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Biogeosciences Discussions

Interactive comment on "Tidal and seasonal forcing of dissolved nutrient fluxes in reef communities" *by* Renee K. Gruber et al.

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MS No.: bg-2018-413 Anonymous Referee #1 Reviewer comments are included below denoted as "Ref1". Author response to each comment is given below the comment denoted as "Authors". Please note that page/line numbers correspond to the revised version of the manuscript rather than the original version.

Ref1: Gruber et al. present measurements of nutrient concentrations and dissolved nutrient flux rates from a macro tidal reef in the Kimberley region of Australia. They compare net rates of dissolved nutrient uptake to the theoretical mass transfer-limited uptake rates. They conclude that the reef acts as a source of DIN and DIP to the water column. I find this manuscript well-written with good logic and structure. I have

some comments to help improve the readability, especially for readers unfamiliar with the sequences of papers that have come from this group of authors on reef physics-biogeochemistry at this site. Overall, I would classify these comments as minor-to-moderate.

Authors: We thank the reviewer for their supportive and constructive comments on this manuscript (ms).

Ref1: I do have one over-arching question/comment: Tallon reef, and the macrotidal Kimberley, seem like end-members on the spectrum of hydrodynamic conditions experienced on reefs. The authors do a good job referencing the Lowe and Falter (2015) paper highlighting the ubiquity of tidal-dominated reefs (even though most research has gone into studying wave-dominated systems), but how applicable do you think the results here are to other systems? Not many other systems feature large amounts of aerial exposure, asymmetric phase duration, and the massive velocities associated with drainage of the platform. How do these conditions affect the applicability of Tallon reef as a model biogeochemical system whose results can be generalized?

Authors: The tidal range at Tallon reef (∼8 m) is typical of ranges experienced by other Kimberley reefs, and our results are likely fairly representative of the ∼2000 km2 of total reef area in this region. An ∼8 m tidal range is indeed extreme compared to most reefs worldwide; however, tidal forcing acting as the dominant process in reef circulation is quite common (for example, most of the Great Barrier Reef has tide-dominated circulation). While the large degree of variability in benthic fluxes presented in this paper would not necessarily be representative of most reef systems, the patterns caused by tides are likely to be common among tide-dominated reefs (∼30% of reefs worldwide). We have added some text to Discussion Section 4.4 to clarify this, as multiple reviewers had similar comments.

Here are some more detailed comments broken down by sections of the paper.

Abstract: Ref1: L15-"moderate amount", replace with an actual quantity of nitrate

Authors: We have added this value to the Abstract.

Introduction: Ref1: I recommend the authors reverse the ordering of their discussion of organic and inorganic nutrients. Since the manuscript focuses on DIN and DIP, it stands to reason that they should be discussed before the refractory DON and DOP pools. I recommend that you move the paragraph discussion inorganic nutrients (p. 2, L 10-23) ahead of the discussion of organic nutrients (p. 2, L 1-8).

Authors: We have changed the order of these paragraphs.

Methods: Section 2.1: Ref1: Please insert your well-worded definition of "tidal phase-averaging" from the Fig. 5 caption into p. 4, L 10-13. The current wording in this paragraph is ambiguous about whether data are averaged within the phases of a tidal cycle or across tidal cycles. The definition in the figure caption relieves this ambiguity.

Authors: We agree this wording was ambiguous and have revised that sentence for clarity.

Section 2.2. Ref 1: How were water samples collected exactly? Did you hold the syringe at the surface and draw up the water? Or was it just above the benthos? Did you directly collect the water with the syringe? Or did you use some auto-sampler to sample the water, and then draw up into a syringe? A few more details would be helpful for conveying you're sampling plan to readers. Authors: We have added some wording to make Section 2.2 p4 L25-26 clearer.

Section 2.3 Ref1: As it stands now, I think this paragraph could benefit for a few clarifications. First, I think the authors need to be more explicit that the J_net estimate is not for the seagrass site, nor for the coral site, but is the average flux rate along the transect moving from the seagrass to the coral site. Even though this may be obvious for people experienced in control volume approaches, I think it is less intuitive for people without control volume backgrounds.

Authors: We agree with the reviewer and have added a sentence to p5 L19 to clarify

this point.

Ref1: When the authors write "C_bar is the mean of concentrations at both stations", do you mean that you average C_bar between the seagrass and coral site at each time-step? If so, say so. I find the current wording confusing.

Authors: We agree with the reviewer and have added text to p5 L17 to clarify.

Ref1: Please either provide more explanation for why you use "local benthic flux" to describe the unsteadiness term on the RHS of Eq. 2.

Authors: This is a naming convention that illustrates we are working in the frame of reference of the sampling stations. We have modified some text to p5 L21 to clarify.

Ref1: At the end of this paragraph, the authors state "... this method is described in greater detail in Gruber et al. (2017).". Is this in reference to your interpolation of advective estimates to when you have nutrient samples? I think the authors need to be clear about how the interpolation proceeds, and do so in a manner which does not require reading Gruber et al. (2017) to understand the interpolation.

Authors: We agree and have added an explanation that clarifies this (p5 L23-27).

Section 2.4 Ref1: There is no equation for C_D (p. 6, L 3-5). Instead the authors state "...following the same approach as used in estimates of reef metabolism (Gruber et al. 2017).". Please give additional information on C_D so that interested readers could evaluate your C_D model without having to read Gruber et al. (2017).

Authors: This was an omission and we have added an equation and explanation for calculating CD (p6 L8-10). It actually wasn't the same method as Gruber et al. 2017 as we found a more realistic (we think) way of estimating the drag coefficient during the time between that article's publication and the submission of this ms.

Minor comments for the Methods: Ref1: Please add in some information about the precision of your nutrient measurements. Please list Sc value numbers for your inorganic

nutrients (or at least diffusion coefficients) (p. 6, L 1-2).

Authors: We have added values for diffusion coefficients to p6 L5-6.

Ref1: Please quantify all error terms that went into your Monte Carlo simulations (p. 6, L 30)

Authors: We have added these terms to p7 L6.

Results: Ref1: p. 7, L 26: Quantify changes in S due to diffusivity

Authors: This should now be clear to readers as we have added values for diffusion coefficients as above, and the differences in S between DIN and DIP species are a proportion of D.

Ref1: p. 7, L 27: Quantify temperature effects on S (don't need a lot here, but something to give readers a sense if the error from ignoring temperature variability is on the order of 0.01%, 0.1%, 1%, 10%, etc. would be useful).

Authors: Keeping temperature constant rather than allowing it to vary (and change viscosity) would change values of S by 0.009%. We have added this value to the ms (p8 L2).

Figures: Ref1: Fig 1: Do you have example photos from the SG and CR sites that could be added to this figure to help convey the communities described in the 1st paragraph of the Methods? I think this visual representation would help readers understand the two sites.

Authors: We have added two photos from the sampling sites to Figure 1.

Ref1: Fig. 4: Please describe the error bars (e.g., SD, SE, 95% CI, etc.)

Authors: Thanks for picking that up! Those are standard deviation, which has been added to the figure caption.

Ref1: Fig. 5: I think it would be interesting to put dashed lines on these plots to show

the range of S estimates from flume and wave-driven field system studies (p. 10, L 24-28). These would really help show that the variability in S in tidal-dominated systems is far larger than in previously studied systems.

Authors: We have added some lines on Figure 5 and some explanatory text in the figure caption showing a range of S values from previous work.

Ref1: Figs. 5 and 6: I think these two figures should be combined, and it would really help readers to see them as a multi-panel plot so that they can understand how closely the J_MTL estimates mirror the S estimates (or alternatively, depart from each other).

Authors: Earlier versions of this ms had Figs 5 and 6 combined, but we found it confusing as S could get mistaken for a benthic flux estimate since the phase averages look fairly similar. We prefer to leave these figures separate and no changes have been made to the ms.

Tables: Ref1: Table 1: "Number of duplicate samples"- does this mean the total number of replicates analyzed? Or the total number of unknown water samples collected, each of which were duplicated? Please clarify. Tables 1 and 2: I think these tables can be combined. This would streamline the manuscript by reducing the number of tables (as it stands right now, Table 1 adds little unique information).

Authors: We have combined Tables 1 and 2 together and clarified the distinction about duplicates in the table caption.

Grammar/typos: Ref1: p. 1, L 30: Correct subscripting/superscripting of NOx and NH4+

Authors: Thanks for picking that up! Addressed.

Ref1: p. 7, L 24: "through" (though)

Authors: Thanks for picking that up! Addressed.

Please also note the supplement to this comment:
https://www.biogeosciences-discuss.net/bg-2018-413/bg-2018-413-AC1-supplement.pdf

Interactive comment on Biogeosciences Discuss., https://doi.org/10.5194/bg-2018-413, 2018.