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Interactive comment on "Formation of anoxia and denitrification in the bottom waters of a tropical estuary, southwest coast of India" *by* G. D. Martin et al.

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We are greatful to the referee for the constructive comments. The clarifications are provided as under.

Point 1) GENERAL This manuscript uses a series of data sets to describe the distribution of nutrients and physico-chemical parameters in the Cochin Estuary and nearshore

coastal waters. The data appear to be of good quality and would add to the limited information available for tropical systems. However, I was disappointed when I read this manuscript that all I got was a description of the nutrients and physico-chemical distributions, which were interpreted as denitrification. Similarly, production of greenhouse gases are discussed but not measured. To reflect the title, and to be a significant contribution to the literature, this manuscript needs denitrification (and anammox?) rate measurements. Measurements of greenhouse gas production would also have been significant. The title should read something like" Nutrients, primary productivity and anoxia in a tropical estuary. . ."

Ans: The Cochin backwaters are found to exhibit increased CO2 emission (> 6000 atm) during monsoon (Guptha et al., 2009). Hence, the hypoxic/anoxic conditions may cause an increase in the nitrite levels through denitrification. Evidence show that denitrification is the major contributor to the N2 loss from the Arabian Sea, and not anammox (Ward et al., 2009). Moreover, nnitrification rates measured in the Cochin backwaters by Miranda et al., (2008) showed very low values (0.06 – 0.4 n moles N L-1 h-1) during the summer monsoon than non-monsoon periods (124 – 166 n moles N L-1 h-1) and find a weak relationship between ammonia concentration and nitrification in non-monsoon periods as a result of intrusion of high salinity Arabian sea water mass. The significant correlation between salinity and nitrite (r2=0.69) and AOU vs. nitrite (r2=0.71) indicates denitrification to be prominent in high saline region.

Point 2) I also have some concern about how the disparate data sets relate to each other. The spatial data was collected in July 2004, the tidal cycle data in July 2007, the DOC, POC and PN data in September 2005, and its not clear when the H2S data were collected. The system hydrology will influence all these data sets, but only data until 2002 is given. Each data set needs to placed in a hydrological context and how these data relate to each other needs to be discussed. Does hydrological variability over the study period (2004 to 2007) influence the interpretations?

Ans: The coastal data collected during July 2004 was used to explain the typical mon-

soon oceanographic process. The carbon data was used to explain the organic enrichment in the estuary. H2S levels were measured only during July 2007 survey and the procedure is incorporated in the new version. Due to technical reasons, processing of hydrological data for the period 2001 to 2009 is delayed. The major study was carried out during July 2007 in the Cochin backwaters so that will not be effect the present interpretations.

SPECIFIC

The whole manuscript needs to be edited for expression and grammar. e.g L. 1754. L1. Remove within; l4. Remove thus; l. 15. Replace “gets” with “is; p. 1754. L. 21. Replace “has” with “was” etc. etc.

Ans: The corrections are incorporated and the whole manuscript is thoroughly edited for grammar.

p. 1752. l3. We are told that denitrification was observed. Whereas in fact only nutrient and physico-chemical distributions were observed and denitrification was inferred.

Ans: Build-up of nitrite levels in anoxic estuarine waters was our observation, while denitrification was inferred. The significant correlation between salinity and nitrite (r2=0.69) and AOU vs. nitrite (r2=0.71) are taken as indicators of denitrification (Deuser, et al., 1978).

p. 1753. L. 17-18. This sentence is not clear. Are the rates one third, or is the amount of denitrification one third?

Ans: The denitrification rates measured in the Arabian Sea was about one-third of the estimated global water column denitrification rate (Naqvi and Jayakumar, 2000; Codispoti et al., 2001; Naqvi et al., 2005).

p. 1754. A hypothesis is needed.

Ans: A hypothesis is included a new version (L. 94 – L. 103).

p. 1755. Not all named places are on Fig. 1 e.g. Azhikode.

Ans: All the names given in text are included in Fig. 1.

p. 1756 and 1757. More detail on methods is required – error, detection limits etc.

Ans: Details of error and detection limits are included in the new version (L 174-L177).

p. 1757. L. 22. No method for H2S.

Ans: Method included in the text (L 184- L 186).

p. 1762. L. 15. Decrease in DOC, POC etc. probably just due to dilution with low concentration coastal water.

Ans: The salinity during the study period was low (12) in the Cochin backwaters, while there was a progressive decrease in the levels of DOC (20-480 μM), POC (20-40 μM) with increase in salinity. This probably was due to increased degradation.

p. 1763. L. 23-24. This is not clear. In other tropical estuaries?

Ans: That sentence was deleted during revision.

p. 1764/ 1765. Some estimates of denitrification rates based on mass balances of nitrates.

Ans: Rate measurements have not been done. But denitrification was inferred based on physio-chemical correlations (Fig. 4d) according to (Deuser, et al., 1978).

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