

The authors investigate effects of different bias-correction methods of ocean surface conditions of CMIP5 models. They discuss the anomaly and quantile-quantile well-known methods for Sea Surface Temperature (SST) corrected existing (look-up table and relative anomaly) and new (analog) methods for Sea-Ice Concentration (SIC). A particular attention is paid to the consistency between SST and SIC fields. Furthermore, a method for correcting Sea-Ice Thickness is also (re)presented and improved by taking into account different parameters for North and South hemisphere. Results of each method are evaluated against a perfect model test and real-case application. They show that the analog method and the proposed method to parameterize Sea-Ice Thickness respectively improve the bias correction of SIC and SIT.

The study is well designed. It presents detailed analysis, a fair and honest discussion about bias correction methods highlighting their advantages and the hypothesis on which they rest. Compared to their first version the authors have strongly improved their manuscript by taken into account reviewer comments even if some points could be improved. The authors can find my comments and stylistic suggestions hereunder.

General comment

Like the reviewer 2, I am in a way surprised that results with HadGEM-ES are never mentioned while using a third model with almost the same results could increase their confidence. I understand that authors already have a lot of results to present but maybe could they add some results and comparison in supplementary file/materials attached to their article?

Point comments

P1, L33 « high-resolution atmospheric global circulation models »

Although some CMIP6 models have performed simulations at higher resolutions than CMIP5 simulations (25-50km for the high resolution model intercomparison project, Haarsma *et al.*, 2016) ; which is an important improvement in comparison to CMIP5, 150km), this range of “high” horizontal resolution appears to be as the lowest RCM resolutions in the CORDEX project so that the term « high-resolution » should (at least) also qualified « Regional Climate Models » (p1,L32).

P3,L67. Are the results influenced by the selection (and the number) of these sectors? Have the authors tested another definition of these sectors? Are these sectors only defined by their geographical location or also by the recent (local) SIC trends observed in the Arctic and the Southern Oceans? See also the comment in Figures and Tables section.

P4,L9. I support the fact that authors have dismissed from their library the CMIP5 AOGCMs that poorly represent the sea-ice annual cycle in present-day climate. However, as already remarked by F. Gallo (Reviewer 1), the selection process is unclear. At this stage of the manuscript, one could wonder how have these “good” models been selected by the authors or how did the authors treat models that are correct for the Arctic ocean and poor for the Southern ocean as for instance MIROC5 (Shu *et al.*, 2015; Turner *et al.*, 2013).

The authors’ answer to R1 could appear in the final version of the manuscript as two reviewers made a comment on it. I also suggest to specify again at the AOGCMs that have been used (or at least to make a reference to section data at P4,L9).

Figures and Tables

P3, L67. The authors should consider to add a map (or at least a table) in supplementary material showing (listing) the defined sectors used in the analog method.

Figure 3 (P6). Unless I'm mistaken, the reference to Figure 3 is missing in your text.

Figure 5 Maybe this figure could be placed in supplement as it has less scientific interest?

Figure 8 and 9 Is it interesting to differentiate the RCP scenarios? As your results do not depend on the RCP scenarios, maybe it is not interesting to differentiate it but two same symbols (circles or crosses) with the same colors and (slight) different meanings are a little bit confusing. However, I note that the authors have strongly increase the clarity of theses figures in comparison with their first version.

Figure 11 and Figure 14 Could the authors consider to merge the two figures as it will make the comparison easier between the general and Arctic-specific parameter results.

Figure 12 and 15; Figure 13 and 16 I also suggest to the authors to merge the corresponding figures of SIT with general and specific parameters leading to easier comparisons. Maybe could you make a panel with two ranks and still 3 columns “Observed, Error General Parameter, Error specific parameter (for instance Observed, March; Error(General Parameter), March; Error(Specific Parameter) March).

Stylistics comments

“sea ice” versus “sea-ice”, please check the consistency of those spellings in all your manuscript (vs sea-ice); for instance “sea-ice thickness” (P1,L30) versus “sea ice thickness” (P5,L4)

P1, L36 “Sea Surface Temperature (SST), Sea Ice Concentration (SIC), Sea-Ice thickness (SIT)” maybe you could consider “Sea-Ice Thickness (SIT)” to be consistent with the first two terms (see also P5L8 and comment for P3,L25);

P2, L11 “by an atmospheric model” I would suggest to specify the type of the atmospheric model as follows ‘by an atmospheric global circulation model’

P3, L20 “in this method,the assumption”, please add a space “in this method, the assumption”

P3, L35 “sea-ice area (SIA)”, following comments on P1,L36 “Sea-Ice Area (SIA)”

P3,L40 “With respect to the method introduced in Krinner et al. (2008), we introduce” I suggest “With respect to the method described by Krinner et al. (2008), we introduce”

P6, L10 “In figure 4 (bottom), we can see the large cold bias of the AOGCM...” Maybe you could modify as follows “Figure 4 (bottom) also show the large cold bias of IPSL-CAM5A-LR...”

P11, L32 “in the tropics,the West African” a space is missing

P12, L23 “In the perfect model test, we have seen that the LUT method shows some reduced errors over most regions (Figure 6). However, we have seen that the frequency distribution of future SIC...” I would suggest to reformulate as follows “The perfect model test pointed out that the LUT

method shows some reduced errors over most regions (Figure 6). However, the frequency distribution of future SIC..”

P12, L34 “the use of SST as a proxy for SIC...” maybe “using SST as a proxy for SIC...”

P12, L51 “the decrease of sea-ice” please change with “the decrease in sea-ice”

P14, L32* “of the sea-ice in the Antarctic,...” maybe “of the Antarctic sea-ice,...”

P14, L* “The fact that both methods over-estimate the decrease in sea ice mainly for CNRM-CM5 scenarios is to be linked to the fact that the historical simulation of this AOGCM shows some considerable negative biases for the sea-ice in the Weddel Sea with respect to the observations”
I suggest “The fact that both methods over-estimate the decrease in sea ice mainly for CNRM-CM5 scenarios is to be linked to some considerable negative biases of its historical simulation for the sea-ice in the Weddel Sea with respect to the observations.”

P14, L* “4.3 Sea-ice Thickness” see first comment about P1,L36

P14,L* “The Central Arctic SITs results” modify by “The Central Artic SIT result”

*(*in the version of your manuscript that I read, line numbers seem to become uncertain starting from page 14. I hope you will be able to find where I suggest you to modify something. My apologies for the inconvenience.)*

References

Shu, Q., Song, Z., and Qiao, F.: Assessment of sea ice simulations in the CMIP5 models, The Cryosphere, 9, 399-409, <https://doi.org/10.5194/tc-9-399-2015>, 2015.

Turner, J., Bracegirdle, T. J., Phillips, T., Marshall, G. J., & Scott Hosking, J. An initial assessment of antarctic sea ice extent in the CMIP5 models. Journal of Climate, 26(5), 1473–1484.
<https://doi.org/10.1175/JCLI-D-12-00068.1>, 2015.