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

Anonymous Referee #2

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This MS reports fluxes of dissolved inorganic nitrogen and phosphorus and theoretical mass-transfer-limited uptake rates on a strongly tide-dominated reef platform. The amount of nutrients that is released in the water column is calculated from these two data sets.

General evaluation:

Overall, this is a very interesting paper, showing that mass-transfer-limited uptake rates may vary by an order of magnitude on the scale of minutes to hours on tide-dominated reefs, due to substantial variability in flow speeds and water depths over the tidal cycle. Differences between wave- and tide-dominated reef biogeochemistry that are due to the hydrodynamic regime are nicely highlighted. I have a number of relatively minor comments aimed at clarifying the methods and results (detailed below), which the au-

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thors should be able to answer easily. The main concern is that nutrient concentrations were not measured in Feb during the first 6 hours of the tidal cycle. Missing data were replaced by nutrient concentrations in offshore waters, which is maybe not perfectly supported by the data, particularly with regard to NOX (Figure 3). I would therefore recommend more caution in the conclusions regarding seasonal differences in JMTL (see below). The discussion about the implications in terms of nutrient limitation is worthwhile, however.

Comments in detail:

Introduction

p. 2 Line 5: you could add a reference about corals: Grover, R., Maguer, J. F., Allemand, D., & Ferrier-Pagès, C. (2008). Uptake of dissolved free amino acids by the scleractinian coral Stylophora pistillata. Journal of Experimental Biology, 211(6), 860-865.

Methods

2.1 Field site

p. 4 Lines 8-10: The hydrodynamic study of Lowe at al. (2015) was performed in March-April 2014, while the MS reports nutrient concentrations from October 2013 and February 2014. Although this is justified later in the MS, the reason why hydrodynamic data collected at the same time as nutrients were not used to calculate mass-transfer-limited uptake rates is unclear at this point.

p. 4 Lines 11-13: It is unclear if this concerns mass-transfer-limited uptake rates only, or nutrient fluxes as well.

2.3 Control volume approach

Line 8: “Depth-averaged flow speeds were bin-averaged”: do you mean that you first averaged flow speeds in each bin (at 5 min intervals) before depth averaging?

Lines 13-21: I think this paragraph needs some clarification. You are using the mean of concentrations at both stations to calculate the local benthic flux, but you explain then that this local term represents nutrient uptake or release occurring at a sampling station (in my mind, CR or SG, while you are calculating Jnet on the transect). The advective flux is described as nutrient uptake or release during transit between sampling stations, which I also find very confusing. Should not it be what is added or subtracted to the transect due to water transport? The minus sign in front of Jnet is also surprising at first glance. It might be more understandable to state that the sign of Jnet was reversed so that uptake is positive and release negative.

2.4 Uptake rates at the limits of mass-transfer

p.5 Lines 25-30: In the results, JMTL is first calculated for both CR and SG (Figure 6), not along the study transect. Maybe the reasoning would be easier to follow if there was first a paragraph about the calculation of mass-transfer velocity and JMTL at each one of the two stations, and then, a new paragraph explaining the calculation of Jrelease.

p.5 Line 30 to p.6 Line 9: This, although necessary, is really hard to follow. There are very nice explanations given in the results (p. 7 Lines 23-27) that might help the reader to go through the equations. Would it be possible to integrate these explanations into this paragraph, specifying the parameters whose variability has the most influence? Maybe, in a second step, you could simplify equation 4, as some parameters are constants (or nearly constant). This would highlight the influence of flow speed (and possibly water depth: the drag coefficient CD was taken as 0.02 in Gruber et al. (2017), but I didn't understand if this is the case here) and nutrient diffusivity?

In Gruber et al. (2017), u* is a function of ux, not u (this MS). Is there an explanation? I would also suggest that you explain why you are using u in S calculation, and not ux.

Lines 16-28: I would suggest to give these informations before Line 10 (calculation of Jrelease). Could you please clarify which instruments were deployed exactly? On Figure 1, a velocimeter is shown at CR, but you are not using the data, right? Jnet was

calculated from the ADCP data at SG, are you using the same current speed data for the calculation of JMTL and then Jrelease, or the data from Lowe et al. (2015)?

Lines 29-30: This deserves more explanations. Do you mean, for example, that error bars on Figure 4 are uncertainties in estimates of each one of the calculated fluxes? Please add this information in the caption.

Results

3.1 Nutrient concentrations and measured fluxes

Line 4: From Table 2, water temperature is about 2°C warmer in Feb (not 3°C).

Some observations could be supported by statistics: line 6 (DIP and DON are slightly lower in Feb); lines 6-7 (concentrations are similar on the reef and offshore until 6 hours after flooding); lines 18-19 (no difference between Oct and Feb for NH4?).

3.2 Mass-transfer velocity and nutrient uptake

It is unclear from p. 6 lines 3-5 that the drag coefficient was calculated as a function of water depth to draw Figure 5 (the drag coefficient was taken as 0.02 in Gruber et al., 2017). Please clarify in the Methods.

p. 7 Lines 26-27: Can you roughly quantify the effect of temperature on S?

p. 7 Line 28: Could you add on Figure 5 the drag coefficient as a function of hours after reef flooding (and maybe flow speed as well, to avoid having to go back to Figure 2). Also state in the caption that hydrodynamic data (and presumably water depth?) are from March-April 2014 (Lowe et al., 2015), while temperature and salinity from Oct 2013 and Feb 2014 (is that right?).

p. 7 Line 32: Figure 2 doesn't show water depth at SG and CR. Could you add tidal phase-averaged water depth at each site on Figure 3?

p. 8 Line 4: Could you explain "which differ by a factor of <4"? Is it the ratio of the flow

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speeds?

Figure 6: There are missing nutrient data, especially in Feb (0-6 hours after reef flooding; Figure 3). I understand from p. 6 Lines 24-26 that missing data were replaced by nutrient concentrations in offshore waters. From Figure 3, this looks acceptable in Oct, but maybe less in Feb, especially for NOx. Could you show on Figure 6 the time periods during which nutrients were actually measured?

p. 8 Line 10: JMTL is not shown for ammonia. Why?

p. 8 Lines 11-13: This looks speculative, as nutrient concentrations were not measured in Feb during the first 6 hours of the tidal cycle (see previous comment on Figure 6). Please state clearly that you are assuming that NOx concentrations are similar on the reef and offshore during this period and add some comment in the Discussion.

Figure 4: I assume that JMTL is the mean of the values shown on Figure 6 for SG and CR?

p. 8 Line 17: Is “NOx release” “net NOx release”?

Seasonal differences: could you add your stats as a column in Table 3?

p. 8 Line 19: This comment refers to Lines 11-13 (see above). I would suggest to simply state that, contrary to DIP, DIN concentrations are similar at both seasons during the part of the tidal cycle studied.

P 8 from Line 21, and Figures 7 and 8: I understand that you averaged S and JMTL over each one of the 12-hours period available, and then averaged these averages. If that’s right, first you should explain why, and then, I don’t think averaging averages is the best way to assess standard deviations (they also appear very small in Figure 7, given the range in Figure 5).

Lines 21-24 and Figure 7: I’m not sure this is very useful. The two points about S are: (1) the small difference between SG and CR, which is already described p. 7 Lines

31-32 and p. 8 Line 3, and (2) the difference between DIN and DIP which you can easily talk about after p. 7 Lines 25-26.

From Line 24 and Figure 8: Again, I would not recommend using all data from Figure 6 due to missing nutrient values. Differences between seasons and sites are already described (p. 8 Lines 6-14).

Discussion

p. 9 Line 17 (DIP and DON): DIP and DON are "slightly lower (. . .) in Feb" p. 7 Line 6 and "similar between seasons" p. 9 Line 17. One of these two sentences needs to be re-written after stats are performed.

Line 28 to p.10 Line 2: Do you mean that mass-transfer-limited uptake was demonstrated in controlled environments because nutrient release was negligible compared to uptake?

p. 10 Line 4: overestimation of DIN release on Tallon: I don't understand your point. Whatever the source, I think that your calculation of DIN release is fine. Could you clarify?

References

There are two papers by Lowe et al., 2015. Please use 2015a and 2015b throughout the text.

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