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Biogeosciences Discussions

Interactive comment on "Agricultural induced impacts on soil carbon cycling and sequestration in a seasonally saturated wetland" *by* J. J. Maynard et al.

J. J. Maynard et al.

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We would like to thank Anonymous Reviewer 1 and Dr. William Renwick for their time and effort in reviewing this manuscript and for their helpful comments and suggestions.

Response to Anonymous Reviewer 1:

We have revised the manuscript with special attention to the two key points raised by the reviewer concerning the role of (i) wetland age, and (ii) wetland management, in maximizing C retention. We agree with the reviewer that these two factors are important determinants in the C storage capacity of wetland systems and thus deserves a

more thorough discussion. These points were expanded upon and clarified within the revised manuscript.

General Comments:

In response to the first point, the role of wetland age, research has shown that newly constructed wetlands are more efficient at trapping sediment and carbon than older wetlands. This is largely due to the effects of long-term sedimentation on the wetland's hydrodynamics and hydraulic efficiency (Persson, 1999). As wetlands begin to fill up with sediment they tend to become channelized and less efficient in retaining inflowing sediment and carbon. The rate at which this occurs is dependent upon the initial wetland design and annual rates of sedimentation. In agricultural landscapes, rates of wetland sedimentation can be high resulting in the rapid filling of these systems (from our observations in California this often occurs within 5-20 years). Consequently, to maintain the C and sediment sink capacity, these systems require regular maintenance which includes the dredging and excavation of deposited sediment. Thus the long-term fate of eroded carbon is ultimately dependent upon what happens to the excavated sediment, e.g., whether it is reapplied to adjacent agricultural fields (further disturbance and oxidation) or mounded to fortify and create levies (buried and physically protected). Although our wetland system was 13 yrs-old at the completion of this study, it maintained a high retention capacity for inflowing sediment and carbon. When viewed in terms of inflow and outflow TSS concentrations, the wetland had 98

In response to the reviewer's second point, the role of wetland management, our data shows markedly different patterns of sediment deposition across the wetland and resulting differences in rates of C stabilization via burial. Although we documented that high rates of sedimentation stabilized the exogenous carbon entering the wetland, these sites where extremely low in endogenous C enrichment resulting in low carbon concentrations (i.e., 14 g kg-1). In contrast, low depositional environments where highly enriched in endogenous C but experienced high rates of decomposition. Thus we conclude that there exists an optimal balance between sediment deposition and endogenous C enrichment that may promote a higher pedogenic organic C equilibrium. Through optimizing wetland designs to promote a more even distribution of sediment deposition, higher rates of sedimentation can occur in areas with high endogenous C productivity, thus stabilizing this carbon via burial. These points are clarified in the revised manuscript.

Our responses to the reviewer's specific comments are presented below.

Specific Comments:

1. *Comment:* Page 6044 Lines 1-5: The correlation between NDVI and AGBM is very weak: The error on the predictions (eg average AGBM and C accumulation rates) should therefore be included in the estimates and the implications of this uncertainty for the interpretation should be discussed.

Response: Regression Kriging models do not require a strong statistical relationship in order to provide an improved prediction over the traditional ordinary kriging approach. The standard error for the mean organic C concentration of vegetation was 9.6 g kg-1 and has been added to Page 6044, Line 2. Additionally, a map displaying the Regression Kriging Standard Error has been provided and will be added to the manuscripts supplemental materials section. The kriging standard error (standard deviation of the predicted value) increases with increasing distance from each sampling point. A relatively even distribution of sampling points across the wetland resulted in generally low kriging standard error for most section of the wetland. The implications of this error are also briefly described in the revised manuscript.

2. *Comment:* Page 6049 Line 15: The pattern seems to be controlled by the distance to the outlet and not the vegetation as suggested in the discussion? Please quantify the key controls on sediment and C deposition patterns.

Response: Although the highest rates of sedimentation occurred along the main flow path during both years (Figs. 1 and 4), vegetation played an important role in influenc-

ing sedimentation patterns as illustrated by the contrasting patterns and rates between 2004 (vegetated) and 2005 (non-vegetated). In 2004, sediment was largely confined to area proximal to the inflow, while in 2005, large amounts of sediment were transported to the southern distal end. While we acknowledge that the location of inflow and outflow water control structures was a dominant factor controlling C and sediment depositional patterns, the presence and distribution of emergent vegetation also has a strong influence on these patterns. We've added a brief section describing the importance of the wetland design features controlling sediment patterns at the beginning of this paragraph (Page 6049, Line 15).

3. *Comment:* Page 6053 Line 5: Is the increased NPP an assumption or an observation?

Response: The relationship between eutrophication and increased NPP in wetland systems has been well documented. See Sanchez-Carrillo et al. (2011). Citation has been added in the revised manuscript.

4. *Comment:* Page 6053 line 10: Please discuss why younger wetlands have higher retention efficiencies (deposition rates) and thus why the observed accumulation rates are substantially lower than the long-term average. This is an important finding as the age of the wetland will control the strength of the C sink? What are the implications of this for the US (average wetland age, etc and relate this to the estimates of US wetland area (line 1 page 6053).

Response: Although there is a general relationship between wetland age and sediment retention efficiency, the rate at which wetlands fill with sediment and decrease in efficiency varies with wetland design and inflowing sediment load. Thus it is difficult to make broader generalizations across the US. See further discussion above in the General Comment section. In our wetland system, retention efficiencies ranging from 82 to 97

5. *Comment:* Page 6054 Line 15-25: The conclusion that a more even sediment

distribution will promote a higher C status doesn't fit with the earlier statement (line 15, same page) that higher rates of sedimentation limit OM decomposition. As this is one of the main conclusions of this paper (page 6055 line 20 Conclusion section), this should be carefully evaluated.

Response: See General Comment section for a discussion on sedimentation patterns and C stabilization.

References:

Sanchez-Carrillo, S., Angeler, D.G., Alvarex-Cobelas, M., and Sanchez-Andres, R.: Freshwater wetland eutrophication, in: Eutrophication: Causes, Consequences, and Control, edited by: Ansari, A.A., Singh Gill, S., Lanza, G.R., and Rast, W., Springer, 195-210, 2011.

Persson, J., Somes, N.L.G., and Wong, T.H.F.: Hydraulic efficiency of constructed wetlands and ponds, Water Science and Technology, 40, 291-300, 1999.

Response to Dr. William Renwick:

We would like to thank Dr. Renwick for his positive review of this manuscript. We have addressed his specific comment and technical correction below.

Specific comment:

Comment: P. 6041, lines 15-24 conclude that C retention efficiency is greater than that indicated by loads alone. While the decline in C loads between inflow and outflow is retention from the standpoint of the water, it may not be so from the standpoint of the atmosphere. Thus it is probably not correct to characterize this as "retention" (see also Table 1), because some of this C is likely released to the atmosphere. From the budget, and the conclusion that ": : : there was no significant additional long-term storage of endogenous C" (p.6055, lines 25-26) it might be possible to make a rough estimate

of that outgassing, if an assumption were made regarding the DOC concentration in seepage.

Response: We agree with the Dr. Renwick's comment that our estimate of C retention based on water fluxes does not account for gaseous losses or DOC exiting the wetland via seepage and therefore this should be explicitly stated in the manuscript. We have revised the manuscript to clarify that these estimates are water column retention efficiencies and do not account for C lost via seepage or via the atmosphere. Although there was no significant change in DOC concentration between inflow and outflow, in terms of loads there was a 32

Technical correction:

Comment: P. 6052, Line 15. "...distribution of C in 2004 was lowest..." should probably be "...concentration of C in 2004 was lowest..."

Response: Suggested correction was incorporated into the revised manuscript.

Interactive comment on Biogeosciences Discuss., 8, 6031, 2011.

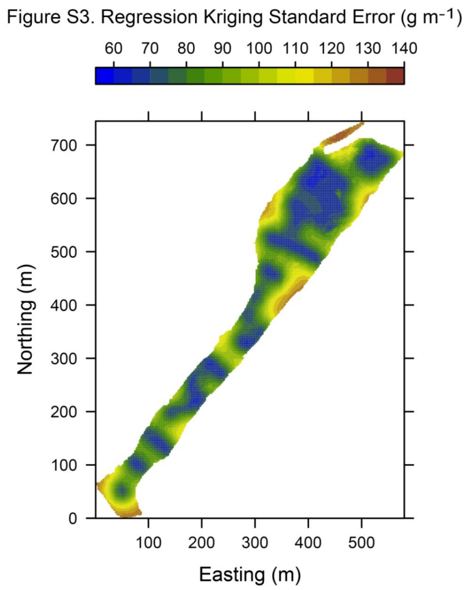

Fig. 1. Regression Kriging Standard Error