

## ***Interactive comment on “Assessing bias-corrections of oceanic surface conditions for atmospheric models” by Julien Beaumet et al.***

### **Anonymous Referee #2**

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This manuscript discusses bias correction of sea-surface temperature using the anomaly method and the quantile-quantile method, and bias correction of sea ice concentration using the look-up table method, the iterative relative anomaly method, and the analog method. These bias correction methodologies are evaluated using a perfect model test (i.e. evaluated using the given model as “observations”) and a real-case application in which the bias correction methods are compared to observations. It is assumed that ideal bias correction will reproduce changes in the mean and variance between observations and projected climate as between historical simulations and projected climate. The authors determine that the presented methods for bias correcting SST are reliable. The methods presented for sea-ice concentration are less reliable, however, the analog method showed promising results and improvement over

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other bias correction methods. Additionally, the authors provide an appendix with a proposed method to parameterize sea-ice thickness, with potential for use in climate modeling applications.

I have a number of major and minor comments for the authors to address. Some of the manuscript was unclearly written, making the arguments difficult to follow. I also question the inclusion of SST bias correction evaluation. In regards to the review criteria, the manuscript does present relevant information that is related to modeling questions, particularly for sea-ice concentration, rendering it suitable for publication. However, much of the methodology for sea-surface temperature bias correction has been noted in other manuscripts.

My comments are below.

General Comments: 1. While the presented results for SIC are novel and will be very helpful for future modeling studies, the presented results for SST are somewhat less of an advancement. SST bias correction has been studied previously. In fact, there is much less discussion surrounding SST bias correction, and the results are almost glossed over by the authors in comparison. While the results are helpful in a summary sense for an interested reader, the concept seems less novel. This section may be able to be reduced even more, or eliminated completely. 2. The Appendix describes a methodology for parameterizing sea-ice thickness, which was noted in Section 4.3 as a strong influence. While you state that an in-detail evaluation of sea ice thickness prescription is beyond the scope of this paper, you evaluate and further refine one of the methods for parameterization in the Appendix. This seems like an important contribution to the field that has been studied comparatively less than, for example, SST bias correction methodologies. I'm concerned that this contribution will be lost due to its presence in supplementary material, and would potentially warrant a separate manuscript that delves more deeply into the topic. 3. I am curious why the CNRM-CM5, IPSL-CM5A-LR, and HadGEM-ES coupled GCM data were explicitly chosen for this study. In addition, you note that HadGEM-ES was used in Section 2.1 near line 25, but

never mention results from this model. 4. I am also curious why you selected the given bias correction methods for SST and SIC, are these arguably the most popular methods in use? If so, it would be helpful to note this as a motivation for the work. 5. Because you are using a perfect model test, can these results be generalized to other models, or are these results specific to the models used? 6. The introduction could benefit from additional discussion on SST biases, as it is written the focus is on SIC biases. 7. Figure 6 and resulting discussion: How does one determine what is a “reasonable” and “very small” error? To me, these look like large errors overall, but perhaps they are reasonable and very small with respect to the relative anomaly method? 8. In Section 4.2, page 18, last sentence on the page: Preferentially selecting output of reasonably “well behaving” AOGCMs is perhaps too simplistically stated here. There are a variety of issues in selecting which models are “well behaving”. Though the following reference focuses on selecting models for regional hydrological studies, some of the general comments will still hold true for model selection: Brekke LD, Dettinger MD, Maurer EP, Anderson M (2008) Significance of model credibility in estimating climate projection distributions for regional hydroclimatological risk assessments. *Clim Change* 89:371–394 . doi: 10.1007/s10584-007-9388-3 9. Is the main result for SST bias correction that either method is appropriate for use due to your evaluation of the reliability of these methods? How does this result differ from other work on SST bias correction?

Technical Comments: The following comments should be easy to address, but will substantially improve the readability of the manuscript. 1. Please confirm that all acronyms are clearly defined, I have not listed all instances, but a few examples follow: CMIP5, AOGCM, AMIP, PCDMI, AGCM, etc. 2. Please confirm that all acronyms are consistent throughout the manuscript. I have not listed all instance, but a few examples follow: a. You define sea-ice concentration (SIC) in the beginning of the abstract, but spell it out in other places. b. You defined sea-ice area (SIA) twice. 3. Some of your terminology is inconsistent throughout the manuscript. For example, sometimes you say “future SST and SIC”, other times you say “projected SST and SIC”, etc., which makes the manuscript difficult to follow. 4. There are a number of grammatical and spelling

errors, for example “The presence of SIC maps from futures AOGCM projections...” should read “The presence of SIC maps from future AOGCM projections...”, please double-check the manuscript for grammar and spelling. 5. Figure 1 (right): It is difficult to determine which line is thick and which is thin, I suggest using a dashed line or adding more thickness. 6. Figure 3 caption: Where should the reader go to “see text”? 7. Figure 7: Including a key for the lines such as in Figure 4 would be helpful for clarity. 8. Figure 8 and 9: The text refers to specific regions, for example the Weddell sea, but I’m not sure how to determine the regions from this Figure. 9. Figure A2 and A5: Including a key for the lines such as in Figure 4 would be helpful for clarity. 10. Equation 1: As some of the parts of the equation refer to a climatological mean, and some to monthly data, adding in summations or “bar” notation would be very helpful. 11. Table 1 and resulting discussion: I may have missed something, but the labeling of this table confuses me, as well as the discussion in the text. In Section 3, below line 25, you state that when comparing corrected RCP SST using the perfect model test and original SST from CNRM-CM5 RCP8.5 you obtain a null bias for the entire globe. Yet in this table you show CNRM-CM5 rcp8.5 – CNRM-CM5 hist has a mean difference of +3.04 degrees C. I assume something is written incorrectly here, but I’m not sure what. In addition, this table is referenced in only in Section 3.1.2, which references the IPSL-CM5A-LR data. I’m confused why you’re changing models here. 12. As SIC is bias corrected independently of SSTA as noted in the first sentence of Section 3.3, this should also be mentioned somewhere in the methods section, providing context for the examination of physical consistency in Section 3.3.

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