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Interactive comment on "C-GEM (v 1.0): a new, cost-efficient biogeochemical model for estuaries and its application to a funnel-shaped system" *by* C. Volta et al.

Anonymous Referee #2

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Journal: GMD Title: C-GEM (v 1.0): A new, cost-efficient biogeochemical model for estuaries and its application to a funnel-shaped system Author(s): C. Volta et al. MS No.: gmd-2013-122 MS Type: Model Description Paper

General Comments

The paper by C. Volta et al deals with the modelling of estuarine biogeochemistry and transfer in the context of its complex hydrology. The precise aim of this paper, as quoted in its abstract, is to produce a "generic" model which can be applied to data-poor estuaries, and which aims to be applied on a global scale. Indeed, this is a need of the global carbon community to be able to quantify in a rigorous manner the estuarine filter

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and the exchange of CO2 in estuaries and deltas Overall, it is a fair attempt to produce such a generic model but it has still a lot of shortcomings which require attention. As quoted by the authors themselves, the main limitation comes from biogeochemical parameters which are neither known nor predictable for unknown environments: the best example is the mineralization rate constant which needs to be tuned for each estuary and to which NEM is very dependent (this is not a large surprise!). More complicated is the dependence on the geometry of the estuary which at a global scale may be poorly resolved and introduces large variations in NEM because of residence time. I would propose to accept the paper with substantial revisions in order to: - include the limitations of the model by the need of a global parameter set in the abstract and conclusion - discuss shortly the role of very large rivers (Amazon, Mississippi, Changjiang, Congo) which delivers their loads to the continental shelf directly (does the model apply to these very large rivers which deliver 40% of the freshwater?) - apply the model on a different system (prismatic?) for which the residence time is shorter, in order to show the capability of the system

Specific Comments

- include the limitations of the model by the need of parameters sets (in the abstract and conclusion) It is visible from the sensitivity analysis that the main biogeochemical outputs (Remineralisation, denitrification or nitrification) are very sensitive to the parameters used for the model calculation. In the section on “model limitations” (p 5676 line 16-26), the authors state that the lack of such a database for model parameters for tropical or polar regions may limit the use of this model, and claim for the building of a worldwide database for these parameters. This limitation by the lack of large scale parameter sets should be quoted in the abstract (which should be rewritten completely, see detailed comments) and the conclusion. Possible parts to include in the abstract and conclusion stands on page 5675 line 6-14 or page 5676 line 16-26. This part should be explicit in the paper.

- discuss shortly the role of very large rivers (Amazon, Mississippi, Changjiang, Congo)

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which delivers their loads to the continental shelf directly Very large rivers which deliver 40% of the freshwater to the global ocean, and have a very different behavior than smaller rivers as the ones dealt with in this paper (Scheldt for exemple). Indeed, a large share of their load is transferred directly to the continental shelf where plume dilution occurs. Is the model able to cope with this type of very large river? This should be specified in the paper, and, if a global vision is the final goal, how to deal with this type of rivers.

- apply the model on a different system (prismatic?) for which the residence time is shorter, in order to show the capability of the system I am surprised that the authors did not provide more application cases for the model as this one is supposed to be able to cover a wide range of estuarine functioning. Especially, they quote that sensitivity analysis would be very different if a prismatic system was chosen (page 5675 line 27 to page 5676 line 4). If possible, it would be good to provide the application of the model on another estuary, as this will strengthened the paper.

Technical corrections

Abstract: the abstract should be rewritten completely as it is more introduction style than abstract. The abstract should provide major results and conclusions of the paper. It is not the case in the present version, as the present abstract just provides the outline of the paper Page 5632 line 7: . . .showing a HALF-gaussian shaped salt intrusion. . . Page 5632 line 19: global biogeochemical cycles. . . Please specify if major rivers are included or not in this framework. If not modify the sentence. Page 5655 line 25: redSi is not defined in Table 1 Page 5665 line 7: the comparison between actual estuarine shape for Scheldt with theoretical description is hard, because Figure 5 is inappropriate. The authors should put the characteristics of Scheldt estuary on the same graph as the model shape, including depth. Page 5666 line 25: “because of heterotrophic nature of the estuary”. Do the authors mean the “human impacted nature”? Page 5668 line 1-2: sensitivity analysis: remineralisation coefficient can vary on 1 order of magnitude when different types of organic matter are transferred to the estuary. This should

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be specified in text. Page 5668 line 7: remove “easily” Page 5668 line 19: “while it overestimates the tidal amplitude. . .” please specify by XX% Page 5669 line 19: Figure 6. Please add the envelope of observed SPM in the estuary to allow comparison with the model simulation. Page 5671 line 20: “while denitrification depends on nitrate production by nitrification”. Is that correct for such high NO3 concentration in river (400 umol/l)? is it model output? Please quote a reference if not or explain better. Page 5672 line 21: “C-GEM predicts lower NH4 in the tidal river”. This is not clearly visible on Fig. 10 where NH4 is plotted versus distance to mouth. You should explain better why nitrification are so much lower in model simulation all over the year. Page 5675 line 6-14: include in abstract Page 5676 line 16-26: important for abstract and conclusion Page 5677 line 23-27: you should be more cautious with this conclusive statement and quote the two limitations: 1- you need a global set of biogeochemical parameters 2- you ignore major rivers which have a different functioning. Figure 13 should be enlarged as it is much too small. Legends are unreadable whatever the magnification, yet this a key Figure of the paper.

Interactive comment on Geosci. Model Dev. Discuss., 6, 5645, 2013.