

# ***Interactive comment on “Development of BFMCOUPLER (v1.0), the coupling scheme that links the MITgcm and BFM models for ocean biogeochemistry simulations” by Gianpiero Cossarini et al.***

## **Anonymous Referee #1**

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- 1 Referee report “Development of BFMCOUPLER (v1.0), the coupling scheme that links the MITgcm and BFM models for ocean biogeochemistry simulations” by Cossarini et al. Geosci. Model Dev. Discuss., 2016**

### 1.1 General Remarks

This manuscript presents a software interface that links two well established models within the marine science community for ocean circulation and marine biogeochem-

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istry, providing a new valuable tool for a vast range of applications indicated in the work. I'd like to compliment the authors for their effort in covering the wide range arguments involved in describing a coupled hydrodynamic biogeochemical system comprehensively in a reasonable amount of space with an adequate level of detail without any major omission. The work covers all relevant scientific and technical aspects and is therefore certainly eligible for publication in Geoscientific Model Development after that some minor issues have been addressed which concern some missing technical information and imprecisions in the scientific description, that are given below.

## 1.2 Technical Omissions

In order to benefit users of this software interface, I believe the addition of the following informations would be crucial:

- The version of the MITgcm used in this work has been specified, but an indication of where to retrieve the model code from would be helpful. Of course, not being the developers themselves, the authors will have no control of the future accessibility to the point of retrieval, but at least an indication of where or how to obtain the code at present is required.
- What is the precise version of the BFM code, that was used? I gather the model is distributed via git, so a commit hash and the link to the repository would suffice.
- Programming languages and version of all parts should be specified. To my understanding all three are coded in FORTRAN, but only for the BFM this is clearly stated including the FORTRAN version.
- As I assume development of the couple will continue, also a hash for the coupler library is needed.
- Specifications of input/output formats are missing.

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## 1.3 Detailed Comments

**page 2, line 12:** Check author names and publication year.

**page 2, line 15:** I don't think it's a matter of complexity, but a structural argument that dictates the model hierarchy between physical driver and biogeochemical model: in all cited cases and all other couplings I am aware of, the physical model provides the overarching geometrical structure of the model (and can run on its own), while the biogeochemical model typically just computes biogeochemical rates on a per pixel base and at the bare minimum requires a 0D driver to run any simulation. In fact, I don't think that the statement that the physical models are far more complex holds generally.

**page 2, line 18:** Instead of "input/output directives" I'd prefer interface specifications or if you want more use the technical term application programming interfaces (APIs) in order to not confuse with actual model in- and output data.

**page 2, line 32-34:** The choice of the authors in itself doesn't require justification, but is there any evidence that performance would suffer from using these tools? I would have thought that depends (to some degree) on how well they are written?

**page 2, lines 34-38:** Worth mentioning here if it deals with online, offline coupling or both.

**page 4, line 36:** Any explicit time integration method is forward-in-time, that includes Adams-Bashforth schemes. Which one is used here, Euler forward?

**equation 10:** The meaning of the hereto unused variables needs to be specified. Specifically the meaning of the two diffusion terms should be made clear. Also, as these equations are still generic at this point, it may be worth using a different sub-script for the biogeochemical sources and sinks.

**page 4, lines 9-15:** Might be worth also to refer already to the possibility of surface/bottom boundary conditions for the biogeochemistry introduced in the BFM-COUPLER section later.

**page 6, lines 16-17:** The information flow between BFM, MITgcm and the coupler in between is not one-way as clearly indicated by figure 2 and the following text. It is true that the ocean physics in the described setting remain unaffected by the biogeochemistry, but that doesn't mean that the information flow is one-way, as the transport model for passive tracers sits in the MITgcm code and requires the biogeochemical sources and sinks for integration (and biogeochemical vertical movement).

**page 6, line 33:** "a source splitting scheme is adopted": the insertion of the biogeochemical rates into the transport solver constitutes a source splitting only of the integration scheme applied effectively omits information or intermediate steps that are required by the coupler. In particular, if the integration scheme is a simple Euler forward scheme, the insertion of the biogeochemical rates does not involve any form of splitting, but constitutes a direct integration of the terms in equation 10.

**page 7, lines 23-24:** The option of applying different time steps to the two modes is not unique to the process splitting, but can be easily adopted in the source splitting method by updating the rates of the slower process only on intermediate time steps. (E.g. Blom, J.G., Verwer, J.G., 2000. A comparison of integration methods for atmospheric transport-chemistry problems. *Journal of Computational and Applied Mathematics* 126, 381–396. doi:10.1016/S0377-0427(99)00366-0)

**page 7, line 26-27:** "to increase the computational performance of the entire code" In which way?

**page 8, line 15 ff, eq 14:** What would actually be required is the average light in each

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cell, which given the exponential distribution is not the light in the cell centre. Using the same formula, it is straight forward to compute the integral of light between the upper and lower cell face and divide by the cell thickness in order to arrive at the correct number.

**page 8, eq. 15:** How is this pde solved numerically? Provide the scheme or a reference to a full description.

**page 9, line 5:** What happens to sinking phytoplankton that hits the sea floor?

**page 9, line 28:** "... which are ..."

**page 10, line 6:** Further down it appears that at least the surface heat has a seasonal cycle, so is not steady?

**page 11, line 6:** "the light extinction factor was calculated considering a background value"

**page 11, line 26:** well-lighted -> well-lid

**figure 6:** caption: what is  $LS_n$ ?

**page 11, line 33-34:** "... to solve ..."

**page 11, line 36:** how does the scaling with numbers of tracers emerge from the figure? What experiments were done in regard?

**page 11, line 40:**  $2400s = 40'$  not  $45'$ ? What does  $LS_n$  mean, I suppose number of time steps per long step, but should be specified.

**figure 7:** Eta?

**page 12, line 36:** connected to the Ionian Sea rather than the Eastern Med.

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**page 13, line 12:** daily fresh water flow rate

**page 13, line 35:** is the bulk background extinction coefficient adequate considering the amount of gelbstoff in the Northern Adriatic?

**page 14, lines 7-9:** The large scale oscillations indicate instability rather than inaccuracy which may have increased earlier, considering that the dominant time scales will be different with respect to the gyre configuration. Or have you actually assessed the inaccuracy?

**page 13, line 39:** No benthic closure as described previously?

**page 14 line 33:** much lower mixed layer depth in winter

**figure 10:** Mention that phosphate is in contours.

**page 14, line 39:** “superimposed longitudinal gradient of the background light extinction”: this is in contrast to the configuration description in line 35 of page 13 which mentions a constant background extinction.

**page 15, line 1:** consistent

**page 15, line 16-17:** drop “into the Mediterranean Sea”

**page 15/16, line 39-2:** A string matching mechanism using variable metadata would be more transparent.

**page 16, line 4-5:** Efficiency in spatial domain decomposition parallelisation is also considered in other coupling interfaces including the ones cited, so not unique to this interface. It may be more efficient, but that statement requires evidence.