

## ***Interactive comment on “S2P3-R (v1.0): a framework for efficient regional modelling of physical and biological structures and processes in shelf seas” by R. Marsh et al.***

**R. Marsh et al.**

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General Comments: One main comment, which I think is fundamental. I like the model system presented but the model system is based on the S2P3 modelling system. This already exists and is published elsewhere. The title and text outline “the provision of a practical tool for linking theory and observations”, whereas reading this I would argue that you are providing an evaluation based on a number of case-study examples. I would agree that this is useful and important but it is not clear what is novel about the S2P3-R framework apart from some source code changes and implementation in differing domains. If there are no other changes, I would present the study differently

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or I would highlight the differences between the S2P3-R and S2P3 more explicitly. Generally though a well-written paper I found informative. I only have issues with the framework context, which may not really be that much of a concern for the GMD format compared to other journals.

Response: In the revised manuscript, we will emphasize that the currently available S2P3 model is presented as a 1D tool mostly for use with idealized forcing, and it has not been extensively used/tested across transects or in regions where the dominance of 1D (vertical) processes mean that the model can be appropriately used for efficiently investigating 3D time-evolving structures. Since submission of the manuscript, the S2P3-R has been further used to investigate seasonal development of stratification and the sub-surface chlorophyll maximum across a wider region (3-9°W, 49-51°N), at 1-km resolution – for direct comparison with glider missions in September/October 2014, and ongoing monitoring elsewhere (e.g., E1). Such studies are now easily facilitated with the S2P3-R framework.

Specific Comments (each followed by Response):

Line 13: what is meant by realistic geographical domains as I find this ambiguous?

By “realistic geographical domains”, we contrast with previous extensive use of S2P3 in semi-idealized settings. We will revise this opening sentence as “An established 1-dimensional model of Shelf Sea Physics and Primary Production (S2P3) is adapted for flexible use in selected regional settings and over selected periods of time.”

Line 14: does the –R actually mean anything? Reanalysis? Again the significance of S2P3-R over the S2P3 model.

“The “-R” indicates the regional version of S2P3. For clarification, we will revise the second sentence in the abstract as “This Regional adaptation of S2P3, the S2P3-R framework (v1.0), can be efficiently used . . .”

Line 36: The S2P3 does provide an efficient tool for addressing numerous scientific

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questions but I would argue choice of model depends on the question. For example, if your question concerns lateral advective processes, you require a different type of model. Practicality would not be an issue, more what modelling tool is required.

As emphasized in our response to the referee's main concern, 1D (vertical) processes dominate 2D (horizontal) processes across much of the shelf seas where we have the observations necessary for a co-evaluation of these processes. In recognition of this issue, we will strengthen this emphasis in the Introduction and Discussion (see also our response to Referee 2).

Line 40: Something simple in the text to clarify the 1D nature of S2P3, which will make the transition to 3D later in the intro clearer.

We will add to the Introduction a brief explanation of the 1D processes represented in S2P3, such as "S2P3 explicitly represents vertical heat fluxes, vertical mixing of momentum, and vertical mixing of heat and tracers (nitrate and chlorophyll concentrations)."

Line 44: exaggerates the problem I have with the text. If this information is on the website, why do I need to read this paper? What is the novelty of the framework stated in the title?

We will re-phrase our reference to the website. The framework presented here (modified source code and ancillary files) is new and is not accessible via the current hosting website.

Line 51: I don't agree with the way this is written. The physics you are describing can be implemented, and is implemented elsewhere. Granted there is a practicality to implementing fine-scale physics operationally but it is not that this model can do a better job, which is how a general reader could understand this sentence. If you disagree with differing responses in the simulations, I would expect to see a figure demonstrating this.

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We will re-phrase the corresponding text to emphasize that our simpler approach is at least "competitive" with more complex, hence expensive, models. We will provide evidence for this by comparison with a recent simulation with the UK Met Office forecast system (O'Dea et al., 2012), which actually has the same coarse resolution as our "Northwest European shelf" domain. We will specifically point out that Fig. 3a in our manuscript - summer surface-bed temperature differences across the northwest European shelf, with fronts identified - bears close resemblance to the model results in Fig. 10 in O'Dea et al. (2012). Note that the latter simulations took years of development and involved large dedicated research teams (hence the 11 authors of O'Dea et al. 2012).

Reference: O'Dea, E.J., Arnold, A.K., Edwards, K.P., Furner, R., Hyder, P., Martin, M.J., Siddom, J.R., Storkey, D., While, J., Holt, J.T., and H. Liu (2012). An operational ocean forecast system incorporating NEMO and SST data assimilation for the tidally driven European North-West shelf. *Journal of Operational Oceanography*, 5 (1). 3-17.

Line 59: repeated link to the Jon Sharples website, the first reference doesn't seem necessary if you didn't have the earlier quote.

We agree that the second link is superfluous, and we will remove it in the revised manuscript.

Lines 64/72: I understand the importance of S2P3 as an educational tool, but two references to this in two consecutive paragraphs could be streamlined.

We will amalgamate these two references into one.

Line 91: "very little changed" can be better phrased

We will elaborate on specific changes.

Line 178: "aborpton"

We will correct the spelling, "absorption".

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Line 184: I don't think it's correct to use colons in a list manner like this?

We will correct accordingly.

Line 233: grammar - comma placements

We will correct accordingly.

Line 247: the extension of S2P3 is something for the discussion

We will move this to the discussion.

Line 254: SCM not defined

We will clarify the SCM being defined here as: "sub-surface chl-a maximum (SCM)"

Line 259: CTD not defined

We will define "Conductivity Temperature Depth (CTD)".

Line 271: "temperature for each domain"

We are unsure of this comment - we believe the meaning, and punctuation, of this text is clear.

Line 273: and the more coastal Scotland domain was for climate and ecosystem changes as well?

We can revise the text for a more specific meaning: "the extent to which vertical processes govern interannual variability of spring blooms in the northern North Sea", but we may in fact remove the "Around Scotland" example entirely, as this largely replicates the "Northwest European shelf" example (see below).

Line 278: "emphasised" mixed anglo-american spelling

We will correct as "emphasized".

Line 280: there seems no context to go with the more coastal North Sea simulations

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compared to the other three simulations

We may remove the "Around Scotland" example (text and figures), as this largely replicates the "Northwest European shelf" example.

Line 308: rework sentence

This long sentence will be split and revised as follows: "For the China Seas, we specify a higher initial temperature of 15.1°C and simulate two consecutive years, accounting for weak wintertime stratification in this region. We analyse only the second year, for which more realistic initial conditions are thus established across the wider domain (on 1 January of the second year)."

Line 376: "... in particular the Irish Sea and parts of the English Channel are consistent ..."

The referee has misunderstood the meaning of this sentence. We can split the sentence as follows: "Net heat fluxes are also notably positive in some regions that are well mixed all year round, in particular the Irish Sea and parts of the English Channel. This is consistent with enhanced heat storage due to mixing throughout the water column of heat gained in summer (Simpson and Bowers 1984)."

Line 381: temperatures?

We will make this change in the revised manuscript.

Line 383: "locations, artefacts can be introduced to the forcing. This depends on..."

We will make this change in the revised manuscript.

Line 395: where nutrients are

We will make this change in the revised manuscript.

Line 405: split the sentence up

We will split the sentence as follows: "Moving towards stratified regions, annual-mean

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carbon production rates generally decline, although remain above 55 g C m<sup>-2</sup> year<sup>-1</sup> at most locations due to the combined result of the major spring and minor autumn blooms (see below). This decline is complemented by elevated productivity throughout summer at the thermocline, associated with the development and persistence of the sub-surface chl-a maximum (SCM)."

Line 443: limitation

We will make this change in the revised manuscript.

Line 476: There is also scope..

We will start a new sentence here, in the revised manuscript.

Line 515: Here, seasonal cycles . . .

We will start a new sentence here, in the revised manuscript.

Line 523: "while simulated each year separately"?

For clarity, we will revise as follows: "Starting on 1 January 2002, we simulate one year at a time, specifying a mixed water column temperature on, e.g., 1 January 2003 with the corresponding temperature on 31 December 2002, etc. This ensures continuity in temperatures between years, respecting a small degree of interannual variability in wintertime temperature at E1."

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Interactive comment on Geosci. Model Dev. Discuss., 8, 673, 2015.