General comment:
The manuscript proposed a non-Redfield carbon fixation in the biogeochemical model which improved significantly the carbon cycle in terms of *spCO2*. The advantage of this implantation is clearly demonstrated. It is quite meaningful for the general model development on the Baltic Sea basin scale, especially with focus on carbon dynamics under different forcing conditions. It has also a potential implementation in the central North Sea, where the simulated *spCO2* is easily overestimated with the Redfield carbon fixation (Prowe eat al., 2009 and Lorkowski et .,2012).

I recommend the publication of the manuscript after a minor revision based on the following comments.

Specific comments:

1. The introduction needs to be reorganized:
   The first paragraph put to the end of the introduction part
   The paragraph stating from line 45 move to the beginning of the intro, which is followed by the paragraph starting from line 20.

2. Line 47: (Martiny et ., 2016) change to Martiny et ., (2016)
3. Line 52: 'a variation between adapted…. a global scale' does this mean that different groups has different N:P ratio?
4. Line 53, state to stated
5. Line 73-81, 'A prominent…mixing occurs.' This is not model description, consider to move them to the introduction or discussion part.
6. Line 82, in situ conditions (Fig.1)
7. Line 82-84, 'The missing organic carbon …. concentrations'. This is not model description, consider to move them to the introduction or discussion part.
8. Line 84: 'decided to' deleted, 'extend' to 'extended'
9. Line 85: 'an' to 'a', 'not limited' change to 'allow extra'
10. Line 86: 'ultimately by' to 'beyond the part limited by'
11. Ling 101-102,'When nutreints……. biomass', Does that mean in this cast, equation 1 does not take place?
12. Line 103-104, 'if both N …. produced', how to define both N and P are limiting? Could you give an explicate definition of N limitation/P limitation and N,P limitation since those terms are pretty important throughout the paper.
13. Figure 2, for nutrient rich conditions, Does that mean only when min(ln,lp,lL)=lL in equation 1, the phytoplankton growth takes place?
14. Figure 3, So the production of DOP/DON/DOC can not happen at the same time? if so, how could that condition with N,P limitation happen (DOC production)? Or how to define N limitation/P limitation and N,P limitation? And DOC change to DOM (DOC)
15. Line 113: 'a doubling of rates within' to 'doubling of growth rate with'
16. Line 119: 'we divide the nutrient …carbon assimilation'. This is quite misleading. If the value is one as shown in Fig.3, which means only equation 1 takes place. We take P: C uptake ratio as example, it is 1 P*106/C=1. When goes to the extreme cases when there is no Nitrogen in the system and very high P concentrations (lp=1,ln=0), then equation 3 and 4 take place if I'm correct? If yes, then in equation 3, dDOP/dt=ro*PY*lL*lT (in P unit as shown in Table 1) in equation4, dDOC/dt=ro*PY*lL*lT (in C unit) then further dDOP/dt=dDOC/dt. we assume dDOP/dt=dDOC/dt=1, which means by producing 1 DOP, 1P and 106 C are assimilated, and by producing 1 DOC, only 1 DOC is assimilated, then the P:C uptake ratio is 1P*106/(106+1)==> it is not 0.5. Is my understanding wrong? could you please correct me?
17. Line 120: equations '1 to 4' change to '2 to 4'
18. Figure 3: 'Nutrients (N,P) to carbon uptake ratios', This is also quite misleading. When talking about N (or P) to C uptake ratio, one always tends to think about the comparison with the Redfield numbers. So can you give it a more accurate defination?
19. Line 125: transparent exopolymer particle (TEP) to TEP
20. Line 137, any reference?
21. Figure 4: What's the mean by f(R,N,P)

22. Figure 4: arrows: respiration→ no-Redfield assimilation and O2, why? What process is this standing for? I did not get it from the process description in appendix.
23. Figure 5: Could you give the colorbar for the bathymetry?
24. Table 2: Can you illuminate these region divisions in Figure 5?
25. Line 254-255: 'the closed budget … should be zero': In Fig.15a, how is the sum of fluxes calculated? is it sum(Riverine load+air->sea flux+transport from north sea+burial+ocean change+sediment change) or sum(Riverine load+air->sea flux+transport from north sea+burial)? If the former, then the term 'sum of fluxes' is rather misleading especially without any explicit expression (change of inventory is not flux). If the later, why it is necessarily zero? Is there any net gain due to anthropogenic influence?
26. Line 260: 'In the water column… 70s': I can not see an obvious increase of nutrient loads in the 1960s and 1970s (especially compared with 1980s). Instead, the increase of water column carbon inventory is more coincident with the change of transport from North Sea (Fig.15a, see for example the sharp increase in 1963-1965).
    Another questions, over the time 1963-1975, the total inventory (water+sediment) shows a constant increase, which means there should be a net carbon flux into the system, but why this is not reflected from the sum of fluxes in Fig.15c, which instead shows a constant slight decrease?
    Could you also re-plot the Fig.15a so that the fluxes are not shielded by the legends?
27. Line 264-265: 'The increasing sum…. source': I can not understand this sentence even though I agree an internal source. If the sum of fluxes (river and transport) is zero, while there are changes in inventory, it indicates an internal source. But as stated here, the increase of fluxes and inventory change is not necessary an internal source. Please re-write this sentence to give a clear argument about the implication of internal source, for instance, smaller riverine load compared with transport but a long-term constant inventory. Probably an additional plot of the sum of river and transport in Fig.16b, which facilitate the comparison with the yellow line.
28. Line 266: ??--> Appendix B4?
29. Line 270-271: denitrification…. Cyanobacteria→ (denitrification…. Cyanobacteria)
30. Figure 6: c) residual of the budget which can be attributed to alkalinity generation: How was this calculated? And is this a cumulated result?
31. Line 276:boundary fluxes: what do 'boundary fluxes' constitute of? likely redundant here, can it be deleted? the same for nitrogen budget.
32. Figure 17: b) legend of 'Denit Ocean' is wrong (line type)
    c) Suggest to make the line type (and legend) of 'Denit Ocean' identical with the other two plots (a and b)
33. Line 345: 'reasonable' to 'reasonably'

References:

Prowe, A.F., Thomas, H., Pätsch, J., Kühn, W., Bozec, Y., Schiettecatte, L.S., Borges, A.V. and de Baar, H.J., 2009. Mechanisms controlling the air–sea CO2 flux in the North Sea. *Continental Shelf Research*, *29*(15), pp.1801-1808.

Lorkowski, I., Pätsch, J., Moll, A. and Kühn, W., 2012. Interannual variability of carbon fluxes in the North Sea from 1970 to 2006–Competing effects of abiotic and biotic drivers on the gas-exchange of CO2. Estuarine, Coastal and Shelf Science, 100, pp.38-57.