

# Heat supply to the fast-thinning Denman glacier in Antarctica: ice and eddies interactions revealed by SWOT and in situ observations.

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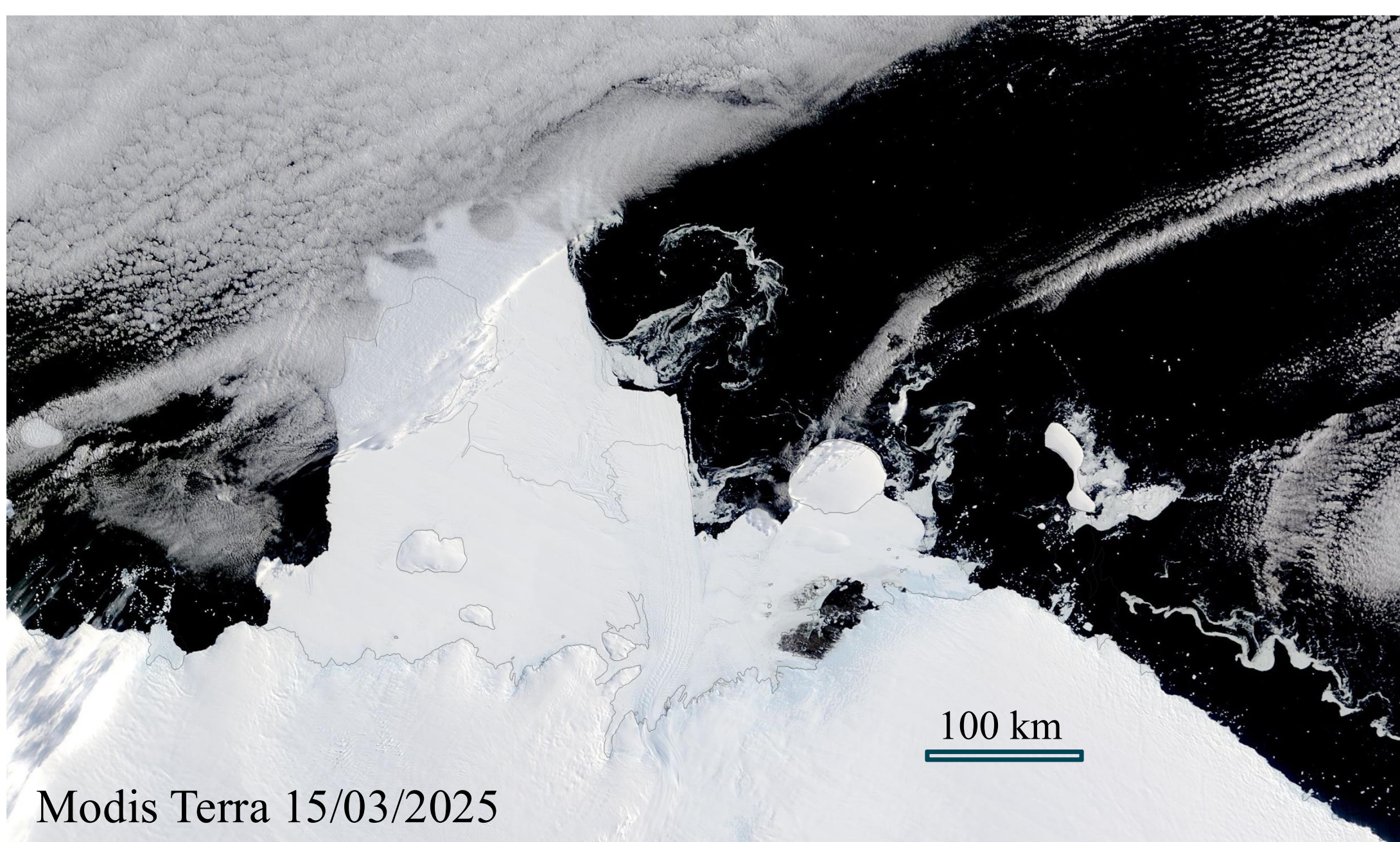


Thanks to the Australian Antarctic Program, the Australian Antarctic Division Technical support and the Crew of the RSV NUYINA

The Denman Glacier Ice Tongue (DGIT) is reported to be one of the fastest thinning in Antarctica with under-ice shelf thinning rates of over 45m/y near the grounding line (Brancato et al., 2020).

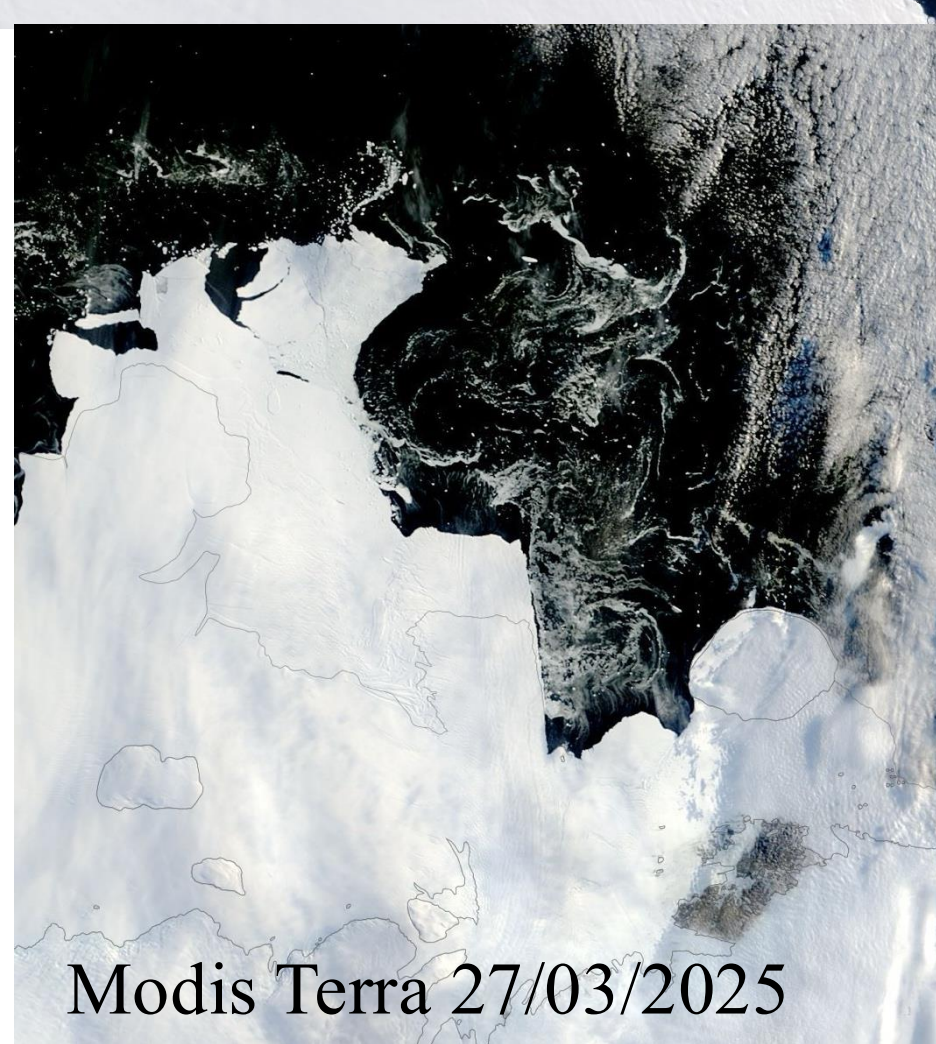
Such melt rates point to a crucial area of Antarctic Ice sheet mass loss. They also require a significant amount of ocean heat to be transported to the area of melt.

The bathymetry of the continental shelf in front of the DGIT was not known until recent scientific expeditions by RV Polarstern (2024) and RSV Nuyina (2025). Here we show the oceanographic configuration of in front of the glacier and thanks to observations collected from the Denman Marine Voyage (DMV) on-board the RSV Nuyina in March-April 2025 and SWOT observed small scale eddies. We suggest a new pathway for warmer waters to be transported down under the DGIT.

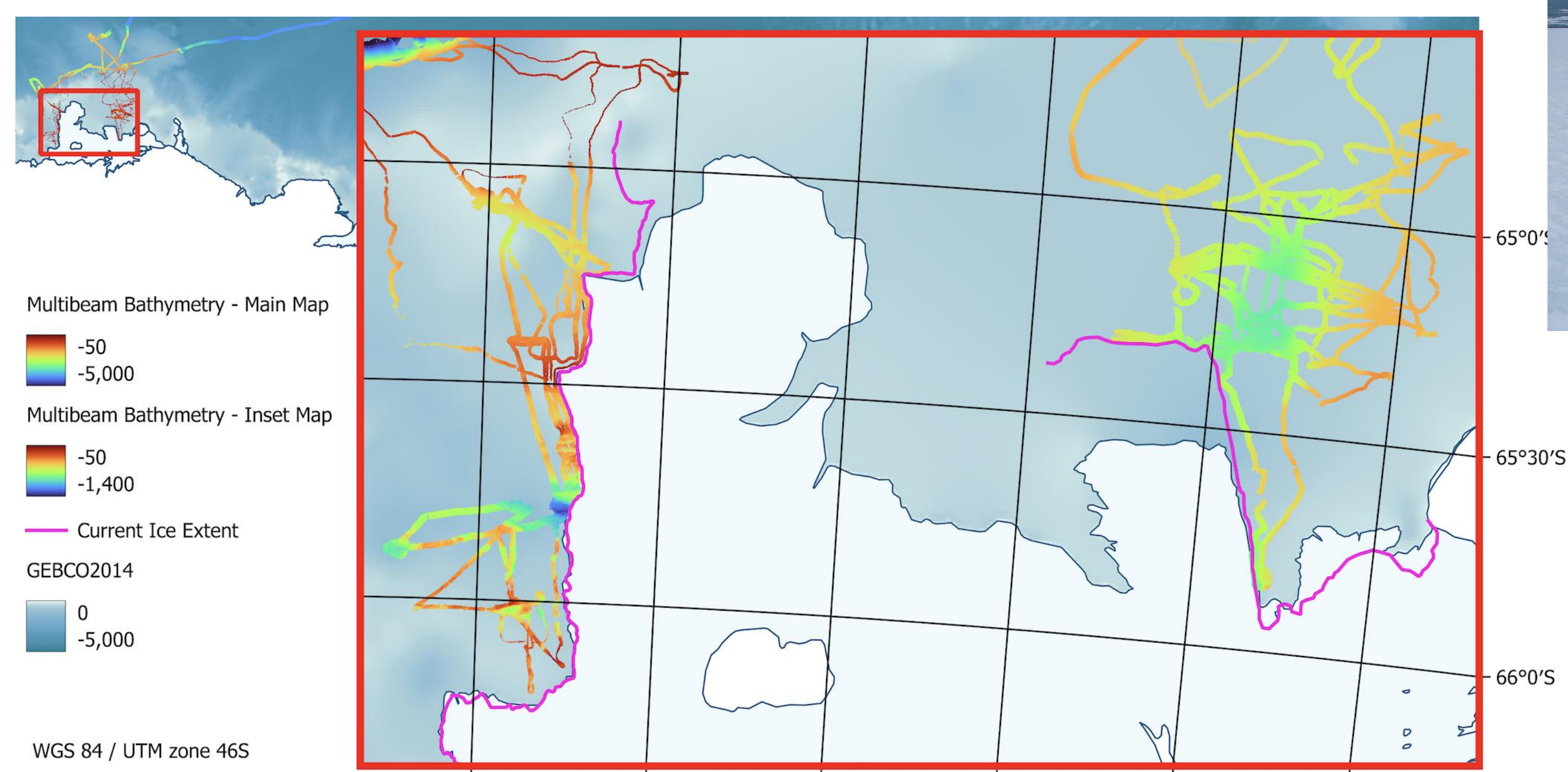


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During periods of low ice concentration, loose ice bit tend to image the surface currents on satellite imagery. This remains very qualitative, and wind can also play a big part in the drawing.



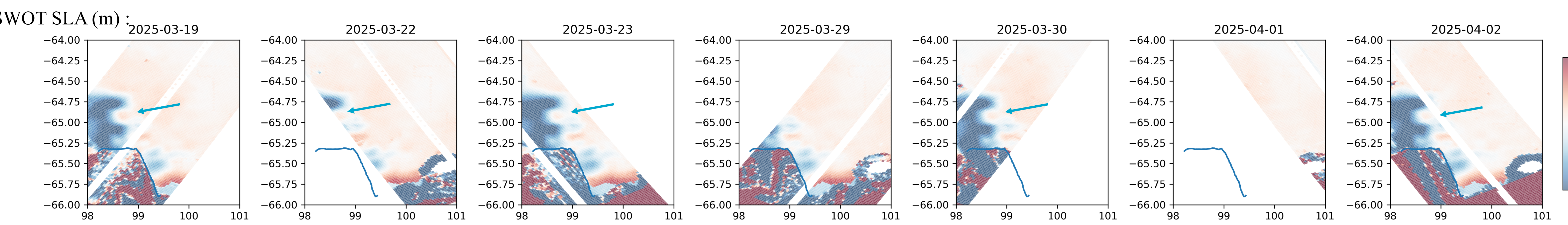
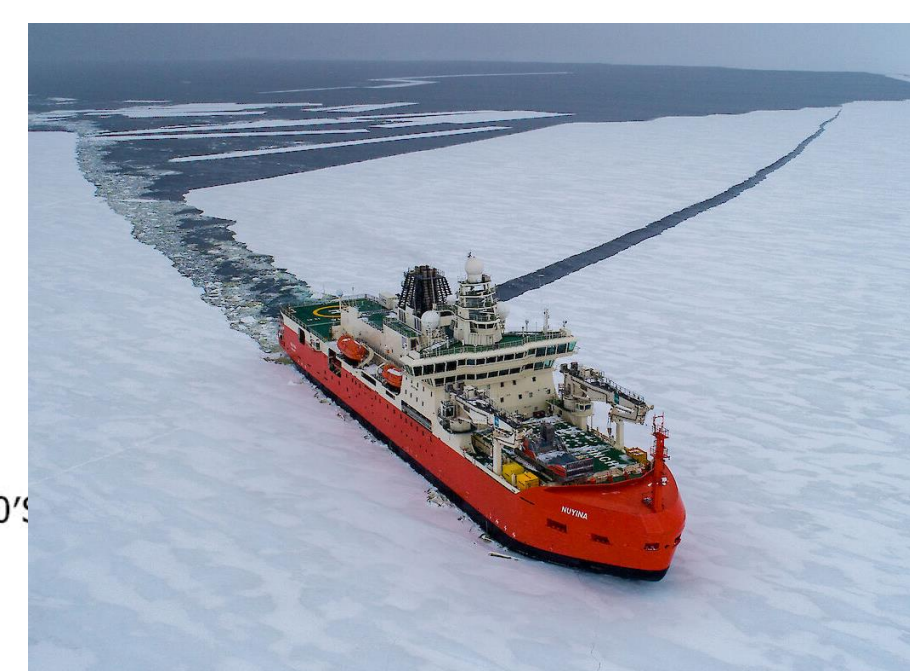
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The bathymetry revealed by the survey shows :

- A seal from the open ocean to the continental shelf of ~400m depth
- A trough to the North-East of the glacier tongue 600 to 800m deep leading to the ice tongue.
- And no other access for circumpolar deep water intrusions.
- The ice front is 400m deep.

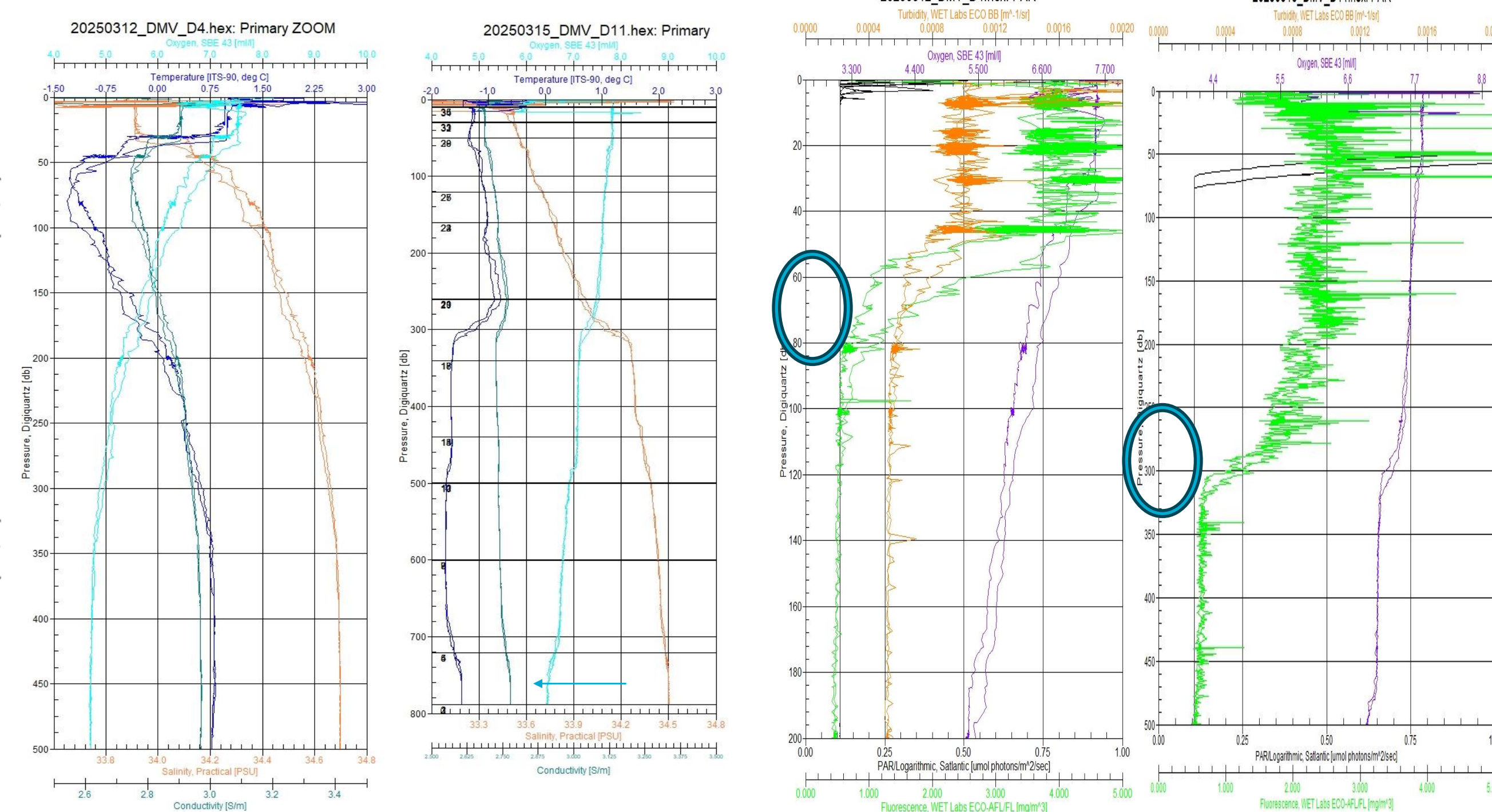
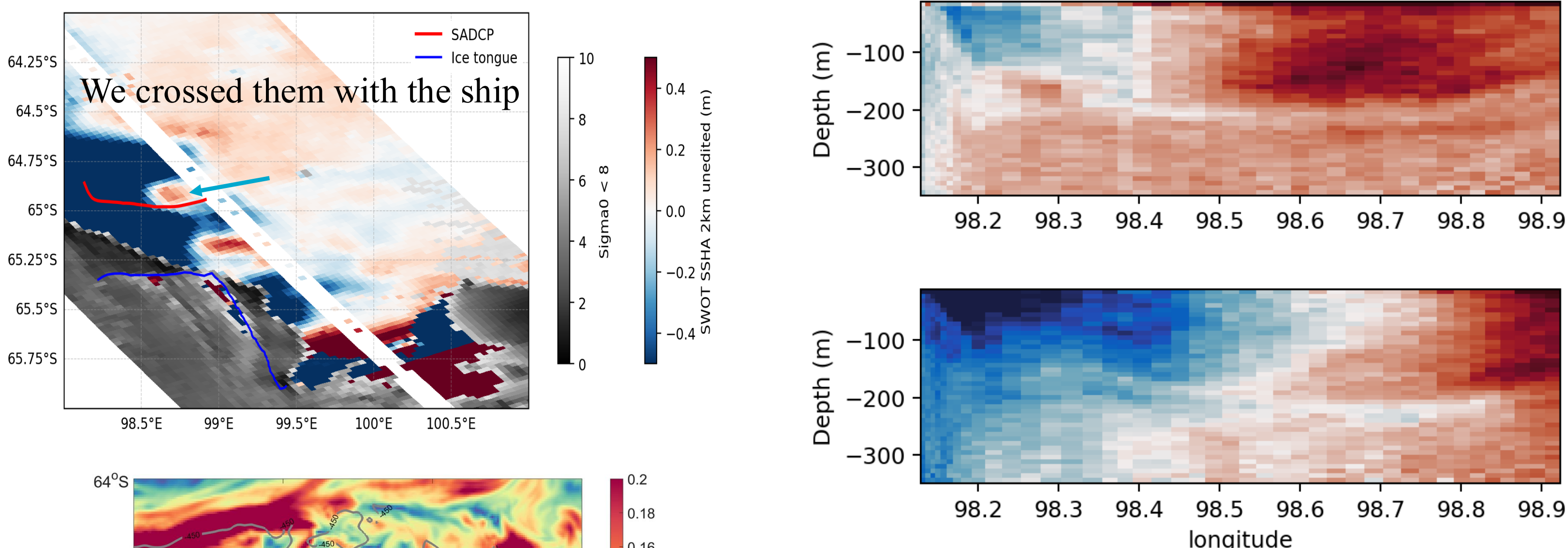
The grounding line of the glacier is over 2km below sea level.



SWOT observations are a game changer. They are challenging with the difficulty to isolate open water from ice...(much progress to be happening in this space).

Yet in the clear water part, SWOT reveals regular small (~10km diameter) eddies. They appear strong with currents reaching 1m/s. They appear very regularly with variable intensity in the SWOT record of the Jan-Mar period of 2024 and 2025.

The Ship ADCP revealed the strong current and shear of the eddies



We could witness the impact in CTD casts. Mix layer much deeper. Chlorophyll found at up to 400m and tested to have been at the surface just few days prior, pointing to necessarily very strong vertical velocities. These sub-mesoscale eddies are also short lived. They must induce pulses of tracers transmission at depth. Including the heat necessary to melt the iceshelf at the grounding line and phytoplankton that we've observed in water sampled and experiments.

We also find these small eddies in high-res. models (Liu et al, 2024, 2025)

**References :**  
Brancato, V., Rignot, E., Milillo, P., Morlighem, M., Mougnot, J., An, L., Scheuchl, B., Jeong, S., Rizzoli, P., Bueso Bello, J. L., and Prats-Iraola, P.: Grounding Line Retreat of Denman Glacier, East Antarctica, Measured With COSMO-SkyMed Radar Interferometry Data, *Geophys. Res. Lett.*, 47, e2019GL086291, <https://doi.org/10.1029/2019GL086291>, 2020  
Liu, Y., M. Nikurashin and B. Pena-Molino (2024) Seafloor roughness reduces melting of East Antarctic ice shelves. *Communications Earth & Environment* 5:322 <https://doi.org/10.1038/s43247-024-01480-x>  
Liu, Y., Nikurashin, M., Pena-Molino, B., Spence, P., Herranz-Borreguero, L. (2025). Warm surface waters dominate melting of the Denman-Shackleton ice shelf system, *J. Geophys. Res.*, in review.

**Conclusion :**

While these results are preliminary; there is a firm result on the intense small-scale conveyors of heat to depth that can explain the strong melt of the Denman glacier tongue. SWOT is a key tool to quantify their intensity.

There is work to do to make clean SWOT induced currents in these icy areas.

