Review of Estrada-Ellis et al. "Budget of the total nitrogen in the Yucatan Shelf: driving mechanisms through a physical-biogeochemical coupled model"

Overview:
The authors present an analysis of the total nitrogen budget on the Yucatan shelf as influenced by physical transports, mixing, river inputs, and biogeochemical processes. A coupled physical-biogeochemical model was used to quantify the processes driving nitrogen source and sink terms. On the eastern boundary of the Yucatan shelf, the Yucatan Current is the dominant flux. Bottom Ekman transport towards the shelf is also important in this area. On the western and northwestern boundary, coastal trapped waves drive exchanges with the open Gulf of Mexico. A westward current on the inner shelf results in N exports at the western boundary of the inner shelf. The results of this work are interesting because the Yucatan shelf has been poorly studied and because the geographic setting provides an interesting interplay of different physical processes that are overlaid on one another.

General Comments:
Unfortunately, I cannot recommend publication of the manuscript at this time for three reasons. First, I found the validation of the physical model insufficient. If there are any measurements of ocean currents for the Yucatan shelf, these should be presented and discussed to evaluate the accuracy of the modeled physical transports. If there are no data for currents, which may be likely especially outside the Yucatan current, the model could be validated by presenting comparisons of modeled versus observed salinity data. Second, I find that the manuscript lacks a discussion of how model bias in physical and biogeochemical state variables may influence results and there is no presentation of uncertainty estimates for the calculated budget source and sink terms, which makes it impossible to compare magnitudes of these terms. Third, the sink and source values were not presented as normalized to a unit area (e.g. m2) and thus the results from this study cannot be compared to results from previous N budget work in the Gulf of Mexico or elsewhere.

Specific Comments:
1. Abstract, L11: Is there a reason for choosing the 250 m isobath as the shelf boundary?

Page 1,
2. The first paragraph of the Introduction needs to be rewritten. References should be updated with recent relevant work on shelf carbon and nitrogen budgets. The last sentence in this paragraph incorrectly lists acidification and eutrophication as socio-economic activities. These processes may result from socio-economic activities but are not activities in themselves. Likewise, the processes listed as part of the climate system are not ones that would immediately come to mind. Please rewrite.

Page 2,
3. L3: Probably should cite Walsh et al. 1989 here

4. L12-13: It would be good to provide more detail about these controversies to help the reader understand the motivation for this study.

5. L26: Show the Yucatan Current in Figure 1.

Page 3,
6. L23: Change “was ran” to “was run”

Page 4,
7. L12: Suggest deleting the first sentence and starting the paragraph with something like “The XIXIMI cruises provided profiles of nutrients and …

8. L22: Does the SDet equate to dissolved organic nitrogen (DON) in the model? In the real world, the components of total nitrogen are DIN, DON, and PON (or PN since there’s some adsorbed inorganic nitrogen on particles). Dissolved organic nitrogen is often equal to or greater than dissolved inorganic nitrogen in the coastal ocean and in coastal rivers. If the SDet does not equate to DON, then your TN definition is incorrect. If SDet does equate to DON, then the assumption of setting PON in rivers equal to 0.1 mmol N m-3 (see comment 11 below) is incorrect.

9. L26 and equation (2): This equation is only for the water-column. The total nitrogen budget also includes the loss to denitrification and to burial in the sediments. Please clarify.

Page 5,
10. L16-20: More details are required about how the freshwater inputs were calculated. Since the freshwater inputs are unknown, it would be justified to include a time-series figure of these inputs, perhaps in the appendix.

11. L23: Setting the PON to this small value is not justified. I suspect that PON must include DON, else the definition of TN used in this study is incorrect. DON concentrations are generally >> 0.1 mmol N m-3.

12. L26: Provide dates for the November cruise.

13. Section 3.1 seems like it should be in the appendix with the other basin wide modeling results. These results aren’t really germane to the analysis except as boundary conditions to the shelf.

Page 6,
14. L20: Why is there no model comparison with salinity data? This should be included to provide confidence the model is accurately representing physical transports.

Page 7,
15. L3-9: Poorly worded paragraph. The explanation of why the model results cannot be compared with other results is incorrect.

The results from this study should be compared to other studies to put the overall budget for the Yucatan shelf into some context in comparison to other more well-studied shelves in the Gulf

such as the West Florida and Louisiana shelves. I recommend normalizing your budget fluxes to area so that they are comparable to other flux estimates.

16. L15: The trend is mentioned here but there's no explanation. Is it real? What is driving the trend? What source/sink terms have changed? The model is deterministic so there's no reason not to get to the bottom of this, especially since the trend suggests that the N budget is not at steady state.

17. L19: I'm not sure what you mean by "a very efficient biological cycle". Please be more specific.

18. L16-17: This logic doesn't make sense to me. Earlier in the ms it was stated that the chlorophyll time series were used in an inverse analysis to prescribe freshwater and N inputs (also see comment 10). Thus, the TN trend and the chlorophyll trend may not really be independent. Please address whether these are completely independent variables.

Page 8,
19. L22: Please report the rates of denitrification (mmol N m^{-2} d^{-1} or something similar) obtained from the model.

20. L24: Fennel et al. (2006) was a study of the Mid-Atlantic and did not address GoM shelves.

Page 9,
21. L29-: This paragraph should be deleted. The last sentence makes it clear that the present analysis cannot address these phenomena.

Page 10,
22. L30: Insert "to" after "due"

23. L31: Change "show" to "shows"

Page 11,
24. L13: Is "2015" a typo?

25. L28: Delete "the" before "unique"

26. Prior to Concluding Remarks there needs to be a discussion of the uncertainties in your budget analysis. How does model bias for N concentrations affect your budget? What is the error (standard deviation of the mean) of each term in the mean budget? Without including this, there is no way to make meaningful judgements about the magnitude of the budget terms.

Page 12,
27. L1-2: Figure 15 shows the physical system but not the biogeochemical system.

28. Table 1: Normalizing the fluxes to a unit area would be more meaningful since the flux estimates presented are driven by the length of the boundaries and the area of the inner and outer shelf.

29. Figure 1: These maps use degrees-minutes whereas other maps use decimal degrees. Be consistent. On Figure 1, the grey contours are difficult to see in panel (a). In panel (b), the vectors are too small to be seen in my copy.

30. Figure 2: It is hard to see the dashed boxes in my copy. Note the isobaths again in this figure caption so the reader knows what these lines are.

31. Figure 3: Should be in appendix with basin-wide results.

32. Figure 4: Should be in appendix. In panel (a), the shadow and dashed line are difficult to differentiate. In panel (b), report the slope of the linear fit.

33. Figures 5, 6, 7: Report model evaluation statistics such as bias and RMSE. The bias in temperature, NO3, and chlorophyll is generally positive with model results being greater than observations. How does this affect the TN budget calculated with the model?

34. Figure 8: For panels a, c, and e report the p-values for the trend lines. The legends are confusing. Perhaps rename them to Inner Shelf TN, Inner Shelf DIN, Inner Shelf PON, etc.

35. Figure 9: There are differences in values and significant digits presented here and Table 1. Double check these values and make corrections. Also some numerical values for fluxes are difficult to read. A simple 2-D map may make a better figure. Plus, the upside down (S-N) orientation is odd for the 3-D figure.

36. Figure 10: Font is too small for gray depths. Latitude is shown in decimal degrees here. "Isobtahs" is misspelled in the caption.

37. Figure 11: I can't see the red dot for the station at Lat = 18.3 and Long = -88.1.

38. Figure 12: Is this figure necessary? It seems to just show a correlation between currents and SLA that could likely be seen with a simple correlation analysis. What is the unit cpd-1 in the y-axis labels?

39. Figure 13: Difficult to see isobaths in panel (a). In panels b, c, and d, change the blue lines to black to match the y-axis label or change the y-axis label to blue.

I did not check references.

END OF REVIEW