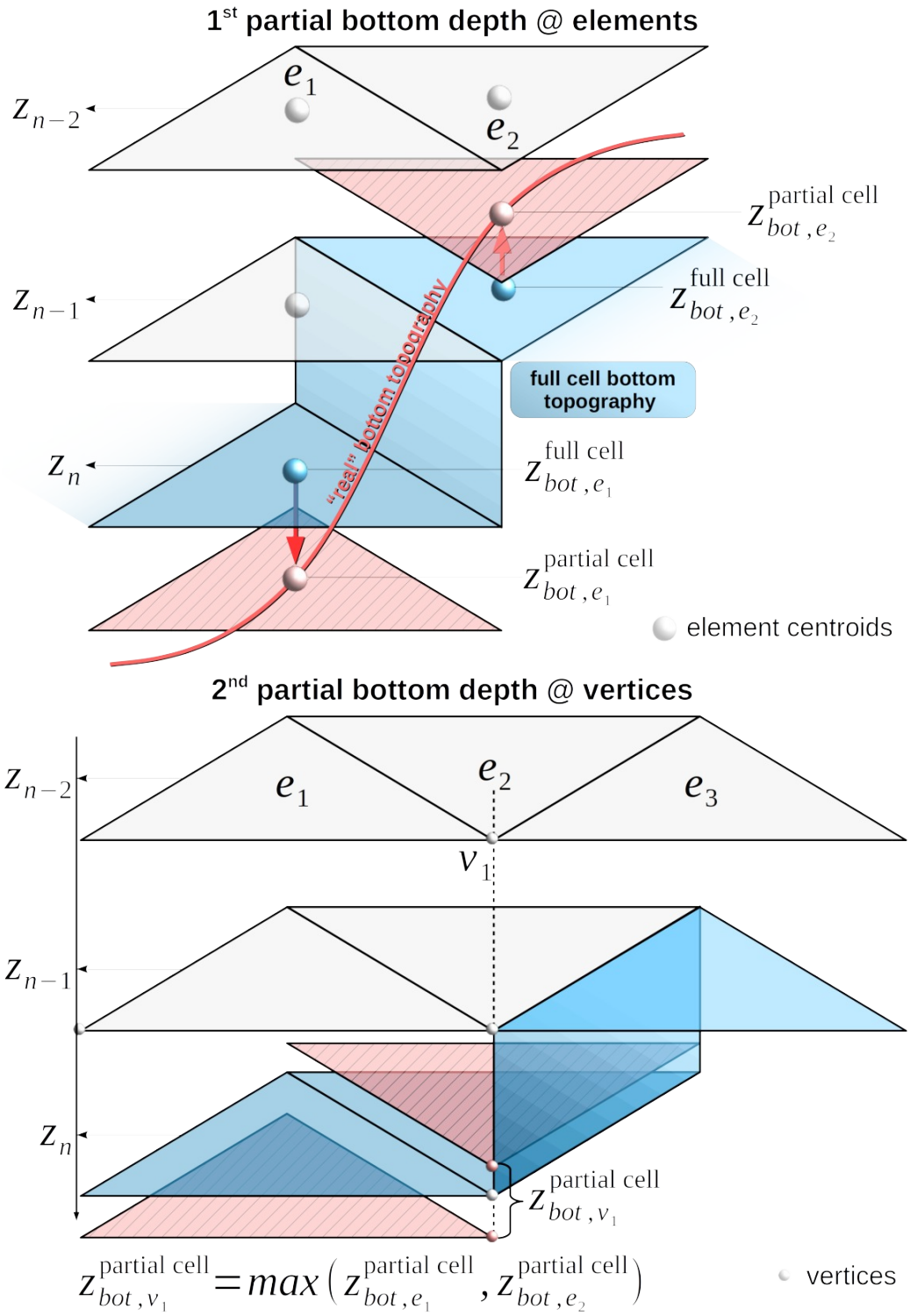
Supplementary:

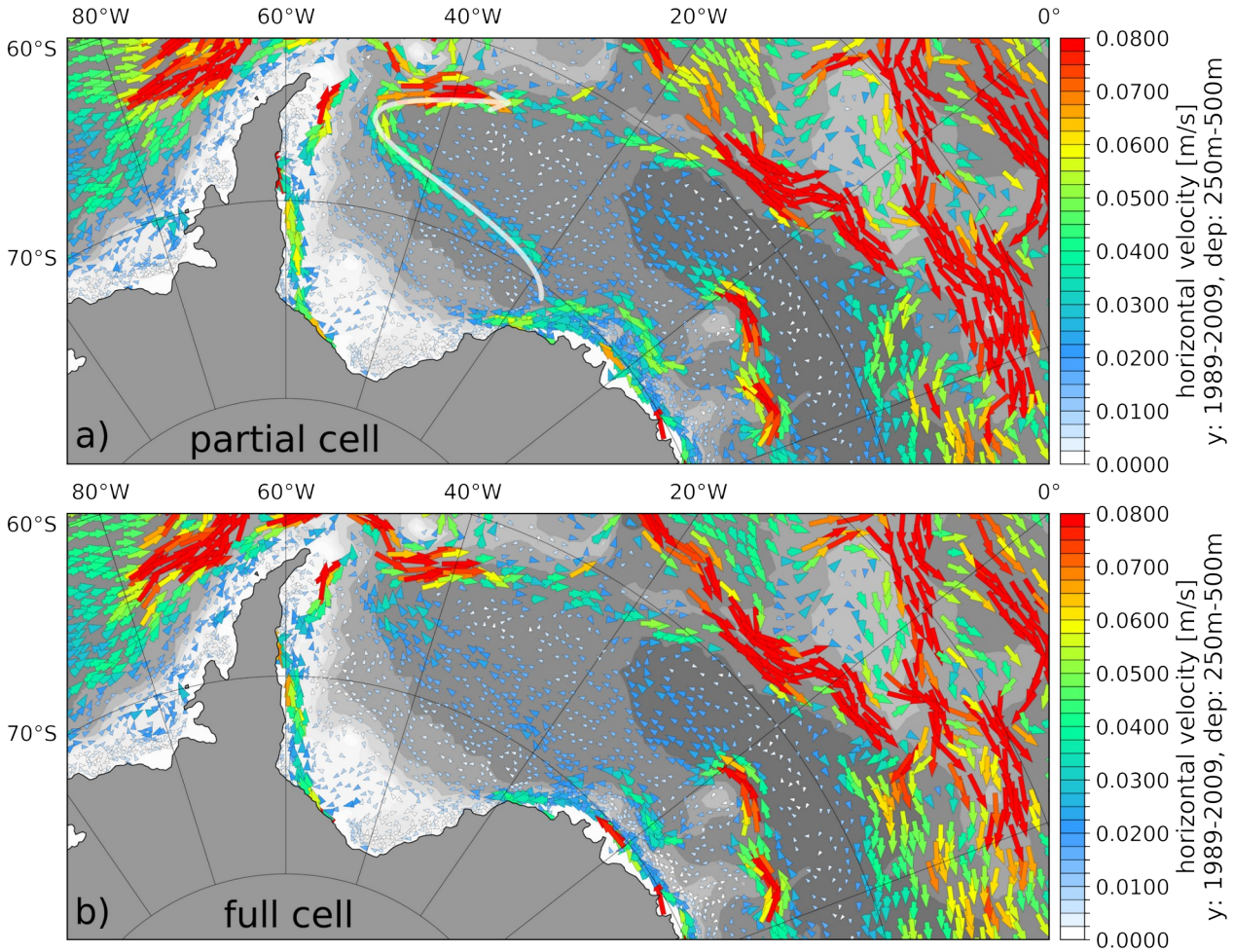
- partial cells:



Suppl. 1: Schematic representation of partial bottom cell implementation in FESOM2.0 at elements and vertices.

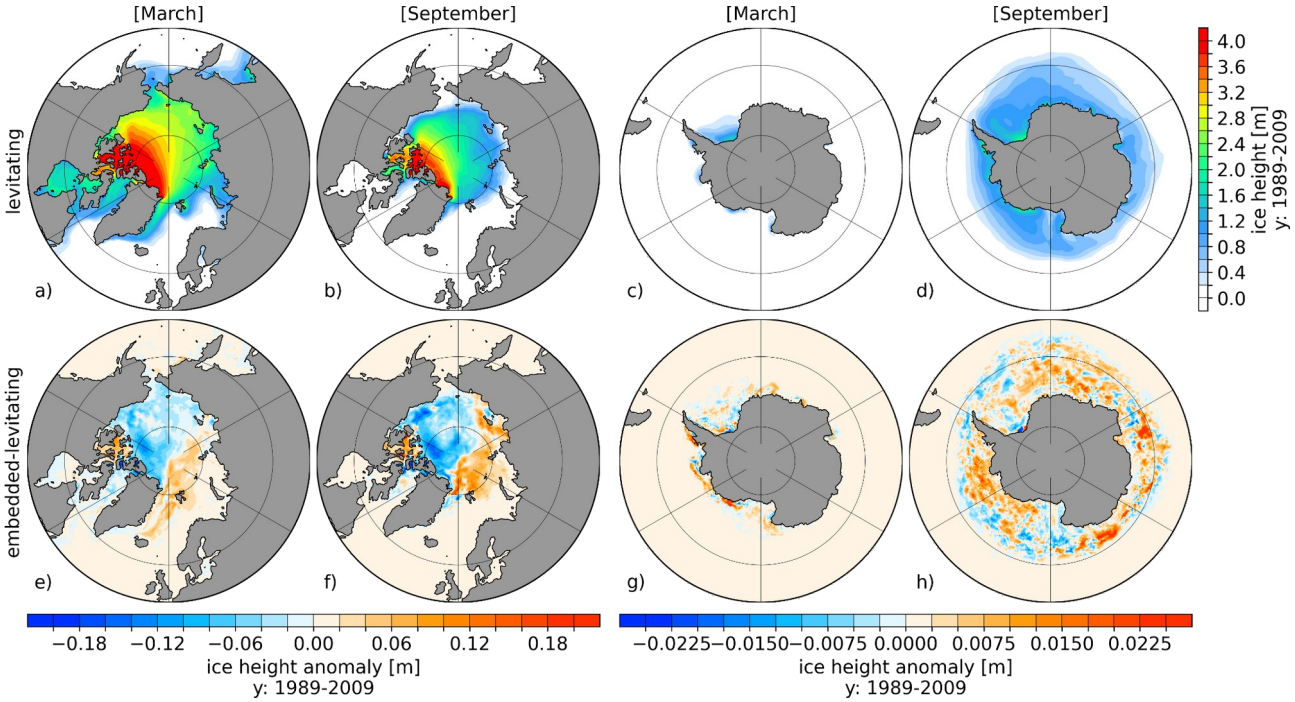
North Atlantic (-80<lon<5, 35<lat<70)	STD (respect to WOA18)		RMSE (respect to WOA18)	
	pc:0	pc:1	pc:0	pc:1
0-250m	1.42	1.35	1.27	1.19
250-500m	1.31	1.28	1.18	1.12
500-1000m	0.84	0.82	0.75	0.71
1000-2000m	0.59	0.61	0.53	0.56
2000-4000m	0.48	0.50	0.48	0.49

Suppl. 2: Table with regional (North Atlantic) mean Standard Deviation (STD) and Root Mean Square Error (RMSE) with respect to WOA18 temperatures, with (pc:1) and without (pc:0) partial cell. It shows that partial cells help to improve the biases especially in the upper and intermediate ocean, while the deep depth ranges indicate a marginal increase in the biases when using partial cells.

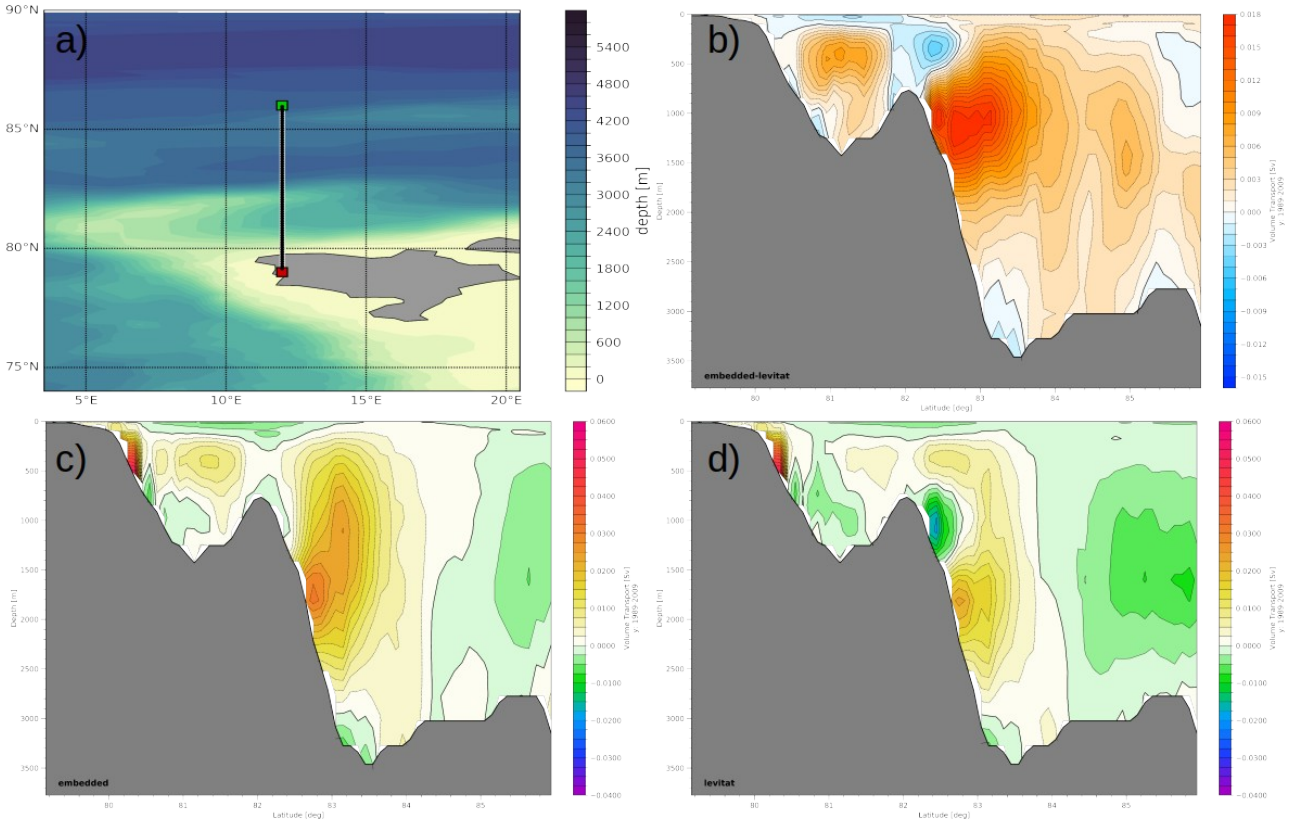


Suppl. 3: Horizontal ocean circulation in the Weddell Sea for partial cell (a) and full cell (b), vertically averaged for the depth range 250-500 m and averaged for the period 1989 to 2009. The white arrow marks the enhanced warm deep water current when using partial cells.

- embedded sea ice:

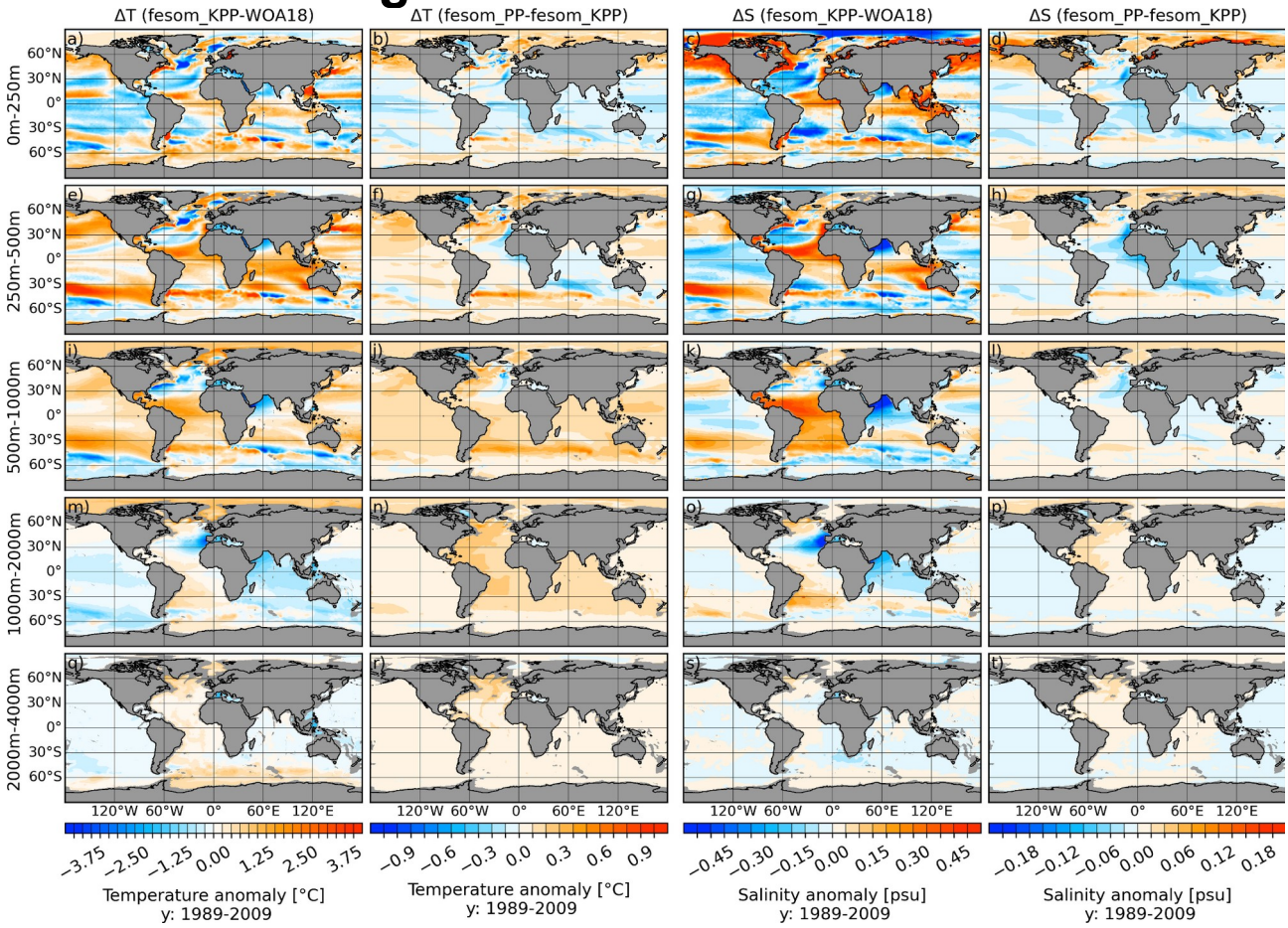


Suppl. 4: Levitating (upper row) northern and southern hemispheric March (a, c) and September (b, d) sea ice thickness averaged for the period 1989-2009. The lower row shows the corresponding sea ice thickness anomalies between embedded and levitating sea ice (embedded minus levitating) averaged over the same period.

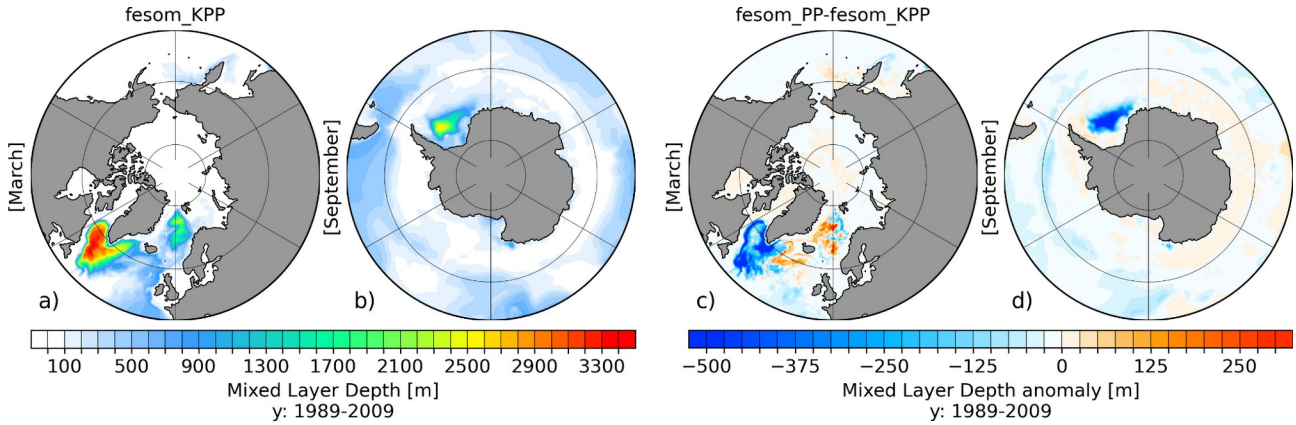


Suppl. 5: a) Section along Arctic continental slope at 12°E, b) anomalous mean transport in Sv through section (a) for embedded minus levitating sea ice averaged for the period 1989-2009. c) and d): absolute transport for levitating (c) and embedded sea ice (d), where positive values stand for transport to the east.

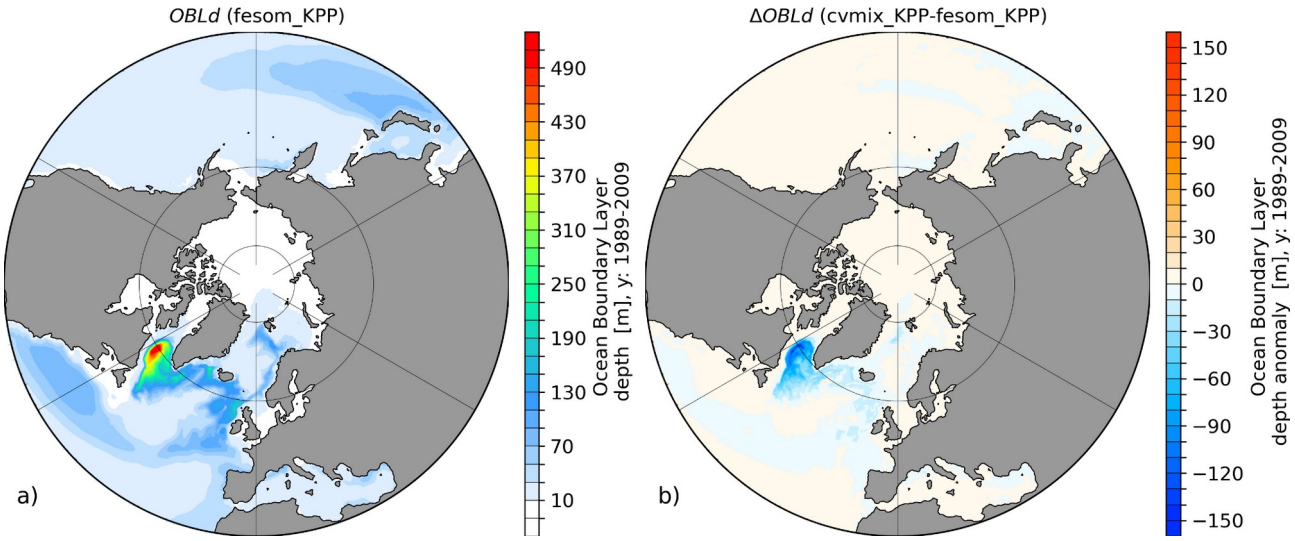
- vertical mixing:



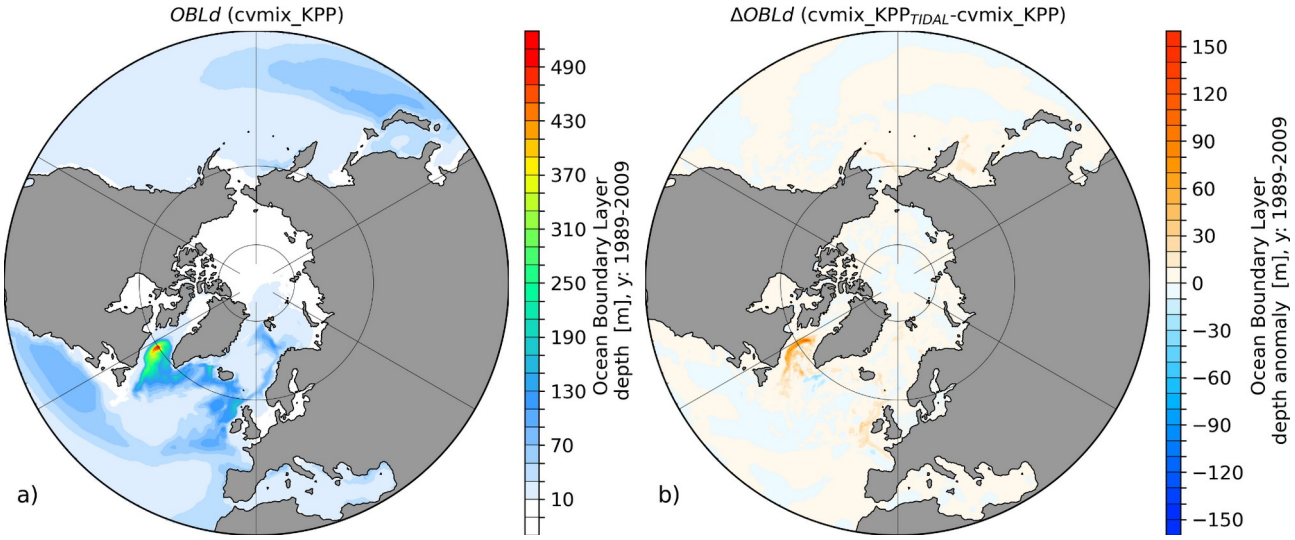
Suppl. 6: Temperature (1st and 2nd column), salinity (3rd and 4th column) difference between fesom_KPP and WOA18 (1st and 3rd column) as well as between fesom_PP and fesom_KPP (2nd and 4th column) averaged for the period 1989 to 2009. From top to bottom, panels show the vertically averaged fields for the depth ranges of 0-250 m, 250-500 m, 500-1000 m, 1000-2000 m and 2000-4000 m.



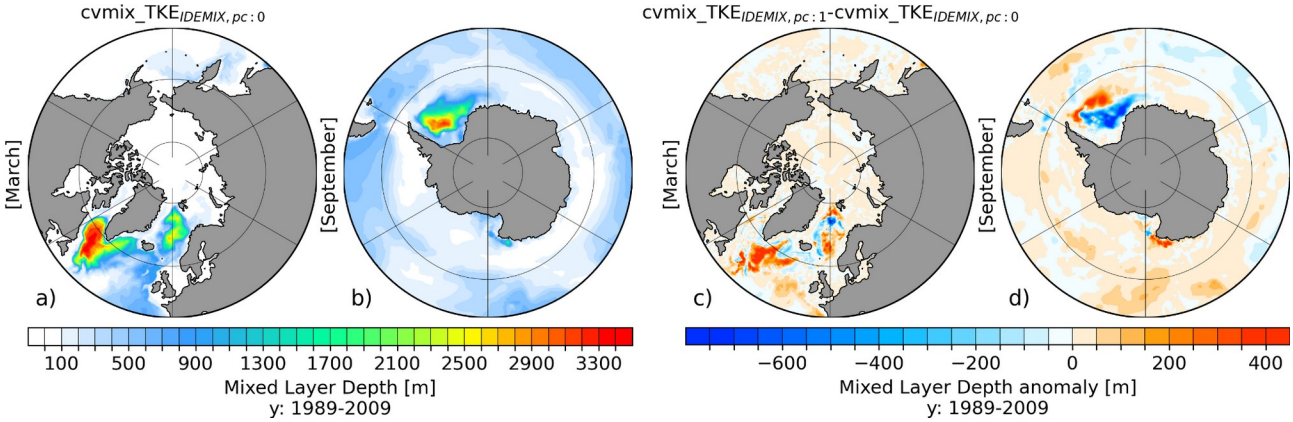
Suppl. 7: Northern hemispheric March (a) and southern Hemispheric September (b) mixed layer depth (MLD) for fesom_KPP implementation as well as corresponding anomalous MLD between fesom_PP and fesom_KPP implementation (c, d), averaged for the period 1989-2009.



Suppl 8: KPP Ocean Boundary Layer depth (OBLd) for fesom_KPP (a) averaged over the period 1989-2009. b) Difference in OBLd between cvmix_KPP and fesom_KPP.



Suppl 9: KPP Ocean Boundary Layer depth (OBLd) for cvmix_KPP (a) averaged over the period 1989-2009. b) Difference in OBLd between cvmix_KPP$_{TIDAL}$ and cvmix_KPP.



Suppl. 10: Northern hemispheric March (a) and southern hemispheric September (b) mixed layer depth (MLD) for cvmix_TKE$_{IDEMIX}$ using full cells (pc:0) as well as corresponding anomalous MLD between cvmix_TKE$_{IDEMIX}$ using partial cells (pc:1) minus full cell (pc:0) (c, d), averaged for the period 1989-2009.