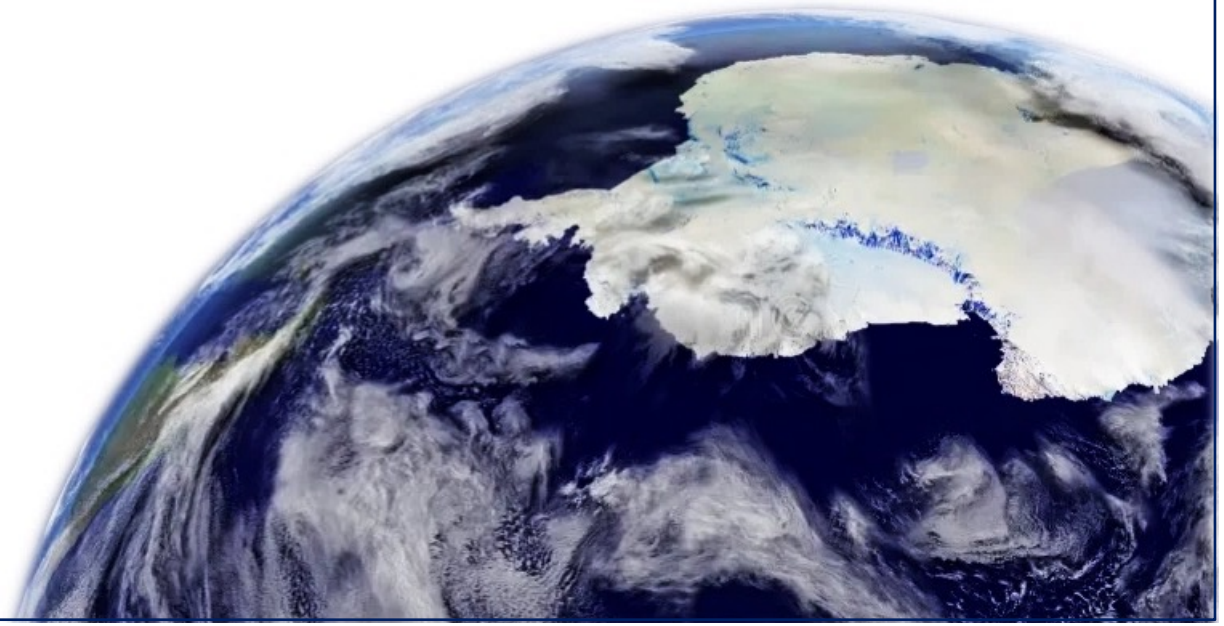
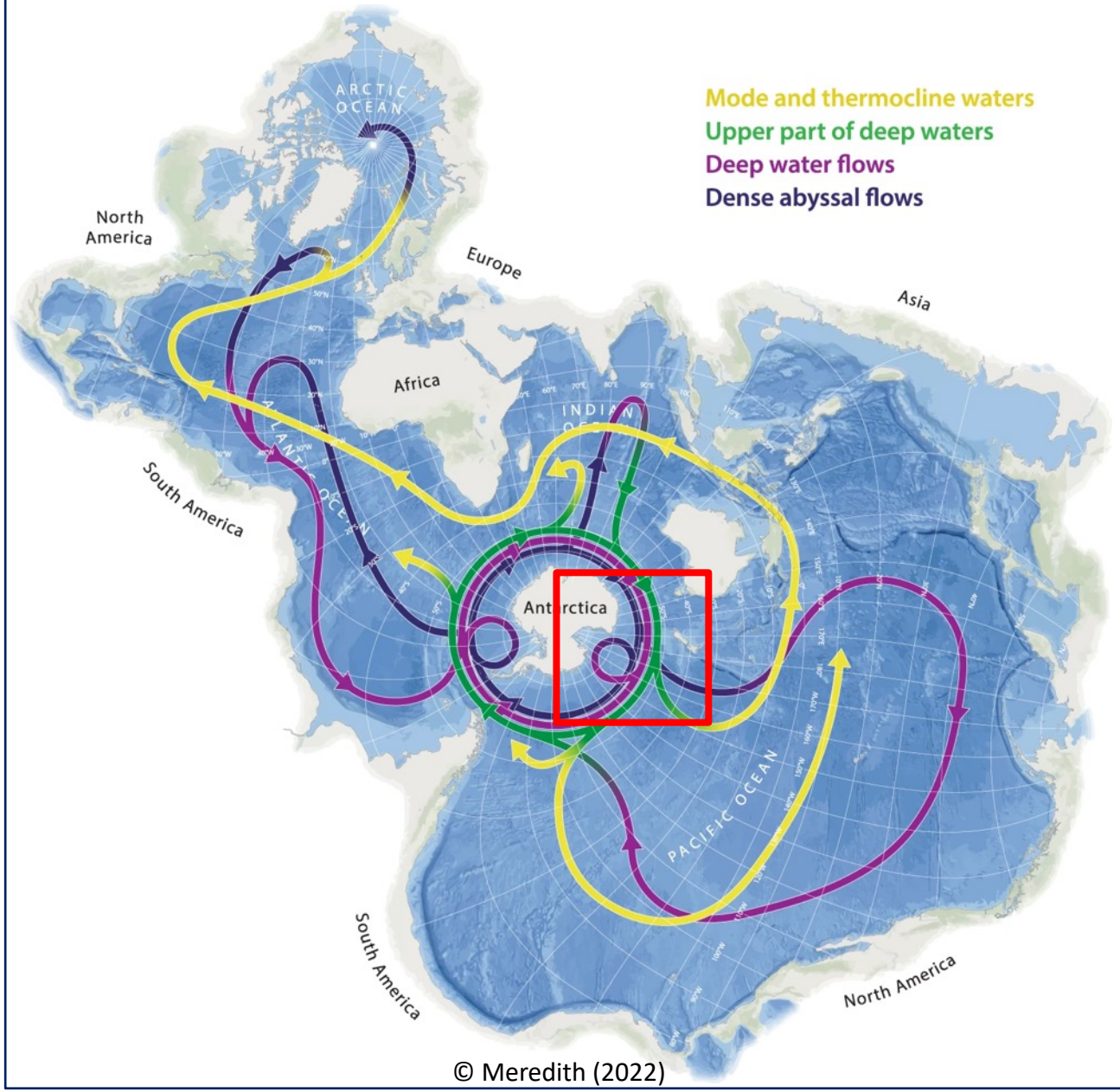
Preliminary insights from a multi-glider survey on the Ross Sea Continental Shelf in Antarctica

Naomi Krauzig, Pierpaolo Falco, Giannetta Fusco, Giuseppe Aulicino, Giorgio Budillon, Yuri Cotroneo , Diana Di Luccio, Simone Di Palma, Massimiliano Esposito, Antonino Ian Ferola, Laura Fortunato, Alberto Greco, Andrea Molino, Enrico Zambianchi, Angela Garzia, Elena Mauri, Stefano Kuchler, Alessandro Bubbi, Piero Zuppelli, Julieta Logarzo, Annunziata Pirro, Riccardo Martelllucci, Christian Saggese, Pasquale Castagno, Jasmin McInerney, Cassandra Elmer, Craig Stewart, Eleanor Haigh, Craig Stevens



Background and motivation: Global role of the Southern Ocean



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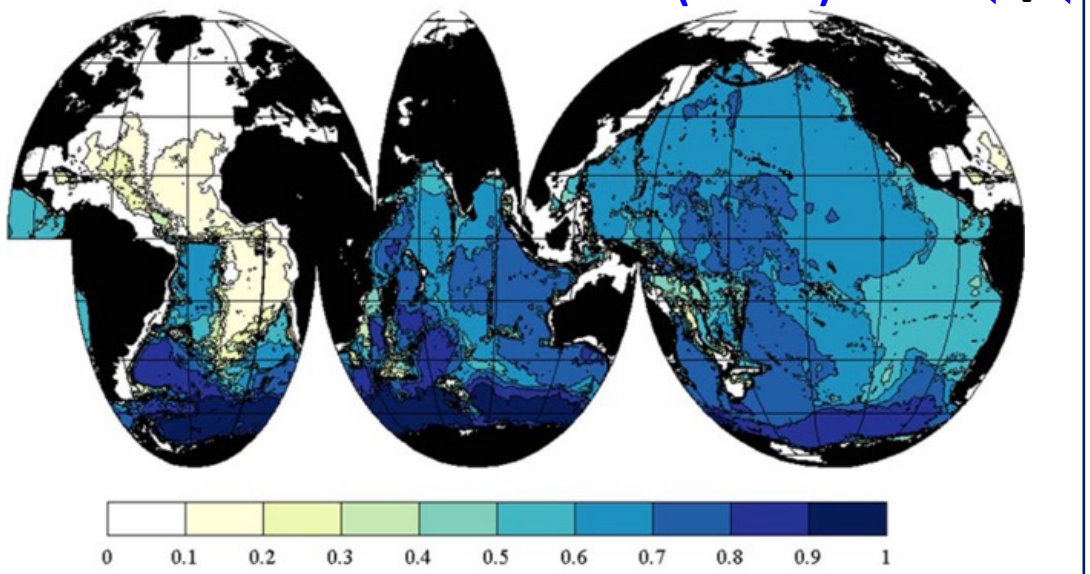
Southern Ocean:

- Connection across planetary scales
- Global circulation and climate dynamics
- Oceanic uptake: 50% carbon & 75% heat

Antarctic Bottom Water (AABW) T↗ S↘ V↘



Fraction of AABW at the deepest sample in the climatology contoured at 0.1 intervals

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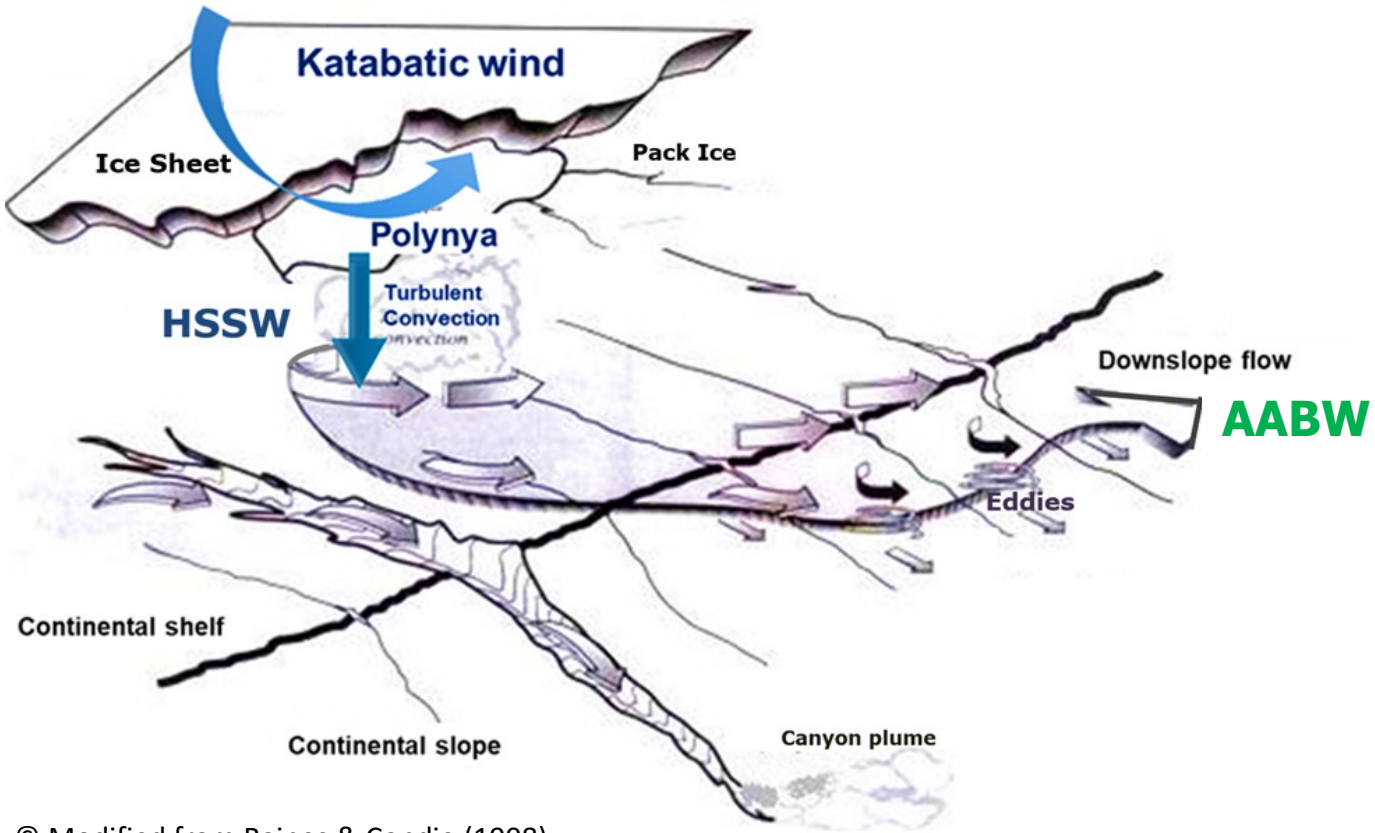
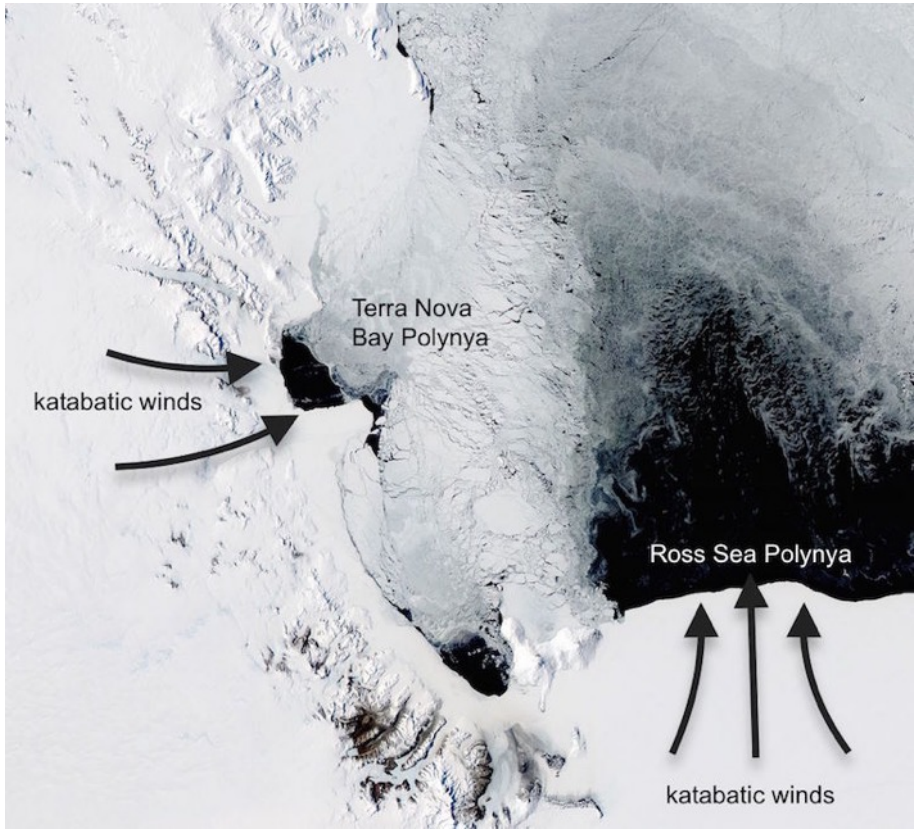
Background and motivation: Role of the Ross Sea



© Modified from Baines & Condie (1998)



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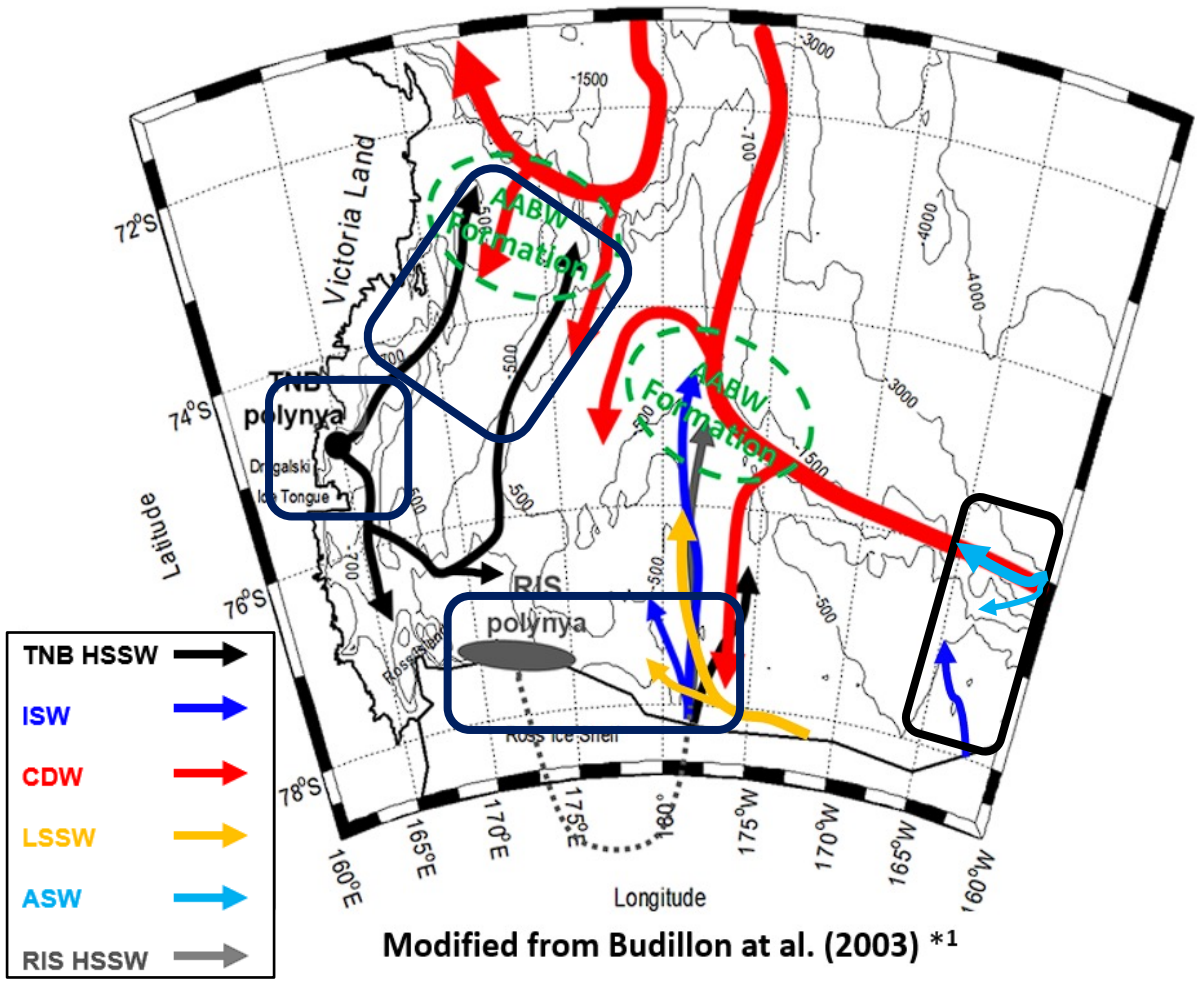
HSSW: High Salinity Shelf Water & AABW: Antarctic Bottom Water

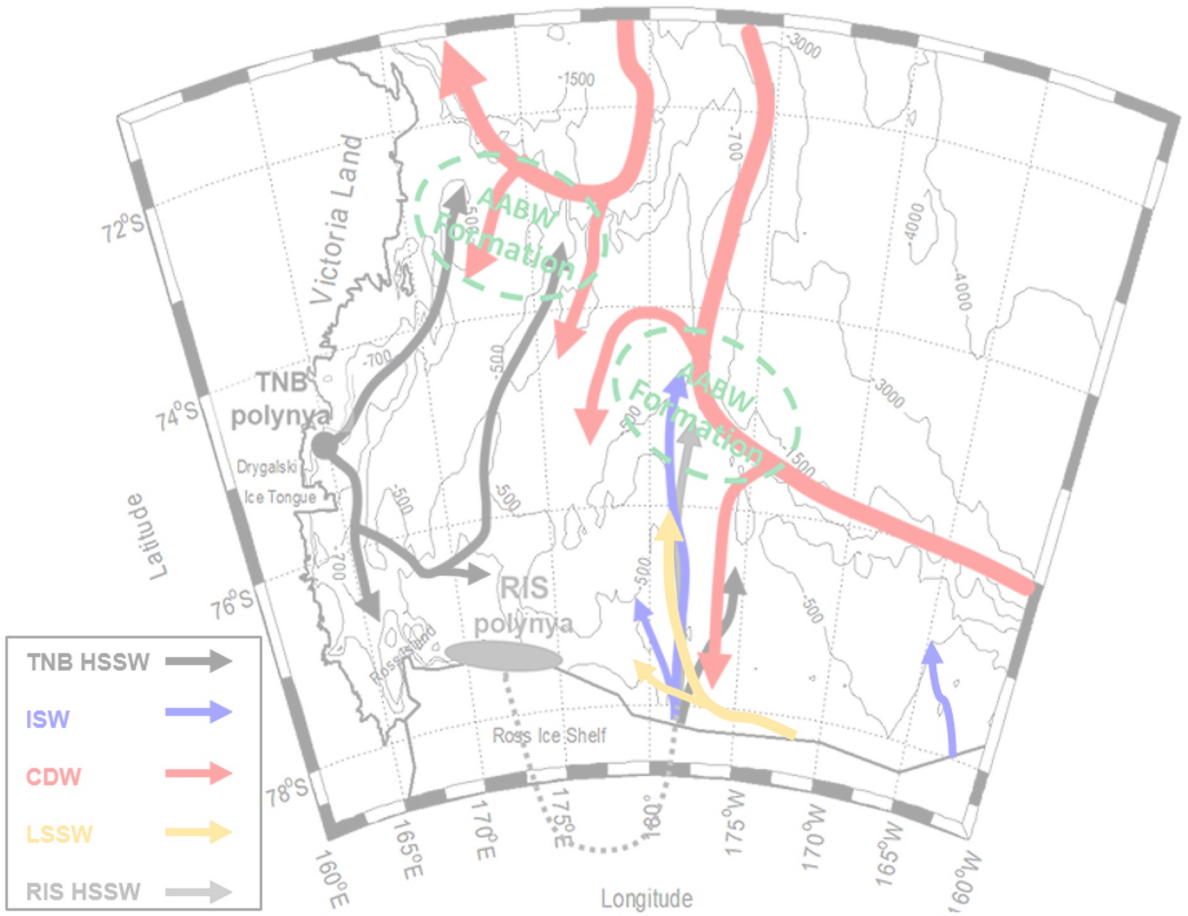
Background and motivation: Ross Sea Bottom Water



Modified from Budillon at al. (2003) *1

*1 Based on: Orsi & Wiederwohl (2009); Jendersie et al. (2018); Rivaro et al. (2022)

Background and motivation: Data and knowledge gap



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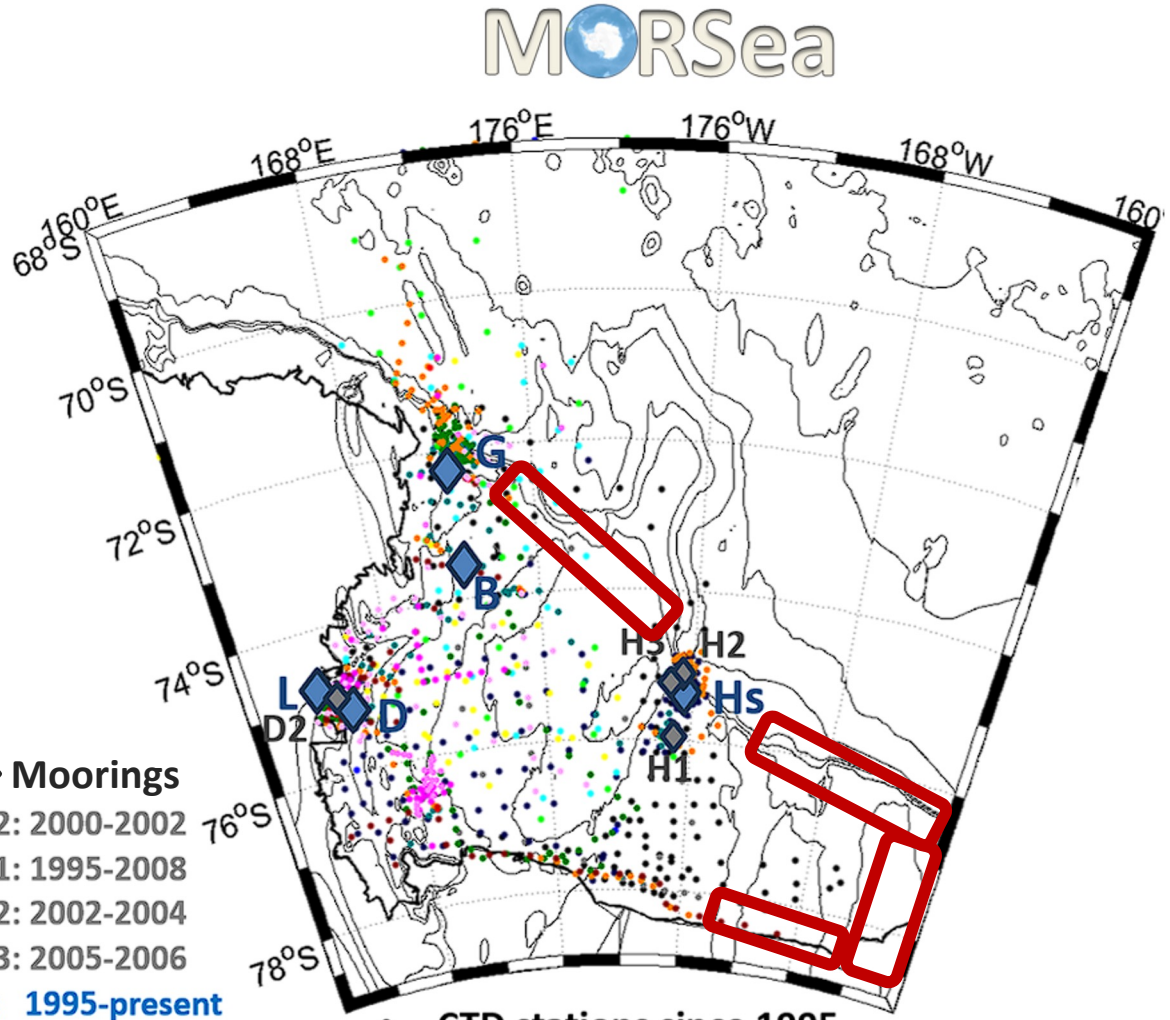


Moorings

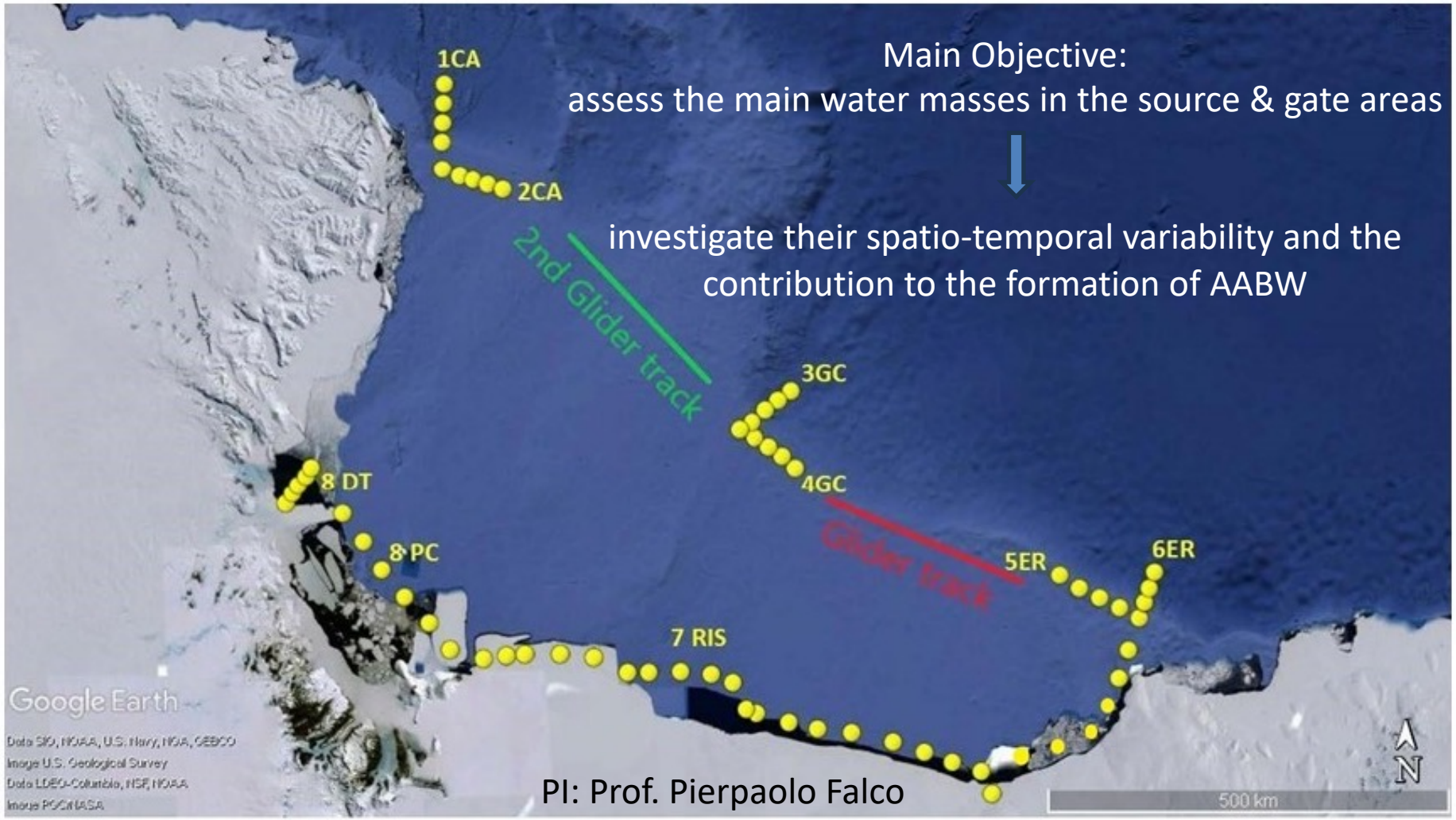
- D2: 2000-2002
- H1: 1995-2008
- H2: 2002-2004
- H3: 2005-2006
- **B: 1995-present**
- **D: 1995-present**
- **L: 1998-present**
- **G: 2003-present**
- **Hs: 2022-present**

• CTD stations since 1995

Consiglio Nazionale delle Ricerche

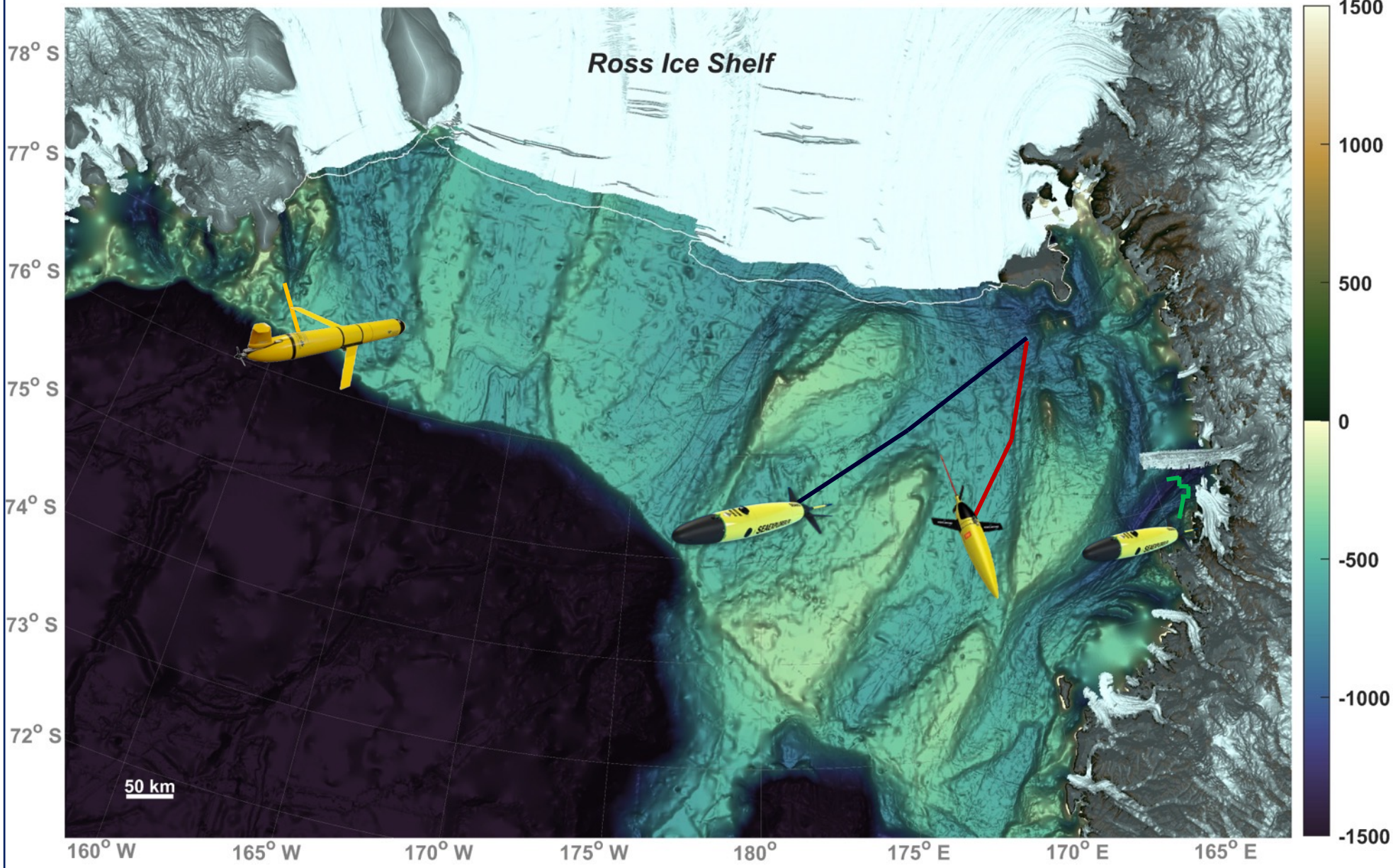
*1 Based on: Orsi & Wiederwohl (2009); Jendersie et al. (2018); Rivaro et al. (2022)

PhySIcal and bioGeochemical traciNg of wATer masses at source areas and export gates in the Ross Sea and impact on the SoUtheRn OcEan (**SIGNATURE**)



PI: Prof. Pierpaolo Falco

Final plan: 3 different gliders & 4 different surveys covering ~760 km



Glider operation overview

a) SeaExplorer 18-21 Jan
CTD, Oxygen, Fluorometer
~77 km; 48 cycles; ~900m

b) Seaglider 27 Jan-9 Feb
CTD, Oxygen, Fluorometer
~200km; 116 cycles; ~750m

c) SeaExplorer 27 Jan-9 Feb
CTD, Oxygen, Fluorometer
~407 km; 241 cycles; ~670m

d) Slocum 2 Feb-6 Feb
CTD, Oxygen, Fluorometer
PAR, CDOM, Backscatter
~70 km; 62 cycles; ~430m

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OGS National Institute of Oceanography and Applied Geophysics
PROGRAMMA NAZIONALE DI RICERCHE IN ANTARTIDE ITALIANTARTIDE
NIWA Taihoro Nukurangi

Project TENORE: Terra Nova Bay

SeaExplorer

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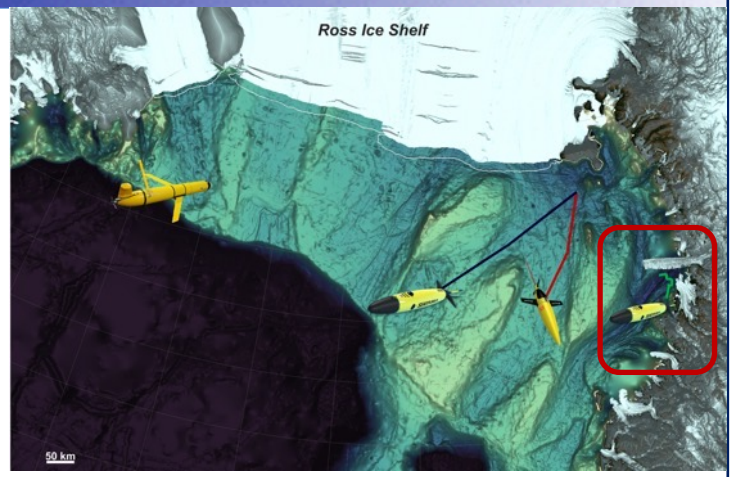

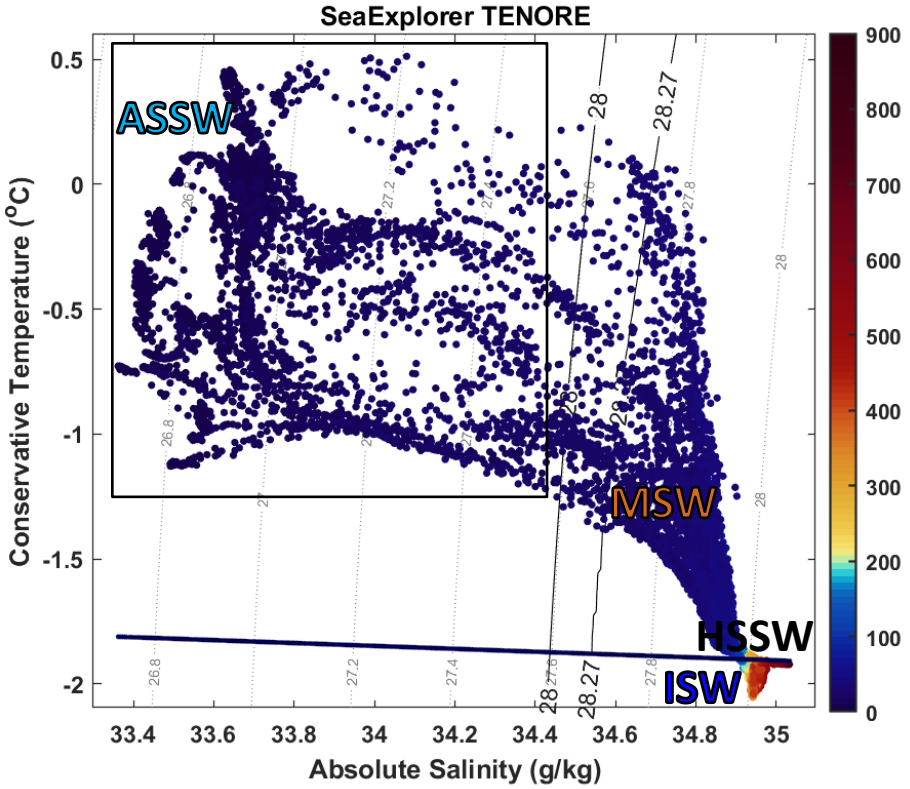

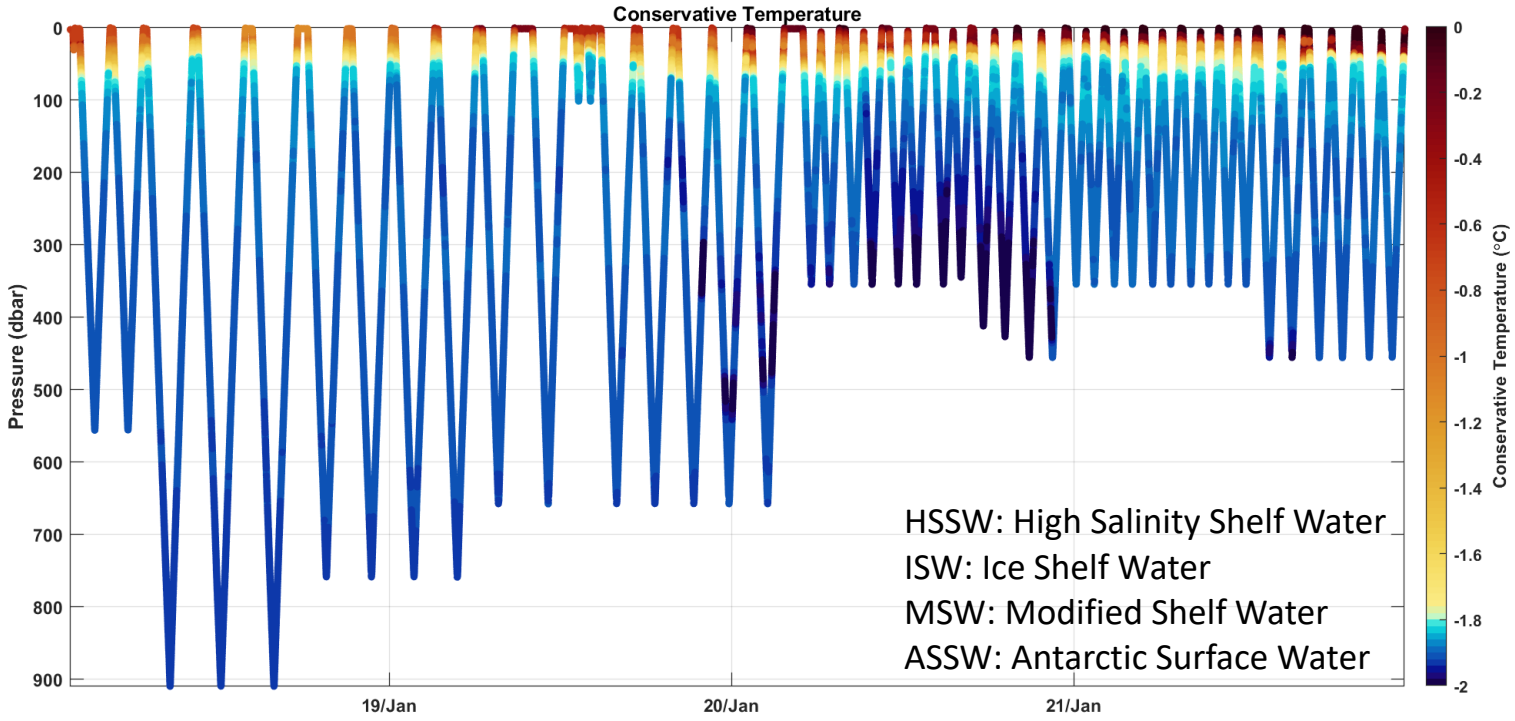

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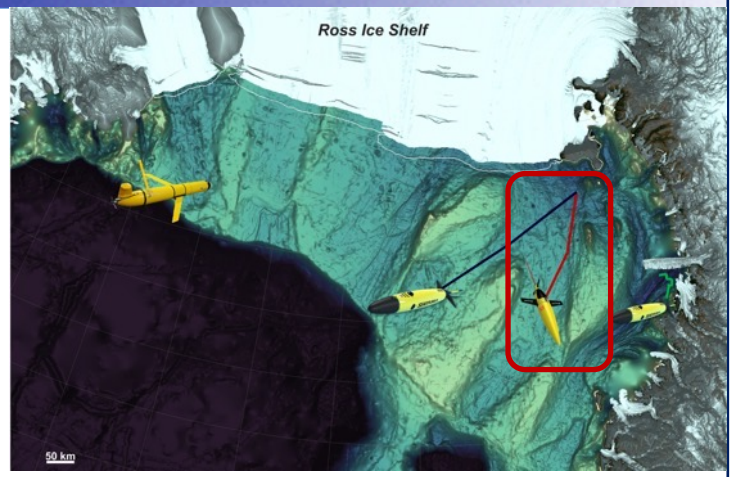
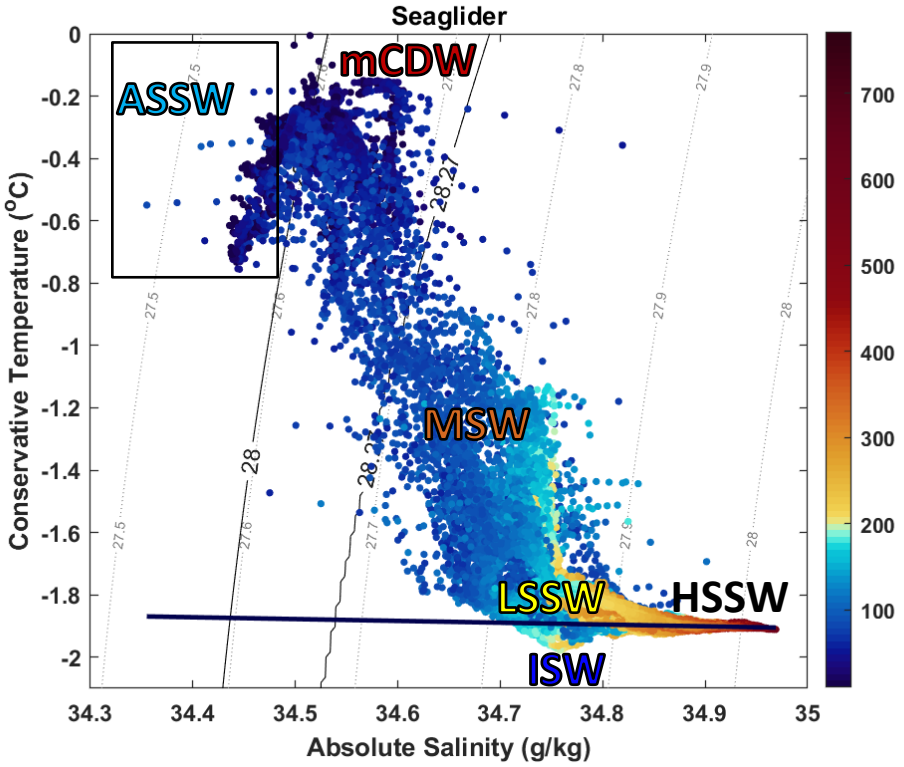
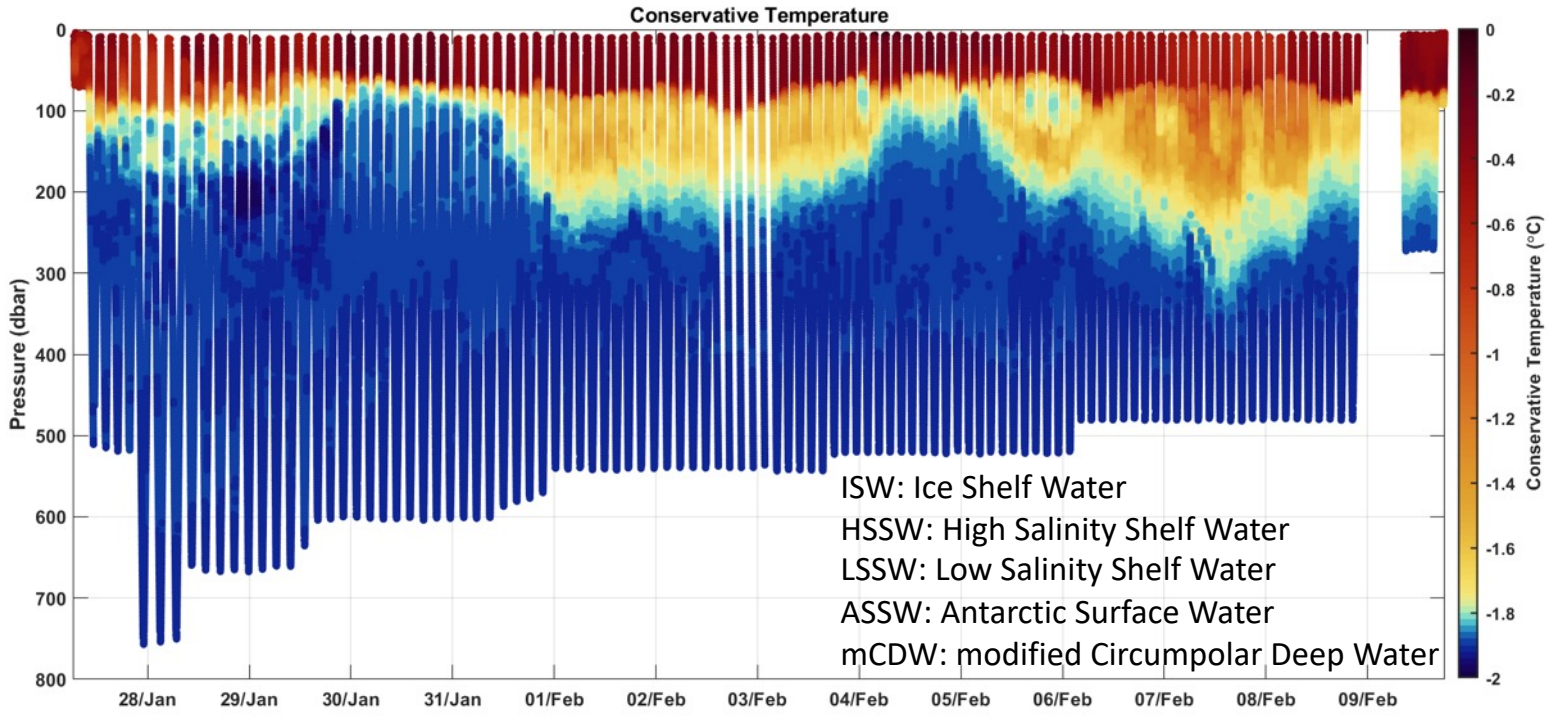
Seaglider







Project SIGNATURE: Pennell Trough

SeaExplorer

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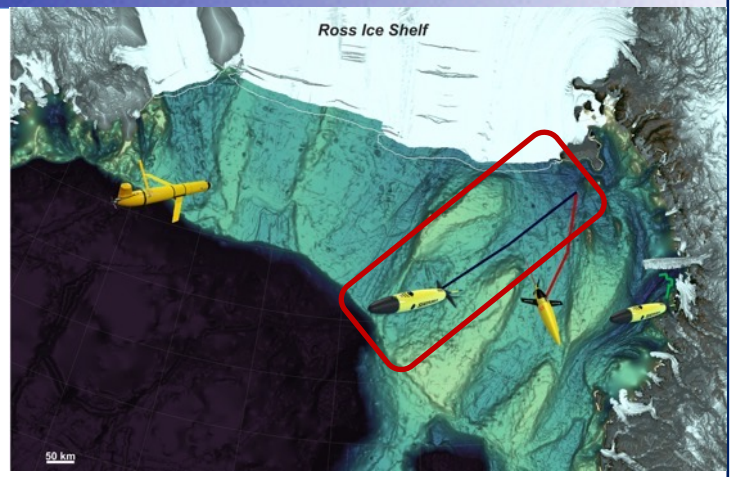
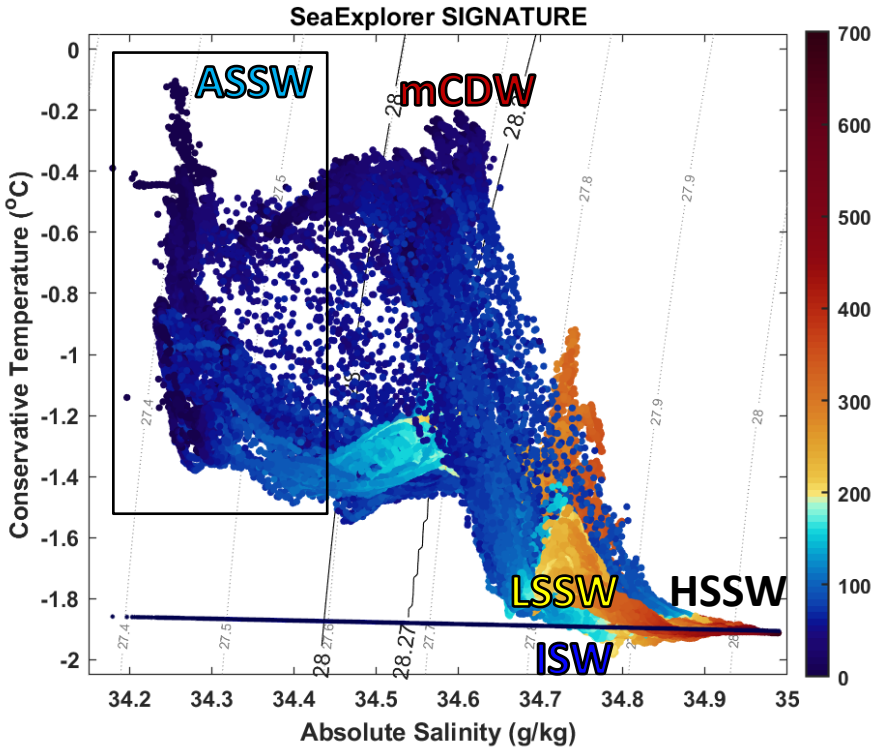
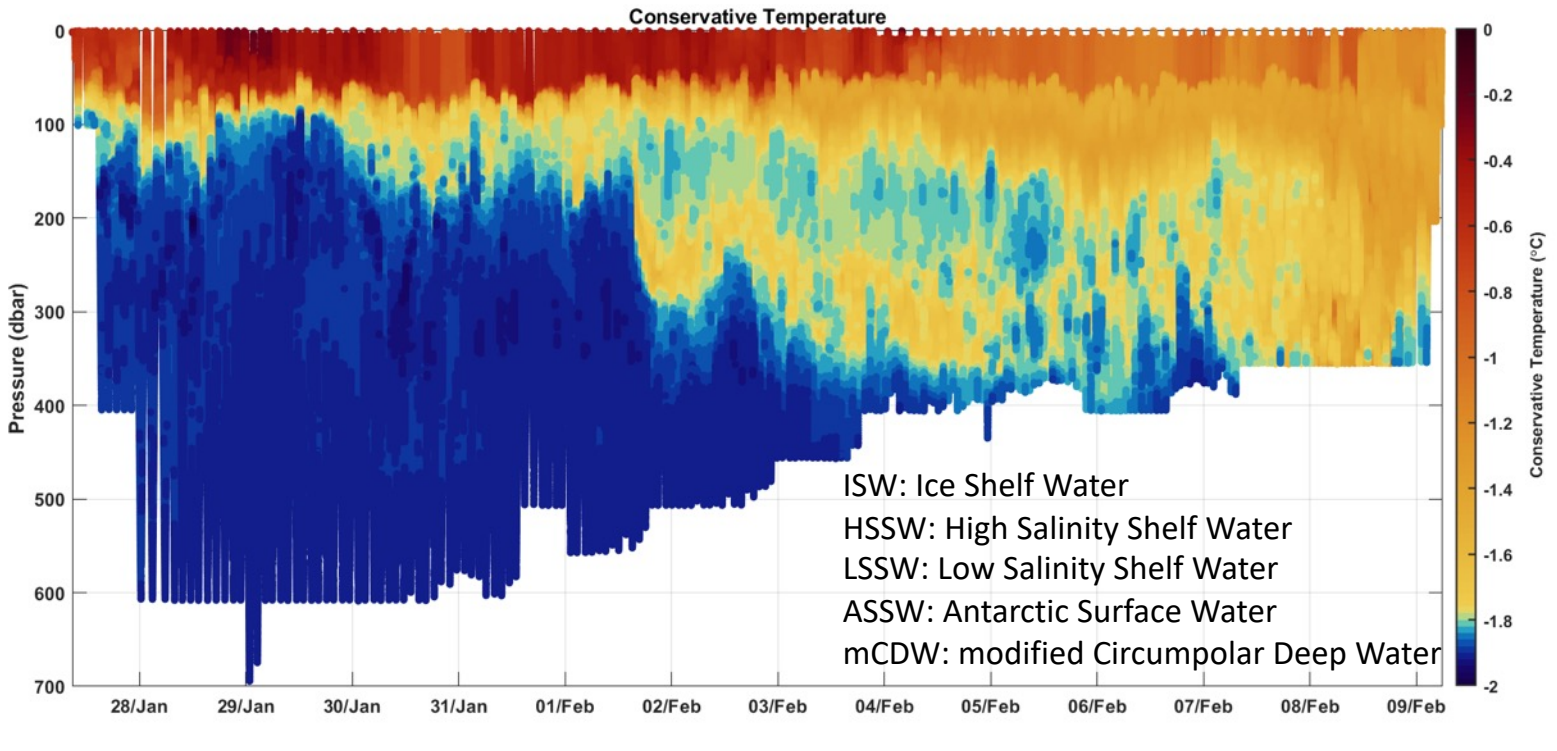




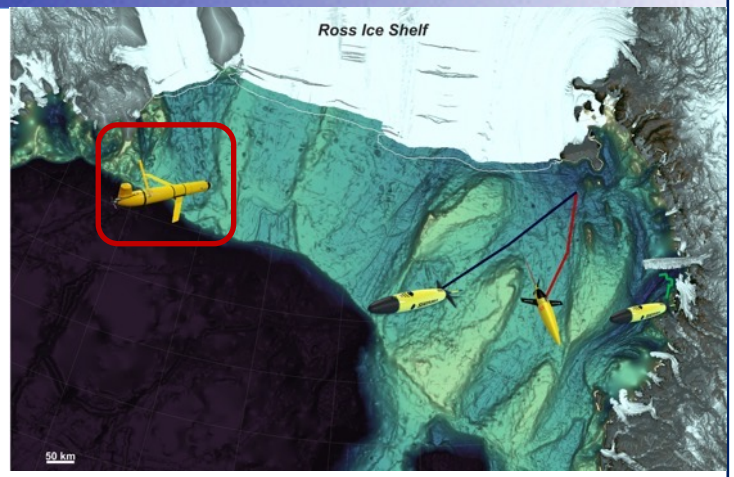


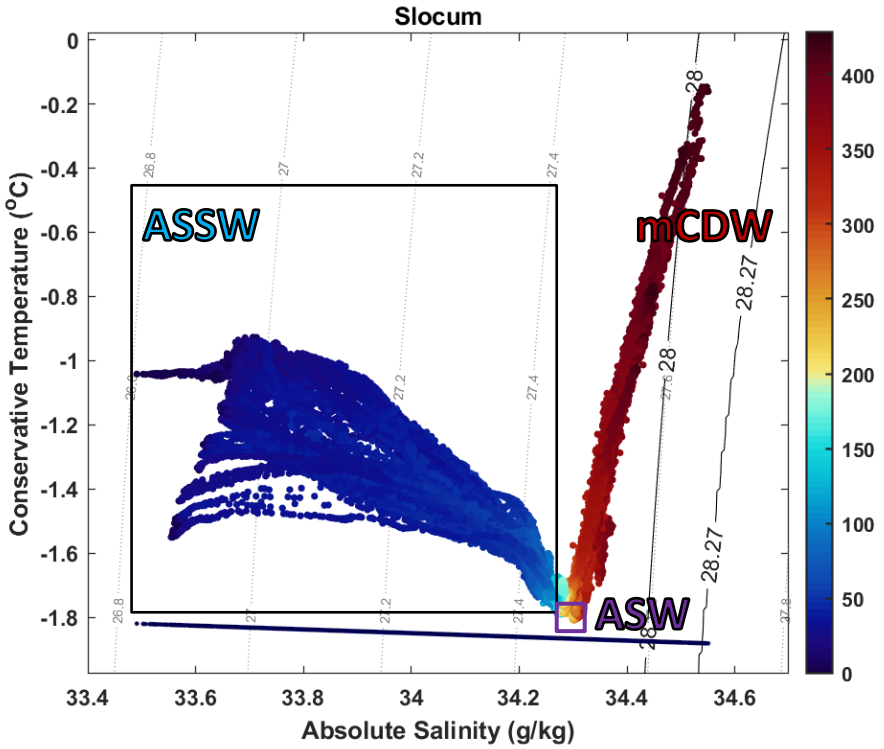
ISW: Ice Shelf Water
HSSW: High Salinity Shelf Water
LSSW: Low Salinity Shelf Water
ASSW: Antarctic Surface Water
mCDW: modified Circumpolar Deep Water

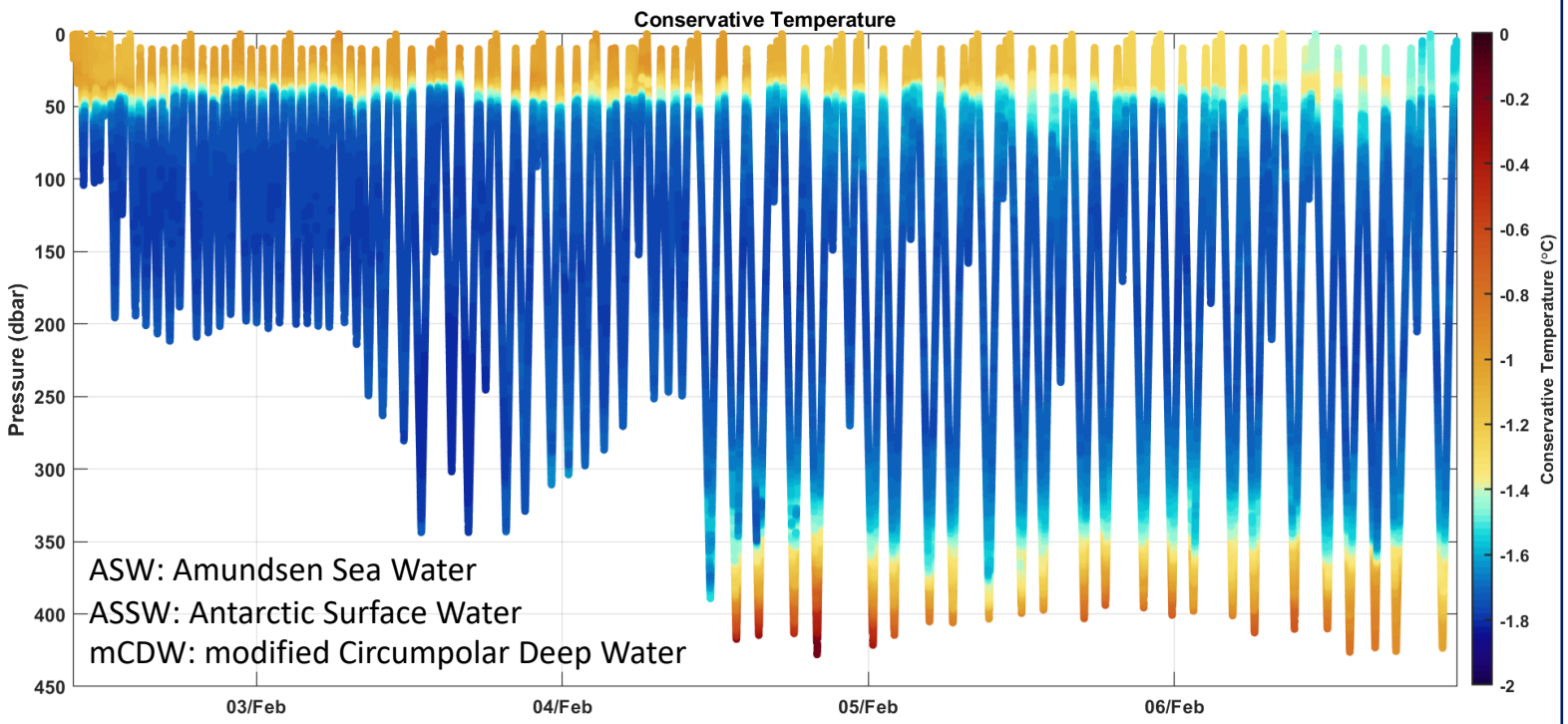
Project SIGNATURE: Eastern Gate

NIWA Taihoro Nukurangi

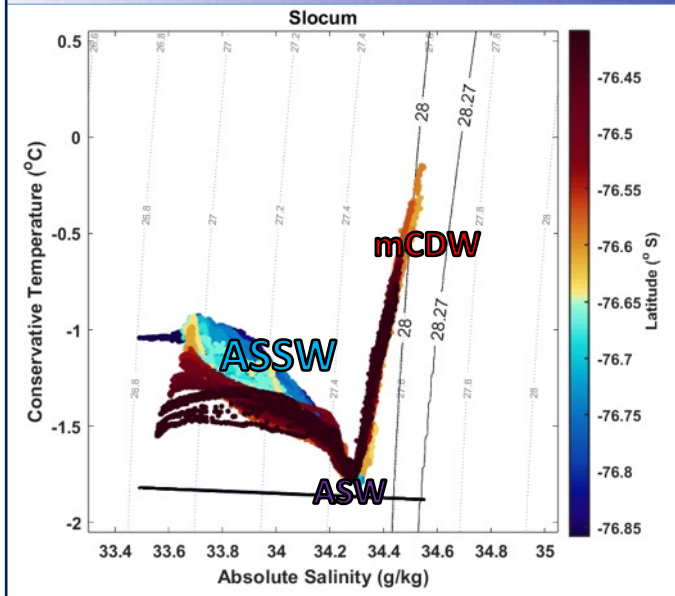
Slocum

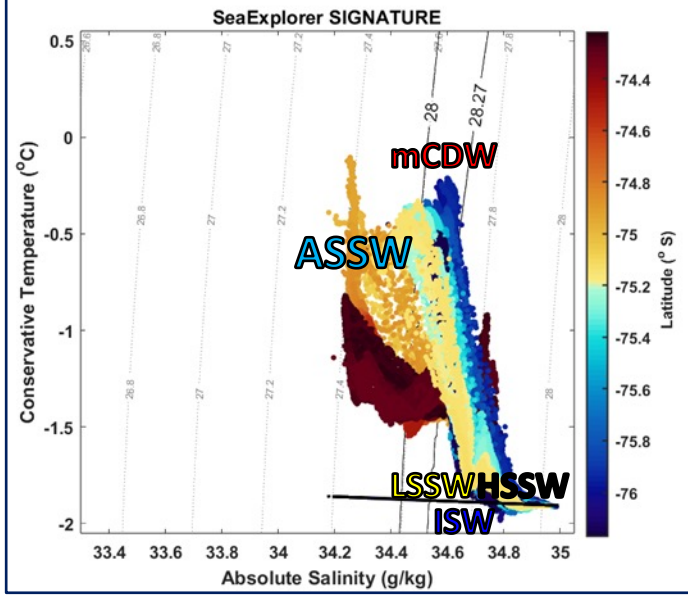




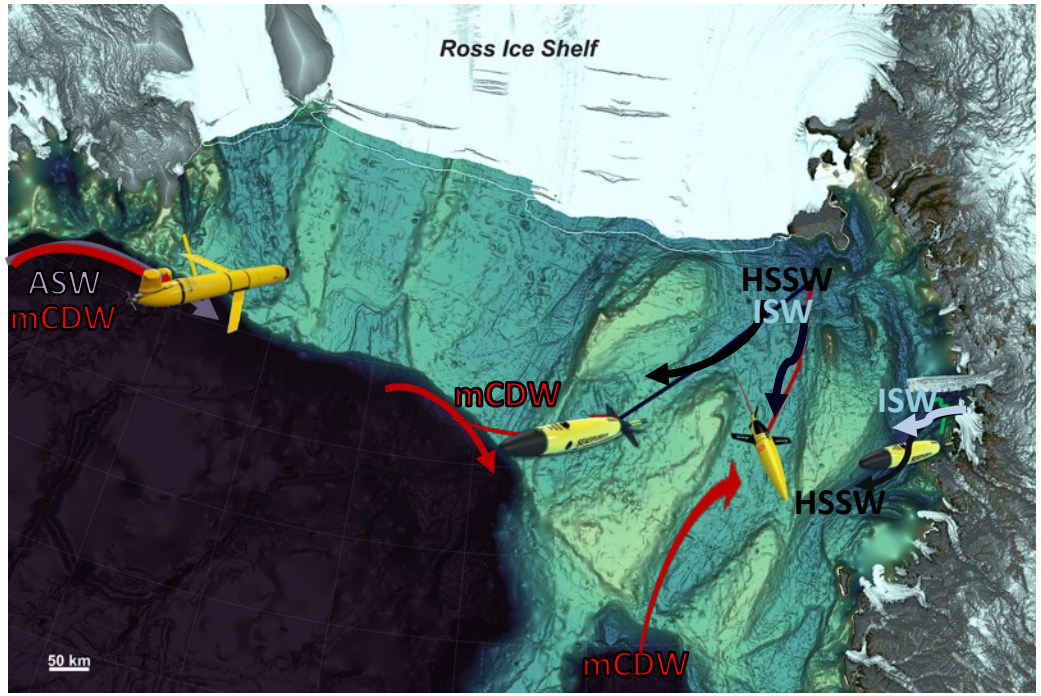


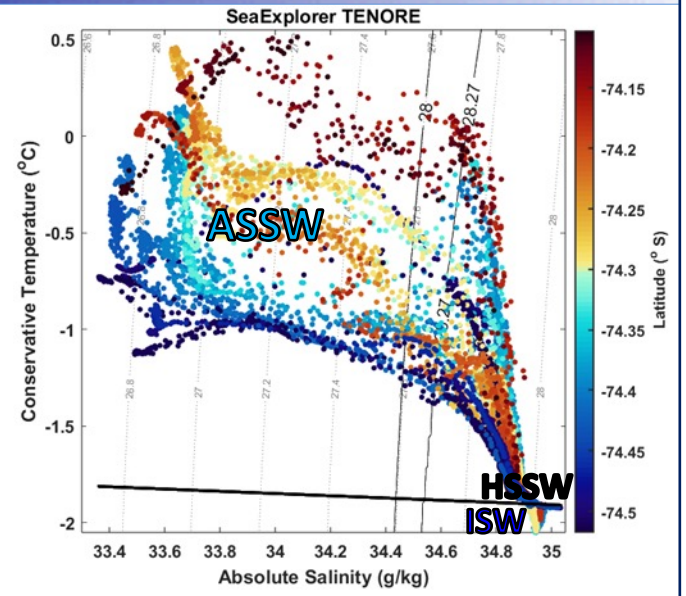
Summary and intercomparison of the sampled water mass properties

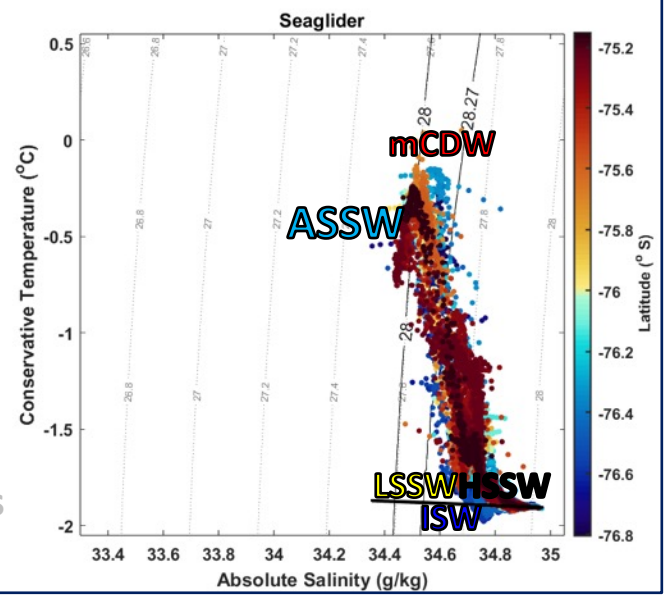




~760 km in strategic areas of the Ross Sea continental shelf







- **HSSW** in its **formation** and **export areas**
- **ISW** flowing out of the ice shelf cavity vs. locally produced
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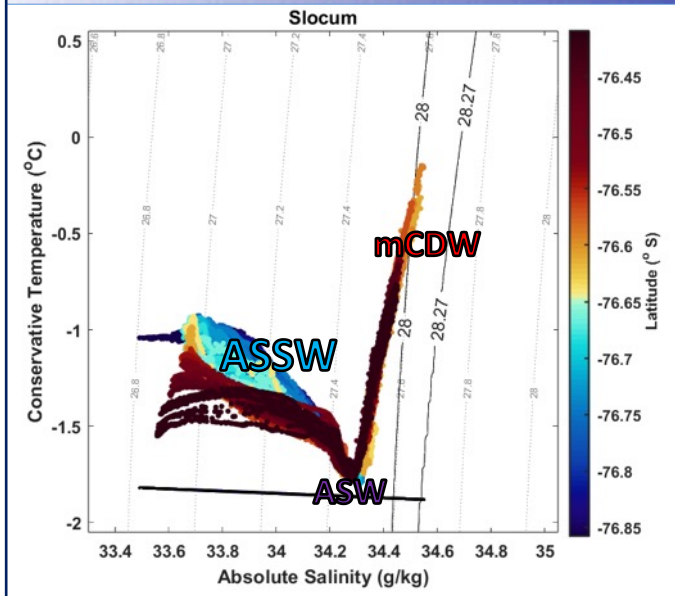

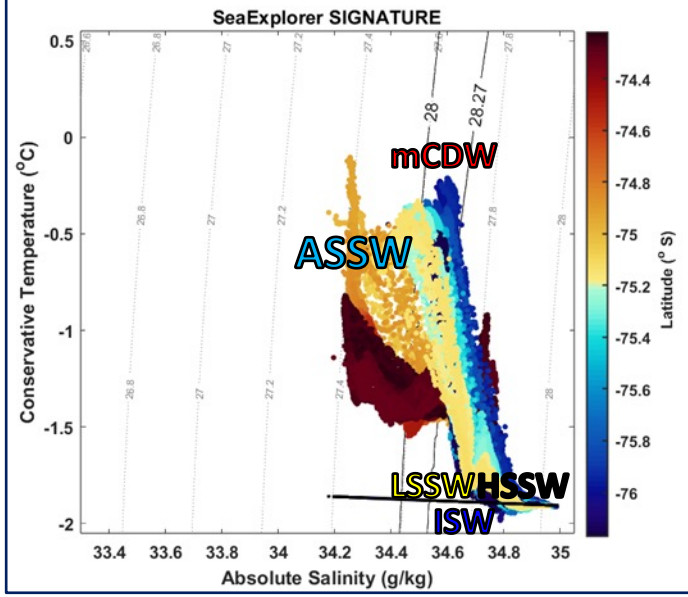

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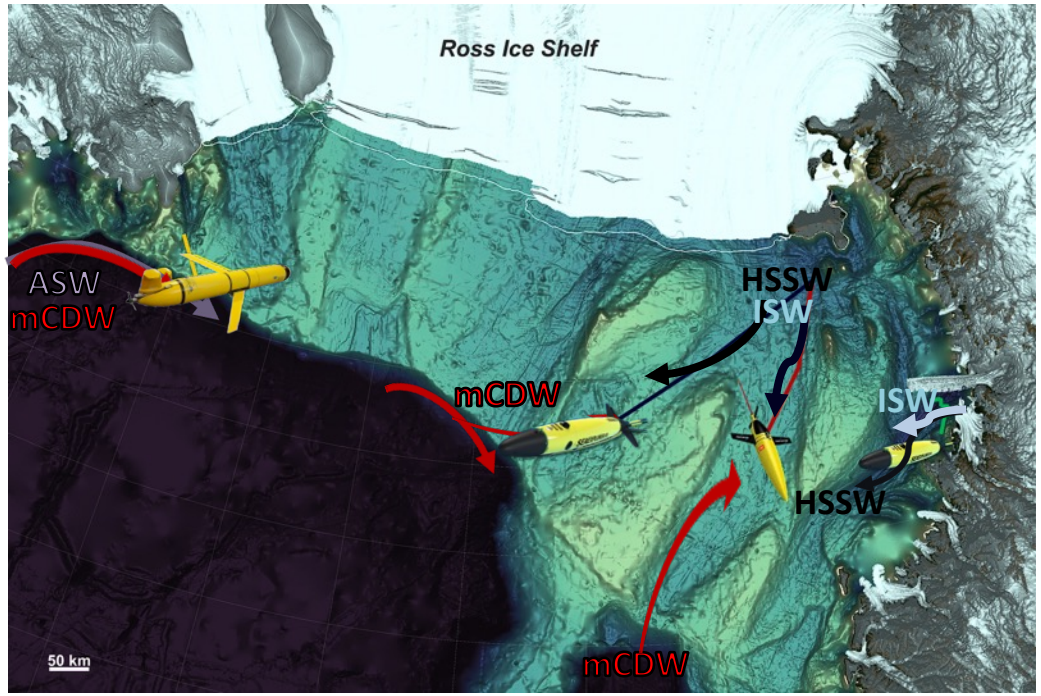

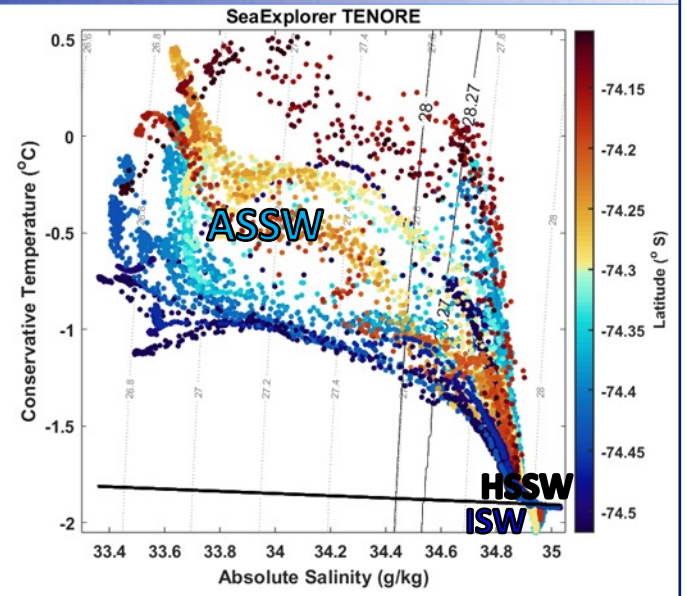

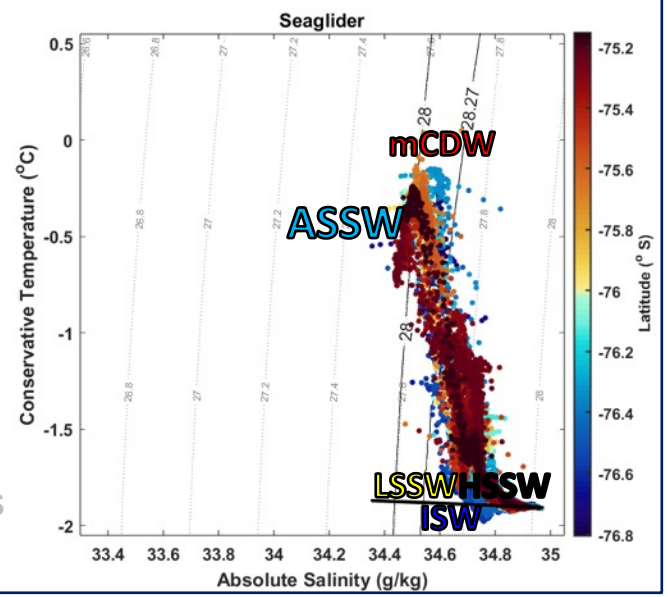

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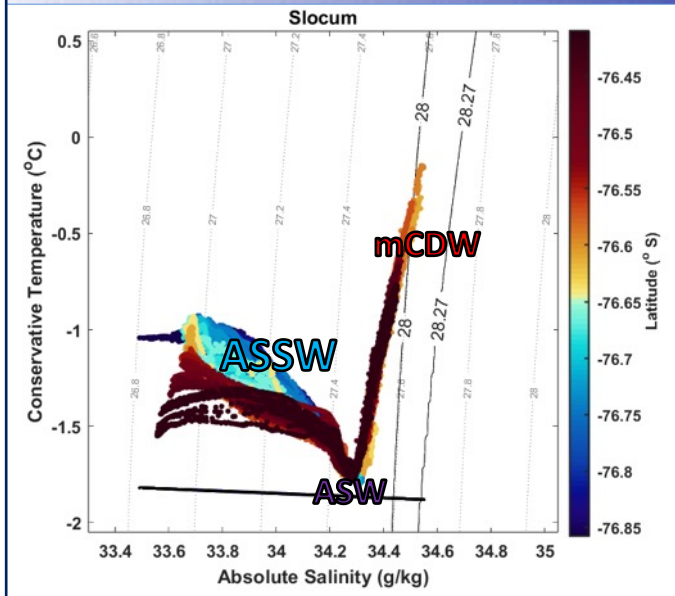

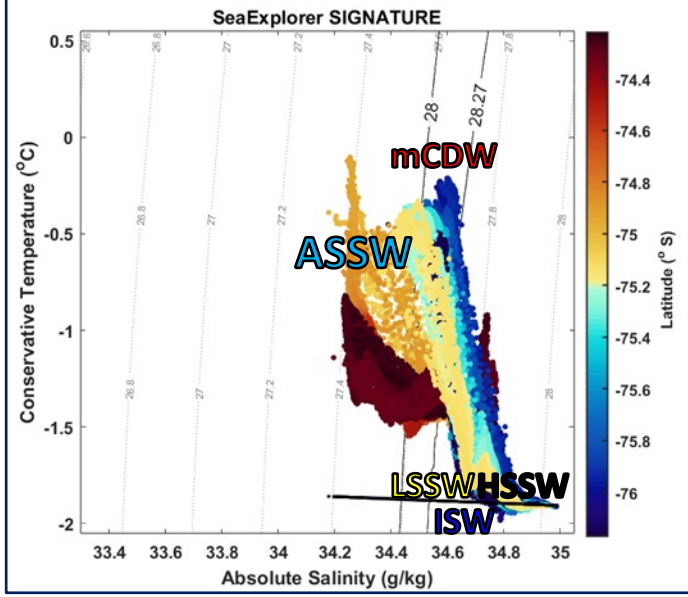

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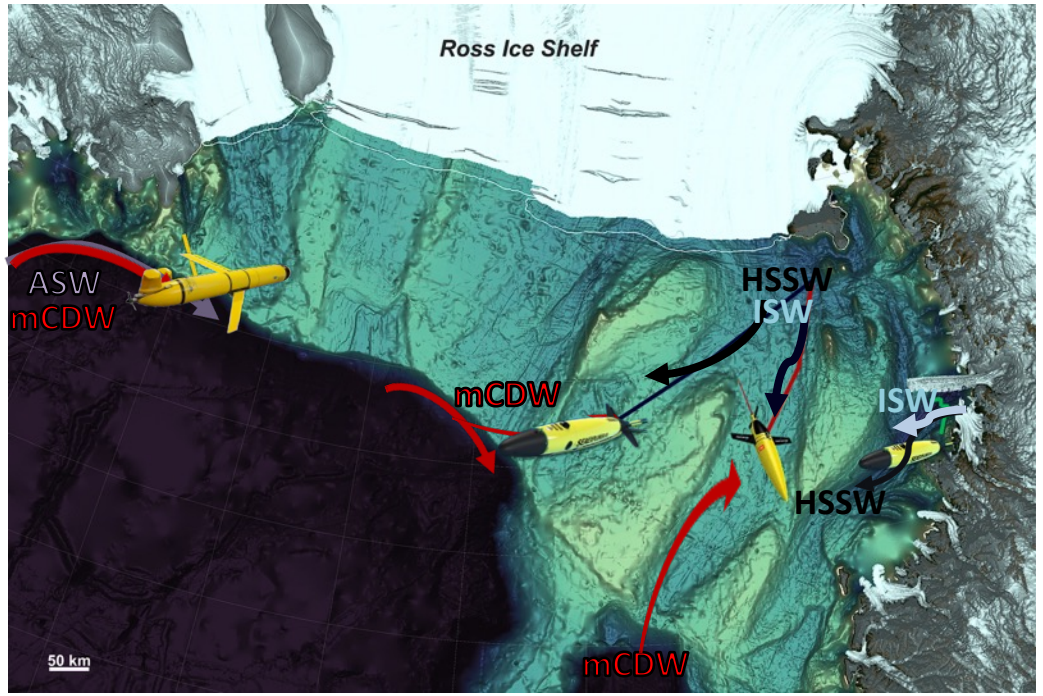

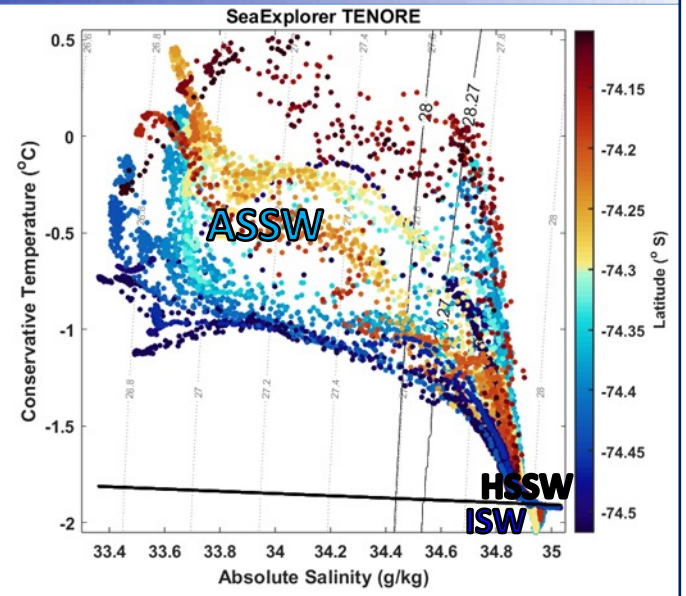

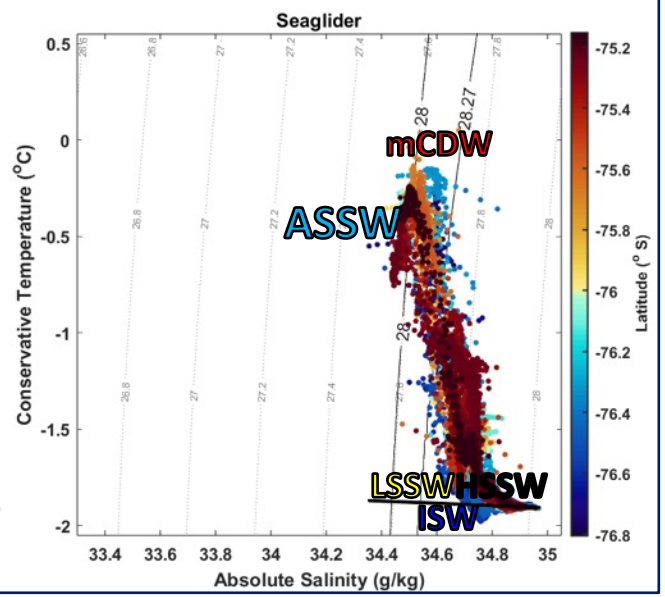

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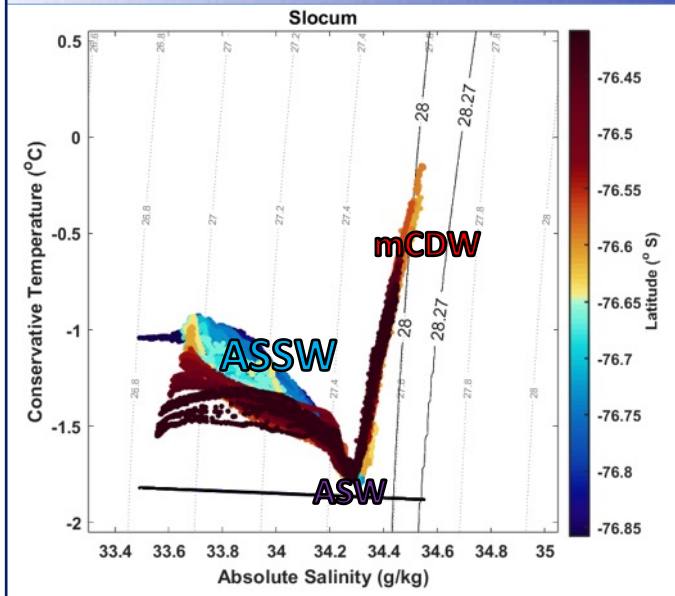

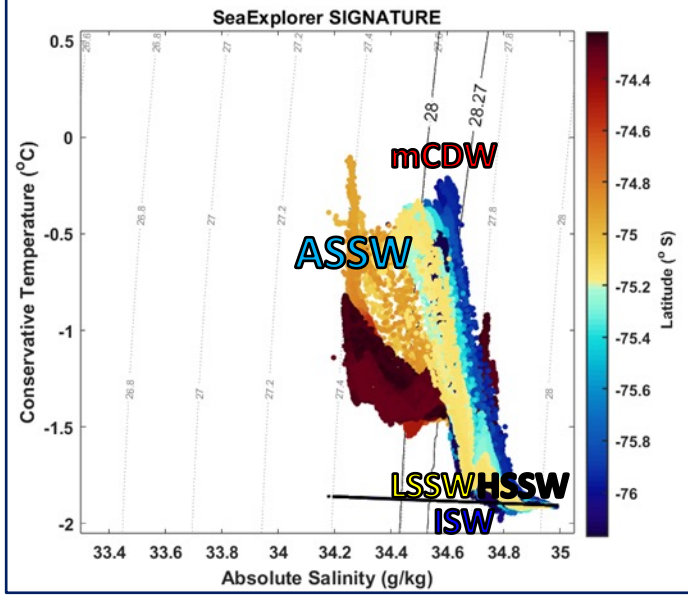

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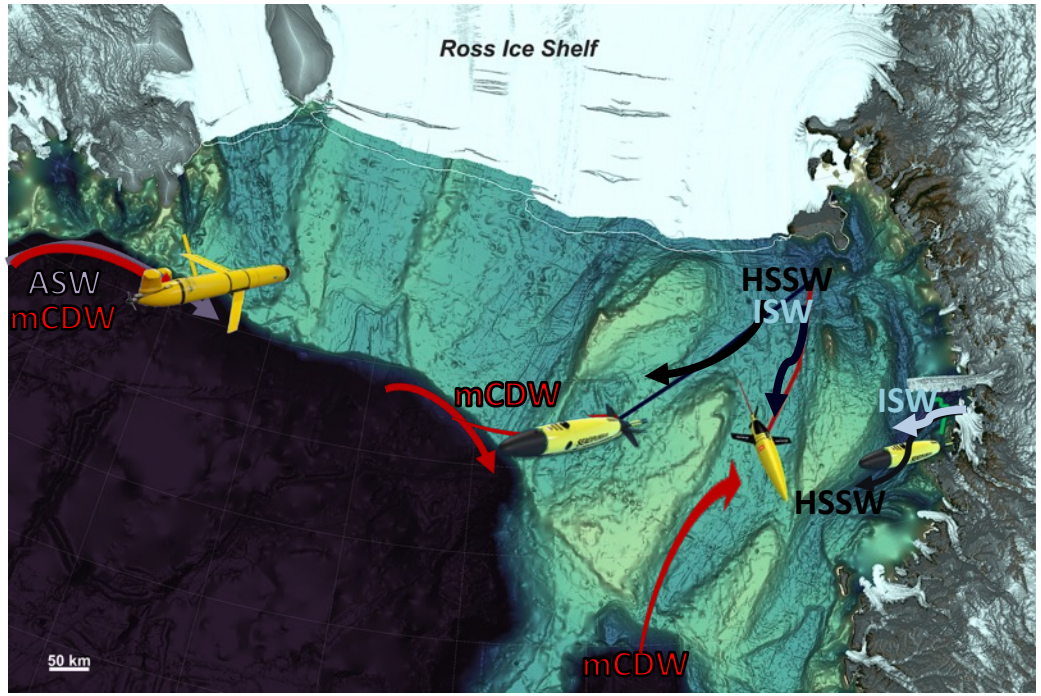

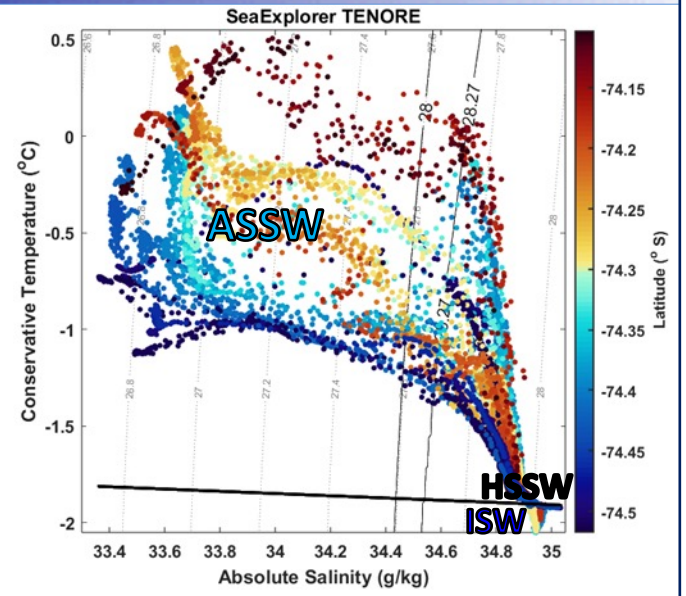

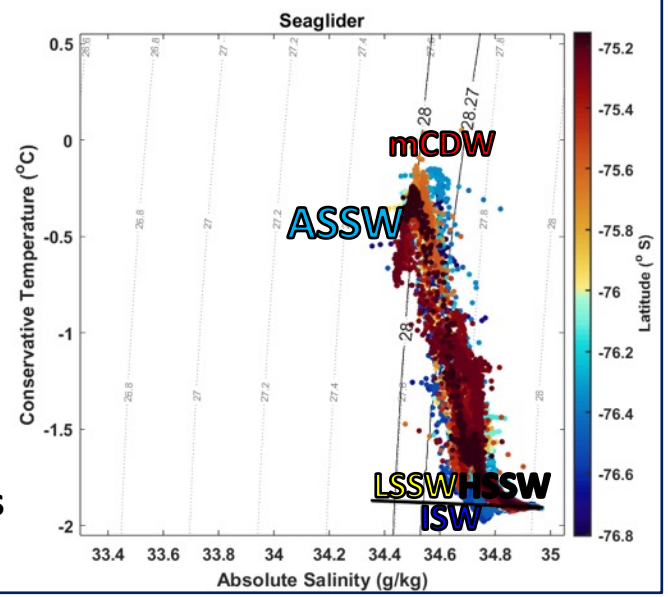

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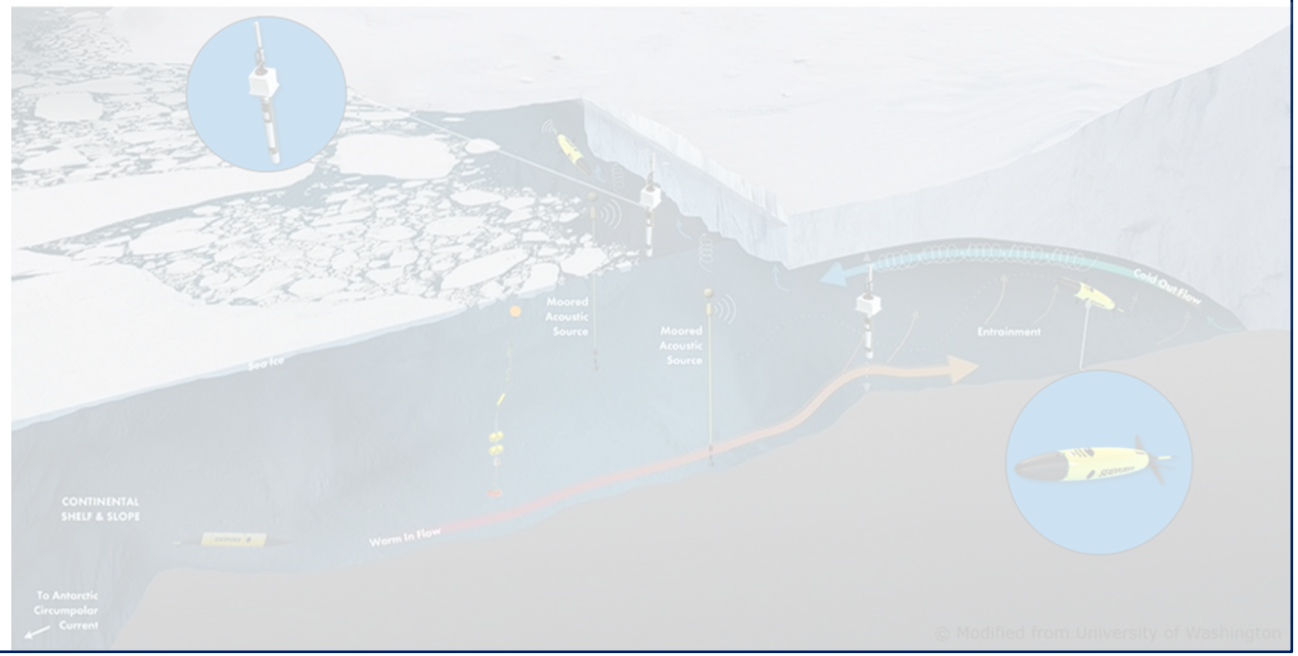
???

Ongoing and future work

- assess small scale processes similarly to Pirro et al. (2022) → comparison with ESTRO glider survey
- quantify particulate organic carbon concentrations (via particulate backscatter) and net production (via dissolved O2 concentrations) following the same methodology as Meyer et al. (2022)

Challenges in polar regions

Lessons from the 2023/24 Antarctic Field Season



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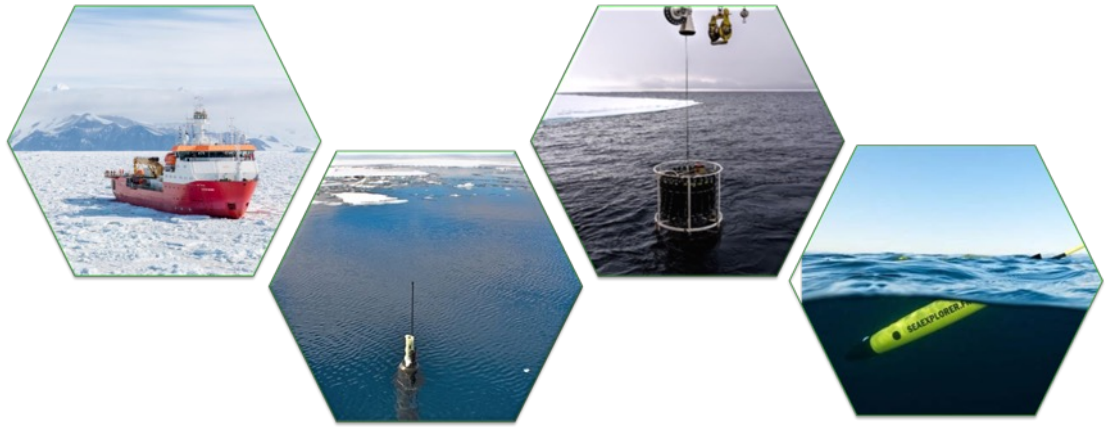

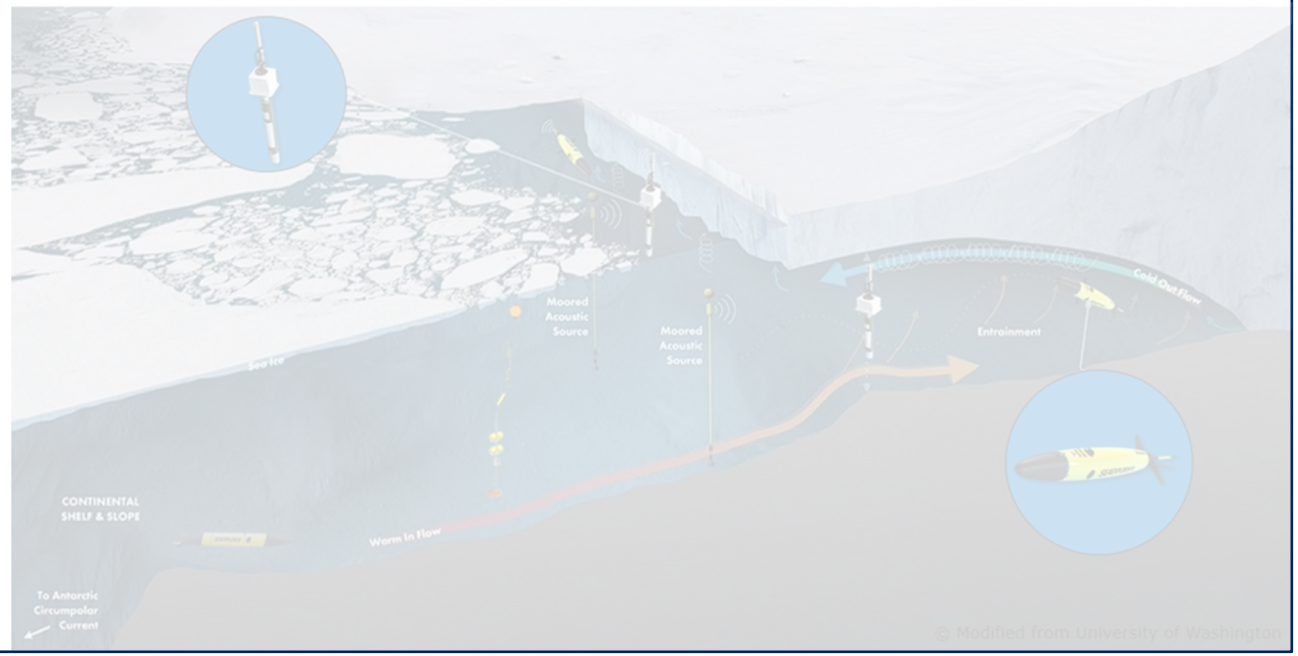

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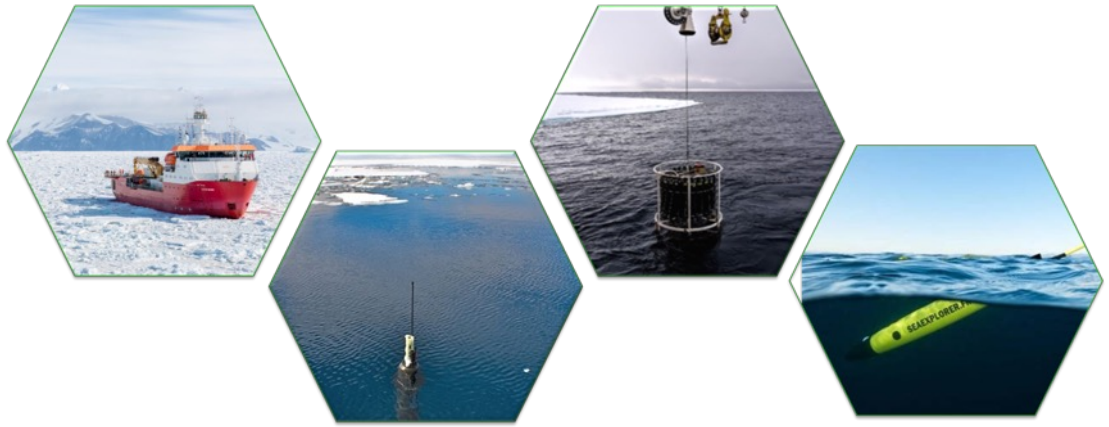
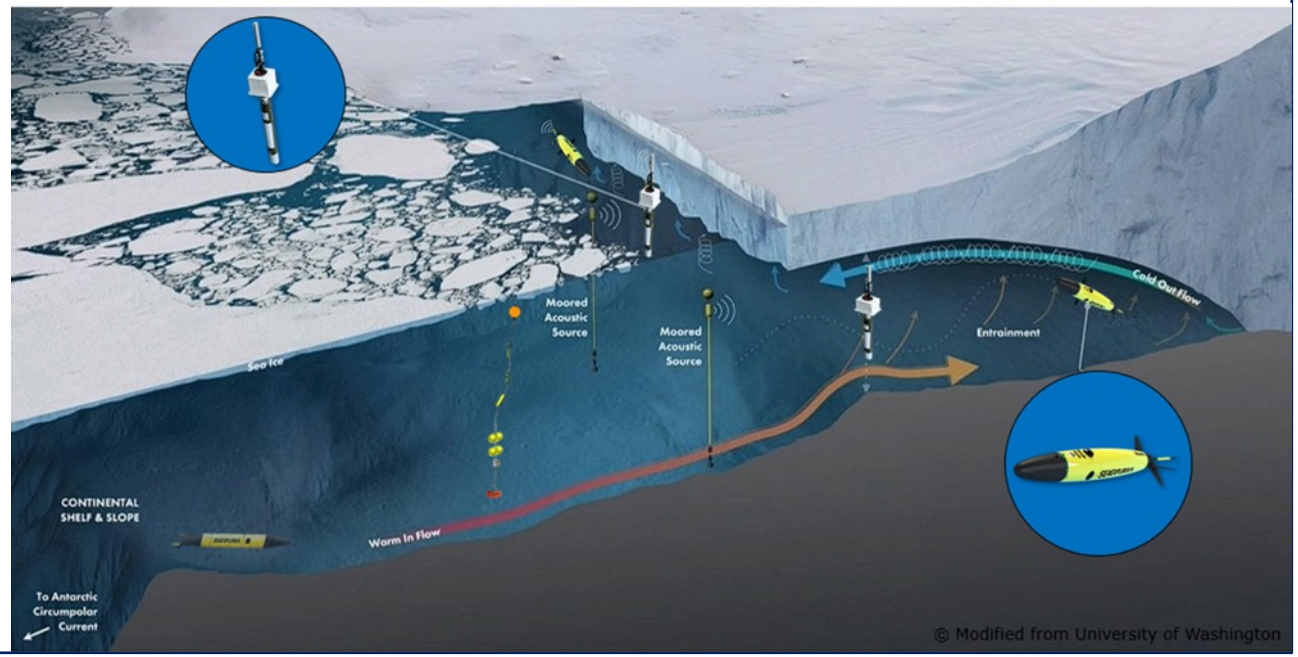




Acknowledgements

Following Orsi and Wiederwohl (2009), we defined the principal water masses of the Ross Sea using both thermohaline parameters and neutral density (Jackett and McDougall, 1997):

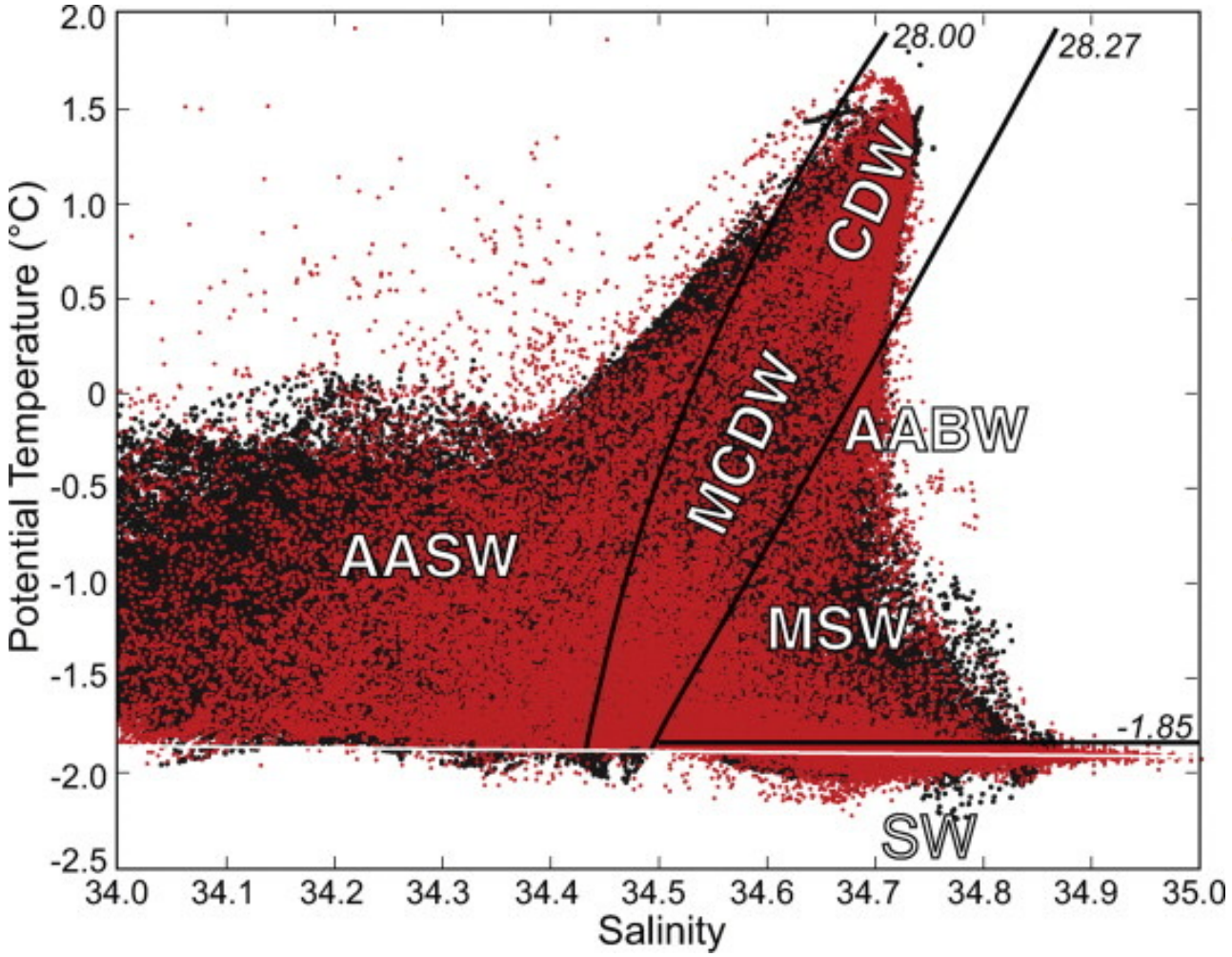


Table 1. Water mass definitions. Shelf/slope 700m demarcation refers to water depth.

γ^n layer (kgm^{-3})	Slope (>700m)	Shelf (<700m)	Properties
Top (L1: <28.0)	AASW	AASW	
Middle (L2: 28<γ^n<28.27)	CDW	MCDW	
Bottom (L3: >28.27)	AABW	MSW	θ>−1.85°C
		SW	θ <−1.85°C
		HSSW	S>34.62
		LSSW	S<34.62
		ISW	θ <−1.95°C

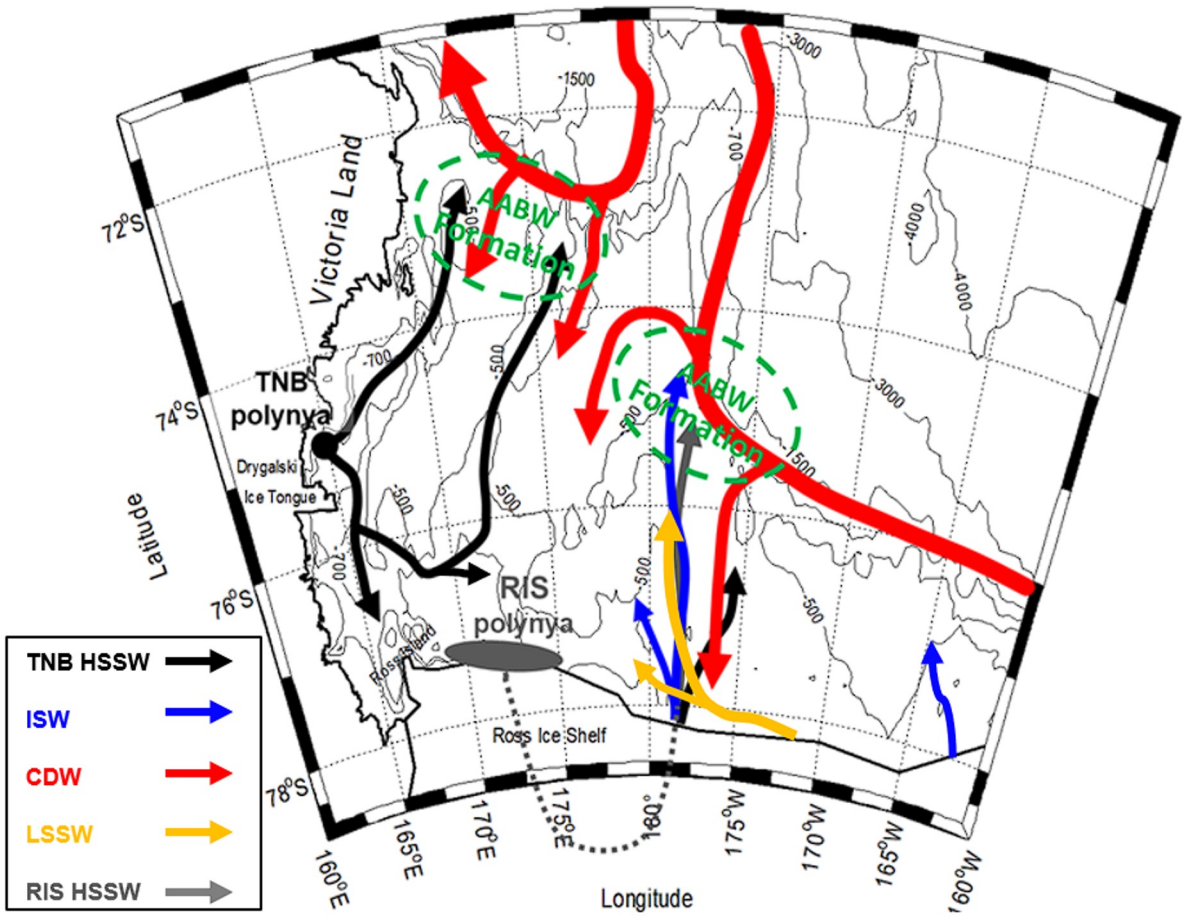
Water mass characterization

Following Orsi and Wiederwohl (2009), we defined the principal water masses of the Ross Sea using both thermohaline parameters and neutral density (Jackett and McDougall, 1997):

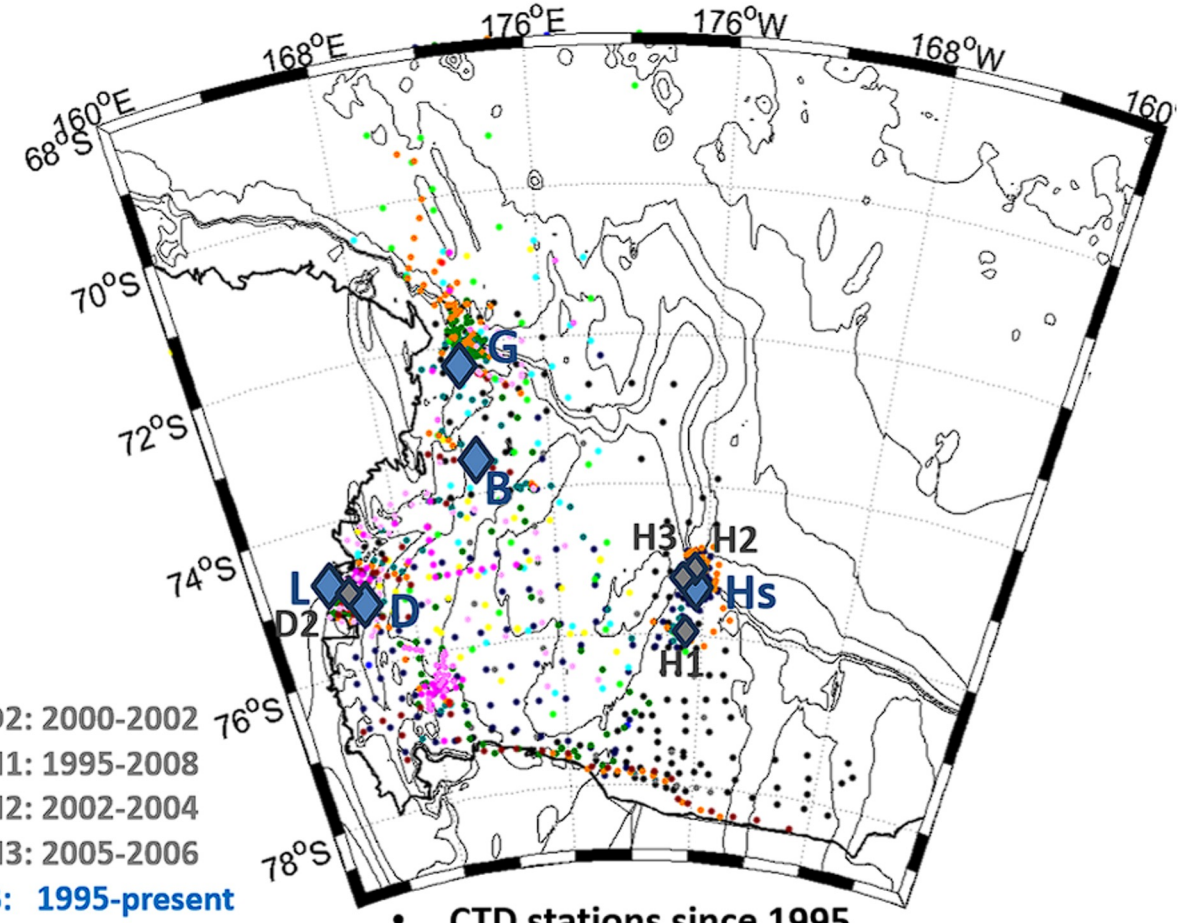
Water Mass	Neutral Density (kg m^{-3})	Depth (m)	Practical Salinity	Absolute Salinity* (g kg^{-1})	Potential Temperature (°C)	Conservative Temperature* (°C)
AASW	$\gamma^n < 28.00$	< 250	S < 34.30	SA < 34.4658	θ >-1.85	CT > -1.8467
ISW	$\gamma^n > 28.27$		S < 34.62	SA < 34.7874	θ <-1.95	CT < -1.9469
LSSW	$\gamma^n > 28.27$		S < 34.62	SA < 34.7874	θ <-1.85	CT < -1.8469
HSSW	$\gamma^n > 28.27$		S > 34.62	SA > 34.7874	θ <-1.85	CT < -1.8469
AABW	$\gamma^n > 28.27$	> 700	S > 34.75	SA > 34.9180	θ >-1.85	CT > -1.8471
CDW	$28.00 < \gamma^n < 28.27$	> 700			θ > 1.20	without SA not possible
mCDW	$28.00 < \gamma^n < 28.27$					
ASW	$\gamma^n < 28.00$	100<d<300	34.10 < S < 34.14	34.2649 < AS < 34.3050	-1.81 < θ < -1.79	-1.8062 < CT < -1.7862

*for surface SA and CT values at longitude 175° E and latitude -75° S

Background and motivation: key areas



Modified from Budillon at al. (2003) *1



- CTD stations since 1995

D2: 2000-2002
H1: 1995-2008
H2: 2002-2004
H3: 2005-2006
B: 1995-present
D: 1995-present
L: 1998-present
G: 2003-present
Hs: 2022-present

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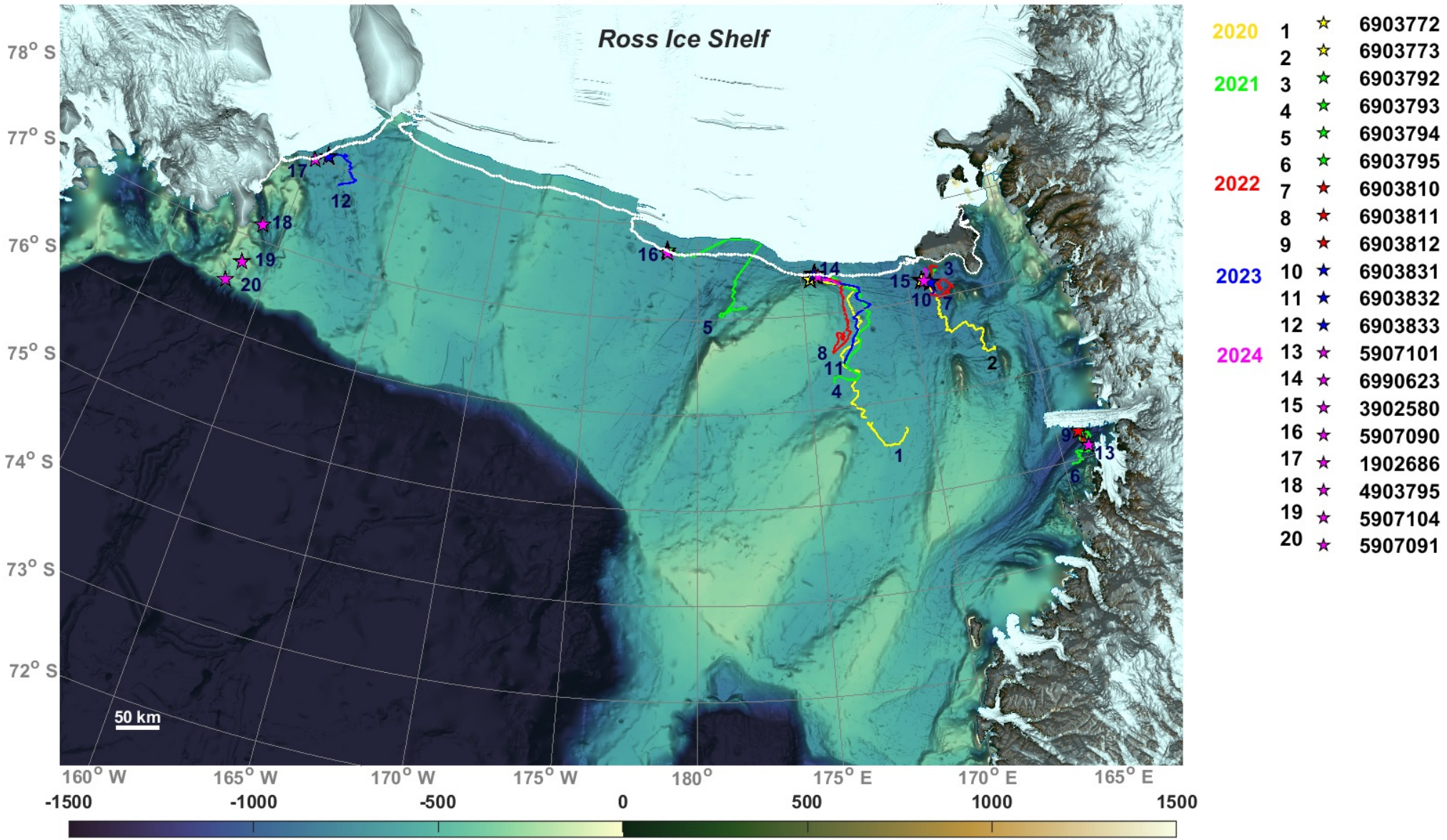
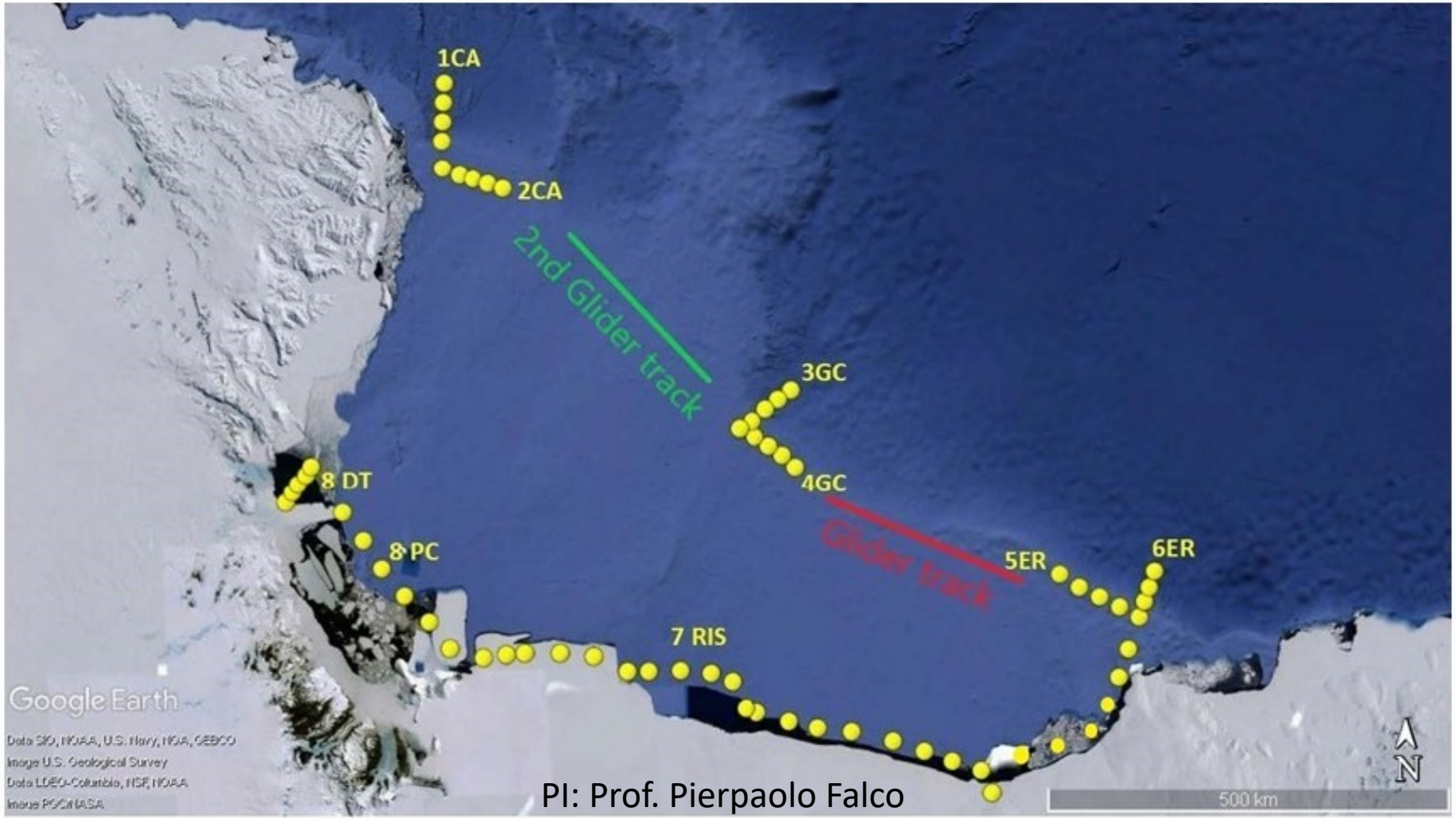
*1 Based on: Orsi & Wiederwohl (2009); Budillon et al. (2011); Jendersie et al. (2018)

Year-round Argo floats

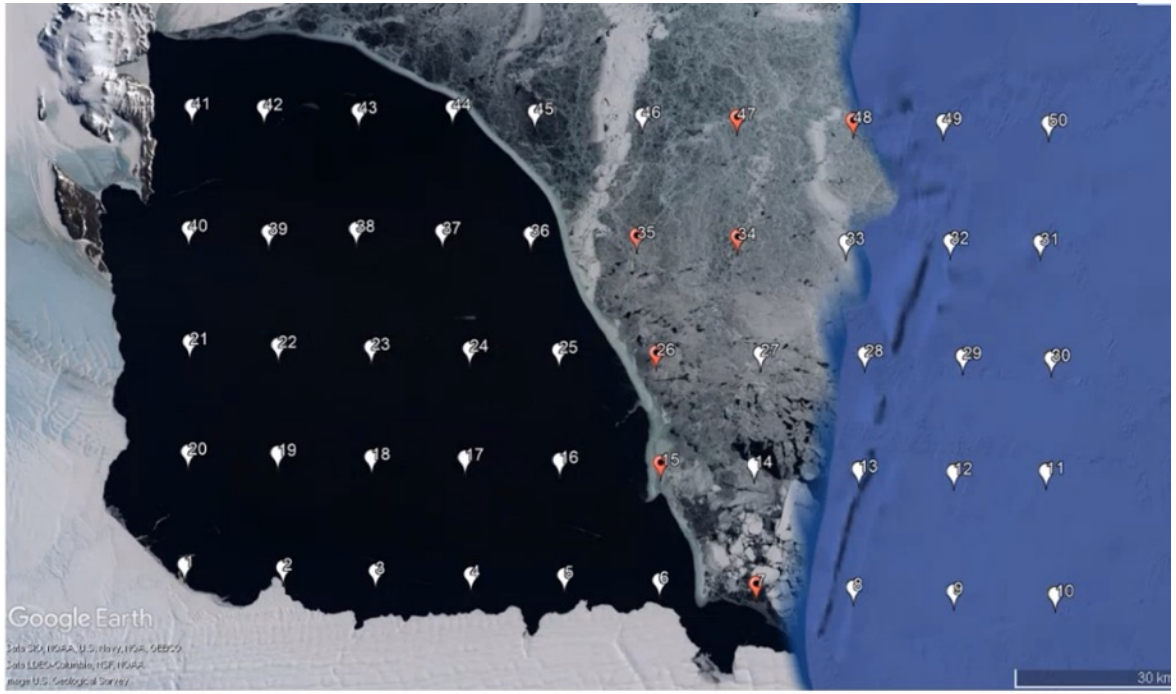


PhySIcal and bioGeochemical traciNg of wATer masses at source areas and export gates in the Ross Sea and impact on the SoUtheRn OcEan (**SIGNATURE**)



PI: Prof. Pierpaolo Falco

TErra NOva bay polynya high Resolution Experiment (**TENORE**)

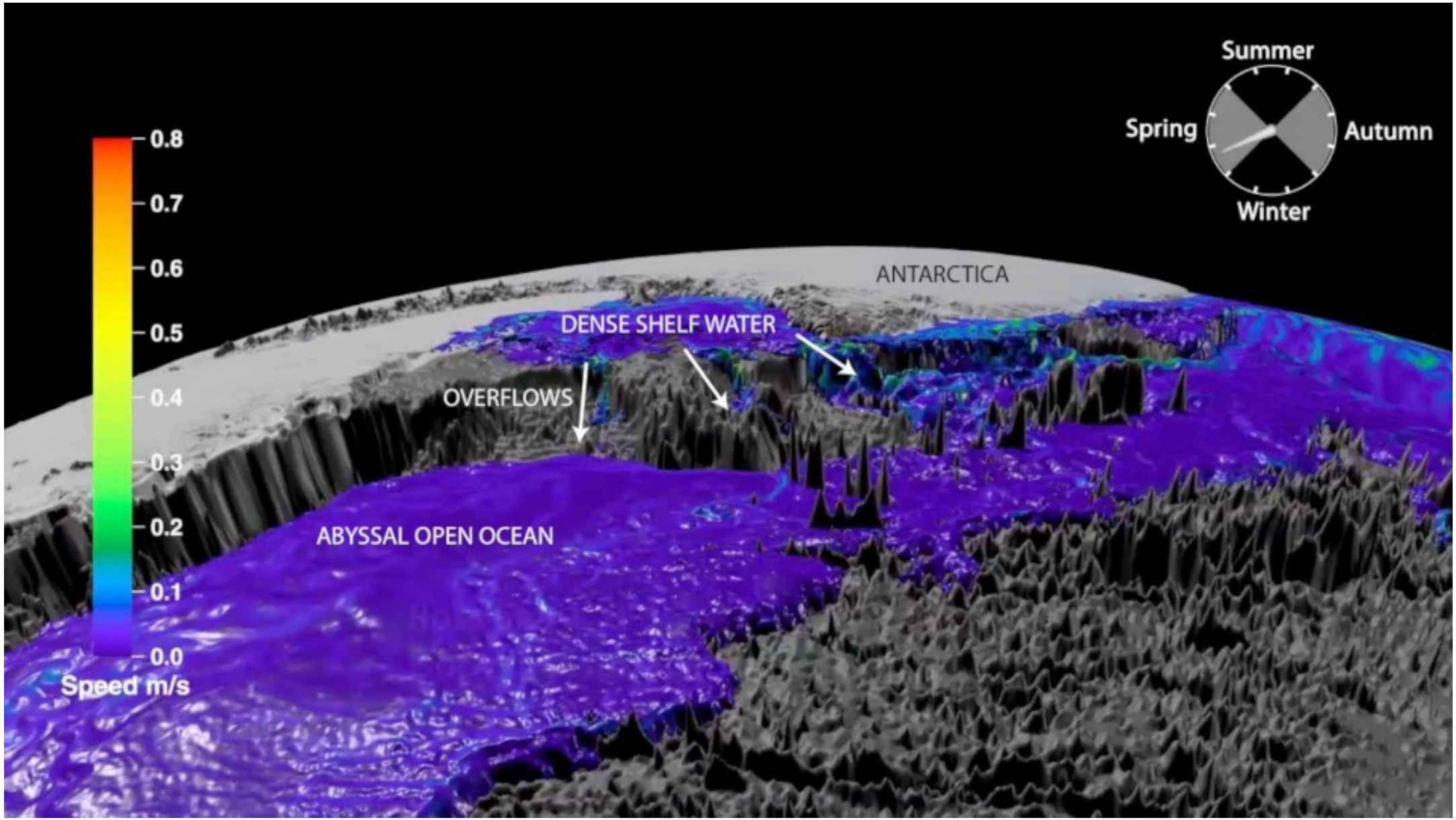


- 50 CTD measurement stations with LADCP acquisition and water sampling
- Flights of a DJI drone equipped with a multispectral and thermal cameras
- Deployment of 13 drifters

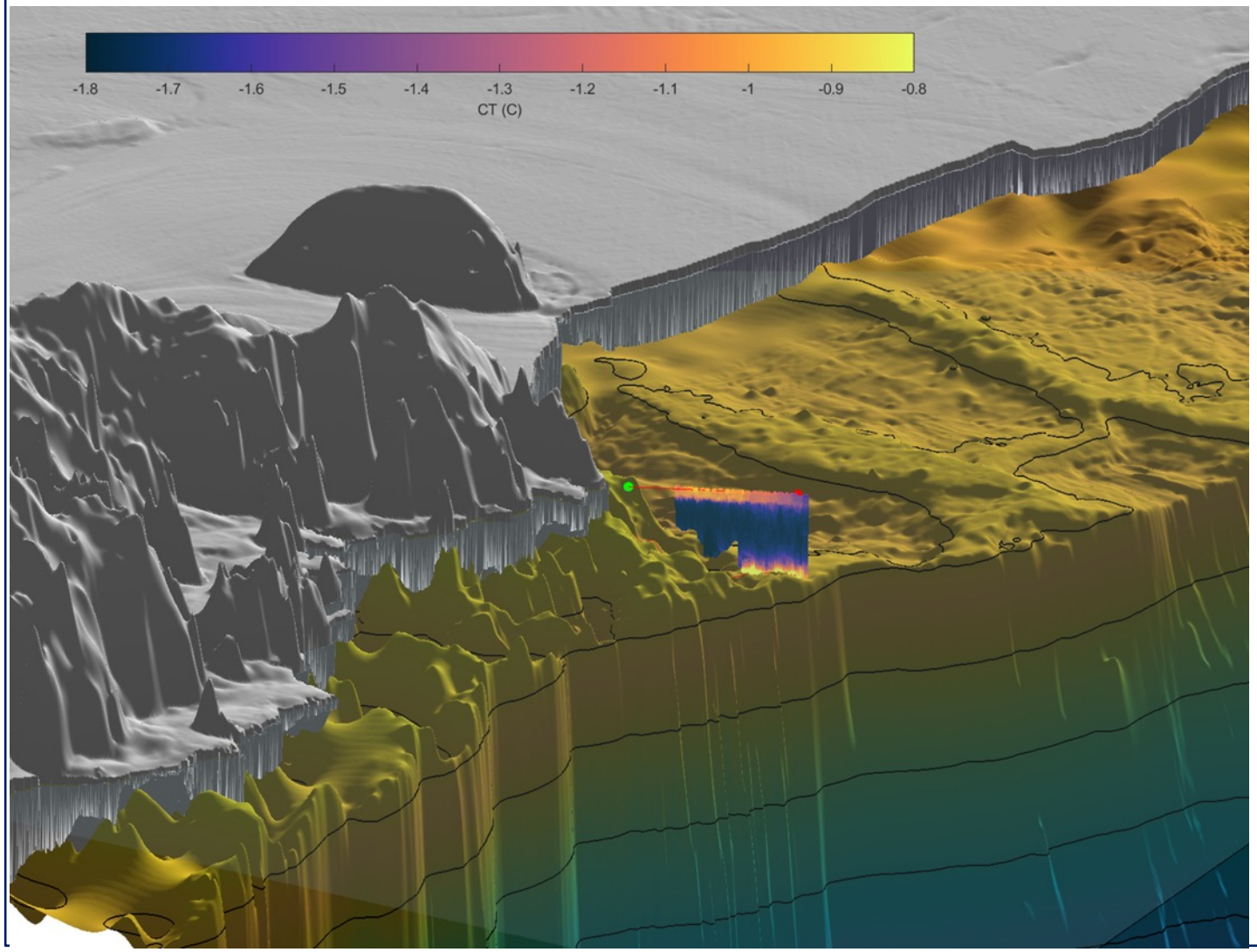
- Glider Mission

PI: Prof. Giannetta Fusco

Background and motivation: role of the Ross Sea Bottom Water



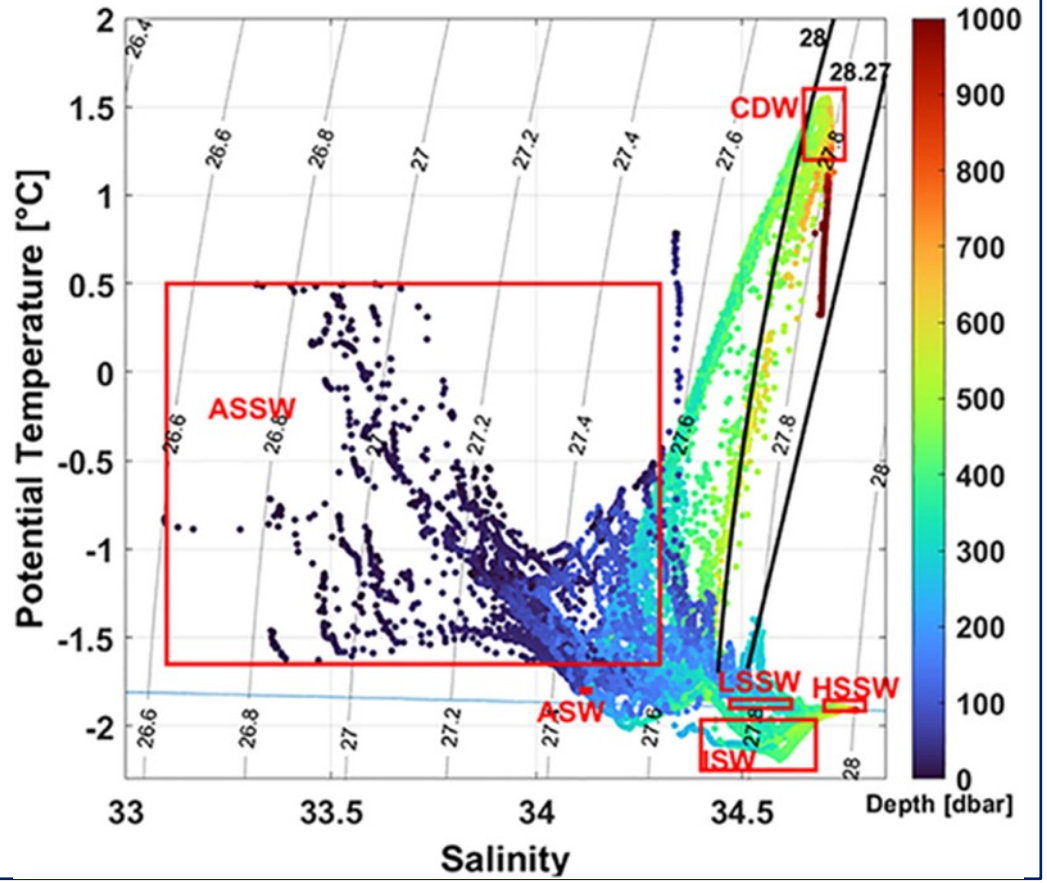
Eastern Gate: mCDW and Amundsen Sea Water detection



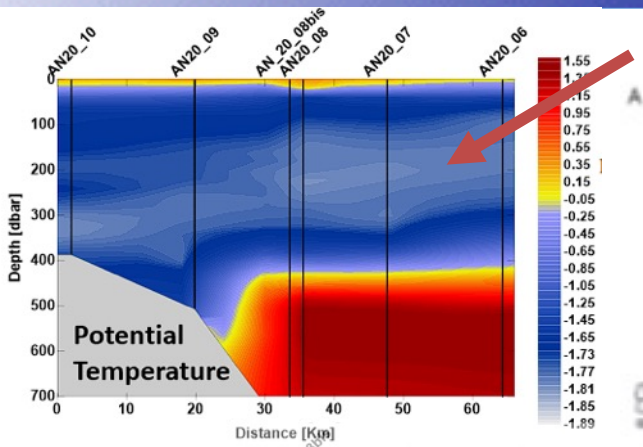
ASW in Eastern Ross Sea (ESTRO)

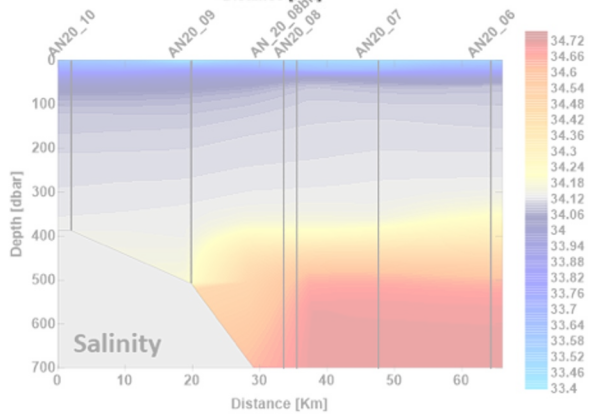
-1.81<θ< -1.79°C & 34.11<S<34.13

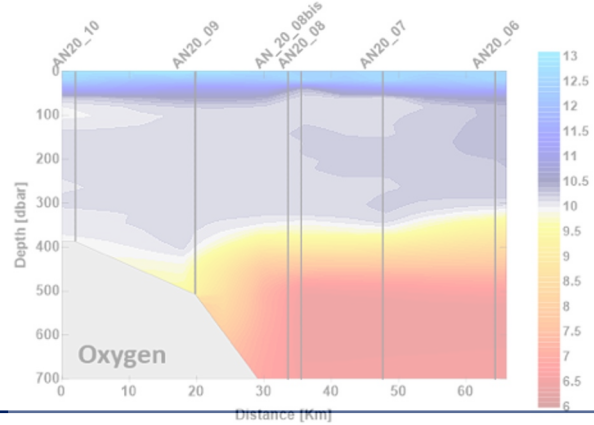
100m < depth < 300 m

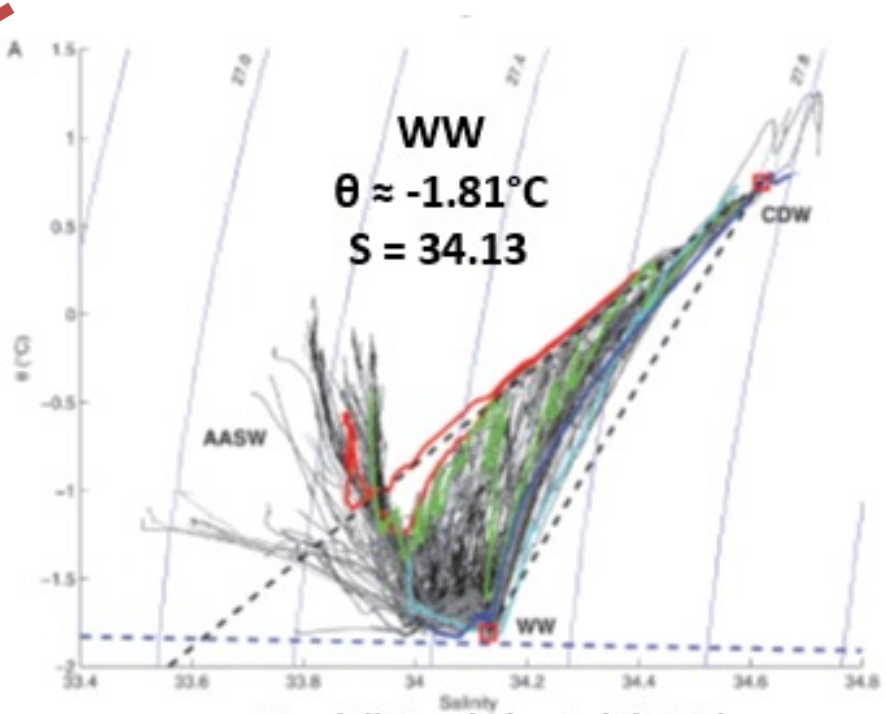


Findings: Identification of Amundsen Sea Water (ASW)

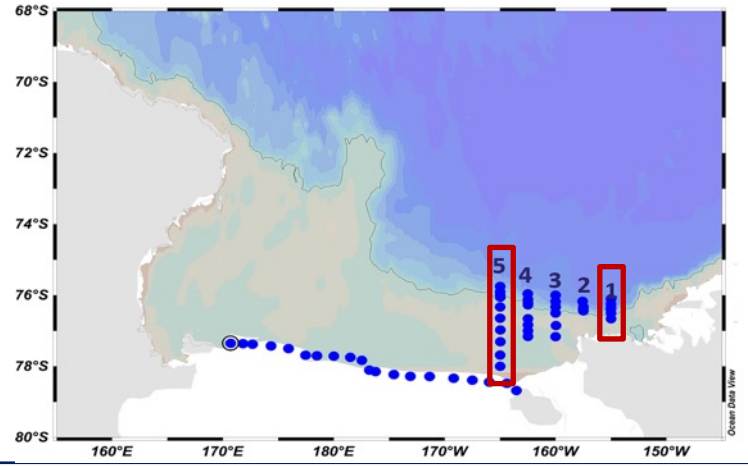


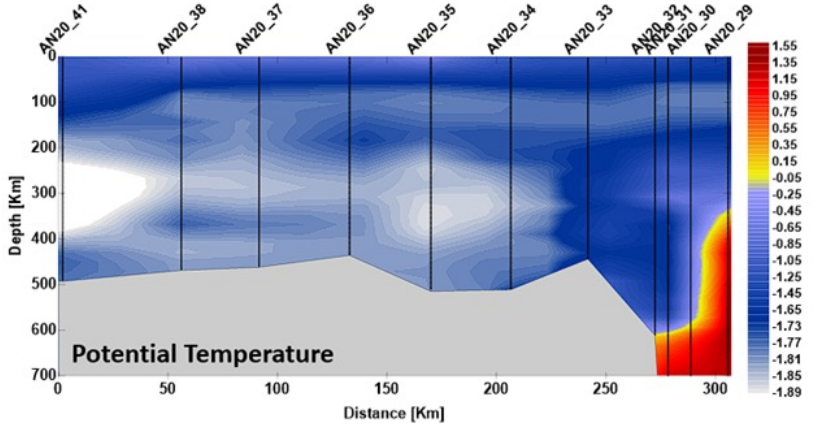


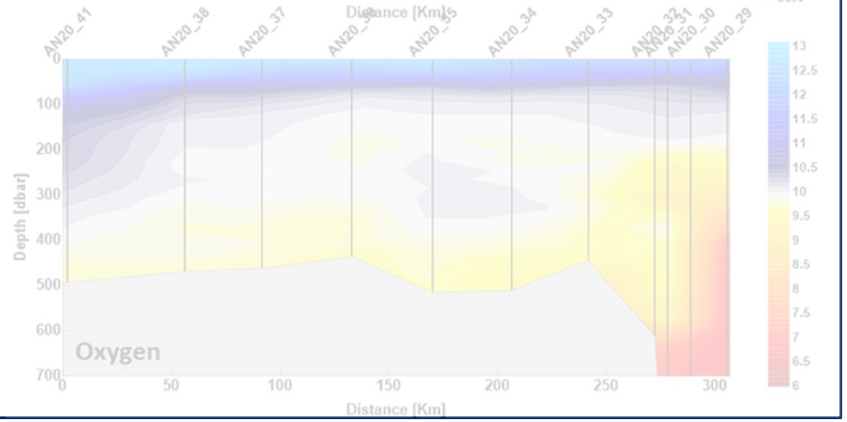




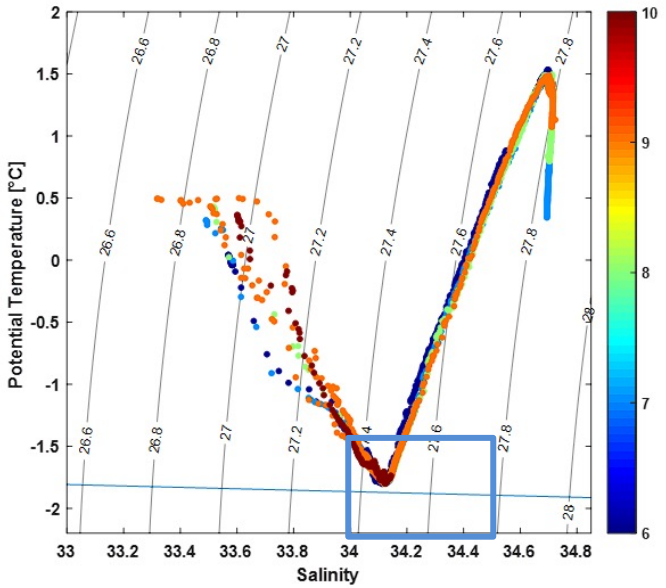
Randall-Goodwin et al. (2017)



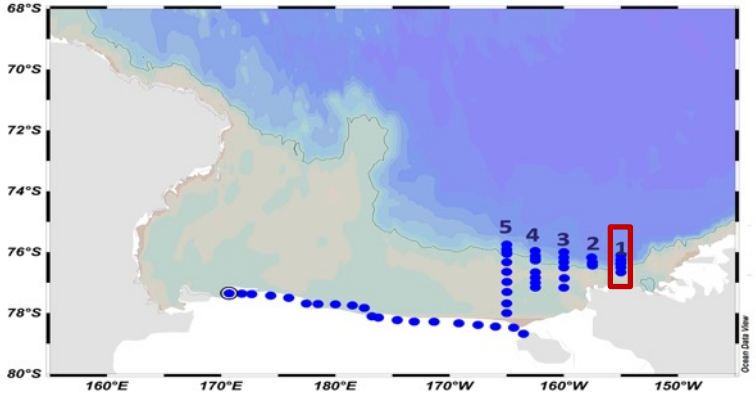


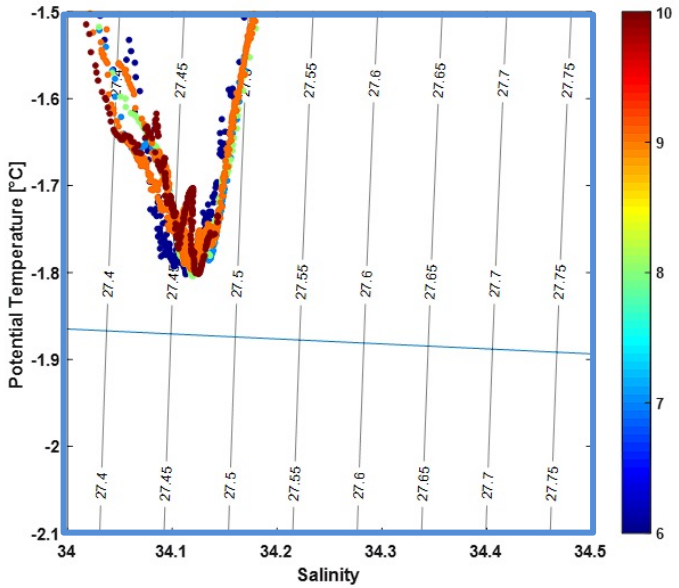


Findings: Modified ASW water mass properties in the Ross Sea

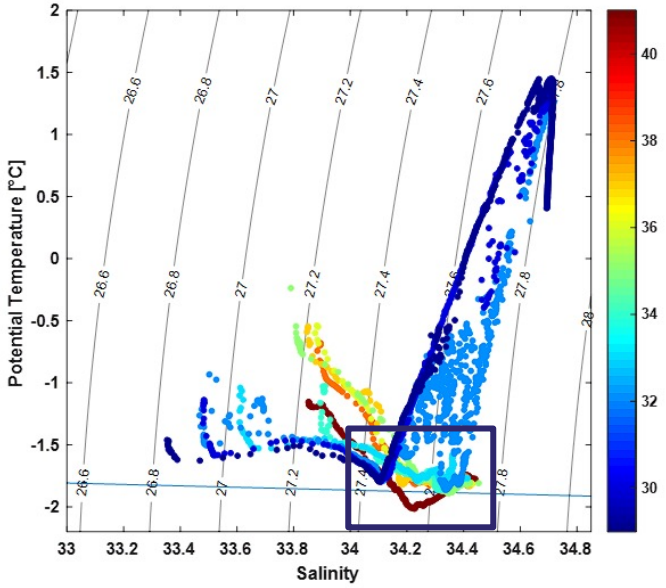


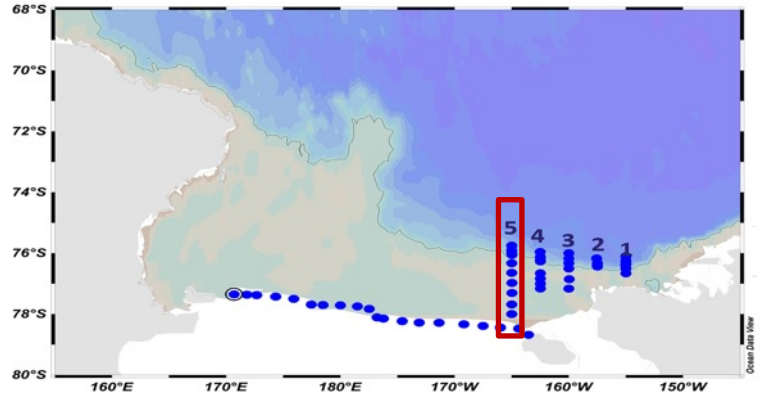
ASW in Ross Sea





-1.81<θ< -1.79°C & 34.11<S<34.13





100m < depth < 300 m