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Interactive comment on "The Relationship between Tropical Cyclone Activity, Nutrient Loading, and Algal Blooms over the Great Barrier Reef" *by* Chelsea L. Parker et al.

Anonymous Referee #2

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An interesting and useful idea to try to assess the extent to which cyclones may be affecting water quality across the GBR. However, I agree with Reviewer #1 that an essential precursor to your study is an accuracy assessment of the MODIS product for GBR waters. I further agree with Reviewer #1 that it makes much more sense to consider each cyclone separately and at the appropriate spatial scale, as I'll comment on below.

Specific comments:

As far as I can tell, you measured storm activity as present or absent anywhere in the GBR based on whether a cyclone track crossed the Lagoon. Or did you do this for every 4km pixel across the GBR? However a given eye position along a cyclone track

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Discussion paper

can be located outside the GBR while its winds and waves penetrate within, depending on its position, intensity, translation speed and circulation size. Thus, you could entirely miss a relevant cyclone. As luck would have it, no such cyclones happened to occur during your study period, but have done so regularly prior to 2004 and could do in future.

I am surprised that the MODIS 8 day product only provides data for an arbitrarily set 8 day period, rather than data for every day based on input from the 8 preceding days or based on the 8 following days.

The necessity of analysing the data in set 8 day blocks introduces uncertainty into the time lag analysis which make it difficult to be certain what the time lags actually represent. For example, if a cyclone affected the GBR within a single day (often the case) and this day happened to be day 1 of the 8 day block, the effective time lag being measured for that storm in the 8 day lag scenario could be up to 15 days even though the analysis suggests it was only 8. Similarly, if a cyclone affects the GBR on day 8 of the 8 day block and the corresponding reduction in water quality is evident in the 8 day lag block, the actual time difference from cyclone to lower water quality could still be a little as a day if the response occurred on day 1 of the lagged 8 day block. When analysing the data statistically, you don't have the ability to account for this which makes it hard to be confident with the associated stats. This seems to confound the ability to be sure that a given Chl A response was caused by wind driven suspension versus a flood plume.

Wind-driven resuspension would be caused by the locally generated wind-sea not the wind itself. Since the magnitude of locally generated seas that form in a given location depends on both wind speed and the duration of those winds, I would have been surprised if wind speed alone was important especially given you did not map the spatial extent of the wind speeds. The max wind speed of a cyclone is typically concentrated in a very narrow band at the eyewall and the bulk of the wind speeds are much lower because wind speed drops quickly with distance from the eye (see Holland, Greg J.

"An analytic model of the wind and pressure profiles in hurricanes." Monthly weather review 108.8 (1980): 1212-1218). In large cyclones, this drop-off occurs more gradually, spreading higher winds over a larger area. It thus makes sense that size would be more important than max wind speed. However, I would expect that it would be the interplay between size, intensity and translation speed that would make the most difference – a large, strong cyclone that moves slowly has the greatest potential to generate the largest local seas for a given maximum wind speed. Also it is very important where the cyclone tracked because the distance of water over which wind of a given speed blows (fetch) is also key to what waves develop. This is why it would make sense to map the spatial extent of the wind fields (for example, see Puotinen, Marji, et al. "A robust operational model for predicting where tropical cyclone waves damage coral reefs." Scientific reports 6 (2016)) rather than just using maximum values for an entire cyclone.

TC rainfall is not evenly distributed around the track and the size of the area where it occurs varies with intensity (for example, see Manuel Lonfat, Frank D. Marks Jr., and Shuyi S. Chen. (2004) Precipitation Distribution in Tropical Cyclones Using the Tropical Rainfall Measuring Mission (TRMM) Microwave Imager: A Global Perspective. Monthly Weather Review 132:7, 1645-1660.) For example, the area over which heavy rainfall occurs contracts significantly as a cyclone intensifies. This may help explain why size was a more important predictor than intensity – even though max rainfall rate is positively correlated with intensity, such rainfall would be spread over a larger area for a bigger storm.

As far as I can tell, you attempted to relate cyclone characteristics (size, intensity, translation speed) to Chl A concentrations without considering the spatial extent of heavy rainfall for a given cyclone at a given time with respect to the area of catchment. First, the cyclone characteristics typically vary considerably along the track so if you used averages for an entire cyclone, it could be very misleading. Further, the spatial extent of area exposed to TC activity will vary along the track, often quite considerably. You

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Discussion paper

could map the spatial zone where cyclone rainfall would be expected to occur using the distance to 64 knot winds (or better the distance to gales) every hour (or at least every 6 hours). From these data, you could calculate the % area of each catchment that coincides with a given cyclone each time step and then determine the total number of hours that rain likely fell across the catchment. Then you could determine whether raised ChlA levels seen in the GBR Lagoon at the time of a given cyclone seem plausible given which catchment likely experienced rain and by how much. Not doing this means you don't know how likely it was that a flood plume entered the GBR Lagoon from a given cyclone and where it was likely to occur, and it means you don't have a basis other than the time-lag analysis upon which to ascertain whether the Chl A response was due to wind driven resuspension versus flood plumes.

You should note that to really be confident that a Chl A response you observe is due to a cyclone flood plume would require modelling the location of such flood plumes over time (and cite the relevant studies) even though that was beyond the scope of your study.

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