

General comments:

In this study, the authors uncovered a newborn basal channel within the extensive channelized network of the southern frontal area of George VI Ice Shelf. That channel exhibits remarkably higher basal melt rate than the surrounding area, and may have the potential to influence the ice shelf weakening. The authors argue that the emergence of that channel is likely linked to the 2015 ENSO event. I think the manuscript is well written and structured, and the uncovering of the new channel is intriguing, but I also do think the mechanism behind the generation of that channel and its influence on the ice-shelf instability are poorly demonstrated by the oceanic models the authors used in view of the quite inadequate horizontal resolution, fixed thermohaline forcing, inconsistency between the model parameter and the modeled results, and the insignificant thermal and speed differences between the BEFORE and AFTER experiments, etc. Please refer to my major comments for more details. As such, I regret that I could not support to publish this manuscript in its current form in *The Cryosphere*. Some minor suggestions are also provided.

Major comments:

First of all, the adopted horizontal spacing in LADDIE is 500 m, and that in the previous MITgcm-based simulation the authors utilized is much coarser, that is, 2-4 km. In contrast, the width of the new channel unveiled here is rather narrow, that is, only 2 km (as shown in Fig. 4j). That means such a fine basal topography is not represented at all in the utilized MITgcm model, and is also poorly represented in the LADDIE. Therefore, those coarse horizontal resolutions are far from adequate to resolve the interaction between the new channel and the underlying ocean. Second, as shown in Fig. 6b and h and Fig. 7c and f, the thermal and speed differences just below the ice base of the focused area between the BEFORE and AFTER periods are no more than 0.2 °C and 2 cm/s, respectively. Those small anomalies I think would not account for “the rapid emergence of a significant channel” with sufficient credibility. Third, the adoption of the constant (only winter-averaged in 2010 and 2020) profiles to force LADDIE seems to be some inappropriate in view of the fast-evolving southern part of George VI Ice Shelf as illustrated in this study. Fourth, there is a significant inconsistency between the large channelized basal melt rate (up to 30 m s⁻¹ as shown in Fig. 1) and both low drag coefficient (3×10^{-4}) and plume speed (the maximum is only 0.15 m/s as shown in Fig. 8b and e), which would make me question the simulated results of LADDIE. At last, the LADDIE results shown in Fig.

8, for me, do not provide any new insights into the channelized meltwater plume and the corresponding basal melting. The plume tends to be topographically guided by the basal channels, and the basal melting is amplified therein. That finding has been proved in a wealth of literatures as listed at the end of this report.

Therefore, after reviewing this manuscript I still have no idea why that channel was born, and what it will bring about for the upcoming evolution of George VI Ice Shelf. I think that could not be simply attributed to ocean warming, the link of which to ENSO, however, remains unclear (as stated in Line 277). Although the authors have acknowledged that “there is a disparity in scale between the model grid size and the size of the channel (Line 255)” and “interpreting circulation changes in more detail and on a smaller scale, particularly in the immediate vicinity of the channel, remains challenging given the coarse model resolution (Line 257-258)”, it is the model flaws they mentioned above that are **SO** critical to resolve my concern. In that sense, maybe the coupled ice sheet-ocean models (as used in Gladish et al., 2012 and Sergienko, 2013) but with sufficiently high resolution would be an effective way.

Specific comments:

The title: I think the temporal scale of this weakening should be specified.

Line 16: “..., largely due to the unknown response of ice shelves.”_response to what? From my point of view, the response of ice shelves to the changing oceanic and climatic conditions is really not unknown in view of increasing relevant literatures, but with deep uncertainty.

Line 24-25: “In some regions of ... (warm cavity ice shelves)”_please add some supporting references.

Line 63: which “two time periods”?

Line 141-142: “two scenarios: i) ... (AFTER experiment).”_confusing statement: you mean the periods of January 2010 to July 2016 and July 2016 to December 2020 respectively for the BEFORE and AFTER experiments?

Line 179: “where the surface temperature (T_0) is based on the surface salinity (S_0)”_you should explicitly state that the surface temperature is set to the surface freezing point.

Line 186-188: “The salinity is in LADDIE, however, described by a quadratic function, ... as for the temperature, following”_It appears to be some redundant to mention the quadratic function.

Line 197: “Ocean models approximate physical processes, which implies that they

need to be tuned in order to match observations.”_the logical relationship between the former and latter clauses is confusing.

Line 206: “The basal melt rate trend from 2010 to 2022, shown in Fig. 1,”_actually, no trend is shown in Fig. 1.

Line 230-231: “in both 2014/15 and 2015/16 (Fig. 5a and b) from ~370 m/yr to almost ~400 m/yr”_such a large increase in ice speed only occurred in 2014/15; “almost ~400 m/yr” => “395 m/yr”.

Line 241: “revealing a regime shift from cold and fresh conditions to warmer and saltier conditions across all profiles” => “revealing both warming and salinization trends across all profiles”, and you should indicate the depth range for that; the surface layer is the exception.

Line 304: “, like Pine Island and Totten, which both have a higher projected potential sea level rise contribution.”_ please add some supporting references.

Typos:

Line 25: “warm cavity ice shelves” => “warm-cavity ice shelves” throughout the whole text

Line 53: give the full spelling of “REMA” for the first appearance

Line 126: “has a monthly temporal resolution” => “has a monthly temporal output”?

Line 176: “Austral winter months” => “austral winter months”

Line 252: “have their outflow” => “have their outflows”

Line 298-299: “in-situ field measurements” => “in-situ measurements” or “field measurements”

Figures:

Fig. 1: in caption “the old and new channel” => “the old and new channels”; “by the white square shows” => “by the white square show”; “Two similar zoom-ins of the highly channelized area marked by the white square”_these two zoom-ins are the same, aren’t they?

Fig. 2: I cannot fully understand the correlation between the statement and the corresponding diagram in each subplot, which needs to be much more understandable and clearer.

Fig. 7: in caption “which roughly corresponds to the layers” => “which roughly correspond to the layers”

Fig. 8: in caption the arrows are also shown in (b) and (e).

References:

- Cheng, C., Jenkins, A., Holland, P. R., Wang, Z., Dong, J., & Liu, C. (2024). Ice shelf basal channel shape determines channelized ice-ocean interactions. *Nature Communications*, 15, 2877.
- Gladish, C. V., Holland, D. M., Holland, P. R., & Price, S. F. (2012). Ice-shelf basal channels in a coupled ice/ocean model. *Journal of Glaciology*, 58, 1227-1244.
- Gourmelen, N., Goldberg, D. N., Snow, K., Henley, S. F., Bingham, R. G., Kimura, S., ... & van de Berg, W. J. (2017). Channelized melting drives thinning under a rapidly melting Antarctic ice shelf. *Geophysical Research Letters*, 44, 9796-9804.
- Lambert, E., Jüling, A., van de Wal, R. S. W., & Holland, P. R. (2023). Modelling Antarctic ice shelf basal melt patterns using the one-layer Antarctic model for dynamical downscaling of ice-ocean exchanges (LADDIE v1.0). *The Cryosphere*, 17, 3203-3228.
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- Payne, A. J., Holland, P. R., Shepherd, A. P., Rutt, I. C., Jenkins, A., & Joughin, I. (2007). Numerical modeling of ocean-ice interactions under Pine Island Bay's ice shelf. *Journal of Geophysical Research: Oceans*, 112, C10019.
- Sergienko, O. V. (2013). Basal channels on ice shelves. *Journal of Geophysical Research: Earth Surface*, 118, 1342-1355.