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Interactive comment on "Improving estimations of greenhouse gas transfer velocities by atmosphere–ocean couplers in Earth-System and regional models" *by* V. M. N. C. S. Vieira et al.

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Reviewer's comments: Vieira et al. present a description of algorithms that can be used in earth system models to better parameterize gas transfer across the air-sea interface and thereby improve flux estimates compared to the simplified algorithms currently used. They emphasize correctly that particularly in coastal regions the simple algorithms are not that robust as many other driving forces are at play over and above wind forcing. Many OGCM's use an outdated parameterization of Wanninkhof et al (1992) that will lead to incorrect flux values. The effort of improving the gas transfer formulation in models is a laudable one and the authors are well aware of the challenges

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of doing so including lack of knowledge how factors other than winds influence gas transfer and how computational limitations limit a full representation. They appear to have some clever approaches to address the computational aspects. The manuscript was very difficult to understand. Grammar and syntax is poor, there are several typos ("form" instead "from", "later" instead of "latter" etc.) and the many symbols are not well explained or seem very similar but have greatly different meaning (kw vs. kh, Rb vs. Ri). The discussion is confusing by different symbols for related parameters e.g. for solubility expressions the "scalar" Kh is the inverse of the Ostwald coefficient.

Author's replies: We performed an extensive revision of the manuscript to make it much clearer. It included grammar and syntax, and corrected "form", "later" and other errors. It is not true the many symbols are not well explained: although well known to the respective scientific community, all symbols and related geophysical processes were nevertheless explained at first appearance and in several cases, more than once. They were always used exactly as in the tens of related literature and, in the more specific cases, exactly as in their original publications, whose reference was given. We gladly verify the reviewer found none inconsistency in the modelling of the geophysical processes, namely the model development, data collection and its analysis.

Reviewer's comments: The key analysis for the validation shown is in Figure 1. It is not described or explained in any detail. All that is mentioned in the text is "The new formulations presented in this work were remarkably consistent with Wanninkhof's formulation while also showing their benefits by representing processes with finer resolution and better accuracy (see Fig. 1)." It is not clear if the accuracy is actually improved.

Author's replies: Originally, we devoted 1 paragraph with 17 lines, more than $\frac{1}{4}$ of the results section, to the analysis relative to Figure 1, where we made clear how our framework represents an improvement from Wanninkhof (1992) formulation. In our revision we enhanced this discussion substantially.

Reviewer's comments: The manuscript is a progress report and commentary, and does

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not offer new insights or novel conclusions. The authors state this towards to end of the manuscript "However, the later still need much improvement and validation. Our solution still needs to integrate the effects of the sea-surface cool-skin and warm-layer, surfactants and rain. But the most urgent is to improve the estimation of transfer velocity from friction velocity and wind-wave breaking, for which very few formulations exist, and the roughness length from the wave field. All the available formulations for these specific purposes lack robust parameter estimations"

Author's replies: The work presents several novelties, namely: (i) the proposed numerical framework, (ii) its application to couple atmosphere and ocean in Earth System Models, and (iii) demonstrating the strong impact of disregarding other important factors besides u10 when simulating the coastal ocean with a finer resolution. There are not any other published works presenting these aspects.

Reviewer's comments: The supplemental material are 5 videos with no explanation.

Author's replies: We add video captions.

Reviewer's comments: This paper cannot be accepted for Biogeosciences. The authors should provide a new manuscript with an algorithm that can be used in Earth system models that is properly validated including an uncertainty analysis.

Author's replies: This is a concise article focusing on demonstrating the problem is real and proposing our framework as a path to achieve the solution. We succeeded in both aspects. To reach a final solution, intermediate steps are required and the insights brought by them are valuable to the scientific community and worth being published.

Interactive comment on Biogeosciences Discuss., 12, 15901, 2015.