Comments for Shevnina et al. (2025) "Summertime evaporation over two lakes in the Schirmacher oasis, East Antarctica"

General comments:

The manuscript by Shevnina et al. (2025) represents a significant advancement in polar hydrology research through its detailed investigation of summertime evaporation processes in Antarctic lakes. The study's principal strength lies in its collection of rare direct eddy-covariance (EC) measurements under extreme polar conditions, providing valuable empirical data for a region where such measurements are exceptionally scarce.

The authors have undertaken a rigorous validation of multiple evaporation methods, including both bulk-aerodynamic approaches and combination formulas, against their direct EC measurements. This systematic comparison provides important insights into the performance characteristics of different estimation techniques in polar environments, with practical implications for hydrological modeling in data-scarce regions. Their finding that appropriately parameterized bulk-aerodynamic methods can achieve errors as low as 6-8% represents a valuable contribution to the field.

The experimental design demonstrates comprehensive field instrumentation including EC systems, HOBO loggers for water temperature monitoring, and digital cameras for ice cover documentation. The data processing protocols follow established methodologies in micrometeorology, with appropriate attention to footprint filtering, gap-filling procedures, and uncertainty quantification. The authors' approach to addressing ice-cover transitions is particularly noteworthy, as this represents a challenging scenario for evaporation estimation that is rarely captured in such detail.

The statistical analysis employs multiple performance metrics (RMSE, SSC, bias calculations) to evaluate method performance, providing a robust assessment of the different estimation approaches. The availability of supplementary code and data further enhances the study's reproducibility and potential for future comparative analyses.

Specific comments:

1. Does the paper address relevant scientific questions within the scope of HESS?
Yes, unequivocally. The paper tackles the critical challenge of quantifying a fundamental component of the water balance—evaporation—in a sensitive and data-scarce polar environment. This directly aligns with the HESS scope of "physical, chemical, and biological processes within the hydrological cycle" and its emphasis on "the interaction of hydrology with other earth system sciences." Understanding these processes in Antarctica is vital for predicting freshwater availability for research stations, assessing the stability of ice shelves influenced by supraglacial lakes, and modeling regional climate feedbacks.

2. Does the paper present novel concepts, ideas, tools, or data?
Yes, primarily through its novel data. The core novelty is the presentation of rare, direct eddy-covariance measurements of lake evaporation in coastal East Antarctica. This dataset is a significant contribution in itself. The development and validation of a wind-dependent parameterization for the bulk transfer coefficient (C_E) specifically for Antarctic lakes is a novel and valuable methodological outcome. While the concepts (EC, bulk method) are established, their application and rigorous validation in this extreme environment provide novel insights.

3. Are substantial conclusions reached?
Yes. The conclusions are robust, significant, and well-supported by the data:

- Direct evaporation rates are quantified (0.3 to 5.0 mm d^{-1}), showing clear dependence on ice cover and wind speed.
- Most combination formulas (Penman, Odrova, etc.) are shown to have severe systematic biases, underestimating evaporation by 27-73%.
- The bulk-aerodynamic method is confirmed to be highly accurate (6-8% bias) but only when using appropriate, site-specific transfer coefficients (e.g., from Arya (1988)), not generic ones.
- Wind speed is identified as the primary driver of short-term evaporation variability, a finding that contrasts with studies in less windy environments (like the Tibetan Plateau in Wang et al. (2019)).

  Wang, B., Ma, Y., Ma, W., Su, B., & Dong, X. (2019). Evaluation of ten methods for estimating evaporation in a small high-elevation lake on the Tibetan Plateau. Theoretical and Applied Climatology, 136(3), 1033-1045.
- The authors did not comment on the role of solar radiation which is the main driver of evaporation and needs to be discussed, even they did not directly measure it.

4. Are the scientific methods and assumptions valid and clearly outlined?
Yes. The methods are state-of-the-art. The use of EC as a reference is the gold standard. The post-processing pipeline (spike removal, footprint filtering, gap-filling) is clearly described and follows established protocols. The assumptions (e.g., the applicability of Monin-Obukhov similarity theory, the representativeness of point measurements) are standard for such studies and are clearly addressed. The statistical analysis using RMSE and SSC is valid and appropriate.

5. Are the results sufficient to support the interpretations and conclusions?
Yes. The results are comprehensive and compelling. The data from two different lakes and two summer seasons provide a robust basis for analysis. The figures (timeseries, diurnal cycles, scatter plots) and tables (method comparison, skill scores) effectively

present the evidence. The clear gradient of performance across the different methods strongly supports the conclusion that parameterization is key. The finding that wind speed correlates better with evaporation than the vapor pressure deficit is convincingly demonstrated.

6. Is the description of experiments and calculations sufficiently complete to allow reproduction?
Yes. The description of the instrumentation, sensor heights, data processing steps, and equations is excellent. The provision of code and data on Zenodo is a major strength that ensures full reproducibility and aligns with best practices in open science.

7. Do the authors give proper credit and indicate their original contribution?
Yes. The introduction and discussion thoroughly contextualize the work within existing literature on polar hydrology and evaporation methods. The authors clearly reference the original sources of the combination formulas they test. Their own original contribution—the unique EC dataset and the subsequent validation of methods—is clearly stated and forms the central pillar of the paper.

- *Note w*hile Wang et al. (2019) focused on a different environment, a discussion acknowledging that their finding (mass transfer methods work well) aligns with conclusions from other extreme environments (like high-altitude lakes) could further strengthen the context.

8. Does the title clearly reflect the contents of the paper?
Yes. The title is accurate, specific, and concise, correctly reflecting the location, subject, and process studied.

9. Does the abstract provide a concise and complete summary?
Yes. The abstract perfectly summarizes the objectives, methods, key results (including quantitative findings), and the main conclusion and recommendation.

10. Is the overall presentation well structured and clear?
Yes. The paper follows a standard and logical structure. The flow is easy to follow, and the argument is built progressively.

11. Is the language fluent and precise?
Yes. The language is clear, formal, and scientific. While there are a few minor grammatical quirks (e.g., "containerizing" on p1), they do not hinder understanding. The manuscript is well-written.

12. Are mathematical formulae, symbols, abbreviations, and units correctly defined and used?
Yes. Formulas are presented clearly. Symbols are defined upon first use (e.g., in the bulk formula on p6). Units are used consistently throughout (mm d^{-1}, ms^{-1}, etc.).

- *Note:* In Table 1, the column "Sum" has units "mm p^{-1}". This should be clarified to "mm per [33-day] period" to avoid ambiguity.

13. Should any parts of the paper be clarified, reduced, combined, or eliminated?

- Clarify: The distinction between "SSC" and "SSg" in the text and Table 4 should be made consistent.
- Clarify: The discussion of spray evaporation (p19) references "Eqs 3, 4", but only Eqs. 2 and 3 are presented. This should be corrected.
- One needs to guess the applicability of Eqs 2,3, the meaning of the coefficients and the height where the wind speed w2 is measured should be explicitly stated.
- L146: the formula for σ should appear before 'where' in L145.

14. Are the number and quality of references appropriate?
Yes. The reference list is extensive, relevant, and includes key historical works, foundational methodological papers, and recent literature. It appropriately covers the fields of micrometeorology, Antarctic science, and hydrological methods.

15. Is the amount and quality of supplementary material appropriate?
Yes, and it is a significant strength. The availability of the raw code and data on Zenodo is exemplary and exceeds typical standards. It ensures full transparency and allows for exact reproduction of the analysis, which is crucial for a validation study like this.