The paper is well-written and demonstrates a high level of scientific quality. The topic is of significant interest and aligns well with current research on the influence of subglacial hydrology on ice motion, particularly within the context of the Antarctic ice sheet. This area of study has gained renewed attention in recent years, addressing gaps in the existing literature.

The research demonstrates the impact of subglacial hydrology on marine ice stream dynamics, coupling various systems in a positive feedback loop involving ice flow, basal heat dissipation, and basal lubrication. By using a simple flow-line model, the authors explore different subglacial phenomena arising from the presence of subglacial water in a soft bed system. Their results emphasize the dependence of ice stream dynamics on basal conditions.

I recommend the publication of this paper following a few minor revisions.

I have structured the comments into general comments and line-by-line comments. The general comments are suggestions to improve clarity for a new reader, curiosity questions, or suggestions of improvements that are recurrent throughout the paper.

General comments and suggestions

- I suggest to summarize in a simple and clear way the model at the beginning of the paper. Indeed, it is a bit complicated during the first read of the paper to understand well in terms of subglacial hydrology what is considered and what is not. For example, please specify that it's a model only applied on a soft bed and which encompasses inefficient and efficient subglacial drainage systems through a hydraulic conductivity factor that increases with decrease of the effective pressure. No switch between efficient and inefficient drainages is assumed, as well as no channels at higher subglacial water flux. Furthermore, no interaction between subglacial water and ocean water and no vertical infiltration are considered. I also think you could more explicitly summarize what subglacial processes the kappa factor encompass.
- Also, I do not understand whether or not $h_{w\&s}$ are limited. That is the case, please mention it.
- Some values used in this research (e.g., constant coefficients in Table 1 or values of kappa used in experiments) are not referenced, and there is no explanation regarding the choice of their values. Please provide the references where applicable and add comments about the choices that had to be made.
- I think it's important to clearly specify that the processes you talk about are subglacial processes. Therefore, make sure to add the term "basal" with "melt" and "subglacial"

with “water” when necessary. The same goes for the term “discharge”—make sure to specify whether it refers to water or ice.

- In general, in the presentation of the results, I suggest emphasizing the quantitative values of the mentioned variations and referencing the relevant figures/videos more regularly.
- Does one of your limit cases could be interpreted as that of a hard bed system ?
- Have other geometries (slope/shape) of beds been investigated?
- In terms of results, more details could be provided regarding the timing of the experiments. For example, I don't understand why, in Figure 2, there is a 800-year difference between d1 and d2, while in the other figures, the results are shown to take place over a scale of a few years. I also think a comment on the initial and final conditions would be interesting.
- What is the computation time for these models?
- In your text, you explain well that kappa is an average used to represent in 1D hydrological systems that would be found in 2D. You also mention that multiple systems can exist for N. However, depending on the drainage system, for the same flow, a different effective pressure could be obtained (cf. Fig. 4 Walder and Fowler, 1994). Maybe you discuss how your model could include other drainage systems.

Line-by-line comments

L6: I don’t understand why a hydraulically controlled motion is called a “**surge**”, while a thermally controlled motion is referred to as an “**oscillation**”. Shouldn't we use the same term, or are these two different phenomena?

L25: Maybe add something that explains why existing observational work does not address the interplay between subglacial hydrology and marine ice-sheet dynamics, such as 'because of the lack of direct observation.'

L27: Maybe add: Gregov, T., Pattyn, F., & Arnst, M. (2023). Grounding-line flux conditions for marine ice-sheet systems under effective-pressure-dependent and hybrid friction laws. *Journal of Fluid Mechanics*, *975*, A6.

L40: By reading this sentence, one might think that in an extreme case, this feedback loop never stops. Is it possible to add something to moderate it, like “up to a certain point”?

L44: add something like “Which is often the case because of the low porosity of this material”

L52: "**subglacial** water" –"and water content of the bed **composed by till**"

L63: Give a numerical value for the low hydraulic conductivity

L64: At what value of hydraulic conductivity is the limiting case obtained?

L68: finite **and intermediate** hydraulic conductivities

2 The Model

L76: It's not clear that the length refers to the domain and not to the flowline.

L77: **depth** or **thickness** to clarify the word "content"

L86-87: For *n*, keep "rheological" as used in the text or "viscosity" as in the table, but not both—avoid using two different terms. The value of epsilon is missing in the table. What is the value, unit, and source of epsilon? Also, please provide more details about C_w.

L88: Refer to some of these recent studies.

L92: Add a note that explains that since μ **is constant** at high effective pressure, you obtain a Weertman-style sliding law. Also, include a reference explaining why **m = 1/3** is used.

L99: Maybe add the reference: Shreve, R. L. (1972). Movement of water in glaciers. *Journal of Glaciology*, *11*(62), 205-214.

L100: Maybe add references like van der Wel et al., 2013, Bougamont et al., 2014 and Bueler and van Pelt, 2015.

van der Wel, N., Christoffersen, P., & Bougamont, M. (2013). The influence of subglacial hydrology on the flow of Kamb Ice Stream, West Antarctica. *Journal of Geophysical Research: Earth Surface*, *118*(1), 97-110.

Bougamont, M., Christoffersen, P., Hubbard, A. L., Fitzpatrick, A. A., Doyle, S. H., & Carter, S. P. (2014). Sensitive response of the Greenland Ice Sheet to surface melt drainage over a soft bed. *Nature communications*, *5*(1), 5052.

Bueler, E., & van Pelt, W. (2015). Mass-conserving subglacial hydrology in the Parallel Ice Sheet Model version 0.6. *Geoscientific Model Development*, *8*(6), 1613-1635.

L100-L102: **subglacial** water

L103: If I understand correctly, the properties of the bed itself are not modified. I would suggest modifying the sentence to: "The conductivity only depends on the water content […] and the properties of the bed are kept constant".

L109: The difference of pressures allows canals to deform the soft bed. So I will modify the sentence by “eroded **and deformed**”.

L120: For the values of the model-specific constants, I suggest adding the sources of the values used.

L140: Add a reference for this.

L14 : Add numbers/letters in Eq. 10 conditions for more clarity. I propose 10b.

L153: Maybe add that the GL and the calving front are the same (even though it is mentioned on line 336).

3 Results

L174: **basal** melt water

L 175: In the limiting case of quasi-infinite conductivity of the hydraulic system, I do not understand how water can be evacuated without hydraulic gradients. From my understanding, this limit case corresponds to the height above buoyancy model. Could you provide me with further explanations?

L 185: you mention fig 5 before fig 4 in the text

L 199: please refer to the corresponding figure to find directly the order of magnitude of variations and the time scale

L209: Figure 5**e**

L222: **subglacial** water fluxes

L232-238: **basal** melt rate

L238-235: Please add numerical values to your analysis.

L250-256: Also, remind us which figure we should observe.

L250: “significant” – Maybe provide a numerical value, if one is available?

4 Discussion

L261: I would nuance this statement by adding “**namely**”

L263: specify the kind of subglacial drainage system

L264: maybe remind the reader that low hydraulic conductivities lead to high subglacial water storage and reduce effective pressure

L288: indic**a**te

L299: Do you obtain such a result also because you considered more things in your "hydraulic conductivity parameter" ?

L306: maybe add reference like Schroeder, D. M., Blankenship, D. D., Young, D. A., Witus, A. E., & Anderson, J. B. (2014). Airborne radar sounding evidence for deformable sediments and outcropping bedrock beneath Thwaites Glacier, West Antarctica. *Geophysical Research Letters*, *41*(20), 7200-7208.

L307: and deforming the bed composed of till/sediments

L313: Papers like Hager 2022 and Dow 2022 consider channels in WAIS. Maybe add a sentence assuming that their existence is plausible in WAIS too.

Hager, A. O., Hoffman, M. J., Price, S. F., & Schroeder, D. M. (2022). Persistent, extensive channelized drainage modeled beneath Thwaites Glacier, West Antarctica. *The Cryosphere*, *16*(9), 3575-3599.

Dow, C. F. (2022). Hidden rivers under Antarctica impact ice flow and stability. *nature geoscience*, *15*, 869-870.

Appendix

L395: Inefficient rather than ineffective (by opposition to "efficient" in line 393).

Figures and table

General comments for the figures : Great figures! However, I always find it clearer when the extreme values of the colorbar are also indicated. Verify that all panels are mentioned and explained in the short text linked to each figure.

Figure 1: not clear that the bed is "downwards"

Table 1: If you don't explain all the parameters in the text, refer to the table. Epsilon, h_m, N_0 are missing from it.

Figure 2: Explain column c and e.

Figure 3: Why showing specifically these values of kappa ? Maybe provide a rationale for that choice.

Figure 4: **basal** melt rate

Figure 5: **Ice discharge** / **subglacial** water