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An assessment of ten ocean reanalyses in the polar regions – supplementary material

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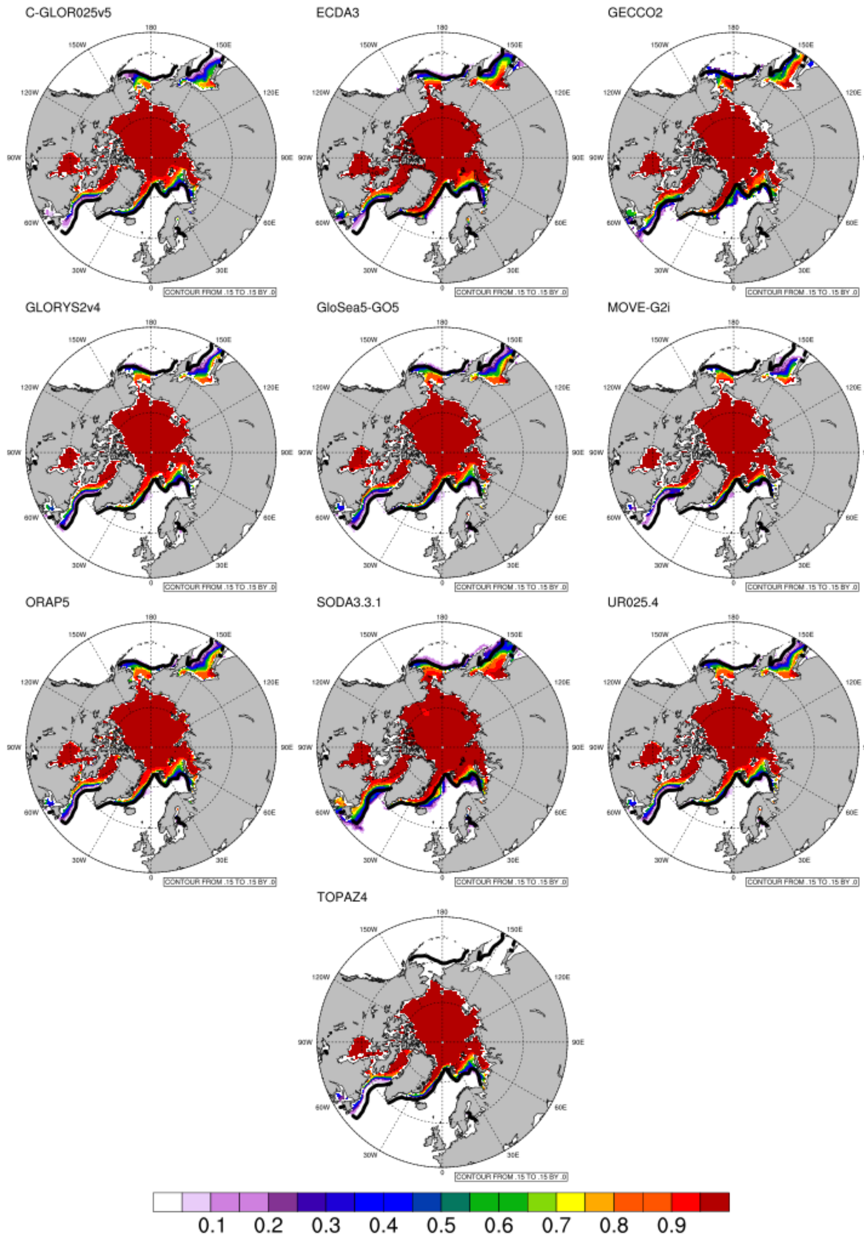

Fig. S1 March climatologies of the Arctic sea-ice concentration for the period 1993 to 2010 of the ORA products. Black lines are the 15% climatological ice edge by NSIDC NASATeam.

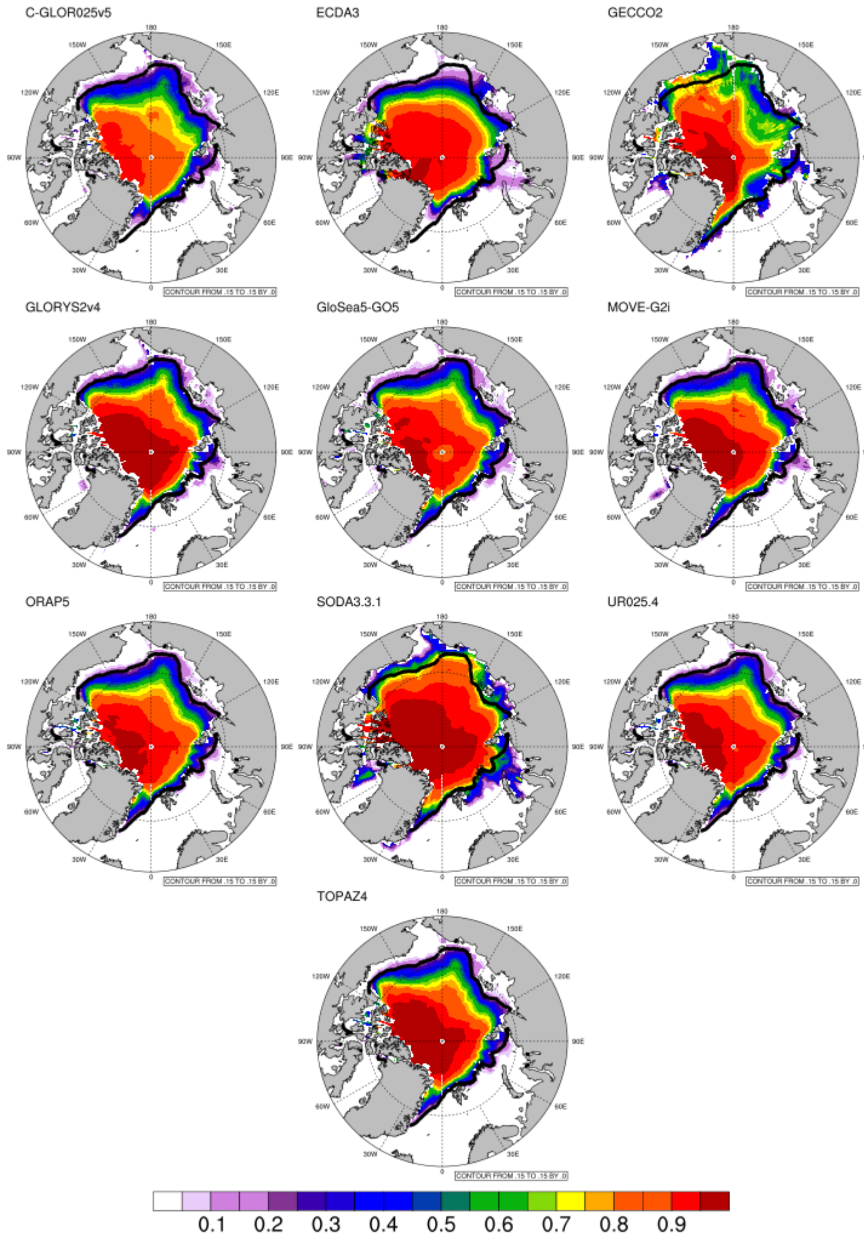

Fig. S2 September climatologies of the Arctic sea-ice concentration for the period 1993 to 2010 of the ORA products. Black lines are the 15% climatological ice edge by NSIDC NASATeam.

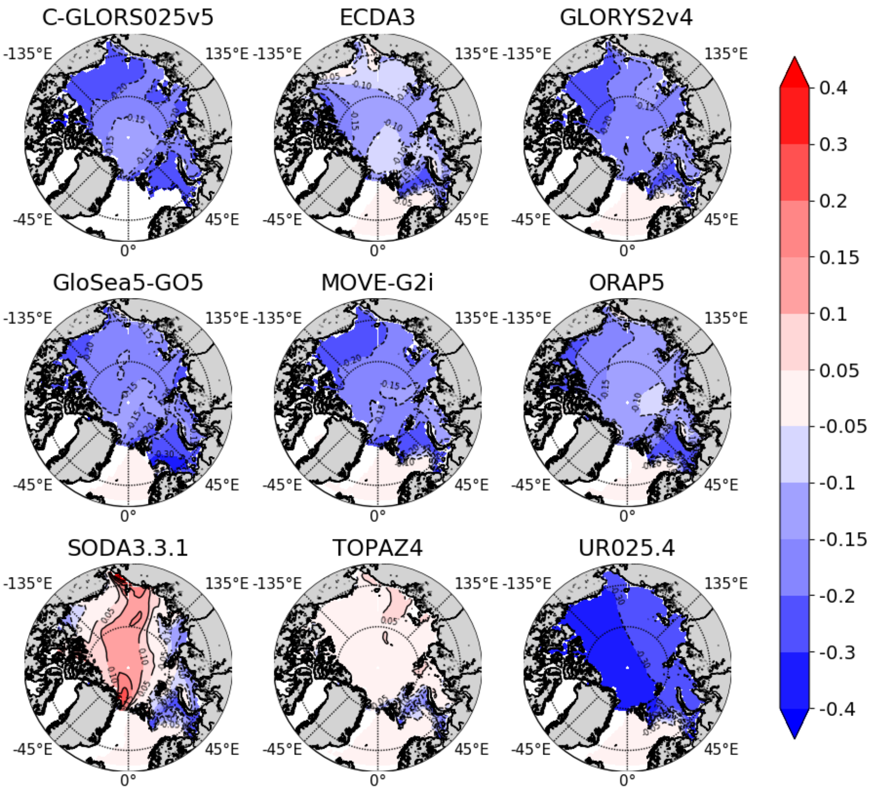

Fig. S3 Differences in March between the ORA mean snow depth [m] from 1993–2010 and the Warren et al. (1999) climatology.

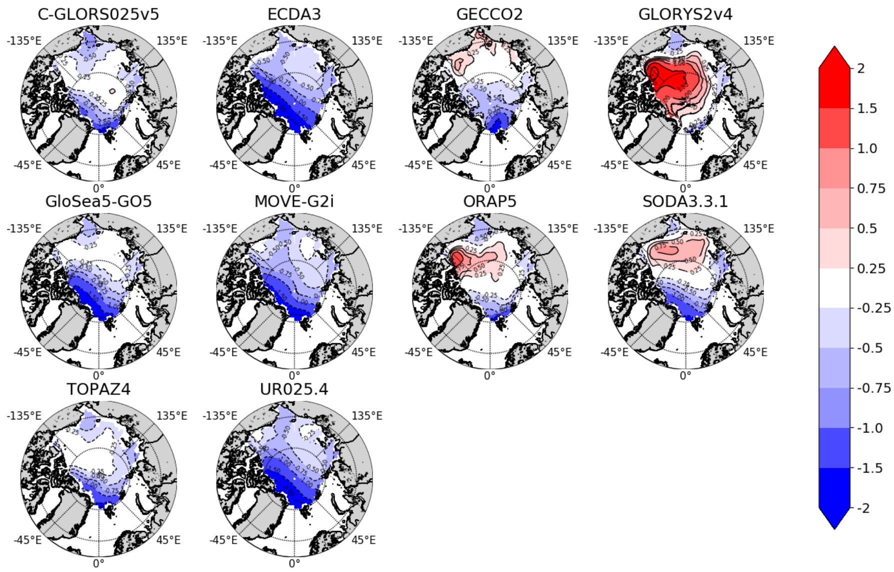

Fig. S4 The 2000–2012 mean differences of the ORAs to the ITRP sea-ice thickness [m] in October–November.

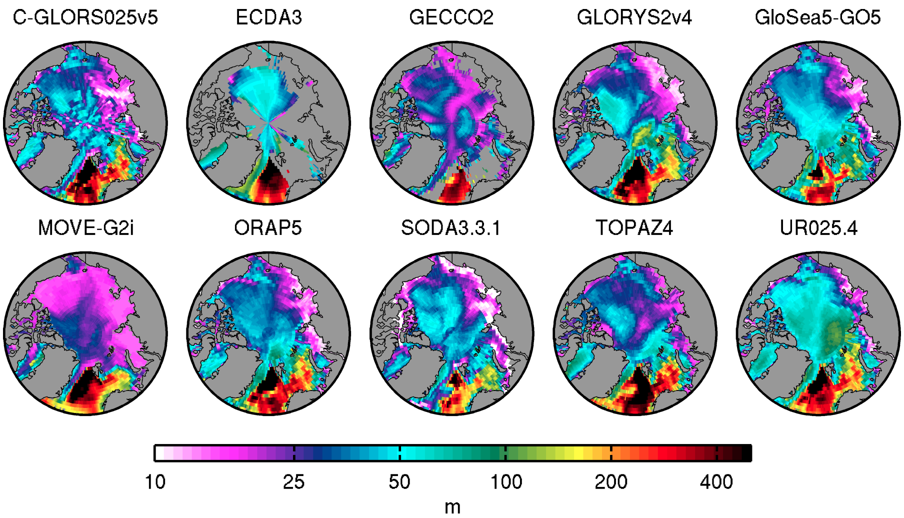

Fig. S5 Arctic mixed layer depth for March in individual ORAs. The over-ocean gray areas indicate missing data in the original ORA output files.

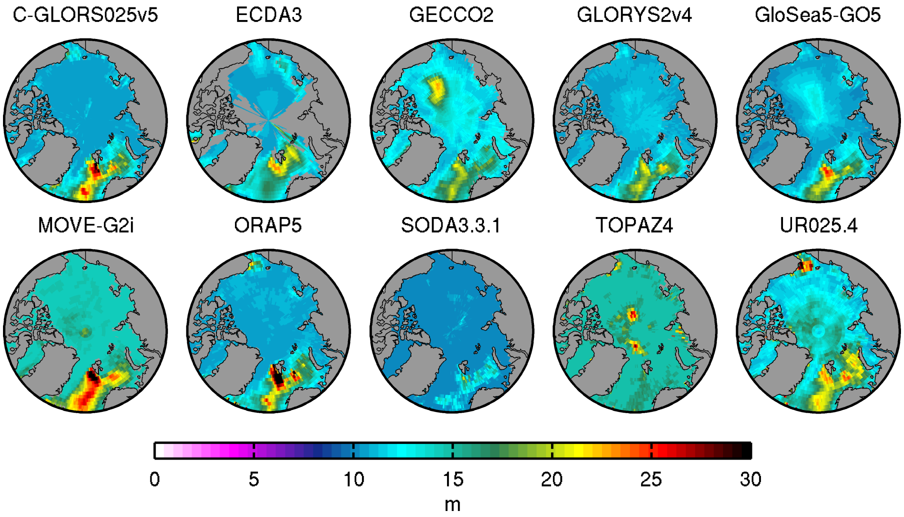

Fig. S6 Arctic mixed layer depth for August in individual ORAs.

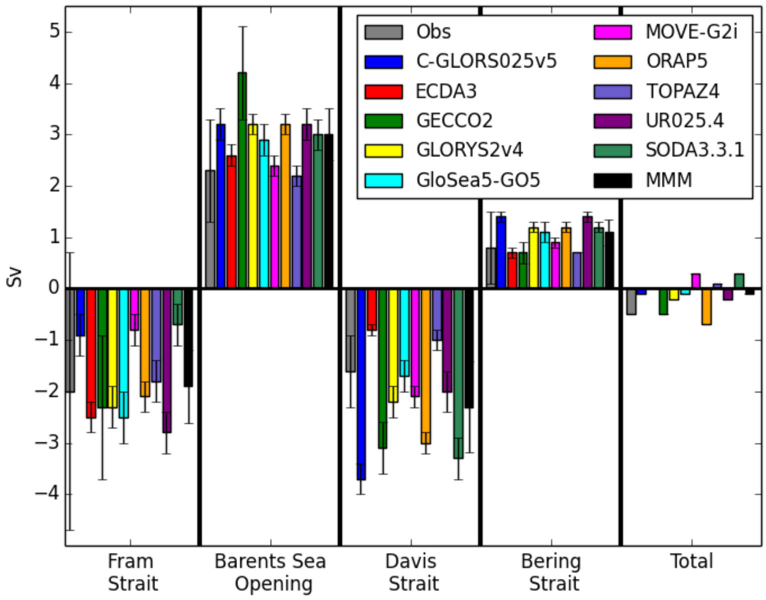

Fig. S7 Arctic liquid ocean volume transport [Sv] through the major Arctic Ocean openings, and their net sum (Total) in the ORAs. Values are from Table S1.

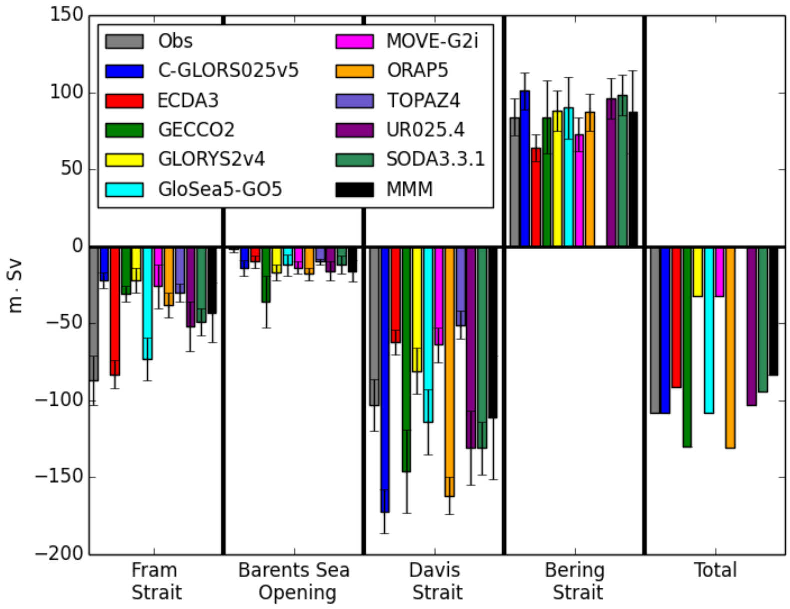

Fig. S8 Arctic liquid ocean fresh water transport [mSv] through the major Arctic Ocean openings, and their net sum (Total) in the ORAs. Values are from Table S1.

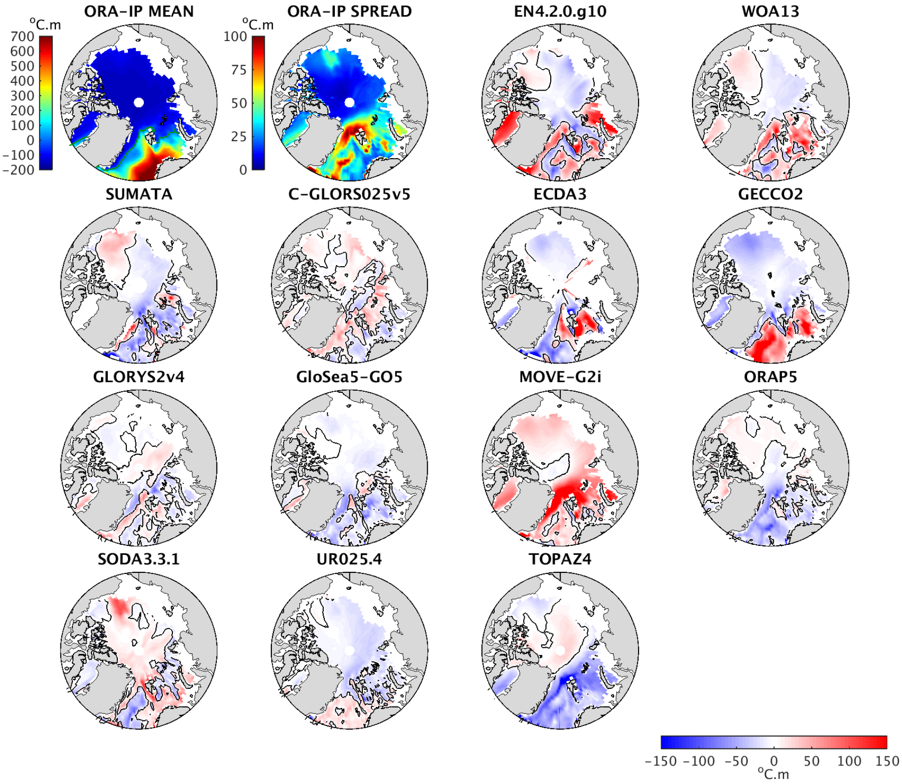

Fig. S9 Averaged multi-model Arctic Ocean Heat Content (OHC) in the layer of 0–100 m (top left panel), its spread (top second left panel) and individual ORA departures from the multi-model mean.

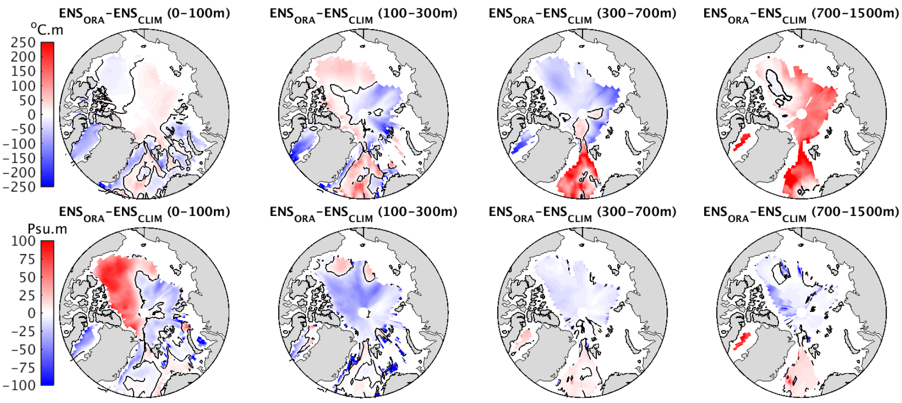

Fig. S10 Multi-model mean departures ($\mathrm{ENS_{ORA}}$) of Arctic Ocean Heat (OHC; upper row) and Salt Content (OSC; lower row) from an observational multi-product mean climatology ($\mathrm{ENS_{CLIM}}$). Departures are averaged vertically in 4 layers (0–100 m, 100–300 m, 300–700 m and 700–1500 m). The observational climatology is the mean of Sumata, WOA13 and EN4.2.0.g10 products.

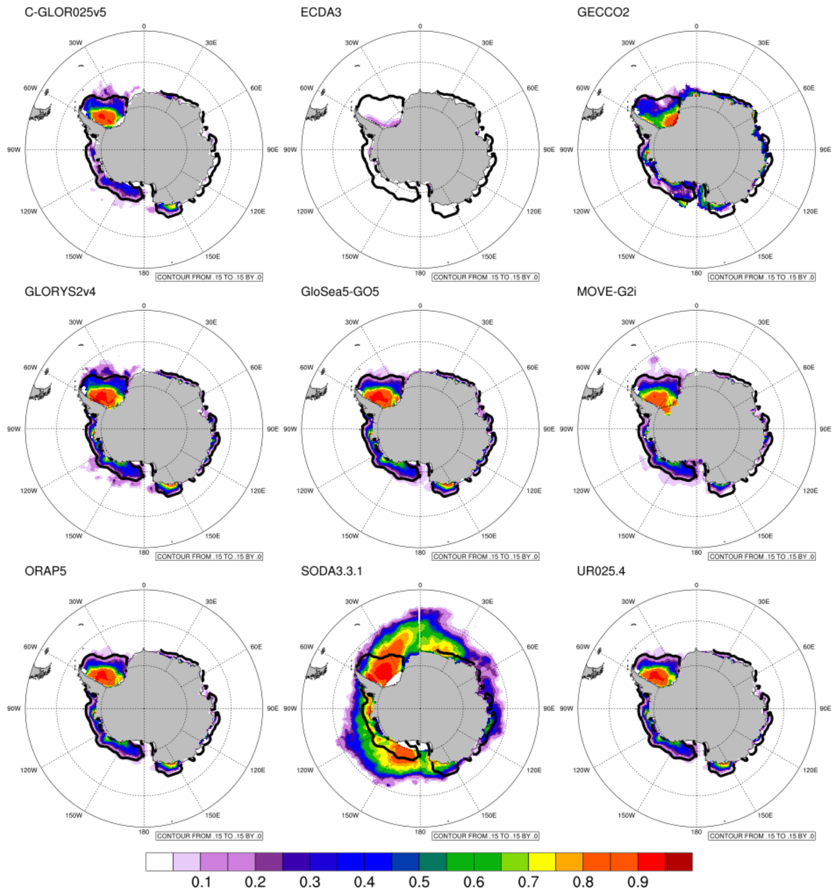

Fig. S11 February climatologies of the Antarctic sea-ice concentration for the period 1993 to 2010 of the ORA products.

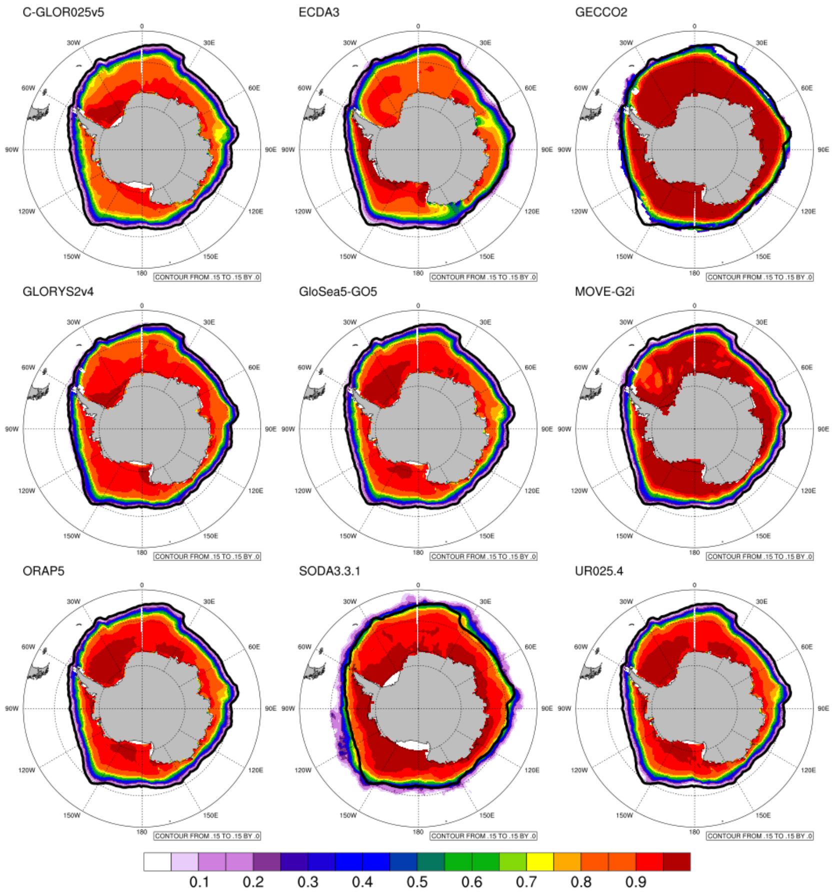

Fig. S12 September climatologies of the Antarctic sea-ice concentration for the period 1993 to 2010 of the ORAs.

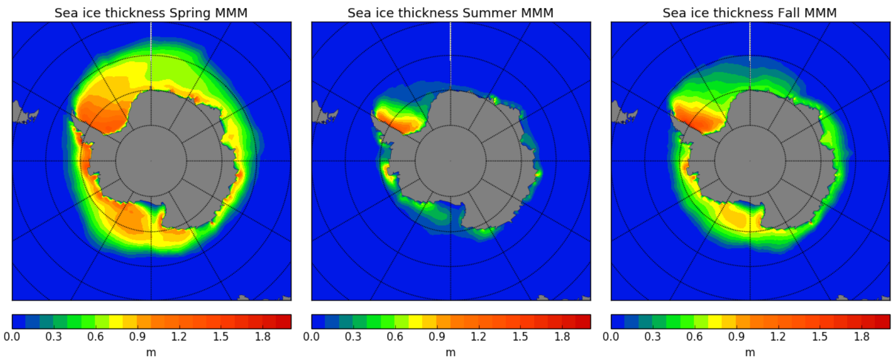

Fig. S13 Sea-ice thickness of the ORA MMM during 2003–2008 Spring, Summer and Fall corresponding to the timing of ICESat campaigns (Kurtz and Markus, 2012, see reference for exact dates of averaging).

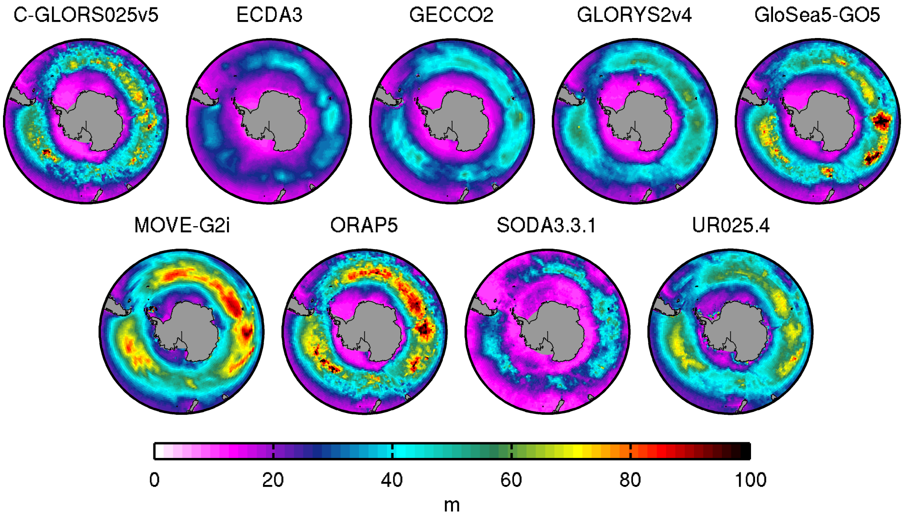

Fig. S14 Antarctic mixed layer depth for January in individual ORAs.

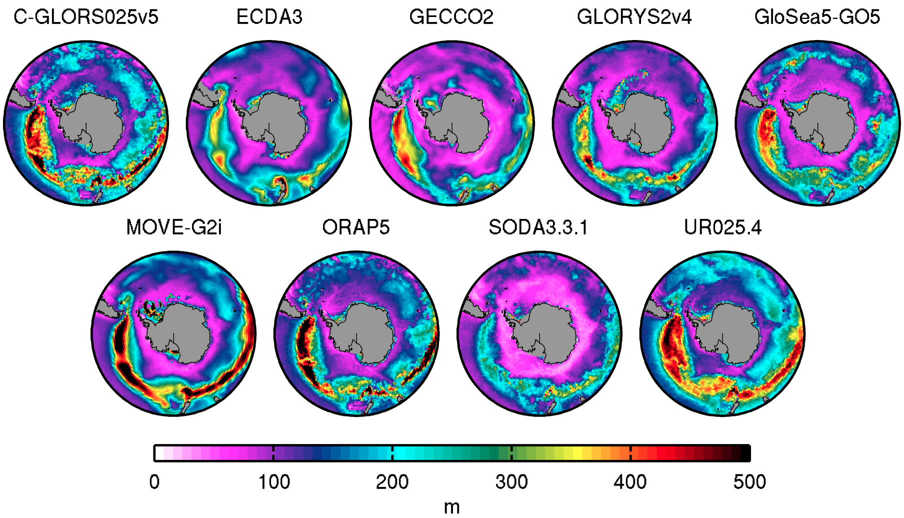

Fig. S15 Antarctic mixed layer depth for August in individual ORAs.

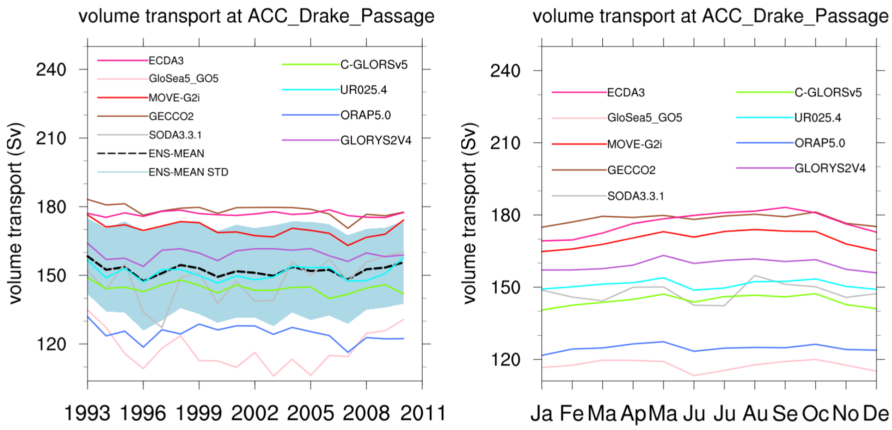

Fig. S16 Annual time series (left) and mean annual cycle (right) of liquid ocean volume transport through the Drake Passage for individual ORAs and their ensemble mean. Units are in Sv (10^6 m^3s^{-1}). Shaded blue area in the left panel is the ± standard deviation of the nine ORAs.

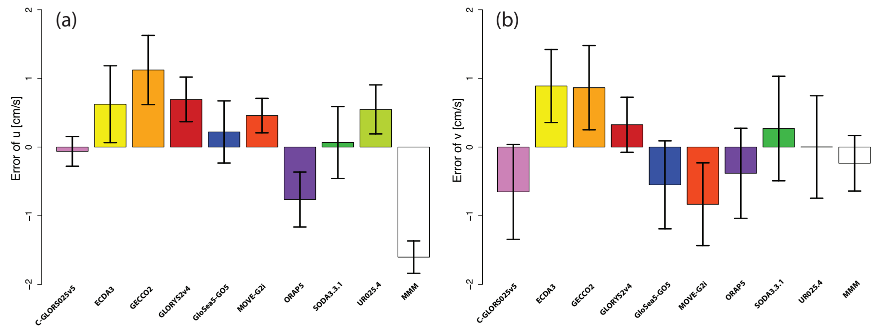

Fig. S17 Mean error of (a) zonal and (b) meridional surface currents south of 50° for nine global ORAs and the ORA MMM with respect to the OSCAR dataset based on monthly mean values from 1993–2010. Error bars show ± standard deviation of mean error. As all mean errors are in the order of 1 cm s^{-1}, they indicate a good match between the ORAs and OSCAR within its accuracy of surface current measurements.

Table S1 Volume (V; [Sv]), heat (Q; [TW]), and freshwater (FW; [mSv]) transport through the Fram Strait (FS), the Barents Sea Opening (BSO), the Davis Strait (DS), and the Bering Strait (BE). Overbar denotes mean values (1993-2010 for models, see text for observations) and ($'$) denotes one standard deviation. Positive values are northward/into the Arctic.

Var	Obs.	C-GLORS025v5	ECDA3	GECCO2	GLORYS2v4	GloSea5-GO5	MOVE-G2i	ORAP5	TOPAZ4	UR025.4	SODA3.3.1	MMM
FS($\bar{V}$)	−2.0[1]	−0.9	−2.5	−2.3	−2.3	−2.5	−0.8	−2.1	−1.8	−2.8	−0.7	−1.9
FS(V')	2.7[1]	0.4	0.3	1.4	0.4	0.5	0.3	0.3	0.4	0.4	0.4	
FS($\bar{Q}$)	36[2]	19	26	8	15	42	6	30	10	26	31	21
FS(Q')	6[2]	4	5	8	7	6	3	5	5	4	8	
FS($\bar{FW}$)	−87[3]	−22	−83	−31	−22	−73	−26	−38	−30	−52	−49	−43
FS(FW')	16	5	9	5	8	14	14	8	6	16	9	
BSO($\bar{V}$)	2.3[4]	3.2	2.6	4.2	3.2	2.9	2.4	3.2	2.2	3.2	3.0	3.0
BSO(V')	1.0†	0.3	0.2	0.9	0.2	0.3	0.2	0.2	0.2	0.3	0.3	
BSO($\bar{Q}$)	70[4]	76	52	111	73	72	57	76	47	77	79	72
BSO(Q')	21†	9	8	32	9	8	6	9	5	9	9	
BSO($\bar{FW}$)	−2[5]	−14	−10	−36	−17	−12	−14	−18	−10	−16	−12	−16
BSO(FW')	2[3]	5	4	17	5	7	4	4	2	6	6	
DS($\bar{V}$)	−1.6[6]	−3.7	−0.8	−3.1	−2.2	−1.7	−2.1	−3.0	−1.0	−2.0	−3.3	−2.3
DS(V')	0.7[6]‡	0.3	0.1	0.5	0.3	0.3	0.2	0.2	0.2	0.4	0.4	
DS($\bar{Q}$)	20[7]	8	7	9	1	14	−10	14	6	8	−5	5
DS(Q')	9[7]	4	1	6	2	3	3	1	1	5	6	
DS($\bar{FW}$)	−103[6]	−172	−62	−146	−81	−114	−64	−162	−51	−131	−131	−111
DS(FW')	17[6]‡	14	8	27	15	21	11	12	9	24	17	
BE($\bar{V}$)	0.8[8]	1.4	0.7	0.7	1.2	1.1	0.9	1.2	0.7**	1.4	1.2	1.1
BE(V')	0.7[8]	0.1	0.1	0.2	0.1	0.2	0.1	0.1	0**	0.1	0.1	
BE($\bar{Q}$)	10–20[9]	4	5	5	4	6	4	6	-**	7	5	5
BE(Q')		2	1	4	2	2	1	2	-**	3	2	
BE($\bar{FW}$)	84[3]	101	64	84	88	90	73	87	-**	96	98	87
BE(FW')	8–16[3]	12	9	24	13	20	11	12	-**	13	13	
Tot(V)	−0.5	−0.1	0	−0.5	−0.2	−0.1	0.3	−0.7	0.1**	−0.2	0.3	−0.1
Tot(Q)	136–146	107	90	134	93	134	58	125	-**	118	110	103
Tot(FW)	−108	−109	−91	−130	−32	−108	−32	−131	-**	−103	−94	−83

[1]Schauer et al. (2008); [2]Schauer and Beszczynska-Möller (2009); [3]Haine et al. (2015); [4]Smedsrud et al. (2013); [5]Rawlins and Co-authors (2010); [6]Curry et al. (2014); [7]Curry et al. (2011) [8]Roach et al. (1995) and [9]Woodgate et al. (2010). **TOPAZ4 regional model domain does not include the Bering Strait. †Note: standard deviation of the Atlantic Water only. ‡Note: annual standard deviation (Curry et al., 2014).

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