Wind forcing control of mCDW intrusions into Vincennes Bay, East Antarctica.

Natalia Ribeiro[1,2], Adele Morrison[3], Stephen Rintoul[4], Laura Herraiz-Borreguero[4] Guy Williams[1], Nathan Bindoff[1]

[1]Institute for Marine and Antarctic Studies, University of Tasmania, Hobart, TAS, Australia
[2]Integrated Marine Observing System, Hobart, TAS, Australia.
[3]Research School of Earth Sciences and ARC Centre of Excellence for Climate Extremes, Australian National Univeristy, Canberra, Australia.
[4]Commonwealth Scientific and Industrial Research Organization - Oceans and Atmosphere (CSIRO) and Centre for Southern Hemisphere Oceans Research (CSHOR), Hobart, TAS, Australia.

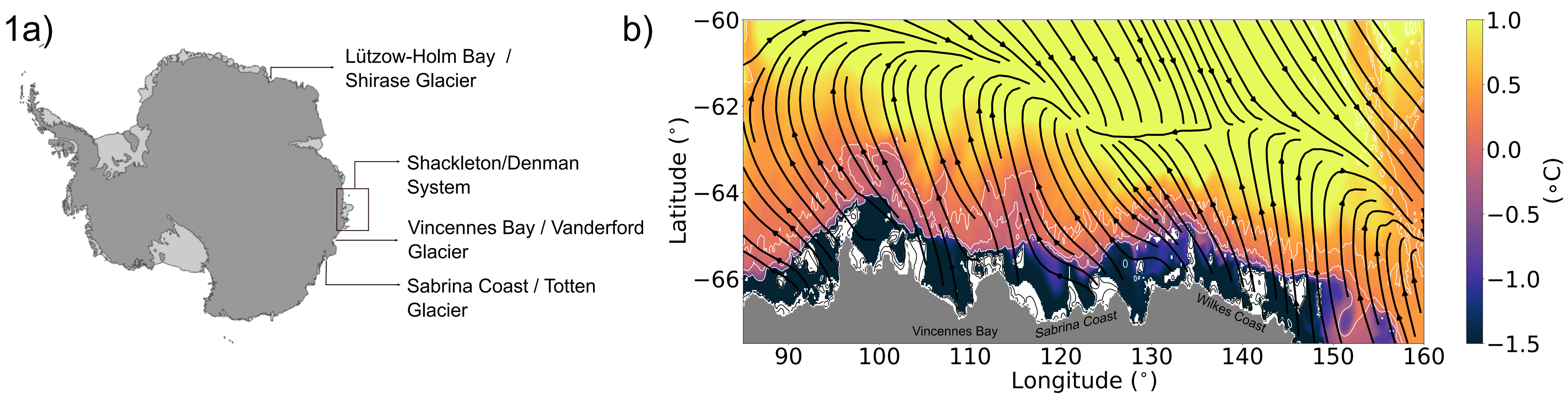
The big question: mCDW intrusions are happening in different regions of East Antarctica, but HOW do they get to the continental shelf?

The problem: data availability in Antarctic Margins is a challenge.

The solution? High-resolution Modelling. 3 simulations of the ACCESS-OM2-01 are used in this work:

i) an InterAnnual Forced simulation (IAF)
i) a Repeat Year Forced simulation (RYF; used as the CONTROL for the perturbation experiments)
iii) a set of wind perturbation experiments**.**

mCDW in East Antarctica



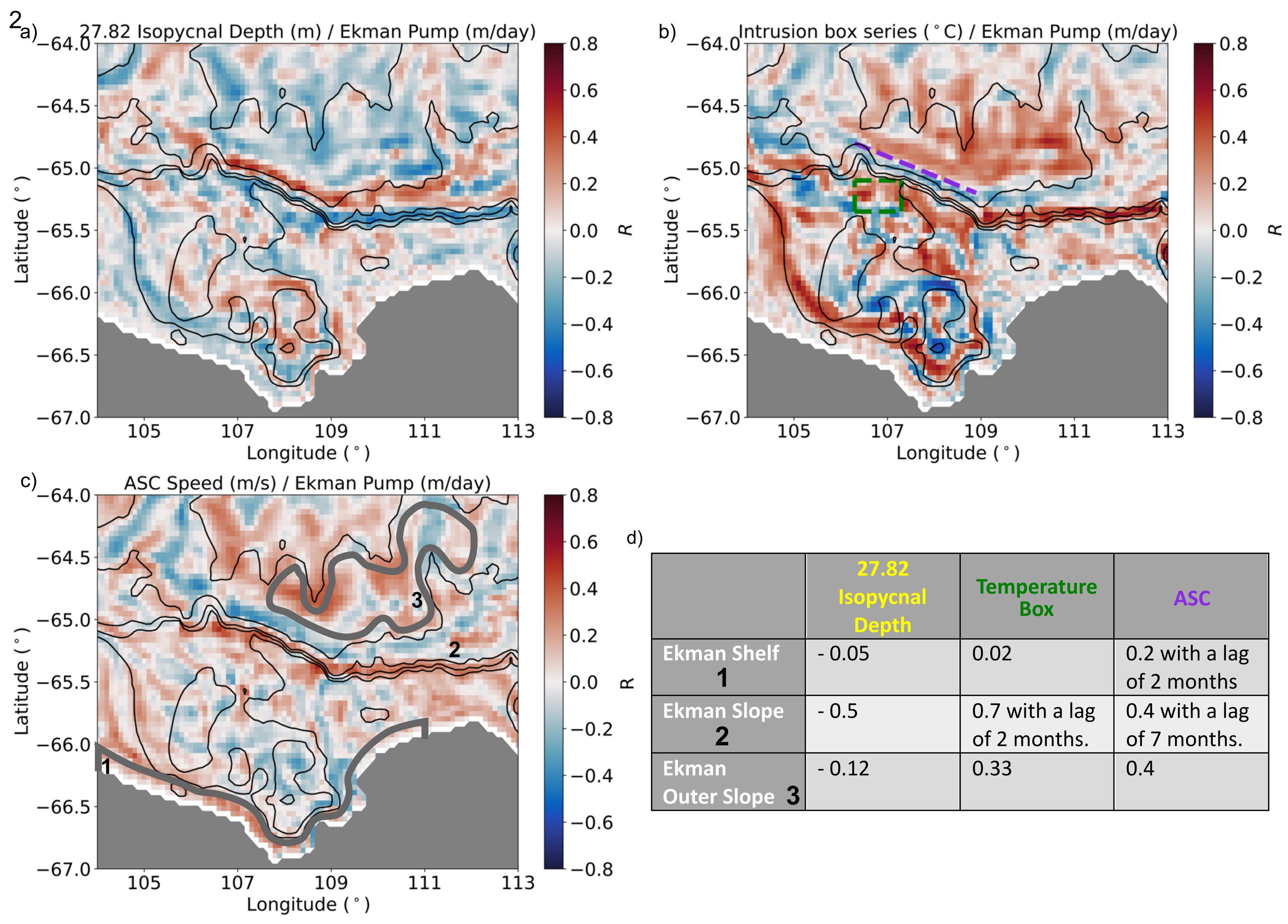
mCDW is reaching the continental shelf and causing enhanced basal melt in some areas of East Antarctica[a,b,c,d]. In Vincennes Bay (Fig. 1), elefant seal data shows unprecedented mCDW intrusions (0.5°C) that reach the glaciers at -0.5°C. The ACCESS-om2-02 reproduces these intrusions (Fig. 1b).

Firstly, we found a correlation between the isopycnal shoaling along the slope and the increase in shelf temperatures. Then we moved to figure out WHY.

Correlations with Ekman pumping

We couldn't find direct correlations with wind, so we tested the spatial and direct correlations of relevant areas between a) isopycnal depth, b) shelf temperatures and c) ocean speed.

Simulations show that onshore heat transport is facilitated by Ekman-driven upwelling along the slope, which drives a shoaling of isopycnals, allowing mCDW to flow onto the continental shelf.

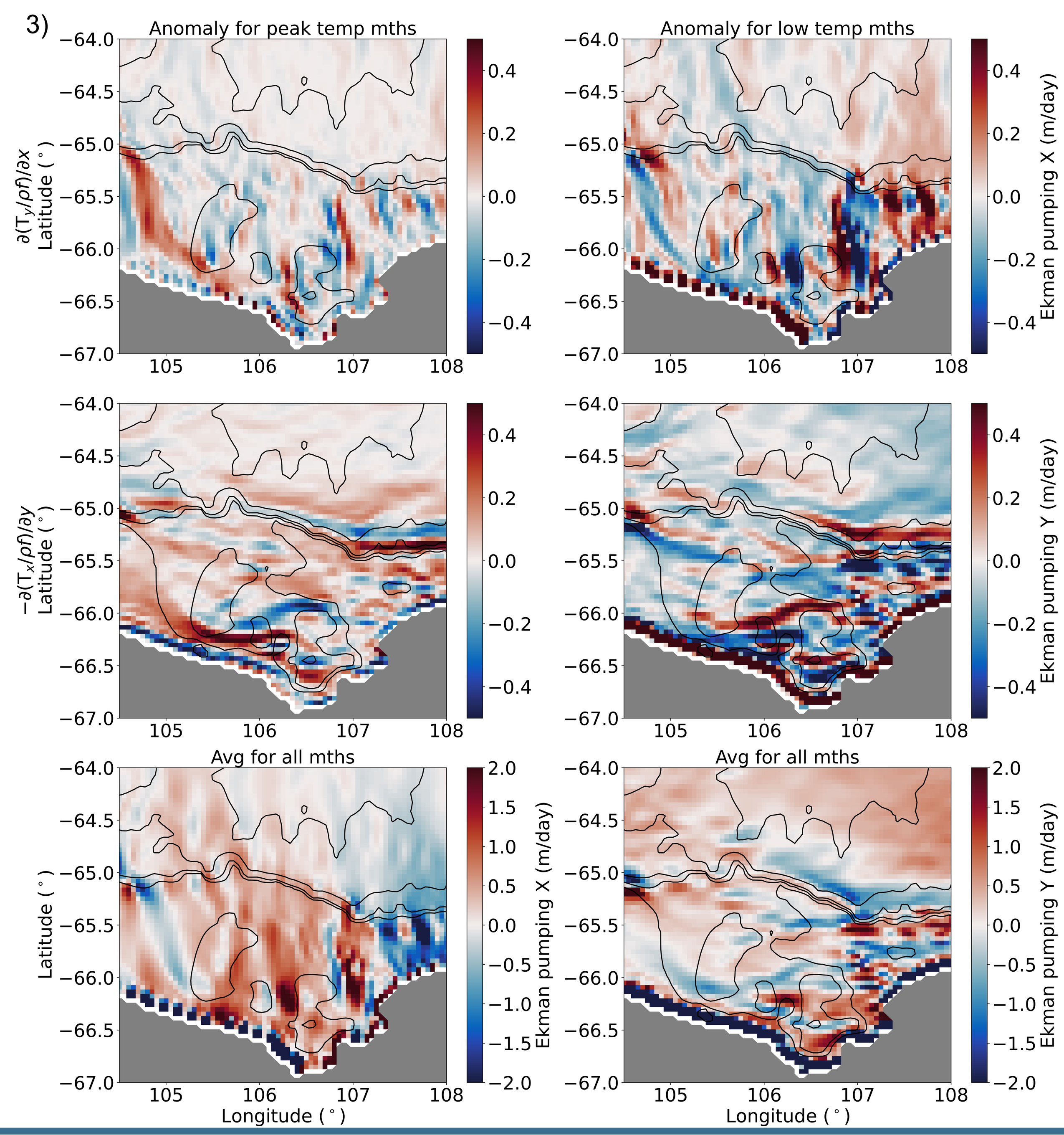


d)

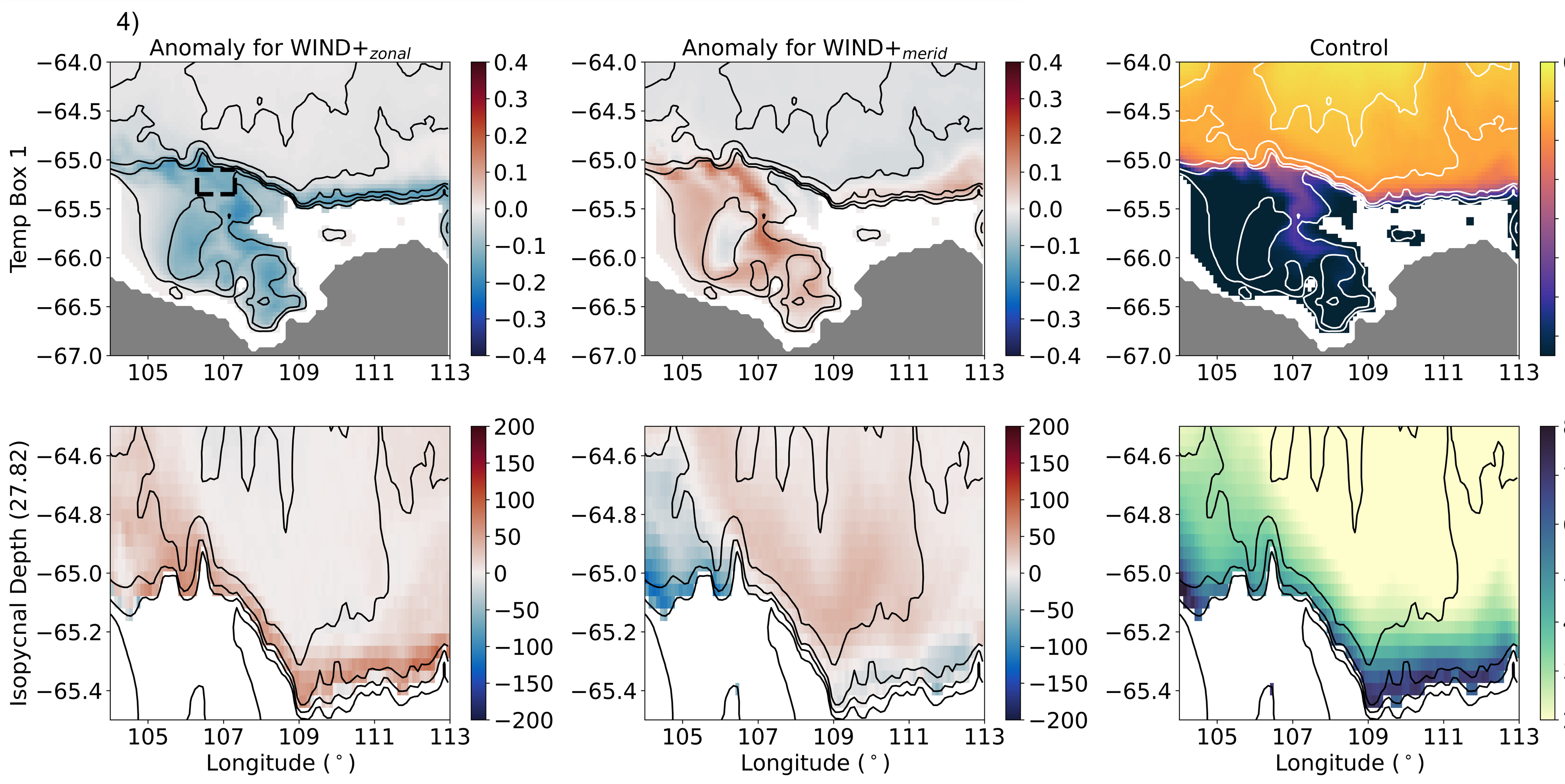
	27.82 Isopycnal Depth	Temperature Box	ASC
Ekman Shelf 1	- 0.05	0.02	0.2 with a lag of 2 months
Ekman Slope 2	- 0.5	0.7 with a lag of 2 months.	0.4 with a lag of 7 months.
Ekman Outer Slope 3	- 0.12	0.33	0.4

Looking into the different Ekman components....

The model shows that the componet driven by the **zonal** wind stress is more significant at the shelf break and over the larger slope area.



The Easterlies experiment simulation (increasing meridional and zonal winds by 10%) is consistent with our results, as the shelf cools down when the zonal wind increases.



Implications

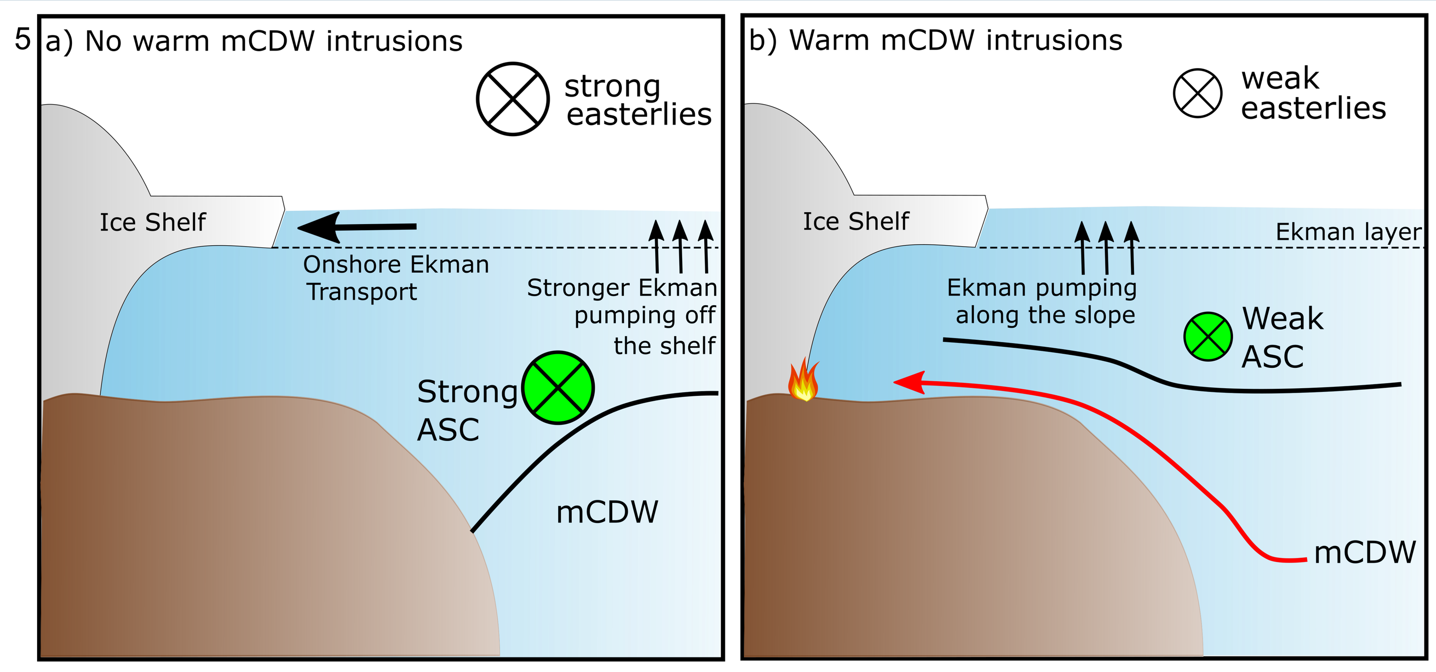
- mCDW intrusions in VB are driven by a weakening of the easterly winds.

- The easterlies are projected to reduce their merional extend and strength as the westerlies shift poleward.

- Results imply that mCDW intrusions into VB will become more frequent, leading to higher basal melt rates.

Finally, the mCDW intrusion mechanism for VB:

The IAF3 simulation implies there is a fresh shelf regime for the scenario of no intrusions. In this case, easterly winds and ASC speed would be close to the average for the whole cycle or stronger than average (Fig. 5a). Strong easterlies drive stronger Ekman transport towards the shelf (pushing isopycnals down on the shelf) and drive stronger Ekman pumping (upwelling) off the shelf (pushing isopycnals up), hence increasing the isopycnals slopes associated with the ASC, and inhibting on shelf flow of mCDW. However, during warm mCDW intrusion episodes (Fig. 5b), the easterly winds weaken, resulting in flatter isopycnals over the continental shelf and enhanced on-shelf flow of mCDW. The ASC also weakens in response to the isopycnal shoaling, allowing more cross-shelf exchange and, therefore, more inflow mCDW.



IMAS INSTITUTE FOR MARINE & ANTARCTIC STUDIES
UNIVERSITY of TASMANIA
IMOS Integrated Marine Observing System

References

[a]van Wijk et al. , 2022.
[b]Ribeiro et al., 2021.
[c]Hirano et al., 2020.
[d]Rintoul et al., 2016.

Questions?

For questions or a chat, please send me an email at:

natalia.ribeirosantos@utas.edu.au