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Interactive comment on "Influences of tidal energy advection on the surface energy balance in a mangrove forest" *by* J. G. Barr et al.

Anonymous Referee #2

GENERAL COMMENTS

The manuscript deals with the energy balance closure of a mangrove ecosystem which is subjected to changes in water level. The authors aim to include the energy advection by tides into the energy budget of the investigated ecosystem. Due to the novelty of the subject, I think that it will be of interest for the Biogeosciences public. The manuscript is generally well organised. In my opinion the section that needs additional work is the Materials and Methods section where some aspects of the methodology have to be deepened and clarified. The peculiarity of the investigated ecosystem requires a specific treatment of some energy budget terms and in particular of the storage variation. The authors include the energy storage variation in the water layer in the calculation of the advection term, I do not fully agree with this formalisation of the

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problem. Advection fluxes are linked to a scalar transport inside or outside the control volume by the mean flow; I would not include in the advection calculation a temporal variation of a scalar within the control volume. Besides, the storage variation comprises the traditional term (1) due to the variation of temperature in the control volume, plus a term (2) which arises because of the variation of water level which leads to a variation of the fraction occupied by water and air in the control volume.

ΔHstor = rho Cw $\sum (Aj(t) * hj(t) * (Tj(t) - Tj(t-\Delta t))) / \Delta t$ (1)

_____ + Tj (t-Δt) * (Aj (t) * hj (t) - Aj (t-Δt) * hj (t-Δt)) / Δt) (2)

I think that these terms should be explicitly reported in section 3.2. Discussion and figures referring to ΔH_stor and ΔH_adv should be changed accordingly. The authors should also clarify in the text how storage in air was treated at half hourly scale.

As an additional reference I would suggest:

Tsai J.L. et al 2007, Surface energy components and land characteristics of a rice paddy. Journal of Applied Meteorology and Climatology 46 1879-1900

It could help to further develop the Results and Discussion section. For the above mentioned reasons my suggestion is to accept the manuscript after the suggested changes are made.

SPECIFIC COMMENTS

P11740 L11- The eddy covariance system measures only turbulent exchanges, the sentence should be changed accordingly

P11740 L18- At this point the parameter used to represent the energy balance closure is not jet defined hence it is not clear what improves from 73 to 82%. The sentence could be changed as follows: "The regression slope of available energy versus sink terms increased from 0.73 to 0.82 including tidal energy advection in the energy balance."

P11742 L6- This information should be reported also in the site description

P11743 I would add a section "Instrumental set-up and data processing" and move in this section information reported in Section 3.1 (P11744 L3-).

P11744 L9- In the data processing description the authors do not mention some major steps of the standard methodology like the lag calculation between the anemometer and the IRGA, rotations, and frequency response corrections (sensor separation, path length...). I think that these details should be reported and discussed in the present paper, although a reference to a previous work is present at the end of the sentence.

P11744 L27 How was the tower flux footprint calculated? Some data that support this sentence should be added, like for example an average footprint size for different stability classes.

P11745 L1 What about the storage in water? I think that it should be included in S and not in the advection calculation

P11745 L5- Does that mean that you ignore storage in above ground biomass and air also at the half-hourly scale (this is what I can infer from eq 2 and fig 9, but not from the text)? It shouldn't be ignored at short time scales, but if this is the case it needs to be clearly stated and justified in the text.

P11745 L13- Move the sentence "The analysis was performed..." at the end of the section: it holds both for the half hourly time scale and for the cumulative values analysis.

P11745 L24 it is not clear what you mean by "independently instrumented", maybe independently could be simply omitted

P11746 L12- water velocity is not used in the analysis I would skip Lines 12-18

P11746 Equation (4) As I previously underlined I think that ΔH_{stor} is part of term S, since advection should account for energy moving in and out the control volume

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transported by the average flow, during a certain time interval and not for time changes of energy stored in the control volume.

P11747 Equation (5): I would replace the expression for Hstor with an expression for ΔHstor in this case Δt has to be added at the denominator (this would be consistent with units reported at line 1 of the same page). More details on Aj calculation are needed at this point. Specify the value of n.

P11747 Equation (6) although correct, this equation is inconsistent with equation (4), since you are dividing twice by Δt, for the above mentioned reasons skip equation (4)

P11747 Equation (7) In order to avoid a different treatment for periods during which water level drops below 0.05 m, I suggest the authors to fit a suitable expression to T point measurements for each half hour in order to extrapolate T values also below 0.05 m.

P11748 L11-12 This sentence is misleading, it needs to be reformulated to highlight that recharge was set equal to the temporal variation of the water volume, instead of using available recharge measurements.

P11748 L16-18 The sentence is not clear, if, as I understand, you averaged values of Jul-Sep 2004 and Jul-Aug 2005 to calculate a mean daily trend, replace "averaged fluxes..." with "mean daily trends of energy fluxes were calculated using data collected in the periods Jul-Sep 2004 and Jul-Aug 2005"

P11749 L3- Instead of using H/Rnet and LE/Rnet I suggest the authors to calculate the daily trend of Bowen ratio for high and low tide conditions and add a panel with this variable to fig 4. The text needs to be changed accordingly.

P11749 L9 "regardless of inundation" this statement does not find a support in the figure, please clarify.

P11749 L9-12 This sentence needs some further discussion.

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P11749 L22 What happens below the 0.1 m height? It should be better explained in the text.

P11750 L19 It is not clear what the author mean by "Ensemble averages", it should be again a mean daily trend

P11750 L21- use average values $\pm$ StDev instead of the range limits i.e. "Rnet was highest (695$\pm$115 W m-2)". The same holds for the other fluxes

P11751 L5 Does "diurnally variable" refer to a variation among days or to the daily trend?

P11751 L12 ΔT value which identifies the transition from sink to source should be reported here.

P11751 L12- The sentence reports a consequence that can be drown from the observed trend, and not something that was observed, therefore I would change it as follows "This trend indicates that flood tides should change from..."

P11752 L13 Paddy fields should also be mentioned here, with some references.

Figure 2 and 3 There is no need to have two separate figures, merge them into one figure adding the control volume and flux arrows to fig 3.

Figure 7 Plot G and Hadv in two separate panels and add a panel for the mean daily trend of the storage

Figure 8 remove the best-fit lines from the legend and add the regression equation and R2 to the figure

Figure 9 I suggest the authors to add two panels to the figure reporting daily values, it should reduce the scatter introduced by the advection term.

Figure 10 I would not plot a cumulative curve which is not a real cumulative curve since it does not include night time fluxes, this figure could be replaced with another one in

which the values of the two input/output ratios are shown. Different ratios could be calculated for the entire period and for daytime periods only.

TECHNICAL CORRECTIONS

P11740 L12 replace with "eddy covariance system installed on a xx m high tower"

P11744 L28 "can then be defined as"

P11745 L1 "between the surface and the eddy covariance system height."

P11745 L3 "A positive value of S indicates that energy is stored in the ecosystem."

P11745 L18 skip "with and without ΔH_{adv} included"

P11747 Equations 5 and 6: replace p symbol for water density with rho

P11748 L18 "exchanges" instead of "changes"

P11748 L18 replace "During July to September 2004 and July and August 2005" with "Figure 4a shows that. . ."

P11748 L20 Skip "(Fig 4a)"

P11749 L5 replace "during 12:00 to 15:00 h" (h is a unit!) with "from 12 to 3 p.m." the same holds for all the other occurrences of h

P11749 L8 and L9 same as L5, "from 7 to 10 a.m." and "from 12 to 6 p.m."

P11749 L11 skip "of July to September."

P11749 L15 replace "at three sites" with "at three measurement locations within the control volume"

P11750 L8 and 9 see comment for P11749 L5

P11750 L15-16 Sentence needs to be reformulated "Temporal patterns of soil heat flux at the tower were comparable to the average patterns of the three measurement

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locations".

P11751 L16 replace "warmer than midday conditions" with "warmer than surrounding air at midday"

P11751 L18 replace "heating" with "heat"

P11751 L19 "within the forest canopy which detrimentally impact.."

P11751 L23 replace "during the period 6-16 August 2005" with "during the observation period"

P11751 L24 "When ΔH_{adv} was included in the surface energy budget, its closure improved. . ." P11751 L27 replace "energy closure" with "energy balance closure" same for all other occurrences of "energy closure"

P11752 L5 end the sentence after (Fig. 10)

P11752 L9 skip the sentence starting with "Furthermore. . ." it is redundant

P11752 L12 "increased closure estimates by 9 to 12% for half hourly regression and ratio of daytime cumulative values, respectively"

P11753 L2 replace "meaningfully affect" with "significantly affects"

P11753 L17 ". . .tidal flows favour the transport of energy. . ."

Figure 4 caption "Mean daily trend (solid lines) $\pm$ 1 sd. . ."

Figure 5 caption replace "three sites" with "three measurement locations" the same holds for other occurrences

Figure 6 caption "on the 13th of August 2005"

Figure 7 caption add the measurement period

Figure 8 caption first line skip "trend", second line skip "depth and site"

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