Responses to referee #1

Dear Dr. Keguang Wang:

Thanks for your helpful comments to improve this manuscript.

Below, we repeat each comment and insert our replies in the text. All responses are in blue font for clarity of reading.

Qinghua Yang

On behalf of all the authors

Main Comments:

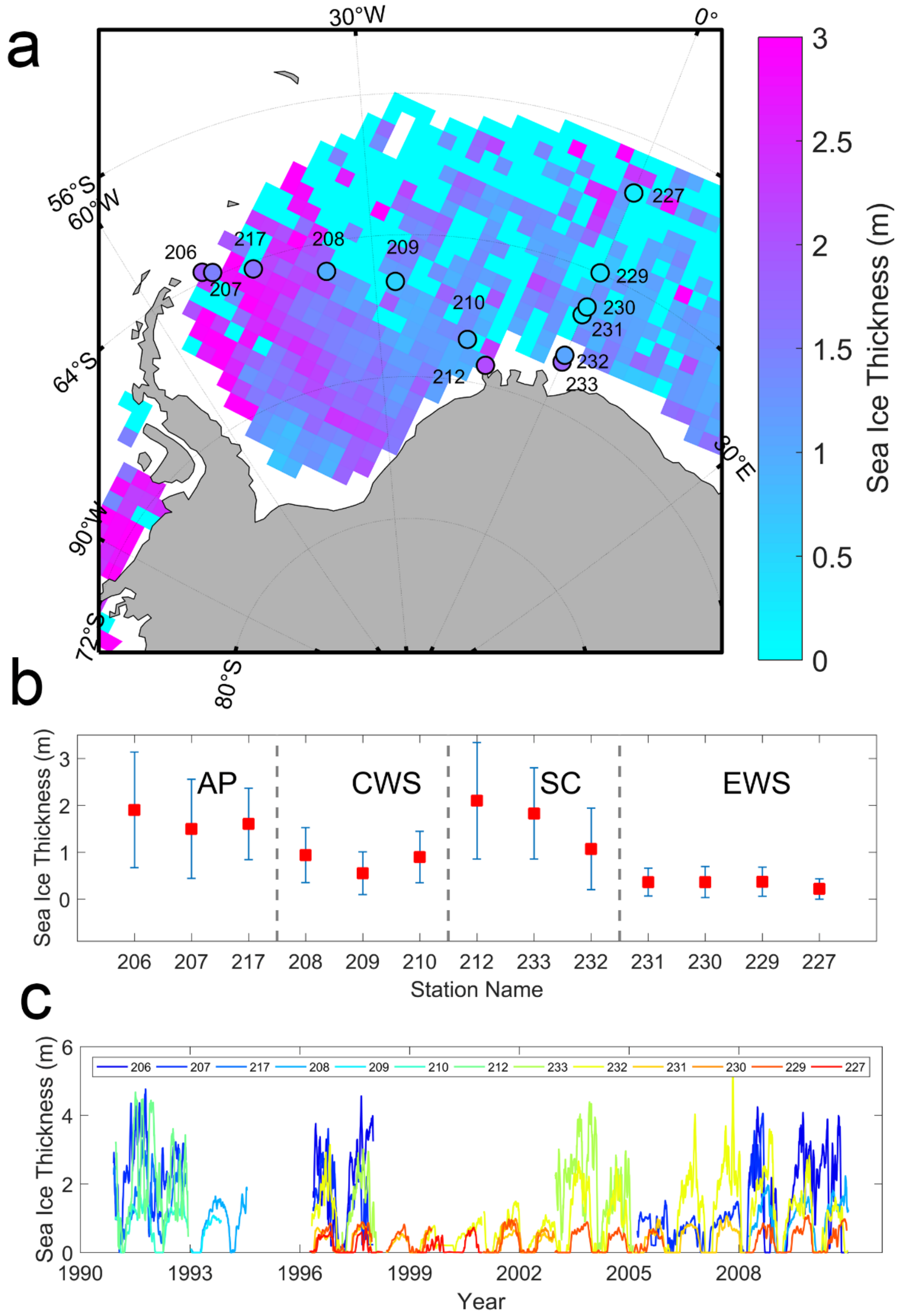
Point 1: There is inconsistency during the comparison in terms of the data. In the "Data and methods" part, the authors state "Comparison are made using monthly means", however, when in 3.3 Comparison with sea-ice thickness from ICESat-1, they are using seasonal mean. This inconsistency must be fixed. It will be much better that the authors describe how they make the comparison in the exact sections.

Response: In the old version, we compared four reanalyzed SIT products with ULS, ASPeCt by monthly mean, but with seasonal mean for products from Envisat and ICESat-1. Now, we deleted "Comparisons are made using monthly means" in the "Data and methods" part, then described the related information in individual sections instead. For example, we added "All ULS recorded once a second are averaged into monthly ice draft" in Line 194 in section 3.1 before "Because thick…"

Point 2: Section 3.1. It remains unclear what kind of mooring data are using here. According to the statement "The aggregate temporal span of ULS observations in AP, CWS, SC and EWS is 148, 79, 185 and 272 months", and consider the numbers of the mooring in these regions, there should be large difference in the mooring data regarding the time duration. I suggest the authors add a plot in their Figure 1 showing the temporal evolution of the mooring observed SIT that are actually used in their comparisons.

Response: The previous description indeed could make the reader confused about the ULS data used in this section. Actually, we collected all daily ULS records of 13 stations in the Weddell Sea from 1990 to 2008. Due to the different ice conditions during this period, the duration of records in the four different sectors (AP, CWS, SC and EWS) are quite different. The aggregate time span is 40(206) + 84(207) + 24(217) = 148 months in AP, 40(208) + 10(209) + 23(210) = 73 months in CWS, 23 (212) + 37(233) + 125(232) = 185 months in SC, and 91(231) + 28(230) + 108(229) + 45(227) = 272 months in EWS. That is to say, the correct aggregate time span of ULS observations in AP, CWS, SC and EWS is 148, 73, 185 and 272 months, respectively. CWS has the fewest observations because it is far away from the coast and has a relatively long ice-covered time. Though CWS has fewer observations than AP and SC, its standard deviation (SD) is lower than AP and SC (new Figure 1b). Considering average of sea ice thickness as well as their SDs, we think current division is reasonable.

According to your suggestion, we added the time series of 15-day moving average sea ice thickness based on daily records of all 13 stations. Besides, we added the standard deviations of daily sea ice thickness as error bars in all mean ice thickness (new Figure 1b) to represent the variations of all stations.



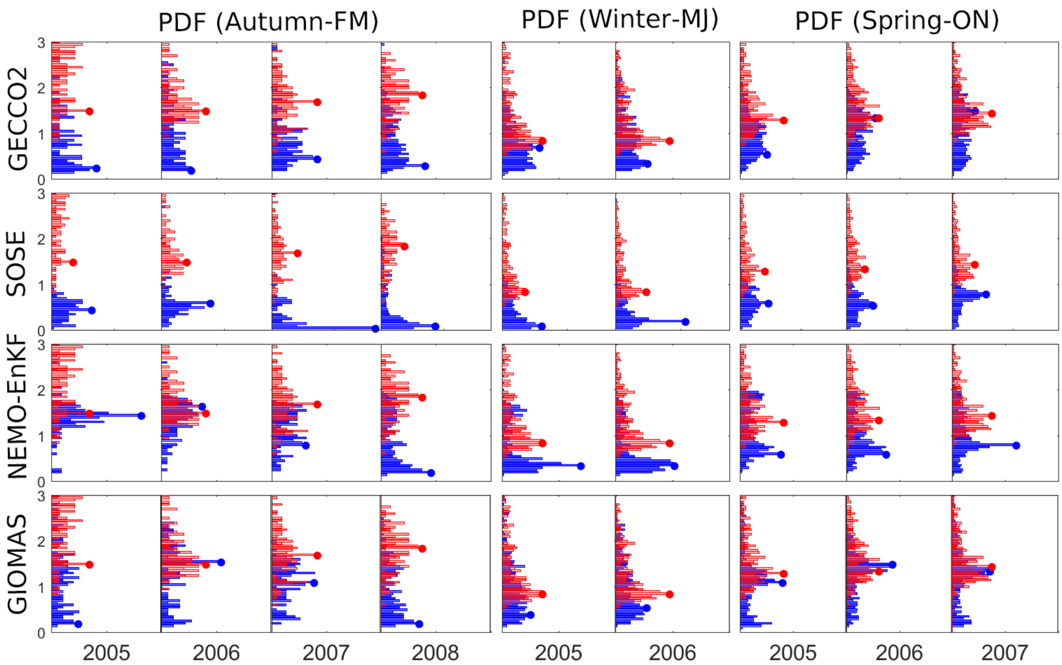
New Figure 1: a) The ICESat-1 sea-ice thickness in autumn of 2005 in the Weddell Sea and the locations of the moored upward looking sonars with their mean thicknesses shaded. b) The mean ULS sea-ice thickness from west to the east in the Weddell Sea. The error bars represent the standard deviation of daily ice thickness for individual stations. Grey dotted lines divide the 13 stations into four parts: the Antarctic Peninsula (AP), the central Weddell Sea (CWS), the southern coast (SC), and the eastern Weddell Sea (EWS). C) The time series of daily sea ice thickness of all 13 stations after a 15-day moving average.

Point 3: Figure 4. Not sure why the authors use SITs from different locations in the three reanalyses (Figs. 4b-d). This means they also use different ASPeCT SIT when comparing with the different reanalyses. What can we infer from such different comparisons? I suggest the authors use a consistent comparison: Use the same ASPeCT SIT, with reanalysis SITs interpolated to the same time and same location.

Response: We are sorry because the old caption for Figure 4 was wrong and this caused the misleading. It is not "Locations of model sea-ice thickness are shown in b …", but should be "Locations of modal sea-ice thickness are shown in b …". We have corrected this.

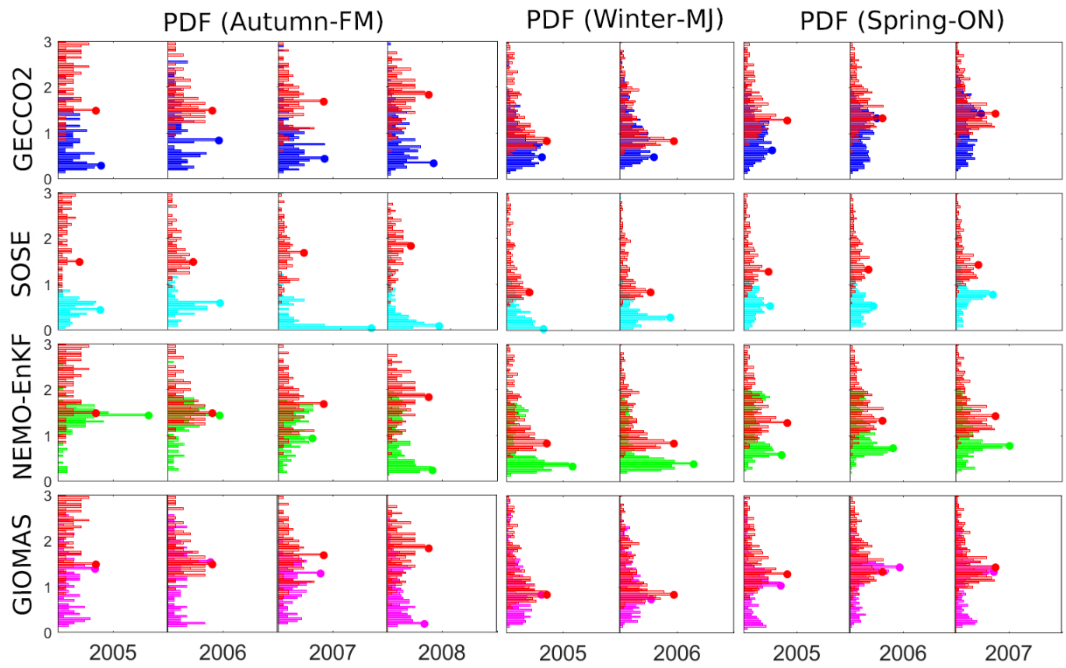
Point 4: Section 3.3. It is not clear what kind of manipulations here for the reanalysis SIT. The authors state "we use October and November to represent spring : : :". However, according to Table 2, the ICESat-1 measurement is irregular, and no full month measurements. Do the authors use the same dates as the observations, or just simply use the full two-month reanalysis data? As the authors here try to compare the mean, it is very important to compare the exact corresponding data in terms of time and locations. Also the authors need give a test with confidence level for the comparison.

Response: We used a two-month mean SIT for reanalyses in Section 3.3 when comparing with ICESat-1. Considering the irregular months of ICESat-1, we performed a time-weighted calculation for all four reanalyses in the new comparison. For example, if the temporal span of FM04 is from 17 January to 21 March, which includes 13 days in February and 21 days in March, then all SIT reanalyses will be averaged by $(13/34)*SIT_{Feb}+(21/34)*SIT_{Mar}$. That is what we plotted for the new Figures 5 & 6. The main change in Figure 5 is for GIOMAS reanalysis. The difference between GIOMAS modal SIT and ICESat-1 modal SIT decreased in FM05, FM07, MJ05 and MJ06 after using the new monthly averaged SIT. The spatial pattern of monthly SIT in the new Figure 6 is generally consistent with that in the old Figure 6. The main difference occurs in the GIOMAS winter, where the new figure 6 has less area with differences around -0.5 m over the central Weddell Sea. Besides, all reanalyses SIT are biased to ICESat-1 SIT with a t-test.

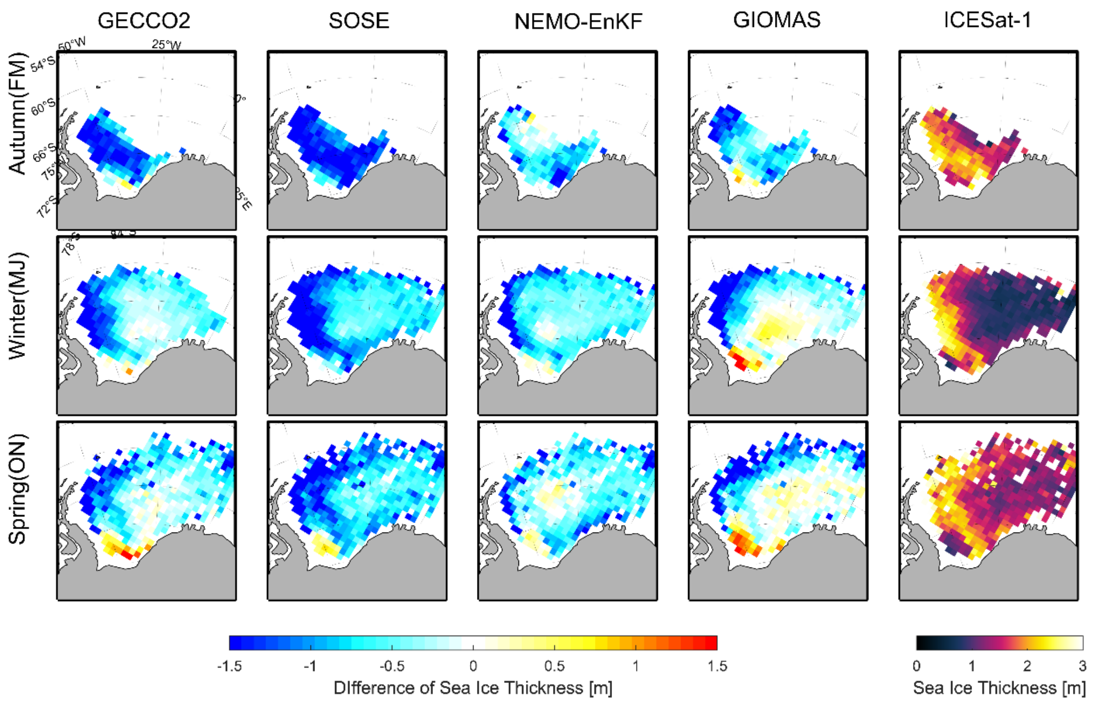


Old Figure 5: The variation of monthly ice thickness distribution from reanalyses (blue) and

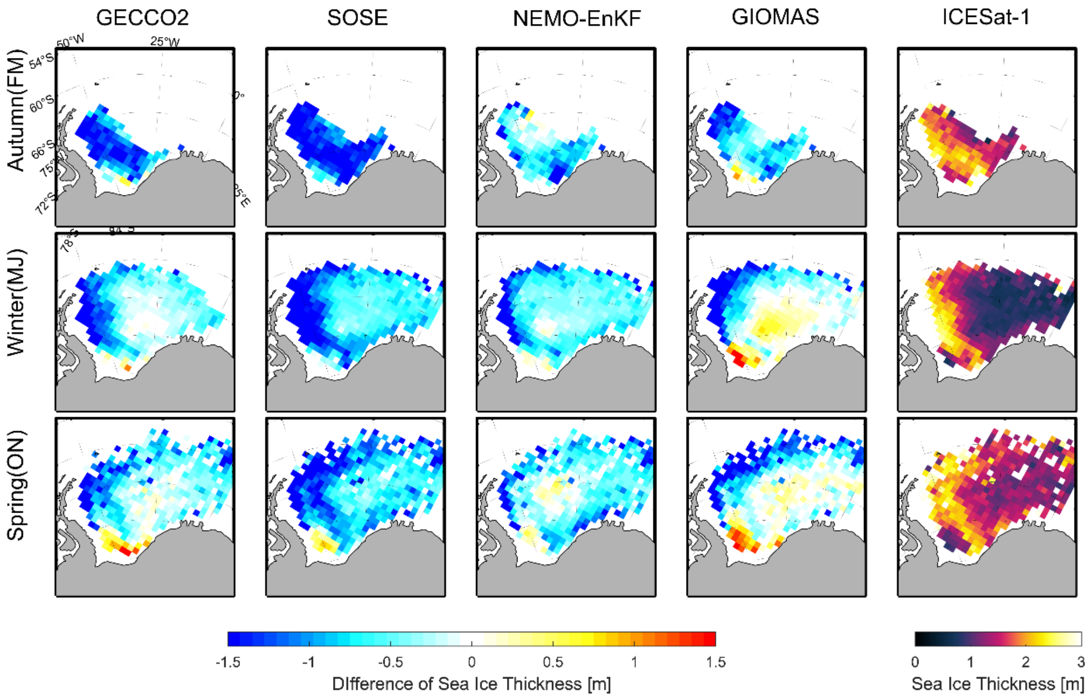
ICESat-1 (red) in Autumn-FM (left), Winter-MJ (middle) and Spring-ON (right). The blue and red dots represent the modal ice thickness of reanalyses (blue) and ICESat-1, respectively.



New Figure 5: The variation of monthly ice thickness distribution from GECCO2 (blue), SOSE (cyan), NEMO-EnKF (green), GIOMAS (pink) and ICESat-1 (red) in Autumn-FM (left), Winter-MJ (middle) and Spring-ON (right). The colored dots represent the modal ice thickness. In order to make the histogram plots readable, different reanalyses has different x range.



Old Figure 6: The Differences of sea ice thickness between GECCO2 (first column), SOSE (second column), NEMO-EnKF (third column), and GIOMAS (fourth column) and ICESat-1 in Autumn-FM (first row), Winter-MJ (second row) and Spring-ON (third row).The contours in last column represent the autumn sea-ice thickness of ICESat-1.



New Figure 6: The Differences of sea ice thickness between GECCO2 (first column), SOSE (second column), NEMO-EnKF (third column), and GIOMAS (fourth column) and ICESat-1 in Autumn-FM (first row), Winter-MJ (second row) and Spring-ON (third row).The contours in last column represent the autumn sea-ice thickness of ICESat-1.

Point 5: Line 280-281. "Compared with ICESat-1, only NEMO-EnKF has a similar variation of modal ice thickness from Autumn-FM to Spring-ON, while GECCO2, SOSE and GIOMAS have monotonically increasing model ice thickness". It seems to me 2005 &2006 for SOSE, and 2006 for GIOMAS have similar seasonal variations in Figure 5. Table 4 looks somewhat misleading as its modal SITs not necessary in the same year.

Response: In the new version, the sentences starting from Line 279, "and the variability of mean ice thickness is less than that of modal ice thickness (Table 4)… " were deleted. Following your suggestion, we added "In most cases, modal ice thickness of reanalyses are lower than that of ICESat-1. For example, in 2008 Autumn-FM, four reanalyses have modal ice thickness lower than 0.3 m, indicating the newly formed sea ice. However, ICESat-1's modal ice thickness is around 1.5 m. SOSE and NEMO-EnKF have a similar variation of modal ice thickness from Autumn-FM to Spring-ON as ICESat-1 in 2005 and 2006. GIOMAS has a similar seasonal variation in 2005. GECCO2 fails to reproduce the decrease of modal ice thickness from Autumn-FM to Winter-MJ. This is because GECCO2 loses most thick ice in summer and thus has lower modal ice thickness than the other data sets." In addition, we deleted Table 4 in the new version to avoid misleading.