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Analysis of the variability of the main physical parameters in the Ross Sea and evaluation of the effects on bottom water production

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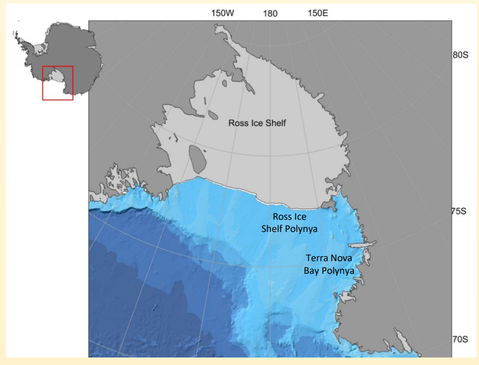
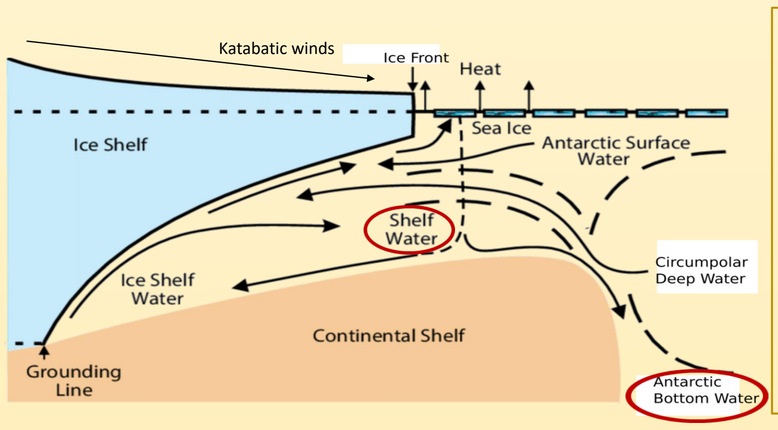
STATE OF THE ART

The Ross Sea (Antarctica) is one of the key area for the Antarctic Bottom Water (AABW) formation[1]. This dense water mass is crucial in driving the thermohaline circulation, facilitating the global redistribution of heat, salt, oxygen and carbon throughout the oceans[1,2].





AABW is formed starting from the mixing of the Circumpolar Deep Water (CDW) with the High Salinity Shelf Water (HSSW), which originates in the Ross Sea polynya areas thanks to the action of katabatic winds, atmospheric cooling and brine rejection during the sea ice formation[3,4].

❖ Shelf Waters (SW) represent a key element in AABW formation, since they are its precursors[5].

❖ Changes in SW properties have consequences on AABW, and its modifications could affect the entire global thermohaline circulation.

AIM OF THE RESEARCH

Study of the variability of the physical properties of the Ross Sea water masses, especially in their formation areas (Terra Nova Bay and Ross Ice Shelf polynyas), to understand the contribution of Shelf Waters (SW) to the Antarctic Bottom Water (AABW) production.

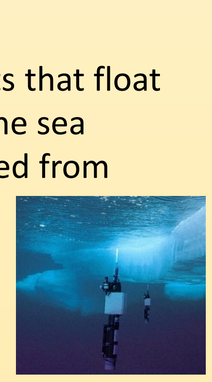
↓

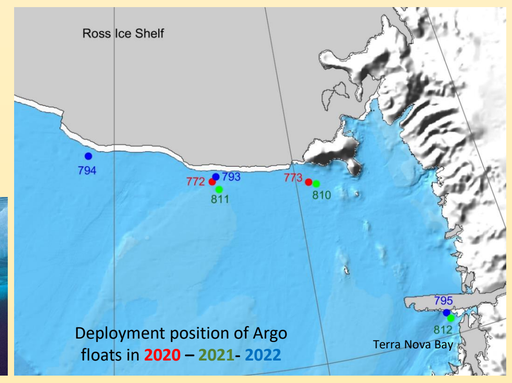
Characterization of Shelf Waters and their spatial-temporal variability

DATASETS and STUDY AREA

Analysis of oceanographic data collected during Italian National Antarctic Research Programme (PNRA) from :

- CTD (Conductivity – Temperature – Depth sensor probe) /LADCP (Lowered Acoustic Doppler Current profiler) casts along the Ross Ice Shelf (RIS);
- Argo floats (instruments that float at different depths in the sea collecting data) deployed from 2020 to 2022 in Terra Nova Bay and in the western sector of the RIS.



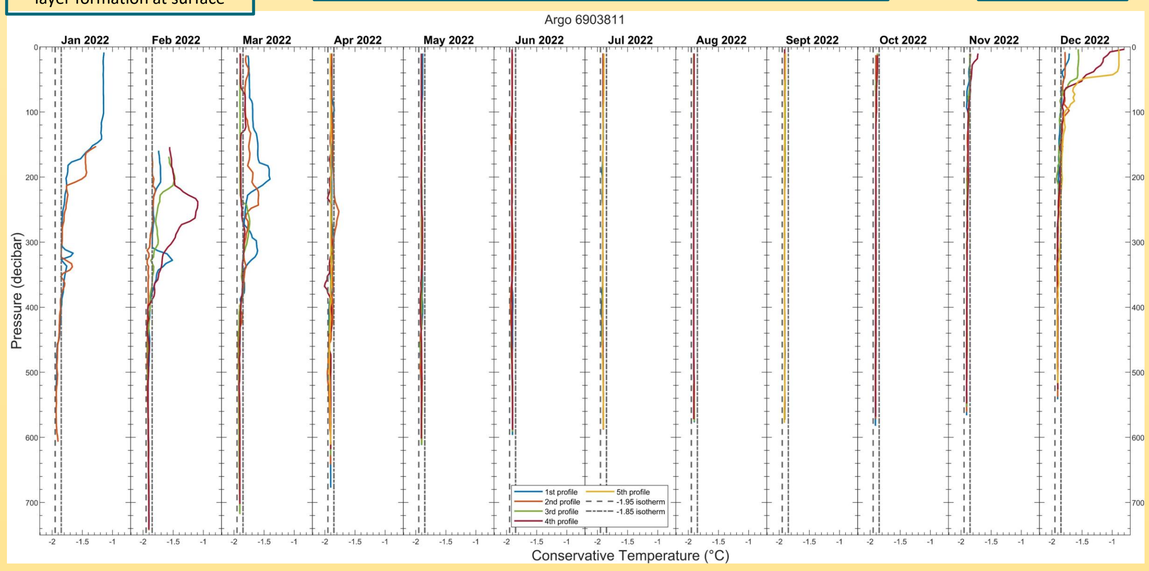


RESULTS

✓ Time series analysis from Argo floats data: description of monthly evolution of conservative temperature profiles and HSSW production

✓ Vertical structure of water column: yearly evolution of absolute salinity

Austral summer: sea ice melting, fresher and warmer layer formation at surface → Austral winter: atmosphere and sea surface cooling, sea ice formation, brine rejection → HSSW production, one uniform layer present → Summer structure

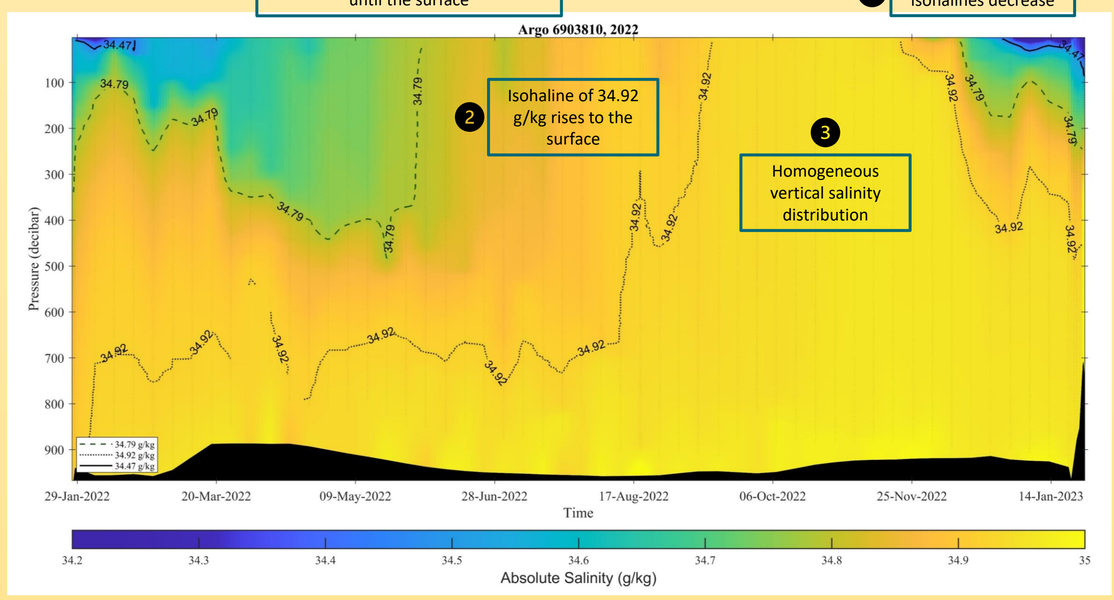


1 Salt release during sea ice formation: increase of the isohaline 34.79 g/kg until the surface

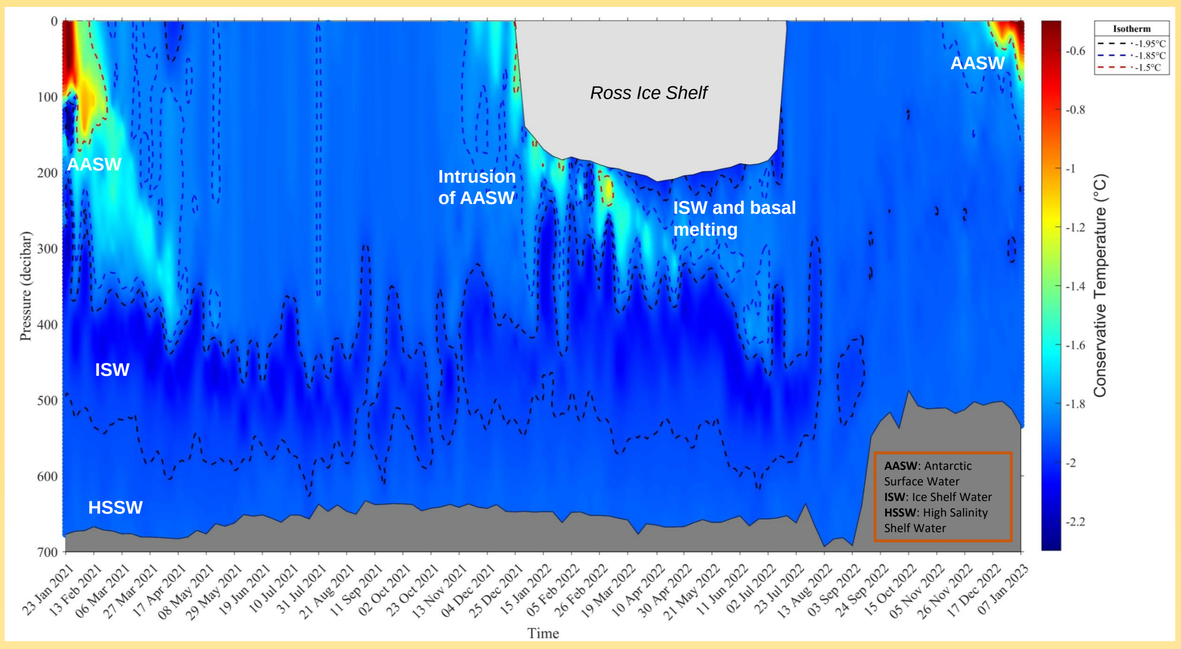
2 Isohaline of 34.92 g/kg rises to the surface

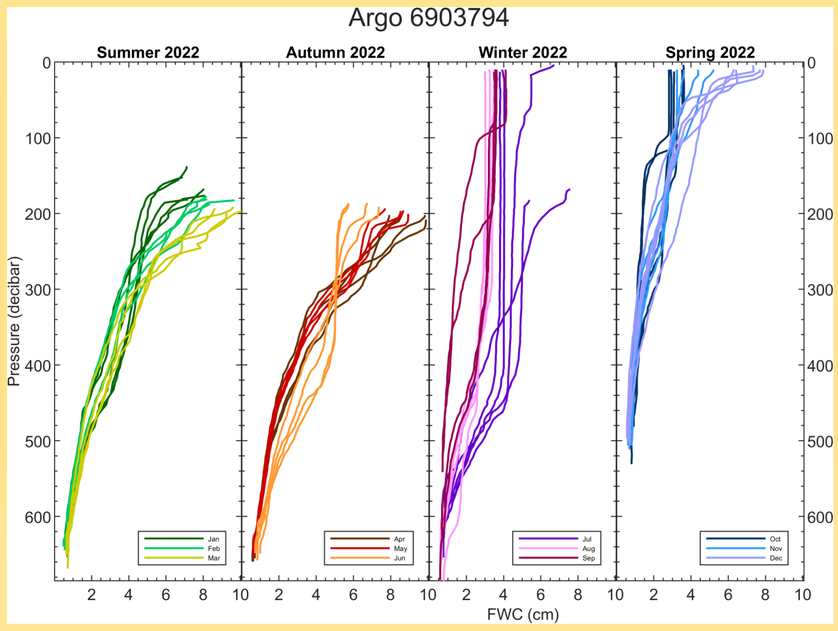
3 Homogeneous vertical salinity distribution

4 Sea ice melting: isohalines decrease



✓ Argo under ice : unprecedented observations under the Ross Ice Shelf captured by Argo float and intrusion of warm surface water into the RIS cavity





- Fresh Water Content (FWC) seasonal estimates under the RIS are similar to values observed in the surface layer in early summer during sea ice melting (up to 10 cm).
- FWC decreases in winter following the seasonal cycle of the sea ice.

Argo 6903794 spent 8 months (December 2021-September 2022) under the RIS cavity. It provided invaluable information about exchange mechanisms between the ice shelf cavity and the open sea, capturing major water mass dynamics, the intrusion of warm summer AASW under the RIS and basal melting of the ice shelf.

FUTURE PERSPECTIVES

➢ Multi-year analysis of physical properties of water masses along the Ross Ice Shelf;
➢ Study of the effects of SW variability on AABW production.

1. Orsi, A.H., Wiederwohl, C.L., 2009. A recount of Ross Sea waters. Deep Sea Res. Part II Top. Stud. Oceanogr. 56, 778–795.
2. Castagno, P. et al., 2019. Rebound of shelf water salinity in the Ross Sea. Nat. Commun. 1–6. https://doi.org/10.1038/s41467-019-13083-8.
3. Jacobs, S.S., Fairbanks, G., 1985. Origin and evolution of water masses near the Antarctic continental margin: evidence from H218O/H216O ratios in seawater. Oceanol. Antarct. Cont. Shelf 43, 59–85.
4. Budillon, G.and Spezie, G., 2000. Thermohaline structure and variability in the Terra Nova Bay Polynya, Ross Sea. Antarctic Science 12 (4),493–508.
5. Jacobs, S.S., Comiso, J.C., 1989. Sea ice and oceanic processes on the Ross Sea continental shelf. J. Geophys. Res. 94. https://doi.org/10.1029/jc094ic12p18195.