Multi-Year DTS Observations of Ice and Ocean from the Thwaites Eastern Ice Self

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Introduction

Two Automated Meteorology-Ice-Geophysics-Ocean System (AMIGOS) stations were installed on the Thwaites Eastern Ice Shelf, both approximately 25 km downstream from the grounding line, as part of the International Thwaites Glacier Collaboration.

From January 2020 to August 2021, surface conditions, ice shelf and hydrography within the ice shelf and cavity have been observed at hourly to daily frequencies, including DTS and nearly continuous CTD data up to January 2023.

Figure 1 below shows typical AMIGOS station sensor suite.

Fig. 1 AMIGOS-IIIc Channel Camp

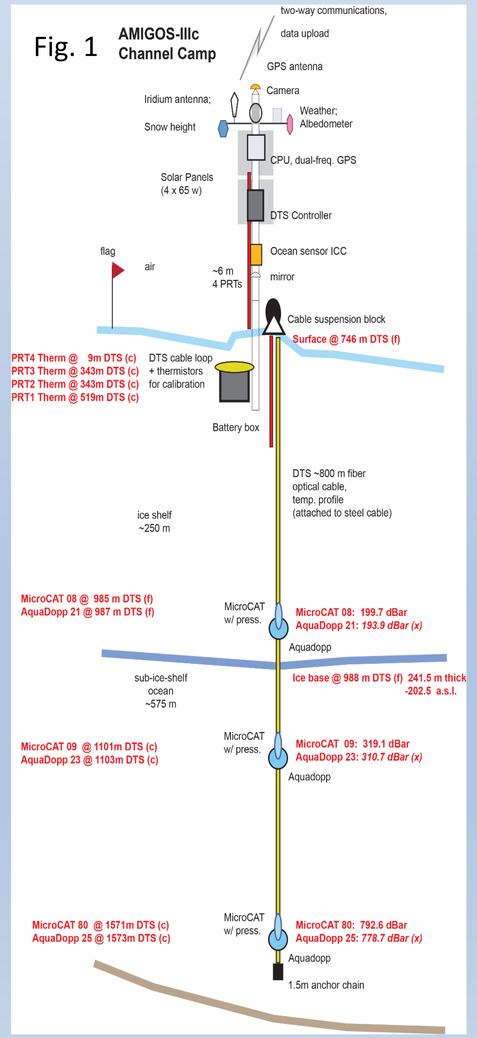
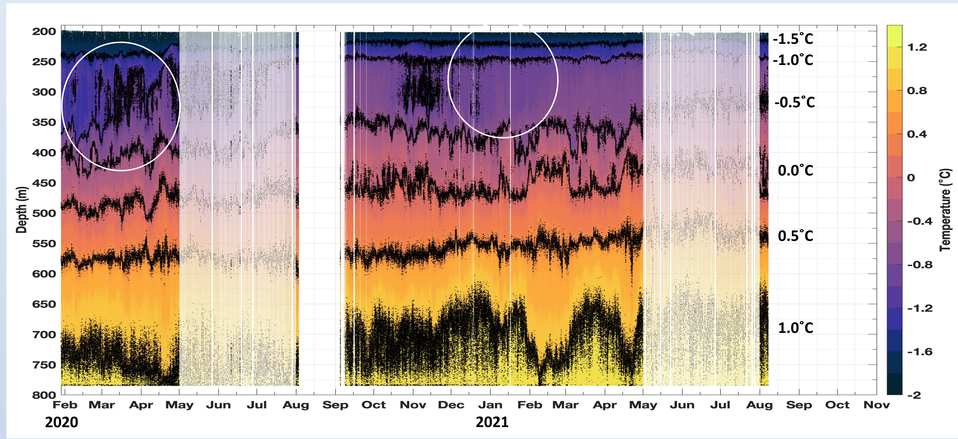
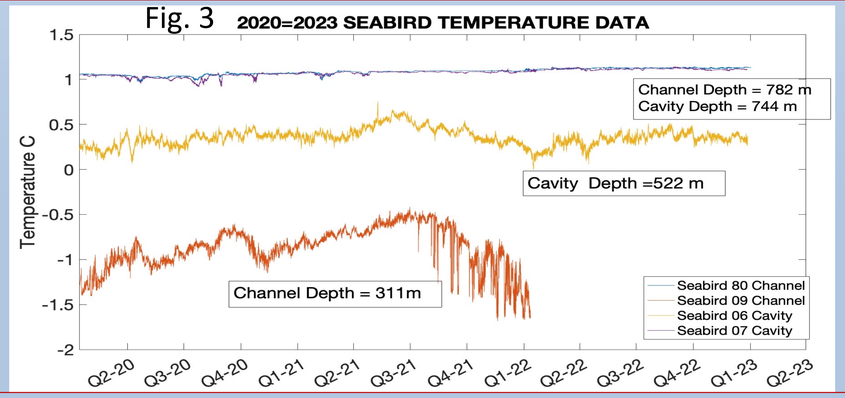


Figure 2: Channel Camp Ocean DTS Evolution
Contours at -1.5, -1.0, -0.5 , 0.0 ,+0.5 and +1.0



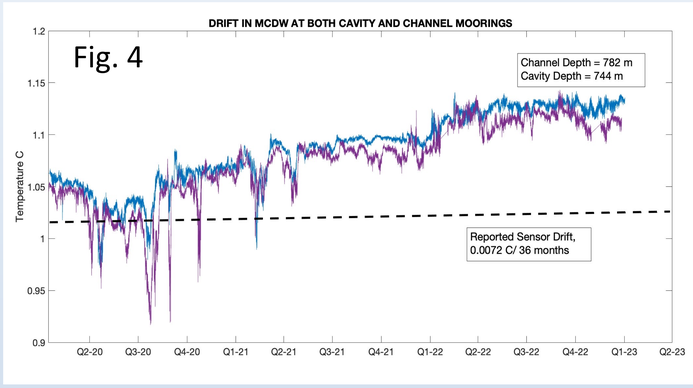
- Figure 2 documents the fiber-based temperature (DTS) ocean profile (only Channel shown). Both stations showed much more near-ice temporal variability (and coherent variation) in the first year of deployment than in Year 2. Dotto et al (2022) proposed that the absence of summer sea ice in the Pine Island Bay in 2020 promoted warm water incursion beneath the ice shelf, leading to greater dynamics. Also note the steepening of the near-ice thermal gradient by Year 2, to be contrasted with 2023 data further in the poster. White areas refer to DTS data gaps greater than 1 day in duration and spatial sampling is 25 cm for most of the time record.

Fig. 3 **2020=2023 SEABIRD TEMPERATURE DATA**



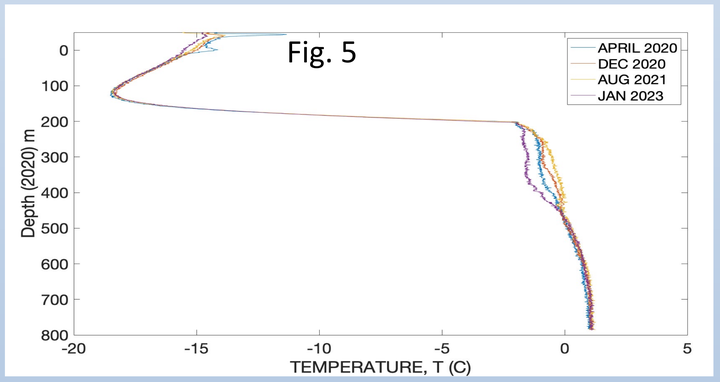
- Figure. 3. Seabird CTD ocean temperatures (10-minute frequency) from Jan 2020 to Jan 2023. Shallower Channel ice shelf water displays a gradual warming through the DTS data interval, and then a steep and variable decline until Jan 2022 when the sensor was disconnected. Salinity (not shown) also displays coherent fluctuations between 34.05 and 34.09 PSU at this depth in the Channel.
- Both deep CTD sensors (located in the mCDW) show a ~0.1˚C increase over the 3-year period of record, (Figure 4) consistent with observations at the grounding zone (P. Davis, personal comm.)

Fig. 4



- Figure 4: Consistent warming ocean temperatures from both Seabird CTDs in the mCDW. During the same period, the Southern Annular Mode (SAM) has been strongly positive (http://www.nerc-bas.ac.uk/icd/gjma/sam.html). The rate of rise is well above the maximum instrument drift value, and consistent between both sensors located more than 4 km apart.

Fig. 5



- Figure 5: A fundamental shift in the upper waters of the Channel ocean temperatures occurred by 2023, from a stratified ice shelf water to a much more well mixed and deep cold water (at or near pressure freezing point). Seen above are several temperature (DTS) profiles from 2020/2021 and Jan 2023. Depth is referenced to ocean depth in Jan 2020.

Conclusions

- Significant and coherent structure in the thermal profiles is evident in 2020, while in 2021, the ice ocean boundary layer is significantly thinned and stabilized (figure 2)
- The deep mCDW shows a consistent warming of 0.1˚C over the 3 years of measurement. (Figure 4)
- By early 2023, a large, melt-impacted mixed water appears to have filled and perhaps overfilled the shelf ”channel” at Channel mooring, suggesting a significant discharge of melt water occurred between Aug 2021 and Jan 2023. (Figure 5)
- Basal melting is not suggested but shelf strain is observed by several instruments (ApRES, DTS and CTD). More on that to come!

Reference:

Dotto et al, (2022), Ocean variability beneath Thwaites Eastern Ice Shelf driven by the Pine Island Bay Gyre strength. *Nature Communications*, https://doi.org/10.1038/s41467-022-35499-5.