäranta et al. (2016) reported the summertime ice sublimation of 0.7 mm d^{-1} for the lakes in the Vestfjella mountains, Droning Maud Land (73°S, Antarctica), and the ice thinning of 10 – 15 mm d^{-1} on a small pond on top of a nunatak during days with the winds speeds exceeding 30 m s^{-1} . Because of no surface melt during days in such windy days, the ice thinning is likely attributed to sublimation (Leppäranta et al., 2016). No EC observations were available from the site but we checked that according to the bulk-aerodynamic method these values are indeed possible under such a wind speed, if the ice surface temperature is close to 0 ºC and the air is very dry.

The bulk-aerodynamic method is sensitive to actual values of the transfer coefficient of moisture (C_E) which is typically considered almost constant with a value of approximately $1.1 \cdot 10^{-3}$ over the ocean (Kantha and Clayson, 2000) and varying between 1.1 and $2.4 \cdot 10^{-3}$ over the natural and artificial lakes (Hicks, 1972; Guseva et al. 2022). Our results showed that the transfer coefficient of moisture (C_{ENz} , z = 10 m) varying between $1.4 \cdot 10^{-3}$ and $2.1 \cdot 10^{-3}$ (Lake Zub/Priyadarshini and Lake Glubokoe, respectively). With these actual values, the bulk-aerodynamic method underestimated the evaporation by 6 – 8 %, and got the scores $s/\sigma < 0.80$ and RMSE of 0.6 mm d^{-1} , which are acceptable to recommend this method to simulate the daily lake evaporation rate for two lakes in the Schirmacher oasis. It aligns to conclusions of the studies focusing on the evaporation over the lakes of Qinghai-Tibetan Plateau (Wang et al., 2019).

The lake evaporation measured with the EC technique includes the contributions of both interfacial evaporation from the lake surface and evaporation from spray droplets in the air. It is difficult to distinguish between these contributions but, based on observations by Guest (2021) over the Southern Ocean, we may assume that under very strong winds the spray evaporation is some 18 % of the interfacial evaporation. Accordingly, if one wants to apply the wind dependent transfer coefficient (Eqs. 16 and 17) solely for the interfacial evaporation, the contribution of spray evaporation must be subtracted from the results. The stability dependence for the transfer coefficient of moisture was minor. This was because during the period of the experiments, the lakes were continuously warmer than the ambient air (on average by 4.7 C in January – February 2018). Hence, when the wind was strong, the stratification was close to neutral and the transfer coefficient was large and not sensitive to the stratification.

Application of the traditional approaches to measure lake evaporation in Antarctica is limited by the difficulty of their maintenance and operation. Defining the actual values for the mass transfer and empirical coefficients requires detailed (micro)meteorological measurements on different heights and episodically done in Antarctica. The tracers-based approach may give an accurate estimate of lake evaporation (Fekete et al., 2006); it, also, requires regular water sampling followed by a unified programme. It, however, is relatively easy to organize on lakes located next to the human settlements."

We also added to the following references:

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