Comment on esd-2021-64
Anonymous Referee #2
Referee comment on "Indian ocean marine biogeochemical variability and its feedback on
simulated South Asia climate" by Dmitry V. Sein et al., Earth Syst. Dynam. Discuss.,
https://doi.org/10.5194/esd-2021-64-RC2, 2021

General Comments:
The paper presents an interesting study on marine biogeochemical variability in the Indian Ocean and its impact on regional climate. The authors investigate the effect of a static and a variable marine biogeochemical light absorption on simulating the regional climate on the Indian Ocean. Both atmosphere and ocean present climate are evaluated against observations, as well as the quality of physical and biogeochemical characteristics simulated. The paper is well written and organised.

We are grateful to the reviewer for his kind feedback and valuable comments, which allowed us to improve the text of the manuscript. Changes made to the manuscript are highlighted in yellow. They are shown in italics in responses to comments.

Specific Comments:
Methods:
Please include the horizontal and vertical resolutions of your simulations.

A description of horizontal and vertical resolutions is included instead of L.125-127 as follows:

In this work, we use for REMO the slightly enlarged South Asia CORDEX domain (http://www.cordex.org), while for MPIOM the global mesh has a variable horizontal resolution which reaches up to 15 km inside the coupled region and ranges from 23.3 to 24.5 km in the part of the Indian Ocean included in this domain (Fig. 1). MPIOM has 40 vertical z-coordinate levels with the following thicknesses(in meters):16, 10, 10, 10, 10, 10, 13, 15, 20, 25, 30, 35, 40, 45, 50, 55, 60, 70, 80, 90, 100, 110, 120, 130, 140, 150, 170, 180, 190, 200, 220, 250, 270, 300, 350, 400, 450, 500, 500, 600. The model is driven by atmospheric data from a CMIP5 20th century simulation with the MPI-ESM LR setup.

The authors describe the setup of simulations performed, but a description of the observations used (WOA13, SeaWiFS and MODIS-Aqua) is missing. I suggest including a brief description of these datasets.

We have provided more accurate references to the data used, corrected the error (we are using MODIS Terra data, not MODIS Aqua), added a short description of the data after L.155 in the following form:
We compare the calculation results for both experiments (INDJ and INDB) with the best observational datasets to date for the region under consideration: they include oceanographic data compiled in the World Ocean Atlas 2013 (WOA13, Levitus et al., 2014) and the satellite data from the Sea-viewing Wide Field-of-view Sensor (SeaWiFS) and Moderate-resolution Imaging Spectroradiometer (MODIS) Terra. The WOA13 is a set of climatological mean, gridded fields of oceanographic variables based on in-situ measurements from a wide variety of sources. Global, decadal averages of temperature, salinity, oxygen and nutrients are provided at monthly, seasonal

and annual averaging periods on 102 standard depth levels from 0 to 5500m, and at 0.25 ° (temperature, salinity) and 1 ° (all variables) horizontal resolutions. We do not use the latest edition of WOA18 (Boyer et al., 2018) for the following reasons: 1) WOA13 is widely used in the scientific literature and thus can be easily compared to other studies that use the same reference, 2) as stated in the WOA18 description (https://www.ncei.noaa.gov/data/oceans/woa/WOA18/DOC/woa18documentation.pdf) WOA18 temperature and salinity data is still published as preliminary in order to take advantage of community-wide quality assurance and comments.
From satellite data, we use SeaWiFS chlorophyll data (NASA Goddard Space Flight Center ..., 2021a) and MODIS Terra chlorophyll data (NASA Goddard Space Flight Center ..., 2021b), as well as SeaWiFS downwelling diffuse attenuation coefficient data (NASA Goddard Space Flight Center ..., 2021c). The SeaWiFS instrument was launched on the OrbView-2 satellite in August 1997, and collected data from September 1997 until the end of mission in December 2010. MODIS is a key instrument aboard the Terra (EOS AM) and Aqua (EOS PM) satellites and its set of data records covers the period from 24 February 2000 to present time. From above satellite data we used their gridded fields of 9km resolution having daily and monthly averaging periods.

References:

Levitus, Sydney; Boyer, Tim P.; Garcia, Hernan E.; Locarnini, Ricardo A.; Zweng, Melissa M.; Mishonov, Alexey V.; Reagan, James R.; Antonov, John I.; Baranova, Olga K.; Biddle, Mathew; Hamilton, Melanie; Johnson, Daphne R.; Paver, Christopher R.; Seidov, Dan (2014). World Ocean Atlas 2013 (NCEI Accession 0114815). NOAA National Centers for Environmental Information. Dataset. https://doi.org/10.7289/v5f769gt Accessed on 30/11/2021.

Boyer, Tim P.; Garcia, Hernan E.; Locarnini, Ricardo A.; Zweng, Melissa M.; Mishonov, Alexey V.; Reagan, James R.; Weathers, Katharine A.; Baranova, Olga K.; Seidov, Dan; Smolyar, Igor V. (2018). World Ocean Atlas 2018. NOAA National Centers for Environmental Information. Dataset. https://accession.nodc.noaa.gov/NCEI-WOA18. Accessed on 30/11/2021.

NASA Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group. (2021a). Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Chlorophyll Data; 2018 Reprocessing. NASA OB.DAAC, Greenbelt, MD, USA. doi: 10.5067/ORBVIEW-2/SEAWIFS/L3M/CHL/2018. Accessed on 01/05/2021

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NASA Goddard Space Flight Center, Ocean Ecology Laboratory, Ocean Biology Processing Group. (2021c). Sea-viewing Wide Field-of-view Sensor (SeaWiFS) Downwelling Diffuse Attenuation Coefficient Data; 2018 Reprocessing. NASA OB.DAAC, Greenbelt, MD, USA. doi: 10.5067/ORBVIEW-2/SEAWIFS/L3M/KD/2018. Accessed on 01/05/2021

L166: Why did you not use a more recent version of the World Ocean Atlas?

We use WOA13 because:

1. WOA13 is widely used in the scientific literature and thus can be easily compared to other studies that use the same reference.
2. As stated in the WOA18 description (https://www.ncei.noaa.gov/data/oceans/woa/WOA18/DOC/woa18documentation.pdf) WOA18 temperature and salinity data is still published as preliminary in order to take advantage of community-wide quality assurance and comments. Therefore, we would avoid confusion with future studies using the WOA18 final version.

We have inserted this explanation into the text (see answer to the previous remark)

L173: Since you use the monsoon season defined as June-September (JJAS), I suggest
changing "summer season" to "monsoon season" or "extended summer" to be coherent with the seasonal periods defined in L169-172. In L180-181, the pre-monsoon and monsoon seasons are referred. Following your first definition (L169-172), this means MAM
and JJAS. Please, check all the text and change accordingly with your first definition, also to be coherent with Section 4 where the summer season is defined as JJA.

As recommended by the reviewer, we have changed the names of the seasonal periods throughout the text to keep the names defined in L169-172. Now the summer season in Section 4 is defined as JJAS, that is, in the same way as in other sections of the article. Figure 16 is replotted in accordance with the used definition of seasons.

L201-203: The spatial distribution of the difference between the INDB and WOA13 SST, SSS and NO3 are identical to Fig2 for INDJ? The authors do not show these results but mention here the INDB simulation.

The spatial distributions of SST, SSS, and other fields in the INDJ and INDB experiments are close to each other, but they are not identical. The difference is related to the impact of marine biogeochemistry's feedback. We discuss the differences between them in detail (for SST, SSS, primary production and nitrates) in section 3.1.4 of the manuscript.

To avoid confusion in L201-203 highlighted by the Reviewer, we have clarified this sentence:

The maximum deviations in surface nitrate field between the model and WOA13 data occur during the bloom periods (winter and monsoon seasons), while this deviation is minimal in pre-monsoon season.

L222-224: Did you perform the same setup but with lateral boundary conditions driven by a reanalysis dataset?

Yes, we did. But it was mainly focused on regional downscaling problems. I.e. on investigation on so-called "added value", etc. The results can be found in Mishra et al. https://epic.awi.de/id/eprint/54121/1/s2_0_S0169809521002337_main.pdf

L255: Why the analysis period is different in Figure 4? Is it related with the availability of satellite data?

Yes, the Reviewer is correct, the period of analysis presented in Fig. 4 is related to the availability of MODIS Terra (2000-2021) and SeaWiFS (1997-2010) data. Because our simulations span up to 2005, the resulting common period for the model results and satellite data is 1997-2005, which is used in Fig. 4 to calculate mean values of surface chlorophyll-a concentration for this period.

This text has been added to the manuscript to clarify the choice of this period:

The period of analysis presented in Fig. 4 is related to the availability of MODIS Terra (2000-2021) and SeaWiFS (1997-2010) data. Because our simulations span up to 2005, the resulting common period for the model results and satellite data is 1997-2005, which is used in Fig. 4 to calculate mean values of surface chlorophyll-a concentration for this period.

L376: Why was the WOA2001 included? In L384-403, there is no discussion about the added value of including two WOA datasets.

The reviewer is absolutely right: including the old WOA dataset to our comparison cannot add anything new. Therefore we removed the old release WOA2001 from the Figure 13 and corrected the relevant text.

Technical corrections:

L190: "Sea surface concentration of dissolved nitrate." -> Italic style

Corrected

L368: "Thermocline dynamics." -> Italic style

Corrected

L500: "Fig. 16" or "Figure 16"

Corrected