Virtual FRISP 2020 meetings

Thursday 25 June, Plenary Session 1

Investigation of Recent Oceanic Contribution to Instability of the Thwaites and Pine Island Glaciers

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LIONESS-TG

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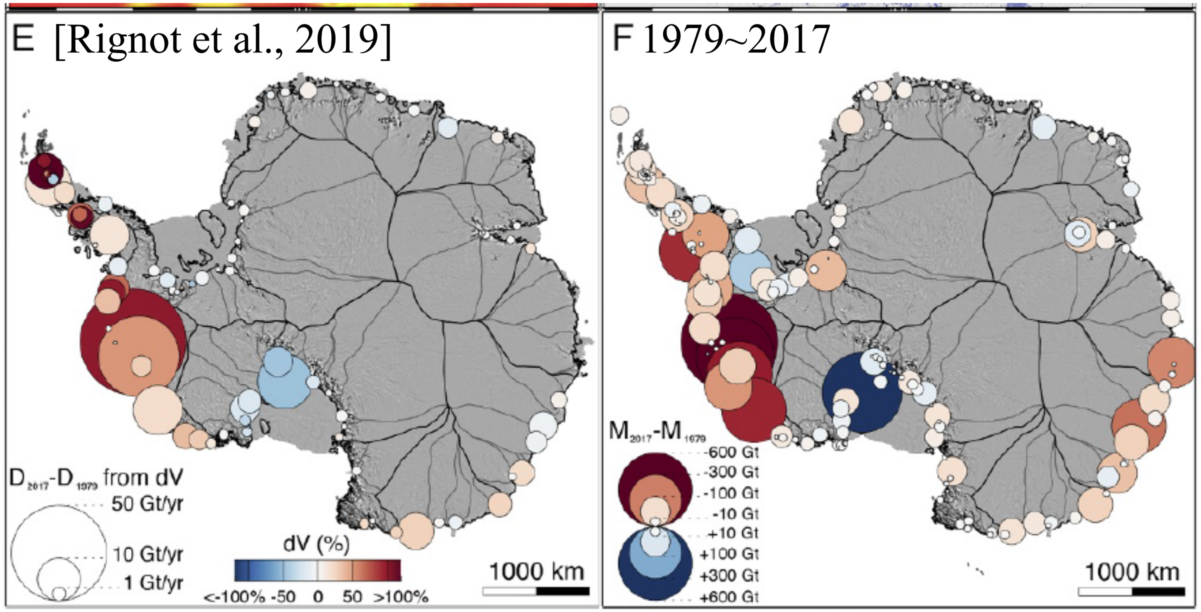
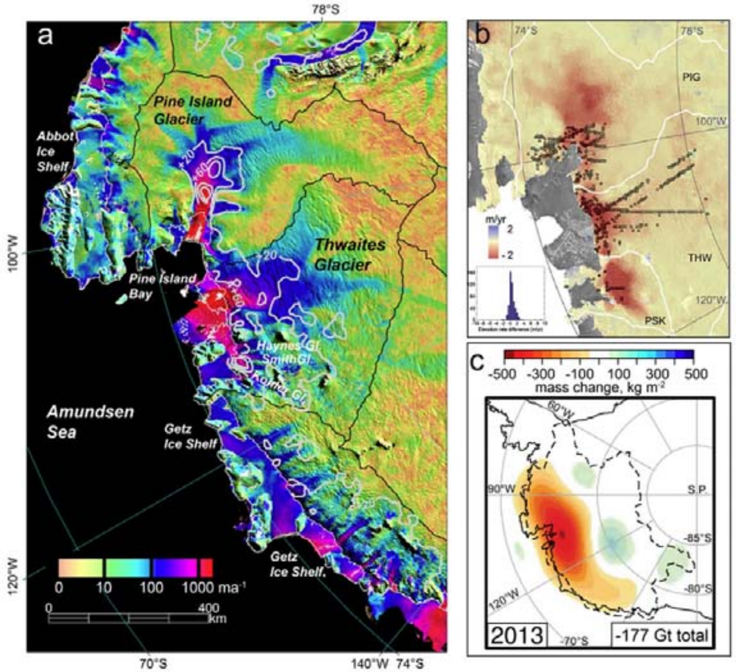
1. Introduction



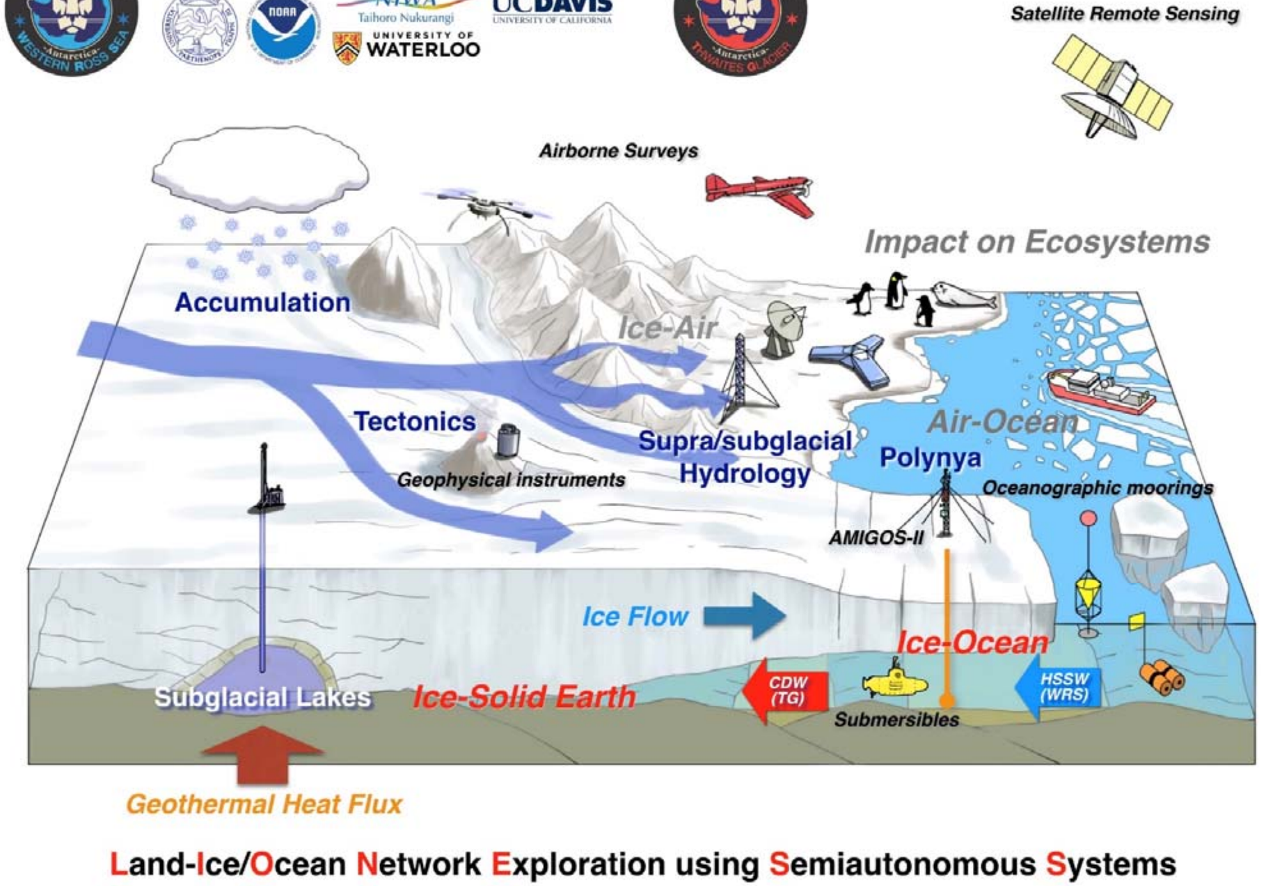
▲ Change in grounding line ice discharge (Red: acceleration; Blue: Deceleration)

▲ Total change in mass (Red: loss; Blue: gain)

[Scambos et al., 2017] ▼ Recent significant increases in mass loss

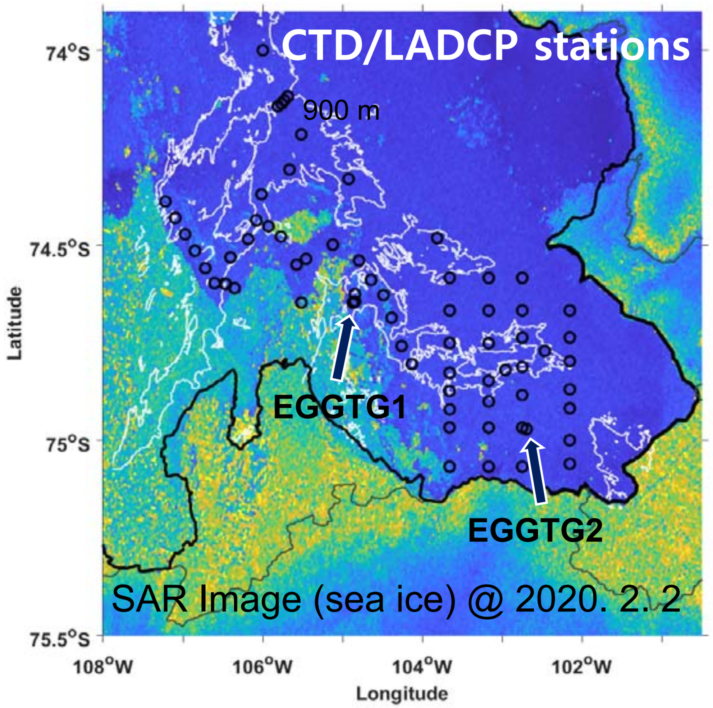


- The Antarctic ice shelves around the Amundsen Sea has experienced the fastest melting together with the rapid grounding line retreat in recent decades
- The most apparent mass loss occurs in the Thwaites and Pine Island Glaciers



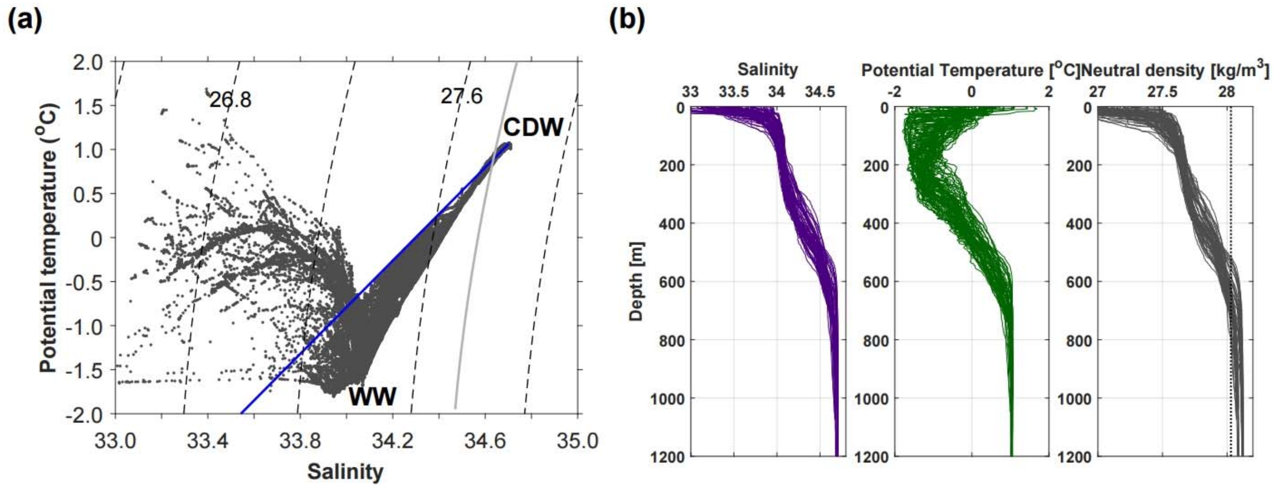
- LIONESS-TG is collaborating with ITGC to investigate one of the most unstable glaciers in Antarctica.

2. 2020 Antarctic survey



▶ I.B.R.V. Araon

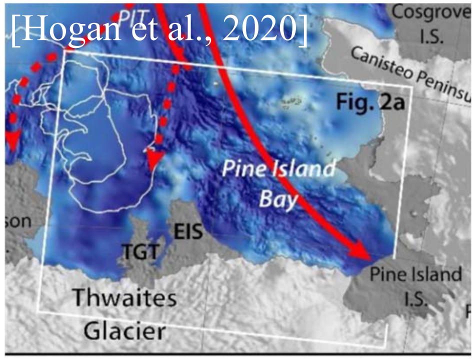
Information for 2020 Antarctic survey	
Research Vessel	Ice Breaker R.V. Araon
Period	2020. 1. 29 ~ 2. 15 (~ 18 days)
# of full-depth profiles	**89 @ 67 stations**
PO mooring	**Deployment @ 2 locations**



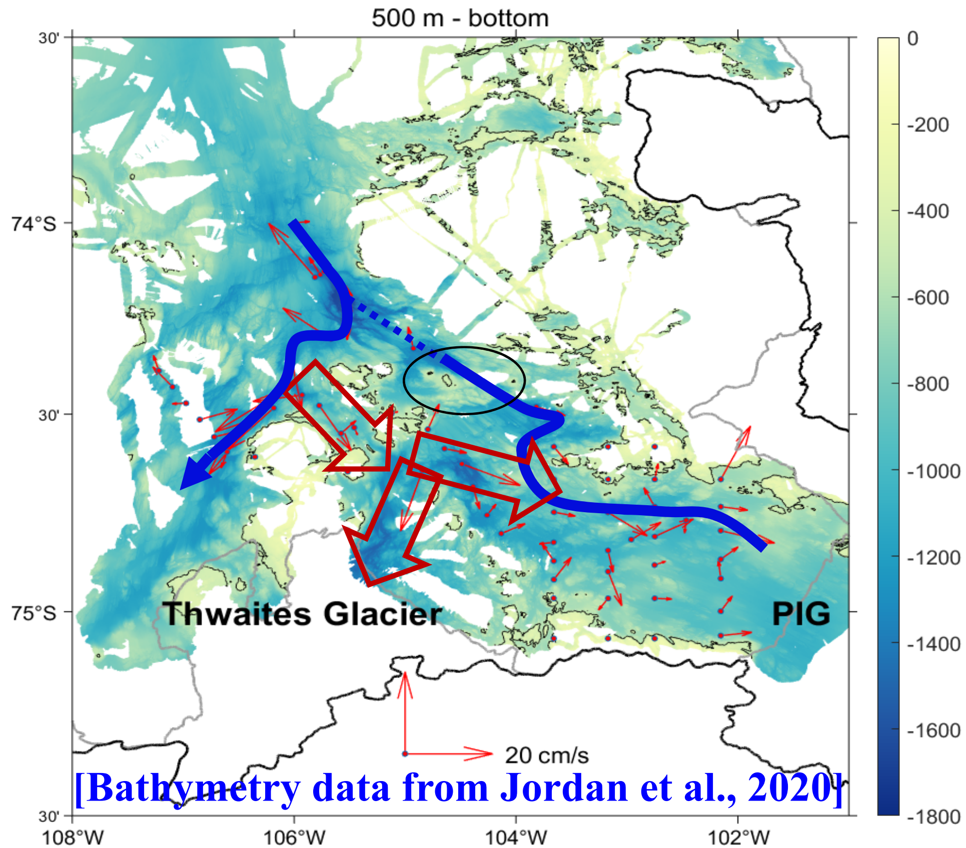
- ➢ WW (Winter Water) and CDW (Circumpolar Deep Water) are well observed.
- ➢ CDW (r_n > 28.03 kg/m^3 [Wahlin et al., 2010]) is found below 500~600 m.

3. Major findings

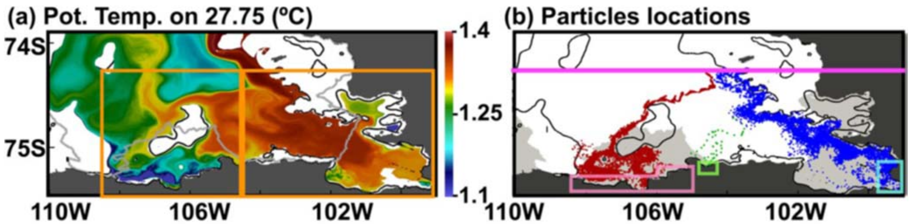
1) Circumpolar Deep Water (CDW) pathway

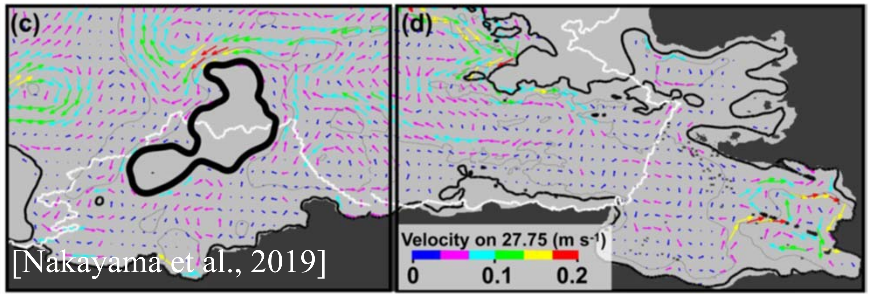


- Expected (dashed line) and observed (solid line) CDW pathways into the Thwaites and Pine Island Glaciers.



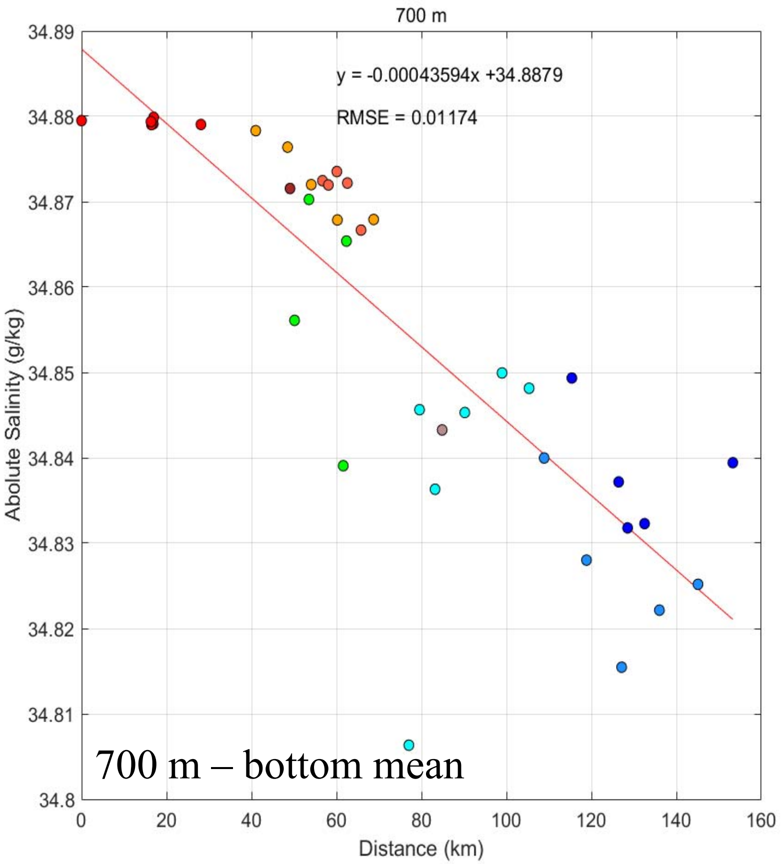
- **Investigate detailed CDW pathways and modification of its properties**

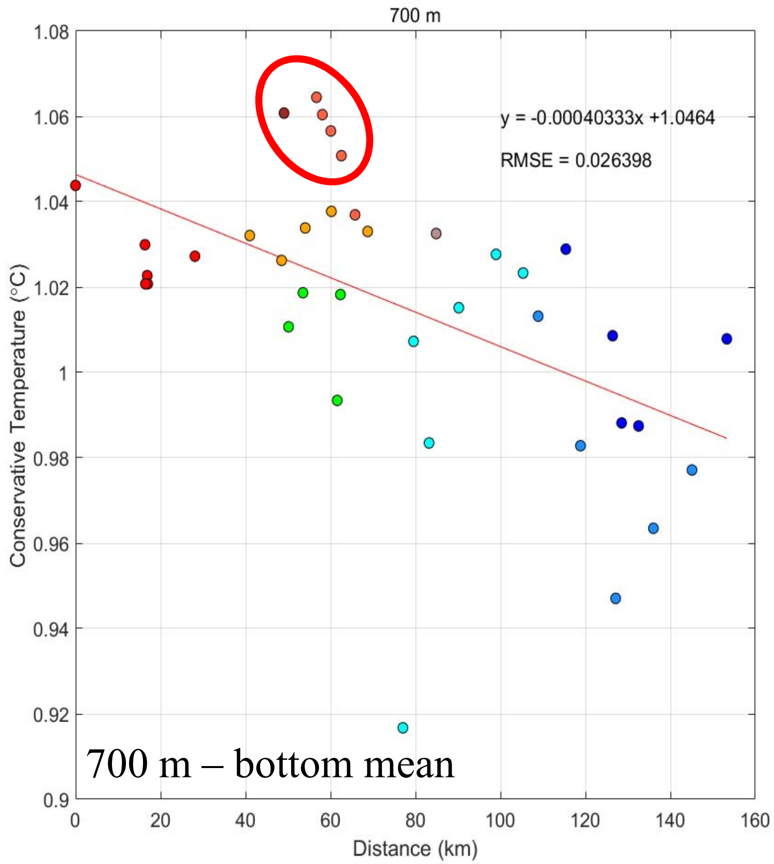


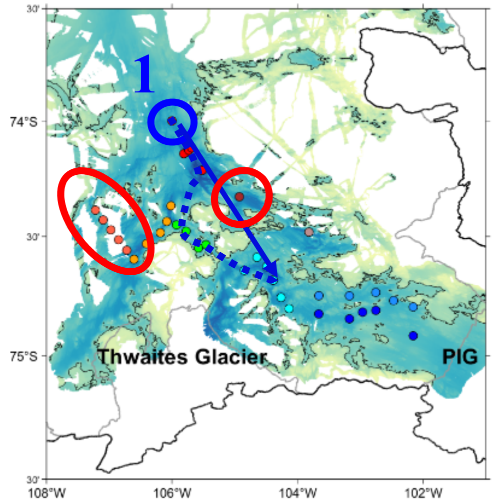


- Pathways of mCDW into the Thwaties and Pine Island Glacier by high resolution ocean model

▼ **Temperature and salinity – distance from station 1 (CDW entrance)**

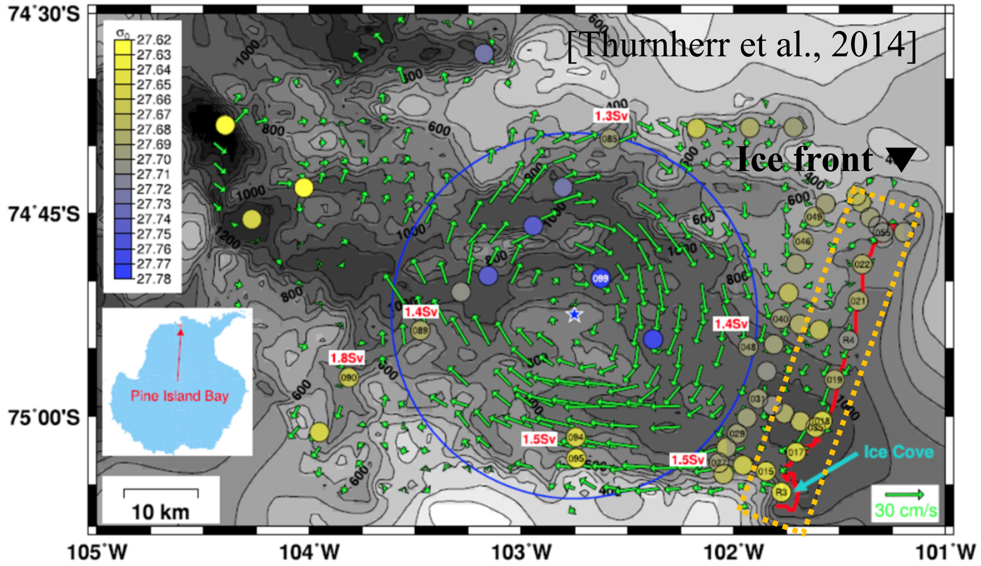




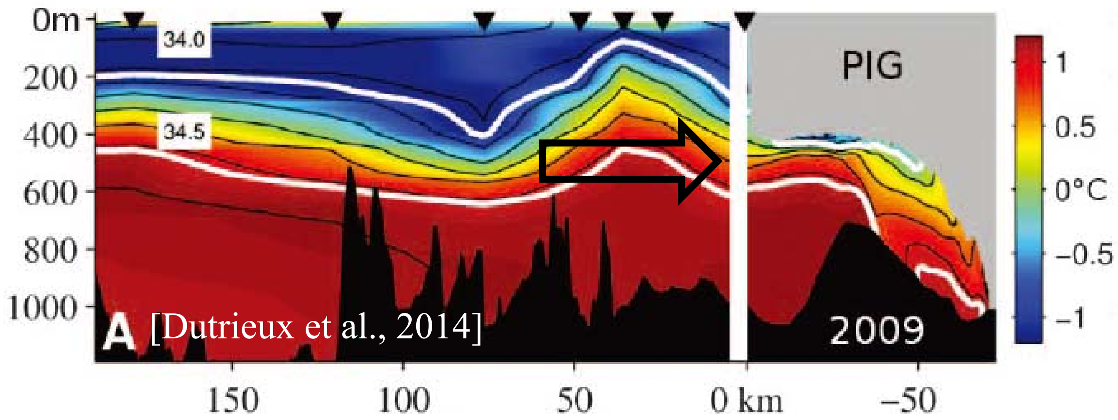


- West and north east region temperatures are higher than station 1 (other heat sources?)
- T&S properties changes as CDW flow into the two ice shelves along troughs

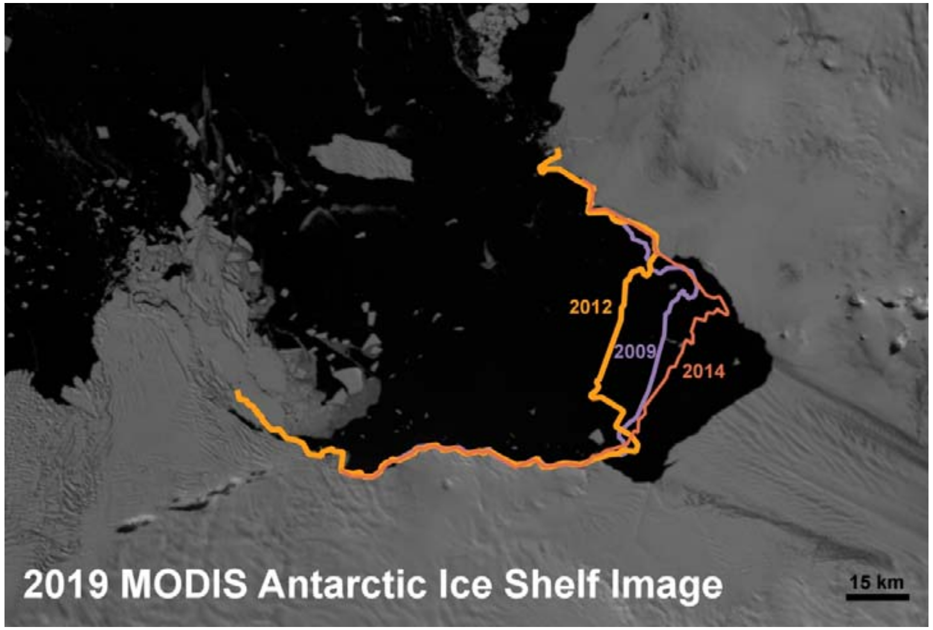
2) Pine Island Bay circulation



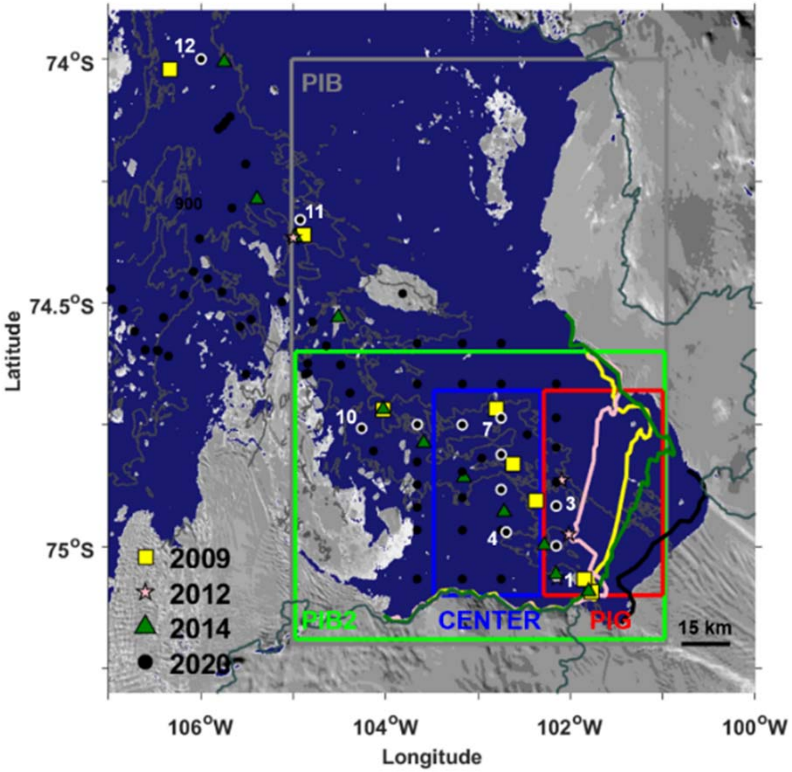
▲ Arrows = SADCP velocities averaged 30 ~ 300 m.

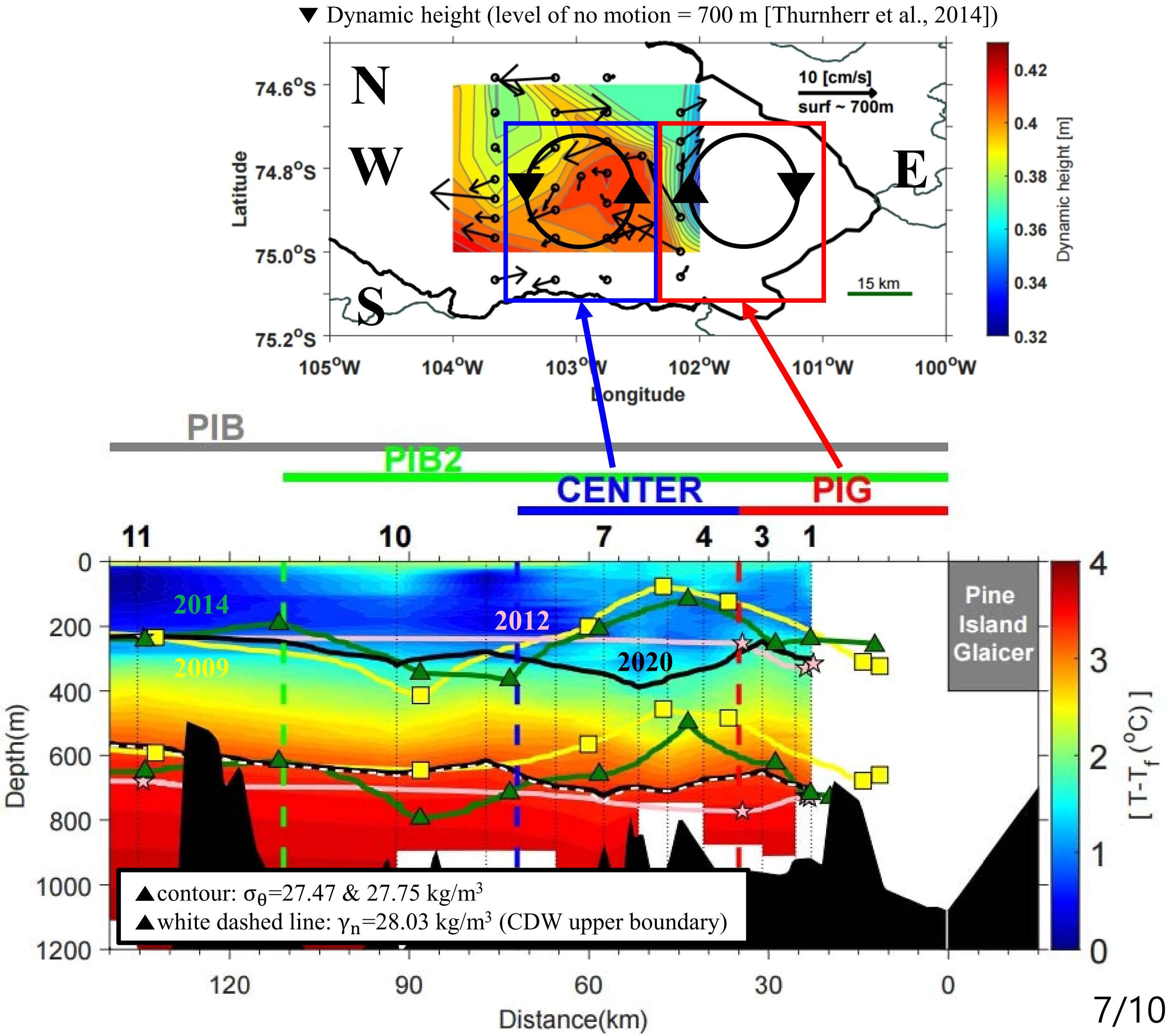


- Cyclonic gyre (radius ~ 25 km) found in front of the Pine Island Glacier Ice front **during the late January 2009**.



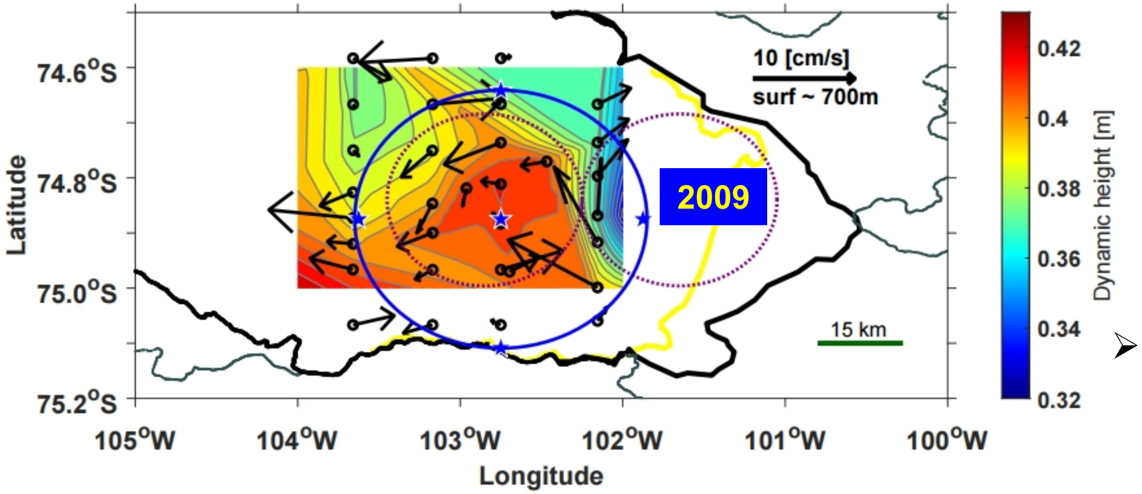
- **Investigate impact of the recent Ice front retreat on the ocean circulation**





- ➢ **Two-cell circulation in the Pine Island Bay**

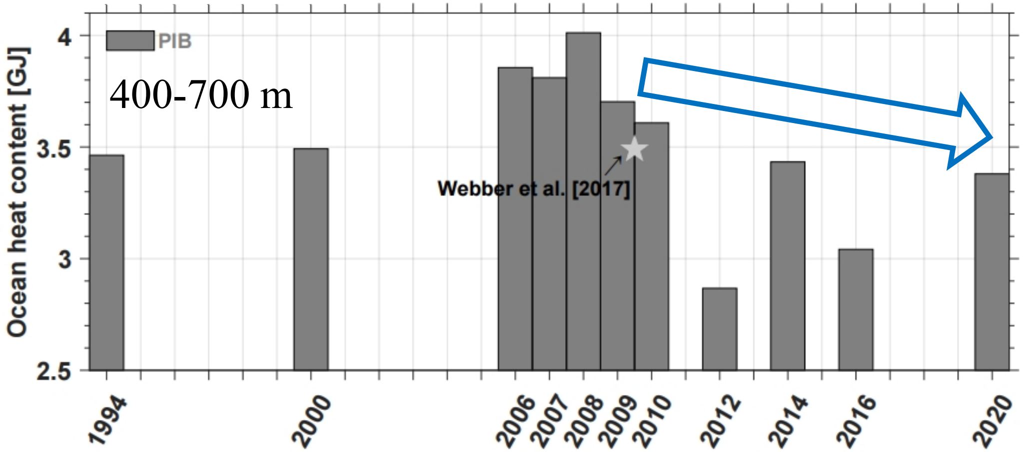
▪ Hypothesis



- Radius of circulation = 17 km in 2020 < 25 km in 2009 (※ 1st baroclinic Rossby radius of deformation 5 ~ 7 km).

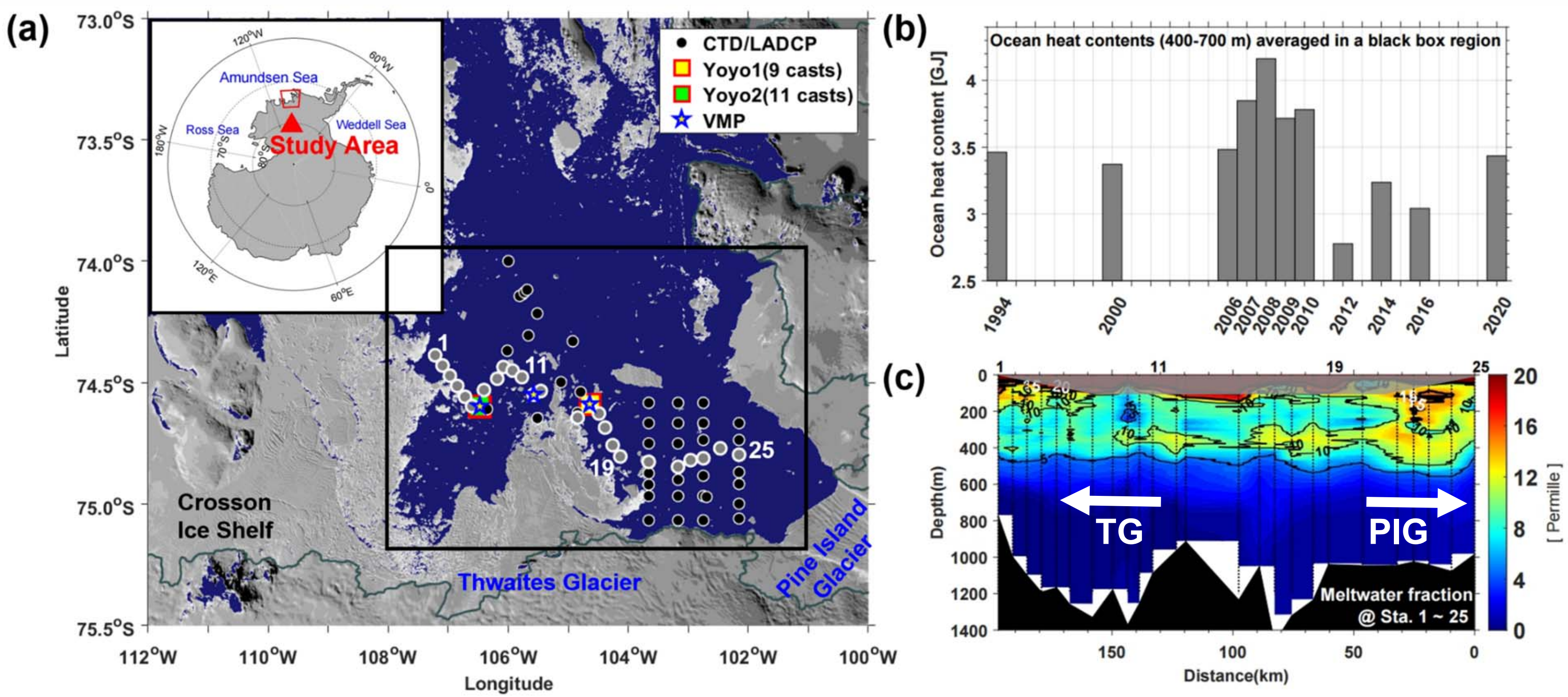
$$Q = \int_{z1}^{z2} \rho c_p (T - T_f),$$

※ 400-700 m approximately coincides with the depth range within the cavity beneath the Pine Island Glacier.



- Decrease ocean heat contents
  - → Decrease basal melting and meltwater flux
  - → **Less Ice Cavity Water transport & Less warmer ambient water**
  - → Weakening circulation (~ decrease density gradient, speed)
  - → **Decrease circulation cell size**
- Continuous Ice front retreat after 2013 ice calving event
  - → **Formation of two cell in the extended horizontal boundaries**

3) Spatial variation of meltwater fraction



- The glacial meltwater flowing out from the two glaciers shape spatial and temporal variability of meltwater fraction at the upper (shallower than 500 m) ocean near and off the ice shelves.

- Ocean heat contents: 2009 > 2020 > 2014 > 2012 so, expect that a little lower melting rate in 2020 than that in 2009.

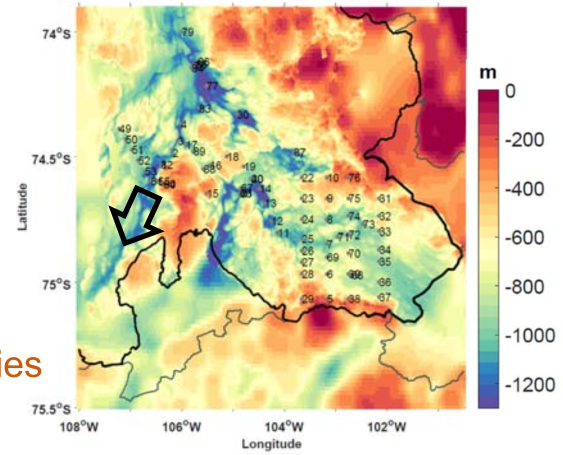
- Melting **80 km³/yr** of ice within the cavity in 2009; **35 km³/yr** in 2012; **40 km³/yr** in 2014 [Jacobs et al., 2011; Dutrieux et al., 2014; Heywood et al., 2016].

4. Future plans

1) CDW pathway controlled by bed topography

: Detailed CDW pathways additionally using UTas's AUV data (60 km round-trip)

: Spatial variations of temperature and salinity of CDW



2) Find meaning of two-cell circulation

: Heat redistribution by two-cell circulation

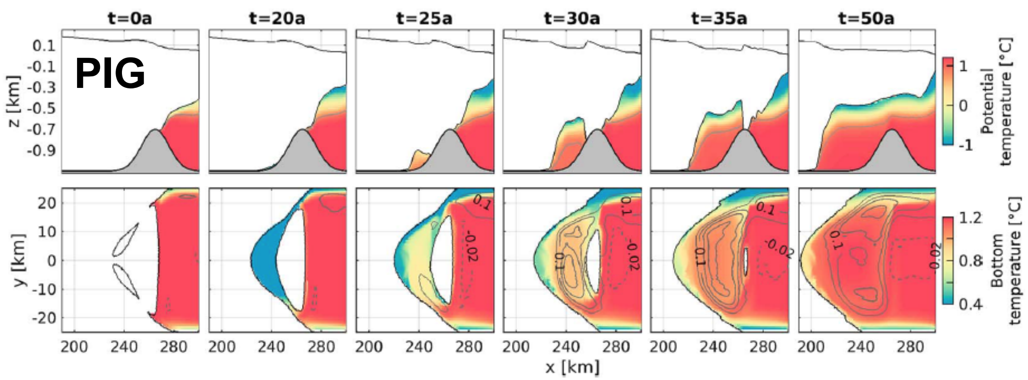
: Need to consider feedback mechanism caused by the extended or reduced ocean boundaries

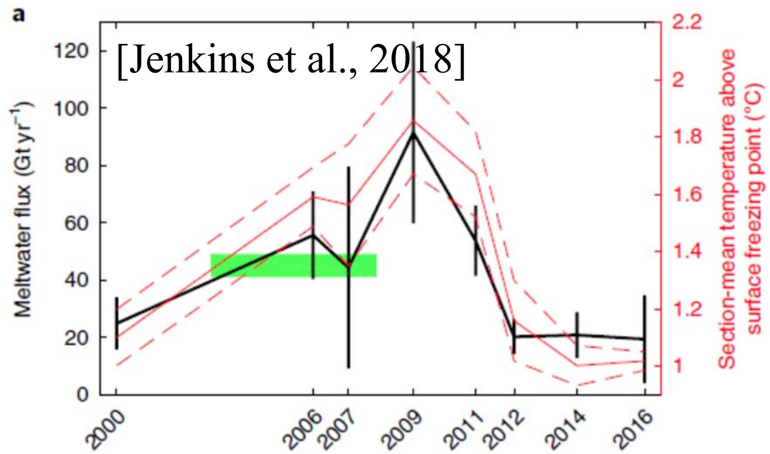
3) Decadal variability of ocean forcing - return to the warm phase period?

: OHC in 2020 is much greater than that in 2012 and a little smaller that in 2009

: Check local atmospheric surface heat loss, heat transport onto the continental shelf break, and wind variability

[De Rydt and Gudmundsson, 2016]





Thank you all !!!

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Acknowledgements

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