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Interactive comment on "Modeling the effects of cold front passages on the heat fluxes and thermal structure of a tropical hydroelectric reservoir" *by* M. P. Curtarelli et al.

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Dear referee,

thanks for reviewing our manuscript. We found the comments helpful, and believe the revised manuscript will represent a significant improvement over the initial submission. We agree with all suggestions and comments about the need to better exploit the results obtained with the hydrodynamic model. We will try to re-thought and re-interpreted all the "Results and Discussion" section, following the suggestions given, in order to better explain the effects of cold fronts on tropical lake dynamics. The following are the responses to your comments and suggestions:

1) p.8468, Line 8: What is the meaning of resilience? How do you quantify it?

In this case we refer to resilience in the ecological sense, that is, the ability of a system to restore their equilibrium after it has been broken by a disturbance, a cold front in this case.

2) p.8468, Line 16: Colder than what?

In this sentence we meant "colder than the reservoir water". I think that this sentence can be rewritten as "The water of the Paranaíba River is colder than reservoir water and contributed to reestablish the thermal stratification following the passages of the cold fronts"

3) p.8469, Line 9: In the sentence "Although the effects of cold fronts. . ." Which effects are you referring to? Do you mean in heat fluxes?

Yes, we are referring to the effects of cold fronts on the heat and mass fluxes.

4) p.8469, Line 9: "reported in North American waters studies...". Which are these reports? Could you cite references?

We will inset the following references in this statement: "Although the effects of cold fronts have been reported for North American water bodies (Blanken et al., 2000; MacIntyre et al., 2009; Liu et al., 2011). . ."

5) p.8469, Line 9: "few studies..." Which studies? Could you site references?

We will inset the following references in this statement: ". . .few studies have addressed this issue in South American lakes and reservoirs (Alcântara et al 2010a)"

6) p.8471, "Site description": Which is the residence time of water in the reservoir?

The residence time of Itumbiara reservoir is around 150 days. We will include this information on "Site description" section.

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7) p.8473, Line 10: Did river inflows keep constant in time? How was the evolution in time of the river inflows?

The river inflows (Paranaíba e Corumbá Rivers) were not considered constant during the simulation period. The total river inflows decreased from 1336 m^3 s-1 (on 26 April 2011) to 879 m^3 s-1 (on 16 July 2011).

8) p.8473, Line 12: How did the company measure total inflow? If it is based on water outflows and reservoir volume, precipitation is double counted (within the inflow rates and as an input to de model).

The total inflow values provided by the company are based on water outflow and the reservoir volume. In order to avoid double count of precipitation we discount its value from total inflow before. This was done because precipitation and inflow are accounted in different way by the model.

9) p.8473, "Satellite data": Did you calibrate satellite data with water samples taken in the river surface or at least with the nearest-to-surface thermistors in S1 and/or S2? Can you explain more in detail how you retrieve WST at the rivers?

The WST of river inflows were retrieved using the M*D11A1 product. We considered the mean temperature obtained with the pixels located at the rivers entrance as the river inflows temperature. In order to avoid erroneous values of WST in the pixels near the edges of reservoir due to land contaminations, we used a Sub-Pixel Temperature Retrieving (SPTR) approach (Setlinger et al. 2008) to extract the WST in Itumbiara Reservoir. This approach assumes that each pixel in the edges of reservoir is composed of two components (i.e. land and water). More details about SPTR are available on Setlinger et al. (2008).

We did not perform any calibration product M * D11A1. However, the M*D11A1 products have been validated at stage 2 via a series of field campaigns conducted between 2000-2007, and over more locations and time periods through radiance-based validation studies (Wan et al., 2002; Wan et al., 2008; Coll et al., 2009). Accuracy is better than 1K (0.5K in most cases), as expected pre-launch.

10) p.8477, Line 21: What you mean with "carefully chosen"? Do you mean a grid independence study? Please explain.

We did not perform a grid independence study. We only follow the recommendations given in ELCOM scientific manual (Hodges; Dallimore, 2010). The definition of horizontal resolution was based on the Courant-Friedrich-Lewis condition. Moreover, the computational method implemented in ELCOM has a better performance (i.e. with greatest accuracy) using a grid with uniform vertical layers.

11) p.8477, Line 22: is 0.03 the value of the water albedo for shortwave or longwave radiation?

Yes, 0.03 was the value used as water albedo for shortwave radiation. We will insert "shortwave radiation" in this sentence.

12) p.8477, Line 22: Since you are using values measured in another reservoir, did you test how sensitive is the model to the value of horizontal diffusivity for this reservoir?

We performed three simulations to evaluate the sensitivity of the model to the horizontal diffusivity. The first simulation was done with the horizontal diffusivity value of 5.25 m^2 s-1 (Pacheco et al., 2011). The second simulation was done with the horizontal diffusivity value of 6.56 m^2 s-1 (+25%) and the third simulation was done with the horizontal diffusivity value of 3.94 m^2 s-1 (-25%). The results of this analysis showed that the model is little sensitive to the horizontal diffusivity for the Itumbiara reservoir. The water temperature simulated in each of the experiments has small difference, less than 2%.

13) p.8478, Line 14: What criteria did you use to separate the areas under the influence of the S1 and S2 meteorological datasets, respectively?

We do not use any specific criteria to divide the reservoir into two sections. We just divide the simulation domain in the middle. The area covering the main body of the reservoir and dam region was considered under S1 influence and the area covering part of main body and the river-reservoir transition zone was considered under S2 influence.

14) p.8478, Line 26: Again, how did you initialize temperature profiles? Linear interpolation from S1 to S2?

The initial temperature profiles were obtained through linear interpolation from S1 and S2 thermistors chain data.

15) p.8480, Line 5: “reasonably” is an ambiguous statement.

We will change this statement to: “At both analyzed points, the model was able to reproduce the thermal structure accurately”.

16) p.8480, Line 10: “lower than 3%”. 3% of what? Mean temperature? Maximum temperature?

In this case we meant 3% of mean temperature.

17) p.8480, Line 16: Again, 1% of what?

In this case we meant 1% of water level variation during the period simulated ($\sim$ 1m)

18) p.8480, Line 17: I think “very well” is not a proper statement.

We will change this statement to: “. . .water level during the simulation period accurately”

19) P.8482, “Heat budget”: What is the effect of taking precipitation into account?

The precipitation effects were not analyzed in this work. The ELCOM model considers the precipitation data only to compute the water balance (Hodges and Dallimore, 2010).

20) p.8483, Line 17: I cannot see upwelling events from Fig. 6i.

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We agree that the upwelling events are not clear from the Figure 6i but they really occurred. The upwelling events were observed both during and after the F4 passage. When F4 passage reaches the Itumbiara reservoir (on 30th May) the wind field changes its direction, from Southeastern to Southwestern, and increases its intensity, reaching 8.8 m s-1. After the F4 passage (2nd July) the wind changes its direction again, from Southwestern to Southeastern, reaching values around 7 m s-1. The two wind episodes (during and after F4) persist for more than 18 hours with wind speed higher than 3.5 m s-1. In both cases, the model results showed the occurrence of downwelling-upwelling cells traveling from the upwind to the downwind side of the reservoir. We will try to explain in more detail this question on “Results and Discussion” section.

21) p.8483, Line 26 to p.8485, Line 2. I think these lines should be part of the “Data and methods” section.

We agree with this suggestion. The methodology to evaluate cold front effects on stratification and mixing processes will be described on "Methodology section".

22) p.8484, Line 4: what is the reference density ïĄš0?

In this case the reference density corresponds to the mean water column density.

23) p. 8485: Where is the discussion section? In which way have you improved knowledge with respect to studies carried out in the same study site (as for example Alcântara et al., 2010a)? How these findings compare to other South American lakes? How is the heat budget changed in comparison to other South American lakes?

We think that the main contribution of our research was to improve knowledge about the effect of cold front passages on spatial heterogeneity of thermal regimes in Itumbiara reservoir. The former studies carried out in Itumbiara reservoir investigated the effects of cold fronts passages on the heat fluxes based on punctual measurements and did not investigated the spatial heterogeneity. The “Results and Discussion” section will

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be redeveloped with a better literature backup and comparing our findings with others South American lakes.

24) p. 8486, “Conclusions”: conclusion is largely a summary of the results of the work. It could benefit from a discussion placing the results of this work in the larger context of how it improves our understanding of the thermal response, mixing and changes in heat fluxes in South American lakes due to the effects of cold from passages.

We will improve the “Conclusions” section take into account the suggestions given.

25) p.8494, Table 2: Is the drop in air temperature Ta, the subtraction of daily-averaged values?

In this case, the drop in the air temperature was computed by the subtraction of daily averaged temperature in the day before the cold front passage and the daily averaged temperature in the coldest day during the cold front activity.

26) p.8497, Fig. 2: it is hard to read letters from Fig. 2.

We will enlarge the font size in the Fig. 2.

27) P.8498, Fig. 3: Could you extend the F1-F5 marks as lines so we can follow your ideas more clearly? It seems to be a trend in the air temperature towards lower values at the end of the period (Fig. 3c), maybe the effect of the cold front passages could be better observed if you subtract this trend. From Fig. 3g and 3h, we can see there are WST variations of $\sim$10°C in each of the rivers... Is this daily variability a common feature?

We will extend the F1-F5 marks as lines in the Figure 3. The WST data will be reprocessed and compared with S1 and S2 data in order to investigate the variability observed.

References

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