

Modeling inorganic carbon dynamics in the Seine River continuum in France by Marescaux et al.

The authors present a modeling effort of inorganic carbon dynamics in the Seine River. It is done in the pyNuts-Riverstrahler model. With the new module, the outgassing of CO₂ is calculated for the time period 2010-2013. Also a budget for inorganic and organic carbon including alkalinity for the whole Seine river basin is presented. The manuscript is well structured. The model performance from small orders to higher orders is reasonable at first sight. However, considering how sensitive the balance between alkalinity – CO₂ – pH is, the model performance from small orders to higher orders is impressive. I recommend to publish this paper after major revision.

Specific comments

- There are many well tested and well described inorganic carbon modules readily available (see for a review: Orr et al., 2015, <https://www.biogeosciences.net/12/1483/2015/bg-12-1483-2015.pdf>). Is there a specific reason to develop an own implementation for pyNuts-riverstrahler?
- In paragraph a kind of sensitivity analyses is presented for the gas transfer velocity. It is not clear to me, why this parameter is chosen. I miss a more extended model sensitivity analyses to determine which input parameters are sensitive to CO₂ emissions or carbon export to the sea. Which model parameter contributes most to variability of CO₂ emissions?

Technical corrections main text

1. Double equation numbers. Equation numbers in SI and in main article overlap. Please give them different names.
2. Line 46: The first highlight of a successful implementation. I was surprised by this highlight. There is no word on the implementation details in this article. I think the model itself is never a highlight. The model is a tool to show some of your findings (as you do in this article). So remove.
3. Line 101: Again purpose of this study is an implementation. I don't think this journal is suited for this purpose.
4. Line 102: "pyNuts modeling environment" I would like to have a reference to this. To me it is not clear what the difference is between RiverStrahler, RIVE pyNuts-Riverstrahler. All names are used here. Please elaborate this.
5. Line 106: remove s from works
6. Line 111: Add unit to the decimal numbers.
7. Lines 147 – 154: This footnote is unclear. Last line: calculation of stream velocity. How? Is something fallen of the page here? Use of parameter WSA is confusing. It could mean: mean_width * Slope * Area (not defined here). Change name or put bracket around name.
8. Line 161: Please make figure captions consistent. Figures 1,5,6,.. ends with a dot, but other figure captions not.
9. Lines 192-197: Message in this paragraph is unclear

10. Line 210: Which module? I only see RIVE in figure 2, including TA and DIC. Highlight the IC module in figure 2.
11. Line 236: Eq 3 is referred to as eq 1 in SI
12. Line 238: Table 2: It is not clear how column TA is made out of the formulas 3 – 8. Please explain.
13. Line 258: values and constants are given in Table 2. Is this reference correct? I don't see them.
14. Line 263: Where are the subsurface and groundwater flow components described? Is this in line 201 and further?
15. Line 296: Are pH values measured? From HCO_3^- and pH, the CO_2 concentrations could be calculated.
16. Line 318: S3. Is this the right reference?
17. Line 343-351: Reservoirs are an integrated component of the river network itself. They are not point sources, they are receivers of alkalinity. This is a strange paragraph. There is no module with DIC module for reservoirs, so measurements from one reservoir are taken. Does this mean that reservoirs are not part of the module? This can't be true....
18. Line 400: Figure 4: missing x-axes like for example "Strahler order".
19. Line 402: Change $\text{mgC- CO}_2 \text{ L}^{-1}$ to mgC L^{-1}
20. Line 409: were followed in were followed.
21. Line 438: Figure 6 is too small to see the results.
22. Line 439: Subscript of CO_2 (twice)
23. Line 440: What is simulation envelope? Can I see this? What is the gray area?
24. Line 448: Here a time lag is mentioned. But size is total different as well. I don't see any explanation for this.
25. Line 451: There is a four (number with dot) shown. Delete.
26. Line 461: to = too
27. Line 522: Subscript of CO_2
28. Line 545: Figure 9, to show the spatial dynamics of the ecology in the continuum, it might be interesting to explicitly present the relative contribution of benthic primary producers and the planktonic primary producers to the total primary production.
29. Line 563: Did you test the performance of the model with the wind speed parameterization suggested by Alin et al. 2011?
30. Line 584: Any sense of direction which specific algae parameter(s) / trophic condition(s) has/have changed that causes the temporal variability not matching?
31. Line 594: Dot at end of line.
32. Line 602-604: What is the contribution of estimated k-value to the uncertainty of the total basin CO_2 emissions? You slightly touch upon in figure 7, but basin total CO_2 emissions are not mentioned.
33. Line 604-606: I would not compare outgassing by surface area to global studies. Reference to temperate rivers are relevant.
34. Lines 613-614: Sentence is not correct.

35. Line 620-624: The OC export estimate by Meybeck is higher, but the detail and scale of his study is incomparable to yours. How do you know erosion in the Seine is limiting for OC export compared other temperate rivers? Also, what makes the trophic state of the Seine other than other temperate rivers?
36. Line 622: change “:.”.
37. Line 624: Add (before Rocher.
38. Line 646: I would add benthic information to figure 9 too
39. Line 660-661: I don't see benthic respiration explicitly mention in figure 9.
40. Line 668: Figure8 add blank.
41. Line 693-694: Where do you show small orders are driven by groundwater discharges?

Technical corrections SI

42. Page 1 and 8 : broken link.
43. Page 2 : *** Now it is added to model RIVE ??
44. Figure S1 : I see nine red hatching areas. Not eight. Please change this also in main text (if 9 is the correct number).
45. Eq 6 does not make sense here. Remove. Will be given in eq 14 and 15.
46. Eq 11 : Remove C from K_2C
47. Section 3: Eq 17 to 19: What is CA? Carbonic Acid? Carbonate Alkalinity?
48. Eq. 28 should be $k_{600} = 13.82 + 0.35v$
49. Reference list: I would like to have one for the SI and one for the main text. Please also check the reference list. I was looking for Milero et al. 2006. It is used in the text (Table S1), but not mentioned in reference list.