SYMPOSIUM OP'24 — ADVANCING OCEAN PREDICTION SCIENCE FOR SOCIETAL BENEFITS

Sub-mesoscale modelling of the Labrador Sea

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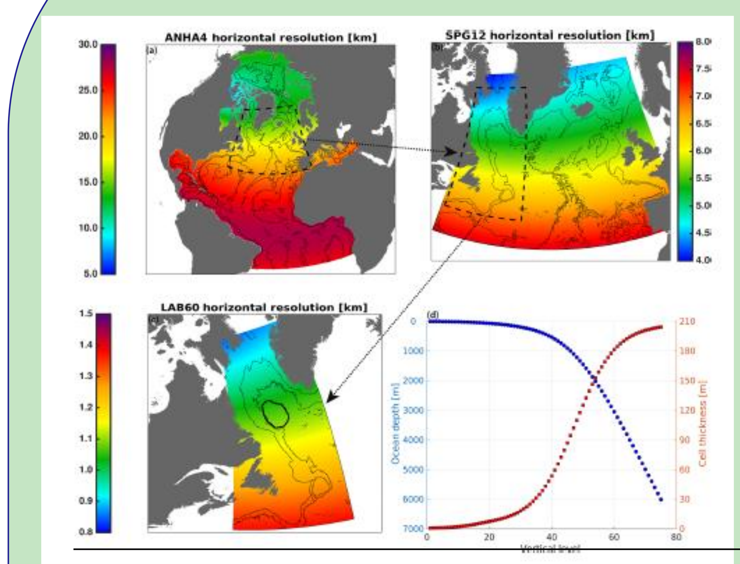
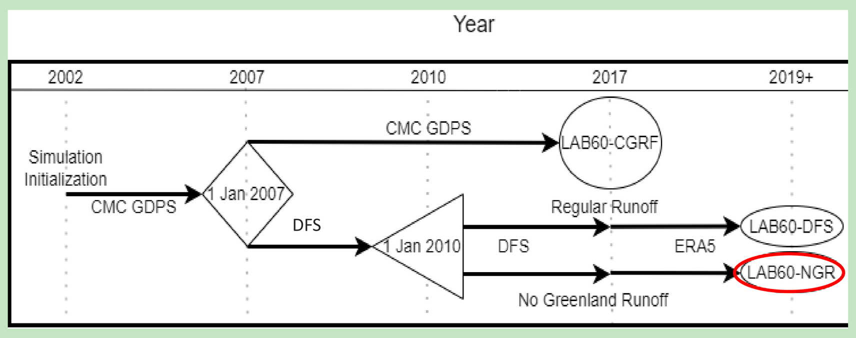
Motivation

- The Labrador Sea contains a region of deep convection
- The result of deep convection is a newly ventilated water mass: Labrador Sea Water
- Labrador Sea Water is one component of the Meridional Overturning Circulation
- Small-scale features, including eddies, play an important role controlling deep convection
- Mesoscale simulations may poorly resolve these features, misrepresenting convection
- Boundary currents may also be misrepresented at lower resolution
- Boundary currents also transfer warm water towards Greenland's tidewater glaciers and low salinity melt and Arctic waters towards the sub-polar North Atlantic
- Thus the volume, variability, and export pathway of Labrador Sea Water may affect on sub-mesoscale features

Model Set-Up and Experiments

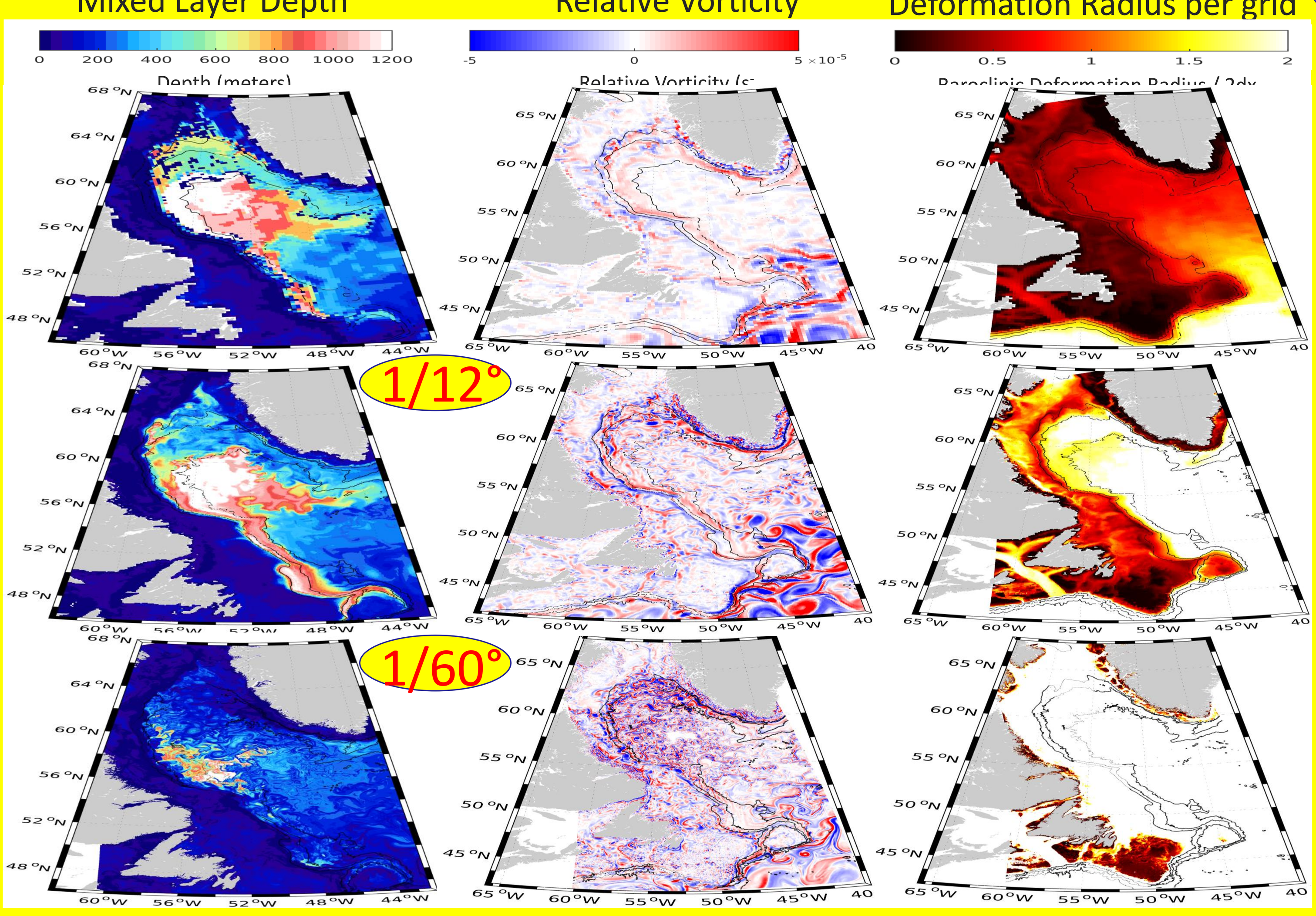


Double nested, regional ANHA4 configuration
1/60 degree in the Labrador Sea, roughly 1 km
75 Vertical levels, no-slip lateral boundary condition. NEMO 3.6

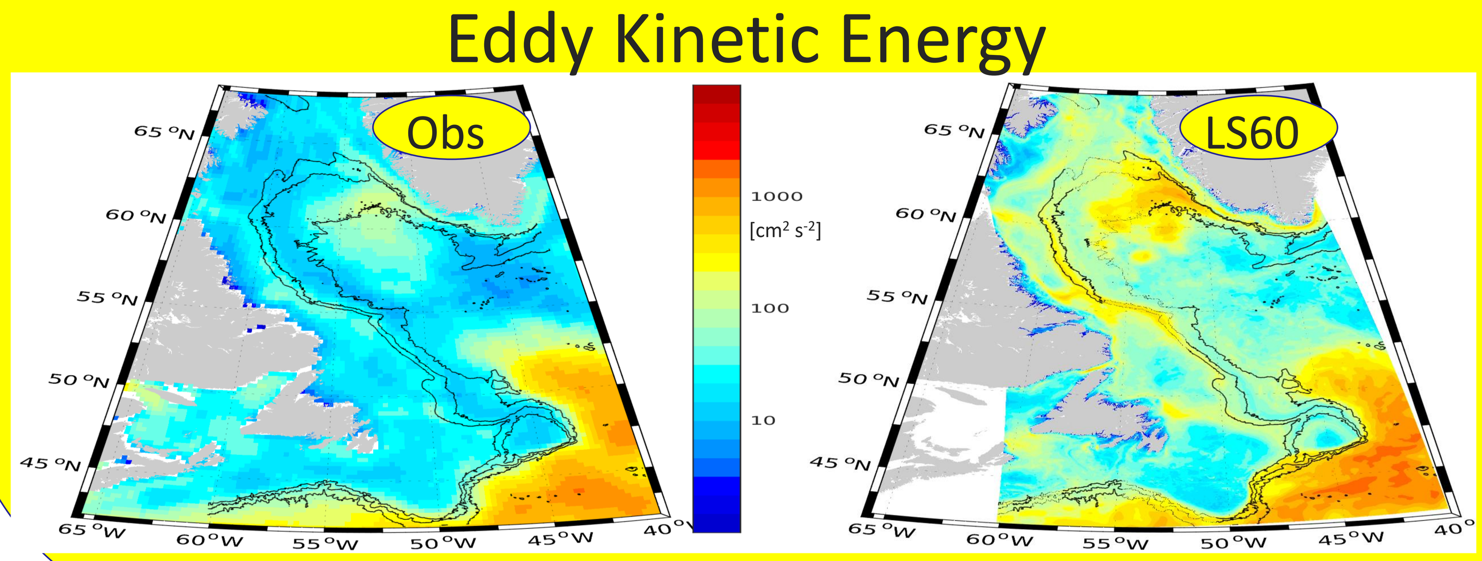


	Configuration			
	ANHA[a]		ANHA4-SPG12-LAB60	
Experiment	ANHA4	ANHA12	LAB60-GLM	LAB60-NoGLM
NEMO ocean model version	3.4	3.4	3.6	
Horizontal Resolution	1/4 °	1/12 °	1/4 ° horizontal resolution with 1/12 ° nest covering Subpolar North Atlantic and 1/60 ° inner nest covering LS	
Vertical levels	50	50	75	
Atmospheric Forcing	CGRF[b]	CGRF	CGRF (to 2007), DFS[c] (to 2017), and ERA5[d] (to 2019)	
Initial and Boundary Conditions	GLORYS2v3[e]	GLORYS2v3	GLORYS1v1	
Greenland Melt	Yes	Yes	Yes	No

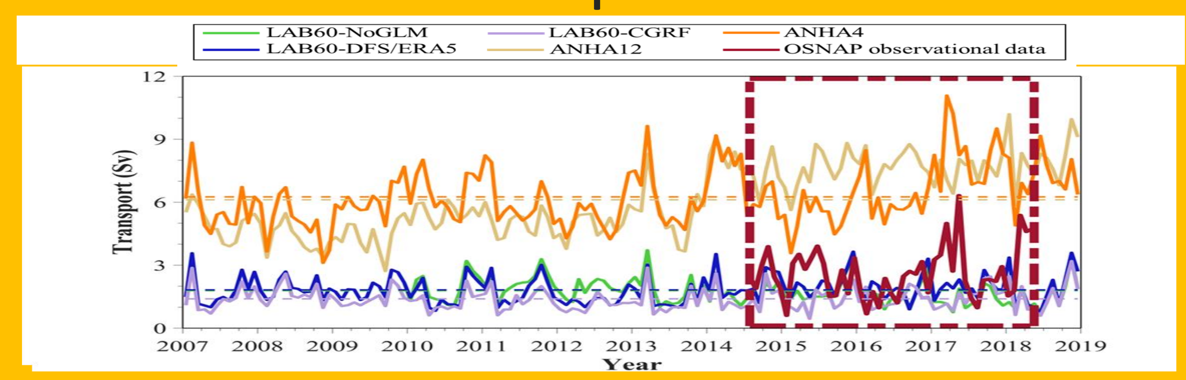
Impact of Model Resolution



Eddy Kinetic Energy

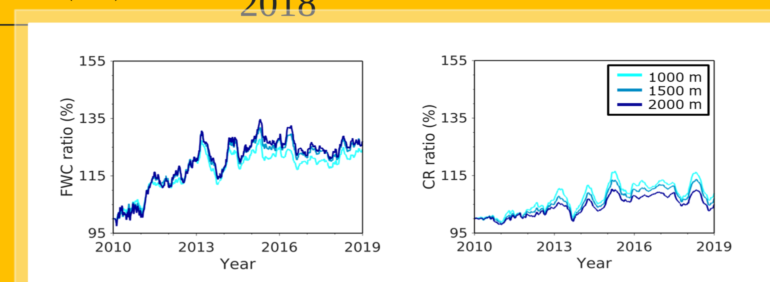


MOC and Impact of Greenland Melt

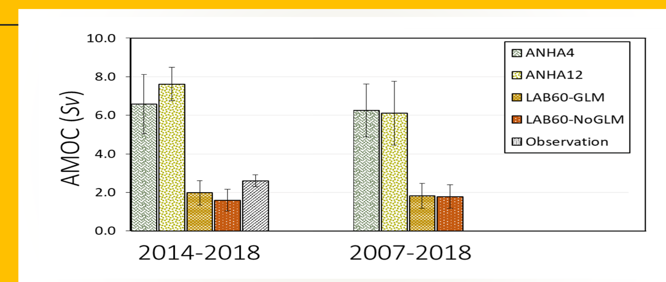


AMOC Strength across the OSNAP West Section

		Configuration					OSNAP Observations [1,2]
	Date	ANHA4	ANHA12	ANHA4-SPG12-LAB60			
Experiment		EXH005	EXH006	ECP007	ECP017	ECP027	
Mean $AMOC_\sigma$ (Sv)	OSNAP Period	6.58±1.53	7.62±0.87	1.43±0.53	1.98±0.63	1.59±0.56	2.6±0.3 Sv
	2007-2018	6.25±1.38	6.11±1.65	1.40±0.53	1.82±0.65	1.78±0.61	-

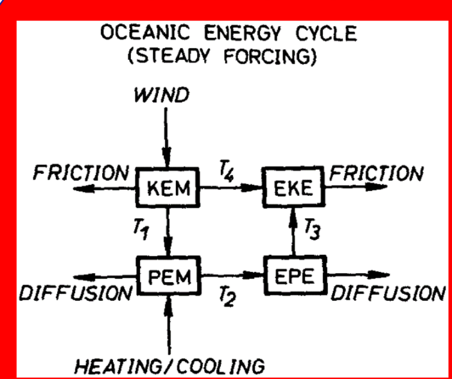


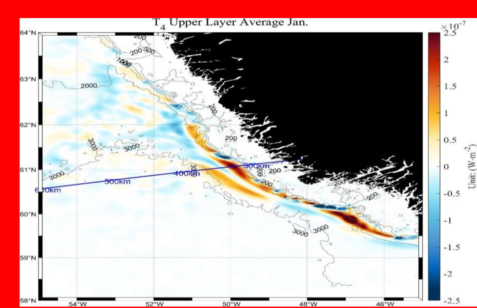
Freshwater content and convective resistance ratios (GLM/noGLM) over Labrador Sea with reference depths of 1000, 1500, and 2000 m



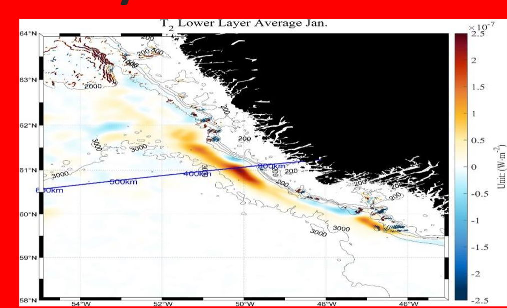
Mean AMOC Strength across the OSNAP West Section

West Greenland Current and Eddy Processes

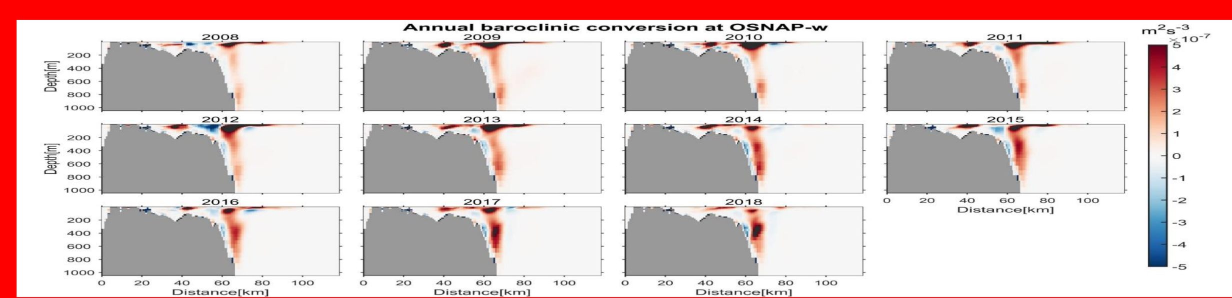




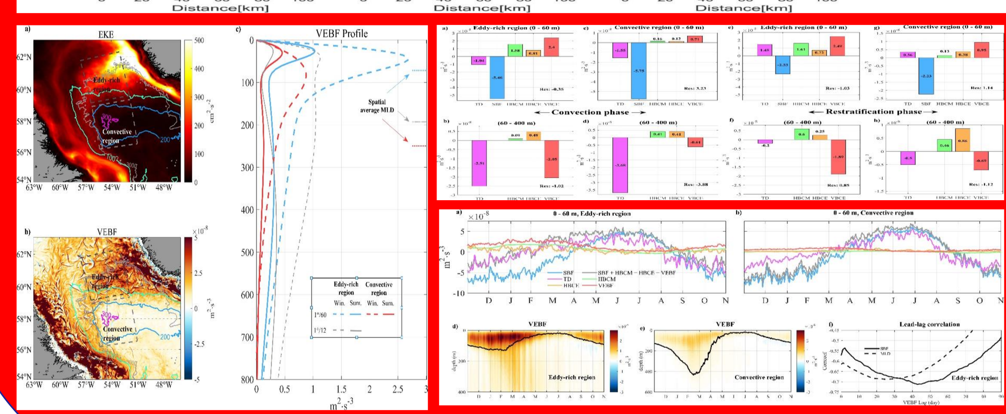
Barotropic Conversion. 2008-2018



Baroclinic Conversion. 2008-2018

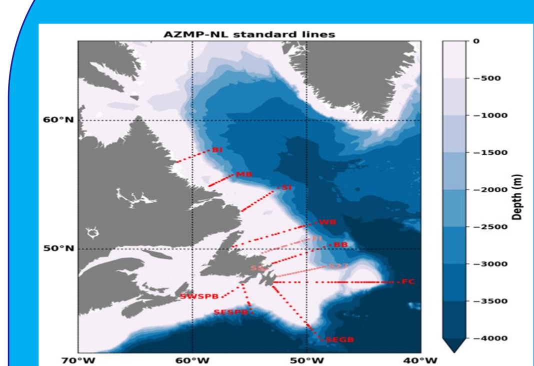


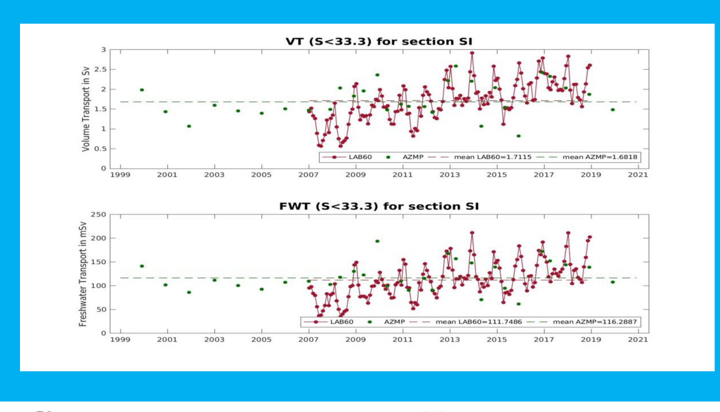
Annual averaged Baroclinic Conversion. at OSNAP-w



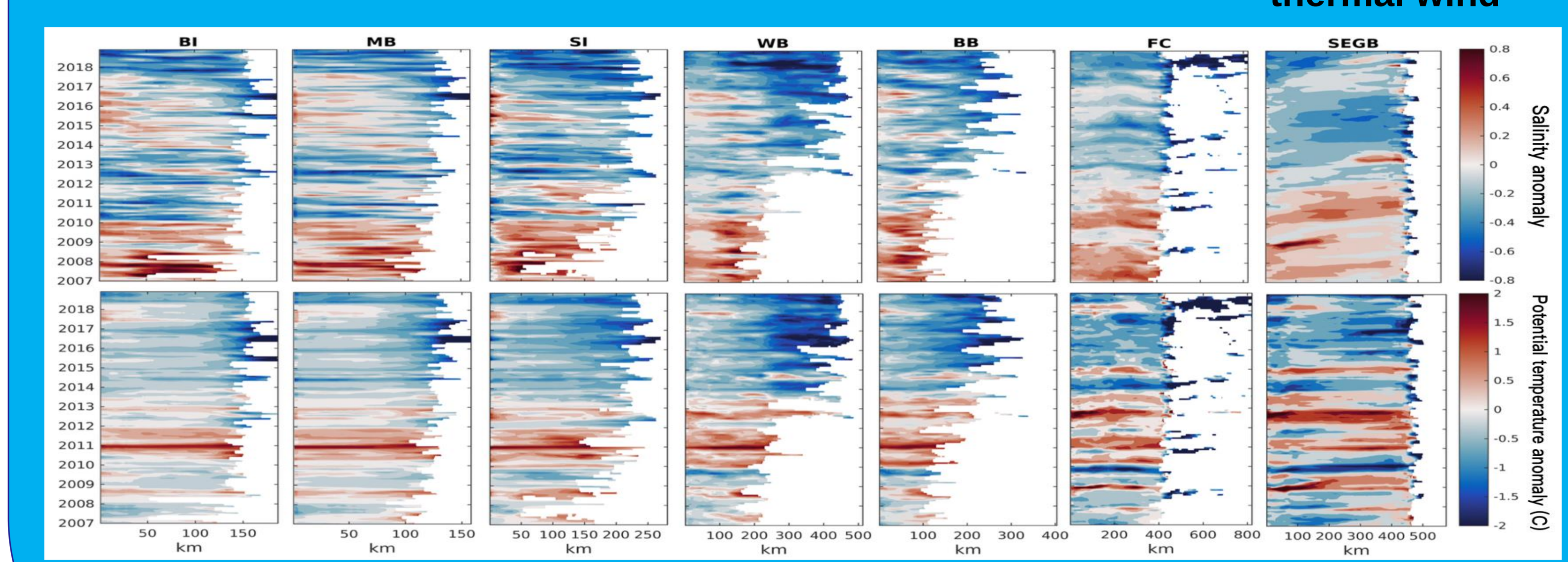
- Surface buoyancy loss (SBF, blue)
- Buoyancy loss tendency (TD, magenta)
- Lateral buoyancy flux by mean flow (HBCM, green)
- Lateral buoyancy flux by eddy (HBCE, yellow)
- Vertical eddy buoyancy flux (VEBF, red)

Labrador Current Freshwater Transport





Labrador Current, Volume and Freshwater transports, Seal Island Section, green dots AZMP data based on thermal wind



LAB60 salinity anomaly, across the AZMP Sections, for the averaged salinity inside the 33.3 isohaline referred to the time-mean salinity for 2007-2018; lower row: same but for the potential temperature. White areas indicate water with a salinity higher than 33.3

REFERENCES: Pennelly, C*; Myers, PG. (2020). Geoscientific Model Development.; Gou, R*; Feucher, C*; Pennelly, C*; Myers, PG. (2021). JGR; Pennelly, C*; Myers, P. (2022). Progress in Oceanography.; Gou, R*; Pennelly, C; Myers, PG. (2022). JGR; Gou, R*; Li, P*; Weigand, KN*; Pennelly, C; Kieke, D; Myers, PG. (2023). JPO; Li, P*; Chen, R; Gou, R*; Pennelly, C; Luo, Y; Myers, PG. (2023). GRL; Hoshyar, P*; Pennelly, C; Myers, PG. (2024). Ocean Modelling; Hoshyar, P. et al., JGR, submitted.; Gebauer et al., PIO, in preparation