Author's response

Please find our responses the Reviewer and Editor requests below. In general, we have changed the manuscript accordingly. Following the Reviewer comment on Mixed Layer Depth, we rewrote parts of the section in question.

Reviewer comments

Page 1, Line 13: This last sentence of the abstract sounds a bit strange. At least the "in" after "effective"should be deleted but I would suggest to reformulate the entire sentence. Do you mean that the drift is due to a stronger deep water formation around Antarctica in LIM3?

Response: Thank you for your comment. We agree that the last sentence sounds strange and we rewrote it. We also did some minor edits in the abstract to improve its clarity and readability. You are right, the drift is probably due to a somewhat stronger deep water formation.

Page 4, Line 10: ETOPO1 (Amante et al., 2009)

Response: Corrected.

Page 8, Line 18: "modeli"

Response: Corrected.

Page 9, line 18: I think, the ice thickness should be the ratio between ice volume and ice area and not ice extent (otherwise ice free areas are also counted for ice concentrations > 15%).

Response: This is true, we have changed the text in the paragraph accordingly.

Page 9, lines 27-31: If this is explaining the difference in trends in GIOMAS and LIM2/ LIM3 in the SH, maybe you should call it "GIOMAS" instead of "PIOMAS".

Response: Well spotted, thanks. We are actually discussing reasons for differences in both hemispheres. Due to this we changed PIOMAS to P/GIOMAS.

Page 11, line 1: . . . faster than LIM2 ice motion.

Response: Corrected.

Page 11, Sea ice salinity: It seems realistic that LIM3 simulates lower ice salinities in summer than in winter. Are there any observations of ice salinity available? If not, it might be worth to state this in the text.

Response: There are salinity observations detailed in Vancoppenolle et al. (2009b). They are consistent with the simulated patterns. We now mention this in the text.

Page 13, line 1: delete one "PHC3"

Response: Deleted.

Page 13, line 26 . . . surface is saltier. . .

Response: Changed accordingly.

Page 16, Mixed Layer Depth: Mixed layer in NEMO might be deeper than in climatologies in many regions but are they really deeper in the deep water formation areas in Labrador Sea and Greenland Sea? It is hard/ impossible to see in the figure 9 because the figures are small but 9a) shows that NEMO-LIM3 has a mean March MLD of below 500m. If I look at the ARGO-climatology (Holte et al. 2016), I find March-mean values of up to 1000m in the Labrador Sea. To

my understanding, the weak deep water formation, particularly in the Labrador Sea, in NEMO is the main reason for the weak AMOC in NEMO.

Response: We agree with your reasoning, and as a result we double checked our routine used to plot Figure 9. We found an error in the routine: instead of subtracting monthly, March in the NH and September in the SH, climatology fields from NEMO MLDs, we had subtracted their annual means. After correcting this error the climatology MLDs used in Figure 9 became deeper and our findings now agree very well with the referee comment. We have rewritten the related text in section 5.9 "Mixed Layer Depth".

It is true that the shallower than ARGO-observed LIM MLDs in the Greenland Sea are difficult to see in Figure 9c and 9f due to their small size. One way to ease their detection is to enlarge the figure panels on a computer screen. This might be an adequate approach as science publications are typically read digitally nowadays.

Editor comments:

The title is improved from the last version, but I do not like the word "some", and also the order of the things you are comparing. The first thing you look at is sea ice, and it is the bulk of the paper, so this should come first in the list. Please revise.

Response: We dropped the word "some"and changed the order of things as suggested.

I do not think the change to the colours in Fig.3 will improve the situation in relation to the issue of color-blindness, I suggest using different colours away from red and green, rather than just changing the tone as you have done.

Response: You are right. We have changed the colour of the hatching in Figure 3 from green to turquoise.

The paper has a lot of acronymns, particularly on page 6, many of which are undefined, while some are common and may be assumed, I think in particular OPA on page 3, and PHC3 on page 6 should be spelt out.

Response: A good point, thanks. We have now spelt most acronyms out.

page 16: line 12, should be "LIM3 becomes, on average, saltier"

Response: Changed accordingly.