Reply from authors on comments from Referee #1

Title: we changed the term “drivers” to “controls”

Abstract rewritten and shortened and focus more on results.
Introduction has been shortened and added text about the organisms possibility to adapt to schanges in pH and carbonate saturation.

Methods section
As mentioned by Ref#1 we performed an internal consistency check in 2006 aiming at investigating the quality in fCO_2 data. We estimated the standard error in fCO_2 to ±9 µatm (Chierici et al., 2012). This corresponds to an error of ±0.02 in ΩAr and ±0.03 in ΩCa.

Moreover, in OSO2010/2011 we sampled water for post-cruise analysis of C_T to provide an internal consistency check and estimate the total error in our AT, CT and derived parameters. We compared the C_T calculated from A_T and pH15 with the measured C_T determined from gas extraction of acidified sample followed by NDIR detection. Based on regression analysis of 26 data points we obtained a standard error of ±7 µmol/kg in C_T (r^2 of 0.904).

Since our study here is focused on $CaCO_3$ saturation we performed a regression analysis between ΩAr calculated from A_T and pH, and the ΩAr values calculated from A_T and C_T. The standard error in ΩAr was ±0.05 (r^2=0.842).
The results from the internal consistency check has been added to methods section in the the revised version of the manuscript.

Determination of C_T was performed 6 months after expedition. Samples were immediately preserved with saturated HgCl2 and stored dark and cool (+4 °C). This has been added in the revised version.

Line 16: We used CRM to set the accuracy of measured CT and AT values by applying correction factors based on the measured and given CRM value. This text has been added to the text and previous text removed.

Mucci (1983) was added as reference for the Ca/S relationship

Hydrography section
We have substantially rewritten the hydrography section and added information on the sub-Antarctic front and the Antarctic Polar Front for all years. We use the surface temperature definitions from Moore et al., 1999, and Dong et al., 2006 to explore the fronts. The references are added in the reference list.

Line 17: rewritten to “large extent” and corrected as accordingly in revised version

Line 18: Removed accordingly

Line 20: This sentence is removed in the revised version. The revised version follows the fronts more detailed
Line 21-22: Completely changed in the revised version and the fronts are defined for each year according to definitions and observations.

Line 22-24: This is more detailed in the revised version. We are considering to add new figures (ODV surface plots) showing the SST and salinity change in more detail in the Amundsen and Ross Sea to facilitate interpretation. From these figures salinity and SST decreases in the ice covered zone north of during all years Increasing salinity coincides with increasing SST implying influence of upwelled warm CDW. New Figure 3.

Line 26: this has been changed and it is only -1.8 C that is relevant

Figure 2. It is not possible to view the details of SST and salinity on x-y plot. However, we still believe the x-y plot is useful. To improve the interpretation and facilitate viewing of changes in Am and Ross seas we introduce new figures (surface ODV) plots which has x-y-z plots. See comment above (L22-24). New Figure 3 (8 more figures)

Sea ice extent
We used a combination of observations onboard and remotely sensed data. Sea ice edge was defined by Worby and Comiso, 2004 and added the tex and reference to revised version" The sea-ice edge was observed onboard the IB Oden using the ASPeCt protocol and defined as the northernmost occurrence of sea ice of at least 10% concentration within a 1 km radius of the ship (Worby and Comiso, 2004)."

Results

We have included more detailed analysis of the variability for all parameters based on observations. We have increased the font and ask the editor to include two figures/page instead of 6 as they are now.

Added new (8 more figures, new Figure 3) for salinity and SST in surface plot ODV format to facilitate detailed viewing in the Amundsen and Ross Sea.

P7890, line 18-19: Agree with Ref#1 and sentences removed.
P7890, line 19-20: Agree, this has been changed to " Between 66 °S and 67 °S, A_T started to decrease, most pronounced in 2010/2011, where A_T dropped to the lowest value of 2258 µmol kg^{-1} (Figure 6a). This coincided with a salinity decrease and minimum salinity of 33.3 (Figure 2b)."

P7890 Line 23: Changed sentence to **"**Except for in 2007/2008 C_T decreased in the RSP, reaching the minimum value of 1989 µmol kg-1 in 2010 (Figure 6b,)."

Table 3 (now table 4) has been changed and includes average values in the Amundsen and Ross seas for the different years.

P7891 line 10: removed whole sentence in revised version

Discussion

The discussion has been rewritten and removed text which is not based on our data. We also comment on the role of melt water for the carbonate system and chl a values is restricted to the finding in the southern part of PFZ and at the ice edge, where we find the low salinity high chl a water in 2010. This has been clarified in the text.

In summer 2010/2011, the sea-ice edge has the northernmost extent which may imply a large marginal ice zone. This is also observed on the December anomalies where sea ice remains in 2010. Our view is that more sea-ice has the potential to create larger volumes of melt water than years with less sea ice. However, we realize there may be other causes for low salinity in the APF is less upwelling of CDW. This has been added to the text and we include a more nuanced explanation for the high chl a values.

We have removed large parts on the role of melt water. It is diffult to discern with our data.

P7893 Line 15-21: Agree with the Ref#1 and this part has been removed from the revised version.

P7893 line 28: This is based on AT, SST, salinity from our study meaning that it is calculated based on a summer situation. This has been clarified in the text and added in Figure caption. We define the regions in the text. It is also possible to observe the estimates for the different regions in Figure 13. Since we do not have AT, SST and salinity data for the whole Pacific sector, we have chosen not to extrapolate the results to encompass a larger area, and only make prediction for the locations.

Dates: This is a misunderstanding mainly due to unclear denotation of the expedition names and years. The dates in Table 1 are correct and show that the expeditions took place between December one year and January next year. Thus 2007/2008 means that this is the expedition that took place in December 2007 to January 2008. We have clarified this in figures captions and denotations and apologize for the confusion this has caused.

We have changed all technical comments accordingly

Table 2: Statistical summary of the principal component analysis (PCA) and the two models from the OPLS-DA on the Amundsen Sea (AmS) and the Ross Sea (RS).

Name	Type	Components	Observations	R2X	R2Y	Q2
Interannual	PCA-X	2	219	0.808	---	0.708
AmS	OPLS-DA	1+1+0	69	0.554	0.99	0.99
RS	OPLS-DA	1+2+0	52	0.885	0.99	0.99

* OPLS-DA loading; Ω_{Ar} (y), 7 variables (x): AT/CT/pH/ pH^{15}/Chl a/SST/salinity; **1**+*1*+0, **1** correlates to y, *1* orthogonal to x, 0 orthogonal to y.

Table 4. Summary of the mean values and standard deviation of the carbonate system parameters, total alkalinity (A_T), total dissolved inorganic carbon (C_T), pH on total scale at 15 ºC (pH^{15}), pH on total scale at *in situ* temperature (pH *in situ*), aragonite saturation (Ω_{Ar}), and calcite saturation (Ω_{Ca}) in the Amundsen Sea (AmS, grey shade) and Ross Sea (RS) for each year. N denotes number of data points used in the study for each year. Minimum and maximum values are denoted min and max, respectively. * *In 2006, samples are located in northern Amundsen Sea (~68 ºS) and not in the polynya or coastal Amundsen Sea, thus intercomparison is irrelevant.*

Expedition (region)	**A_T ($\mu molkg^{-1}$)**	**min/ max**	**C_T ($\mu molkg^{-1}$)**	**min/ max**	**pH^{15}**	**min/ max**	**pH *in situ***	**min/ max**	**Ω_{Ar}**	**min/ max**	**Ω_{Ca}**	**min/ max**	**N**
*OSO2006 (AmS)**	*2303±12*	*2287/ 2316*	*2170 ±14*	*2147 /2192*	*7.846 ±0.017*	*7.819/ 7.871*	*8.106 ±0.016*	*8.082/ 8.130*	*1.54 ±0.05*	*1.46/ 1.63*	*2.45 ±0.09*	*2.33 2.61*	*16*
OSO2006 (RS)	2305±12	2289 /2331	2192 ±9	2181/ 2216	7.793 ±0.035	7.733/ 7.859	8.060 ±0.032	8.004/ 8.121	1.37 ±0.12	1.18/ 1.60	2.19 ±0.19	1.89/ 2.55	25
OSO2007/2008 (AmS)	2295±12	2270/ 2322	2190 ±22	2141/ 2225	7.771 ±0.063	7.675/ 7.900	8.038 ±0.067	7.932/ 8.179	1.30± 0.19	1.03/ 1.71	2.07 ±0.30	1.64/ 2.73	34
OSO2007/2008 (RS)	2313±19	2285/ 2343	2196±18	2153/ 2213	7.794 ±0.074	7.730/ 7.969	8.053 ±0.075	7.994/ 8.235	1.40± 0.27	1.18/ 2.05	2.23 ±0.43	1.88/ 3.27	9
OSO2008/2009 (AmS)	2288±11	2275/ 2315	2182 ±32	2094/ 2202	7.771 ±0.100	7.710/ 8.030	8.041 ±0.103	7.976/ 8.304	1.32± 0.36	1.11/ 2.26	2.10 ±0.58	1.77/ 3.61	13
OSO2008/2009 (RS)	2321±13	2299/ 2344	2185 ±20	2005/ 2205	7.876 ±0.109	7.780/ 8.180	8.101 ±0.067	8.039/ 8.443	1.58 ±0.25	1.34/ 3.02	2.52 ±0.40	2.13/ 4.82	20
OSO2010/2011 (AmS)	2293±14	2263/ 2313	2173 ±25	2137/ 2211	7.817 ±0.067	7.730/ 7.930	8.084 ±0.071	7.968/ 8.184	1.45 ±0.22	1.19/ 1.80	2.31 ±0.35	1.90/ 2.87	12
OSO2010/2011 (RS)	2309±11	2289/ 2326	2071 ±51	1989/ 2129	8.070 ±0.100	7.910 8.220	8.327 ±0.092	8.184/ 8.471	2.50 ±0.50	1.75/ 3.28	3.98 ±0.79	2.79/ 5.23	10
Mean AmS	2295±6		2179±9		7.801 ±0.037		8.067 ±0.033		1.40 ±0.11		2.23 ±0.18		
Mean RS	2312±7		2180±6		7.883 ±0.130		8.135 ±0.130		1.71 ±0.53		2.73 ±0.85		

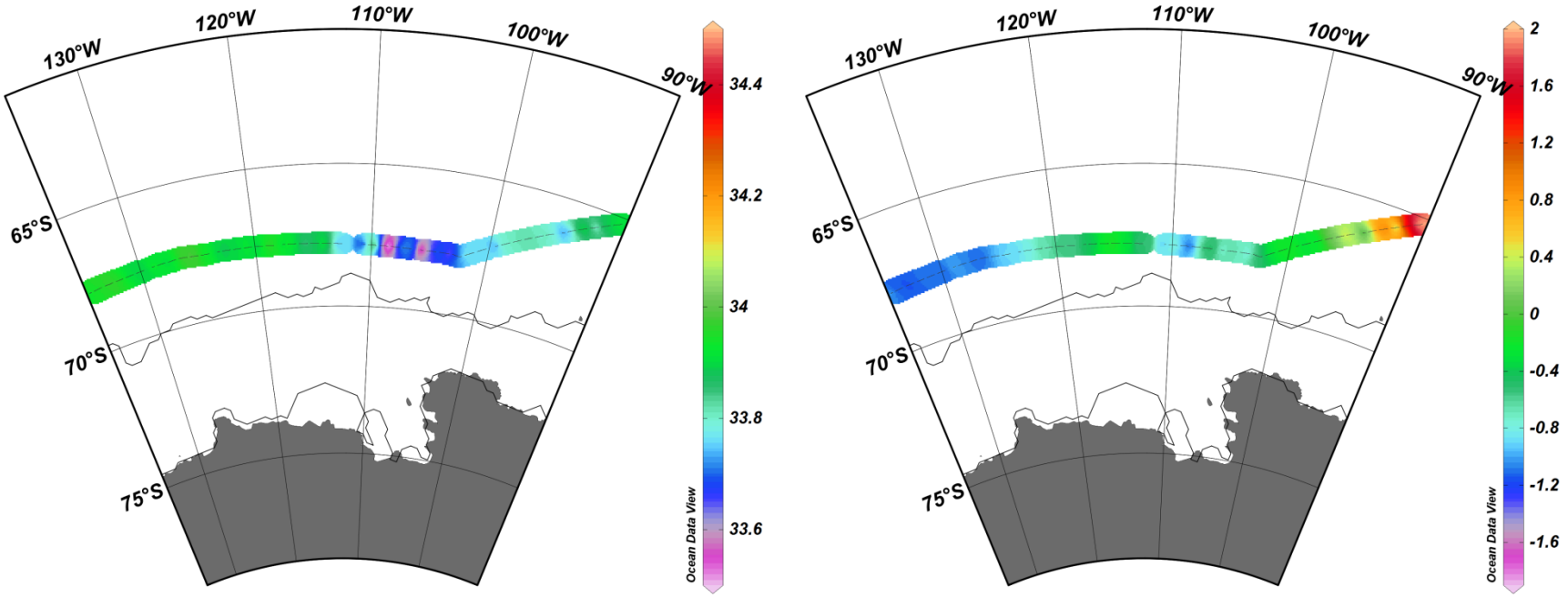


Figure 3: Variability of a) salinity and b) SST in the Amundsen Sea in 2006. The grey thin lines mark the December sea-ice edge.

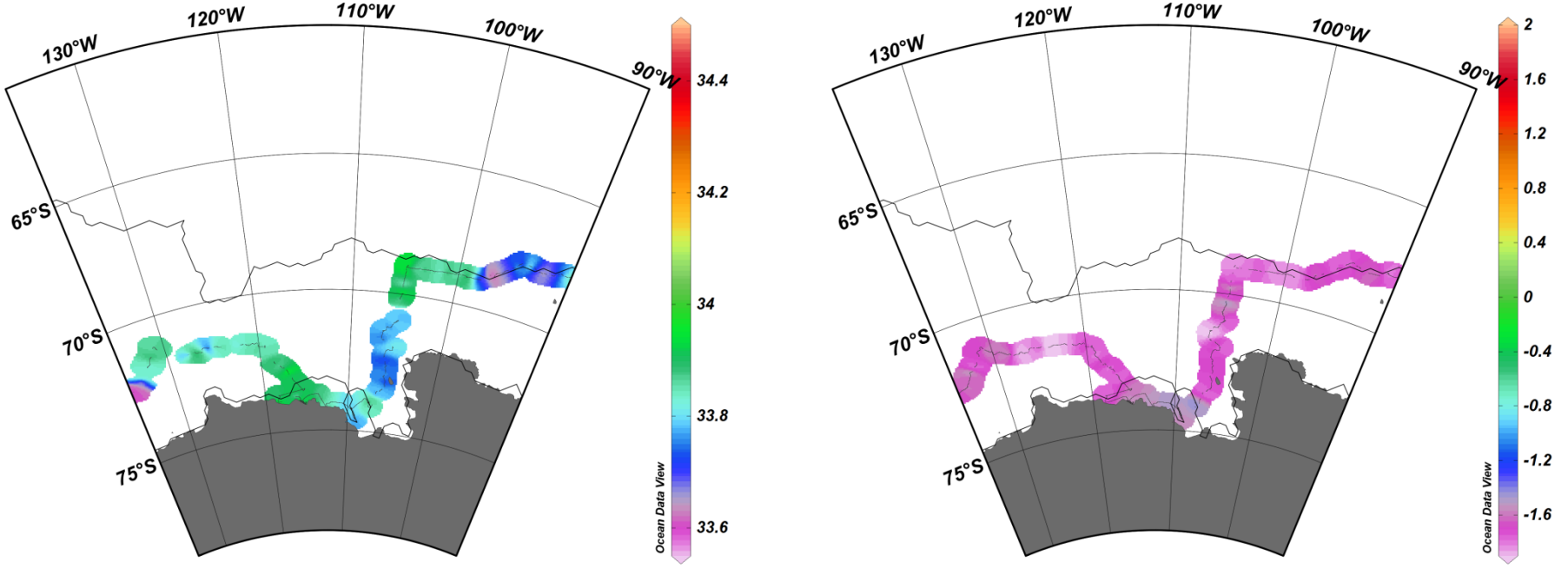


Figure 3: Variability of c) salinity and d) SST in the Amundsen Sea in 2007. The grey thin lines mark the December sea-ice edge.

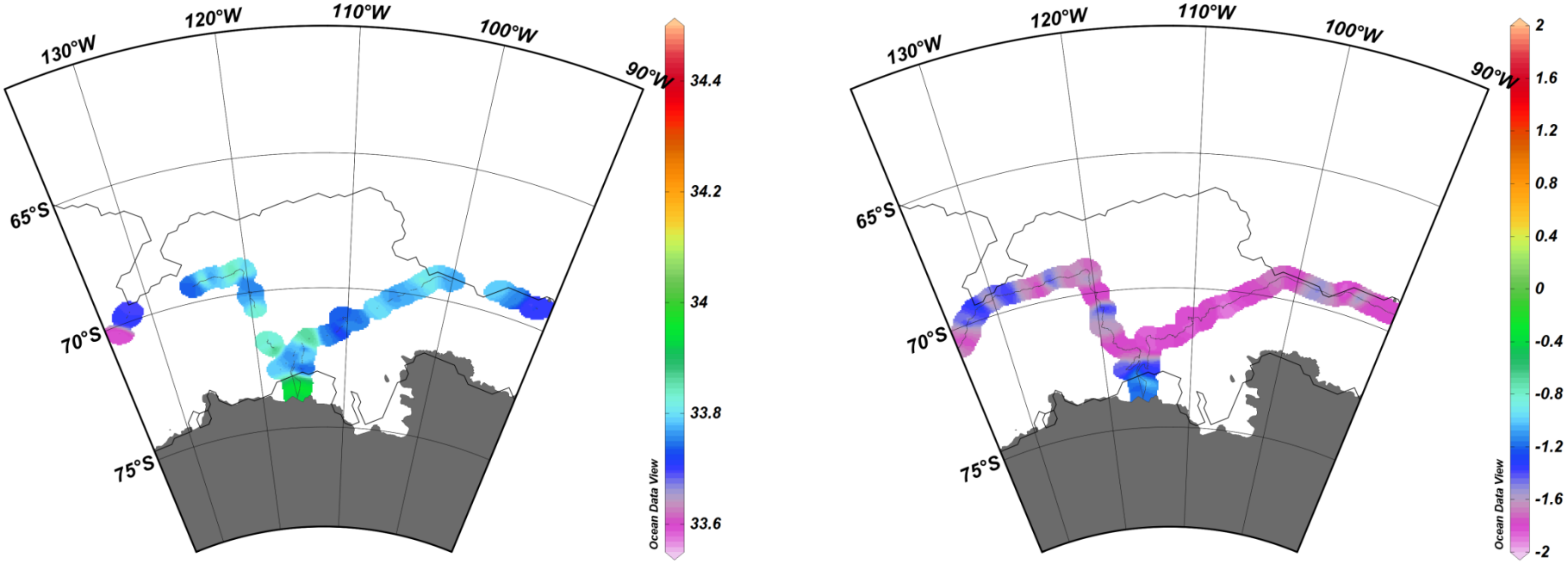
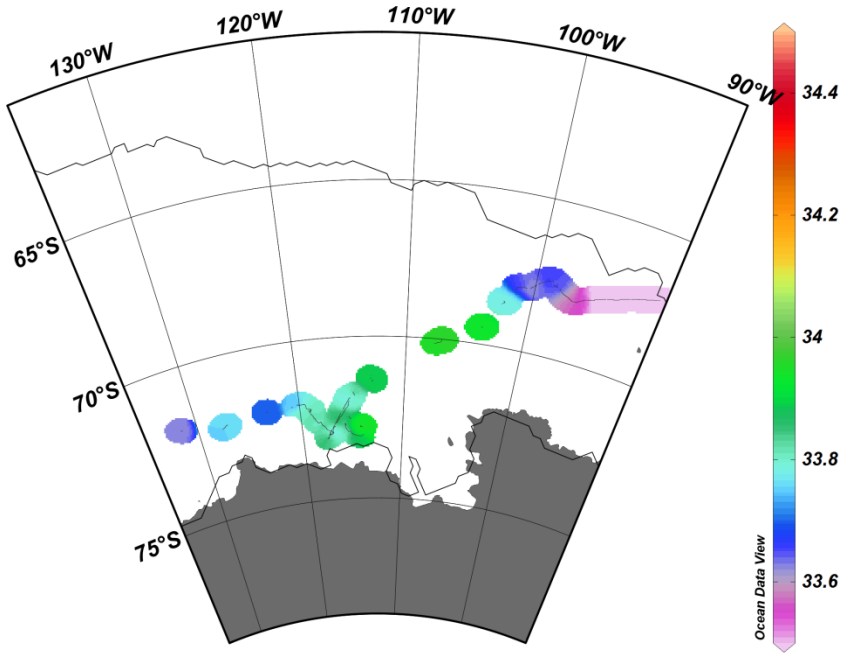


Figure 3: Variability of e) salinity and f) SST in the Amundsen Sea in 2008. The grey thin lines mark the December sea-ice edge.



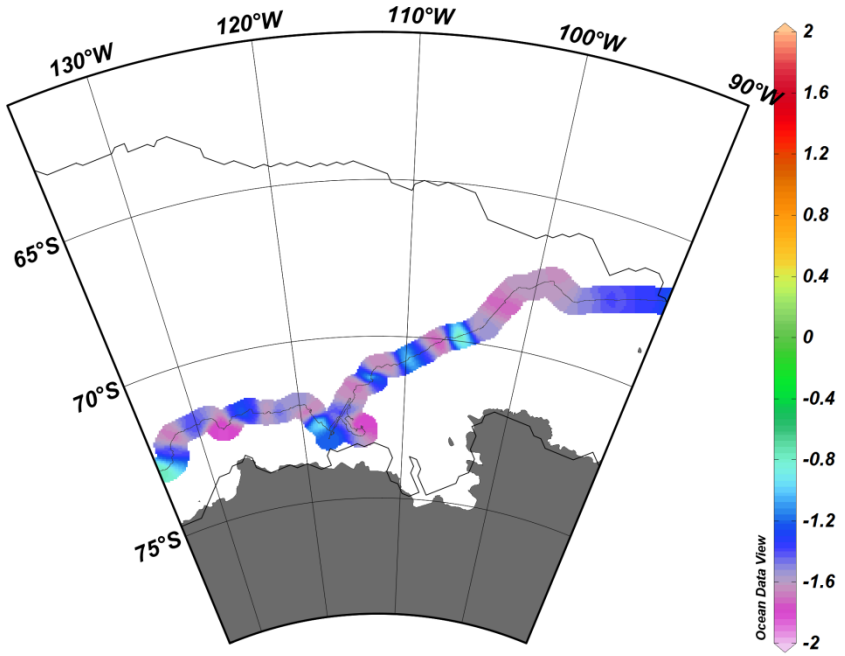
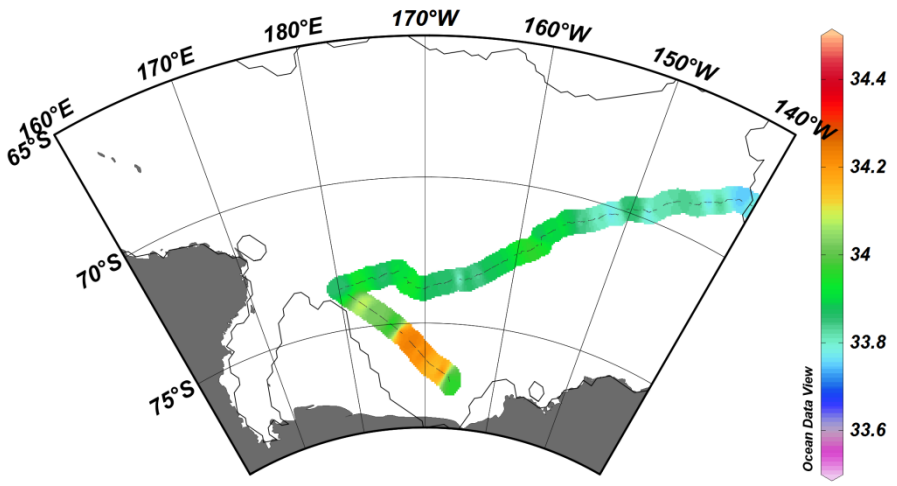


Figure 3: Variability of g) salinity and h) SST in the Amundsen Sea in 2010. The grey thin lines mark the December sea-ice edge.



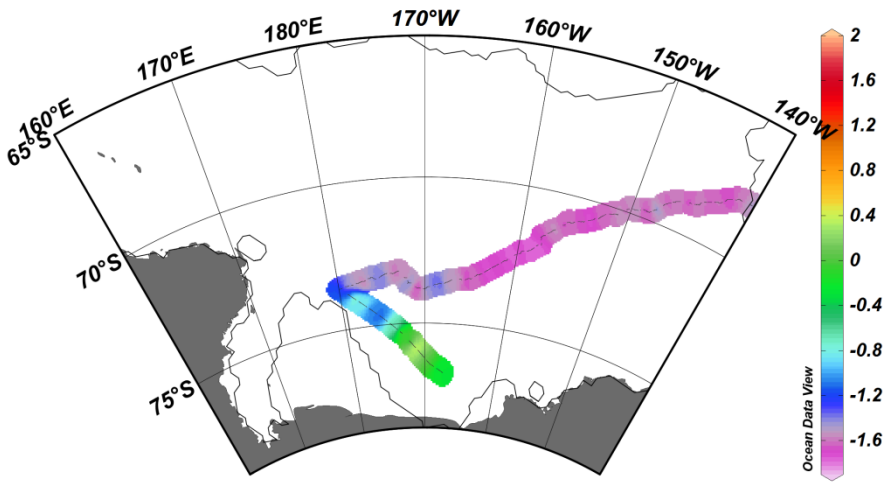


Figure 3: Variability of i) salinity and j) SST in the Ross Sea in 2006.
The grey thin lines mark the December sea-ice edge.

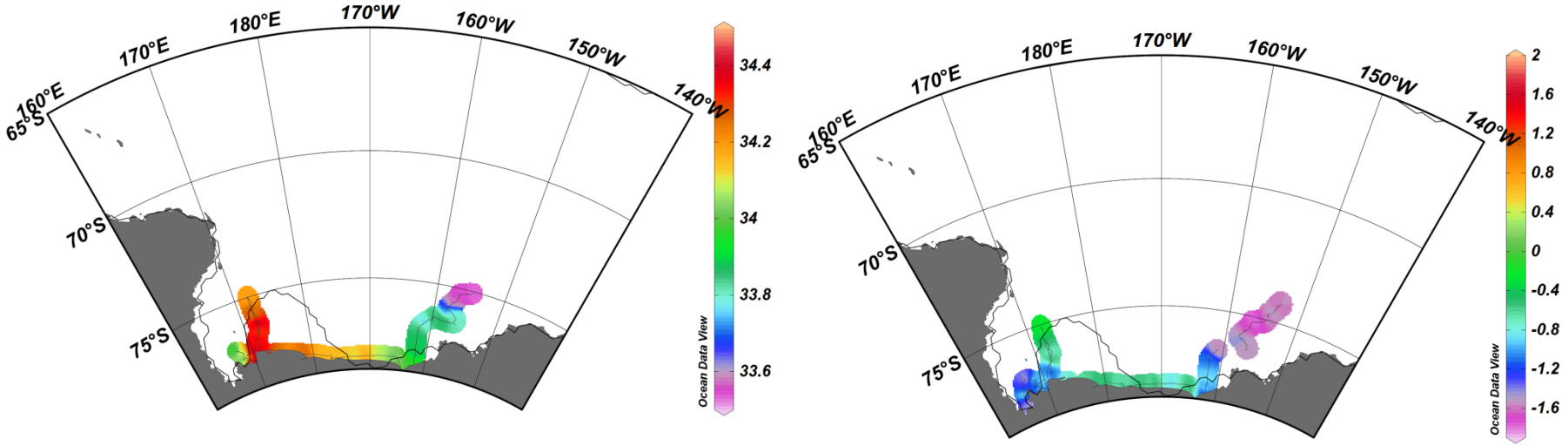


Figure 3: Variability of k) salinity and l) SST in the Ross Sea in 2007/2008. The grey thin lines mark the December sea-ice edge.

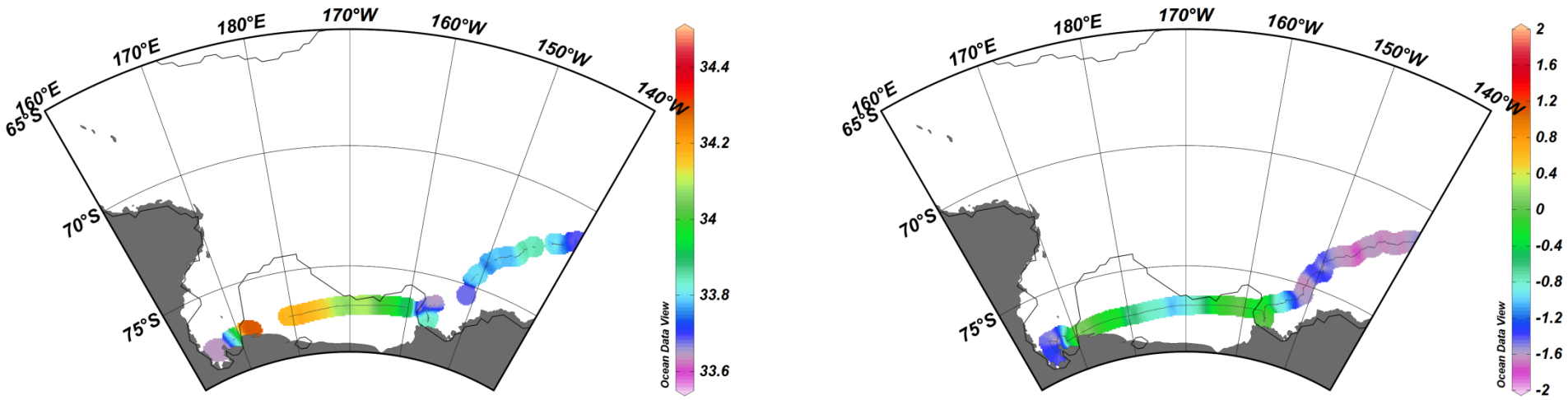


Figure 3: Variability of m) salinity and n) SST in the Ross Sea in 2008/2009. The grey thin lines mark the December sea-ice edge.

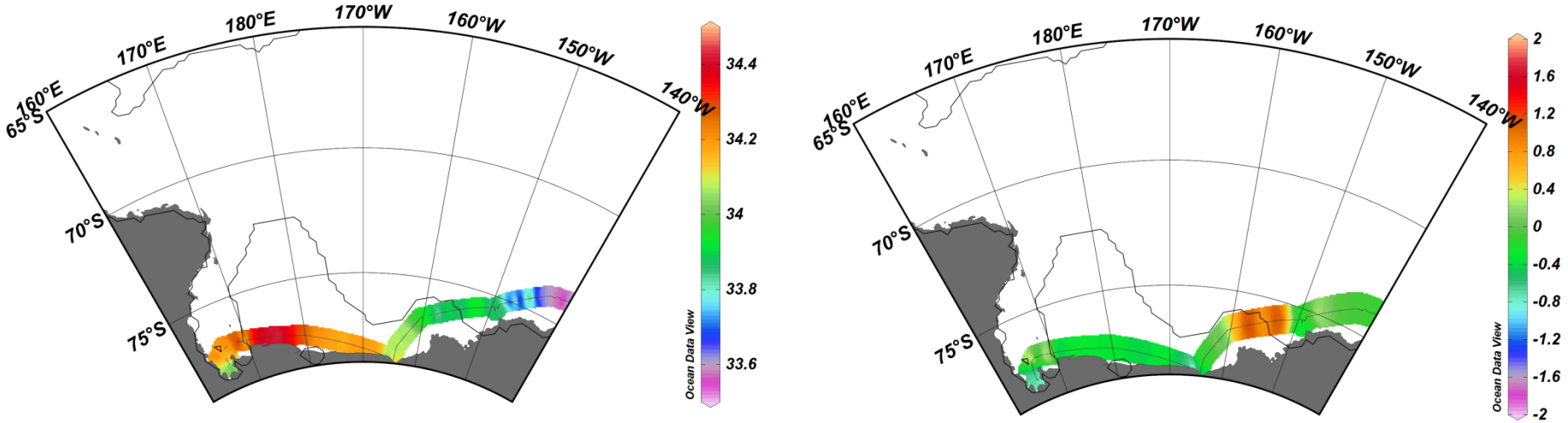


Figure 3: Variability of o) salinity and p) SST in the Ross Sea in 2010/2011. The grey thin lines mark the December sea-ice edge.