

Interactive comment on “Satellite-Derived Light Extinction Coefficient and its Impact on Thermal Structure Simulations in a 1-D Lake Model” by Kiana Zolfaghari et al.

Anonymous Referee #3

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General comments

The manuscript presents a study on the use of light extinction coefficient values derived from MERIS satellite imagery in the FLake 1-D lake model. FLake is the most widely used lake scheme in numerical weather prediction (NWP) models. To take advantage of the coupling of lake schemes to NWP and climate models it is necessary to have data on the lakes transparency. As they are not observations in an in-situ operational way, the most promising strategy is to use satellite images. Therefore this study deals with a current scientific issue, that really fit in the HESS scope. As far as I my English allow, the manuscript is well written. The study is original and contains new results which are worth to be published. In my opinion the manuscript requires major revision

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before being accepted. Please, consider the following comments, with different levels of importance:

Detailed comments:

pag. 2 line 3 land → continental

line 12: In the first mention to the FLake model, a reference to the the model may be given. This: Mironov, D. V., 2008: Parametrization of lakes in numerical weather prediction. Description of a lake model. COSMO Technical Report, No. 11, Deutscher Wetterdienst, Offenbach am Main, Germany, 41 pp. or this: Mironov, D., E. Heise, E. Kourzeneva, B. Ritter, N. Schneider, and A. Terzhevik, 2010: Implementation of the lake parametrisation scheme FLake into the numerical weather prediction model COSMO. Boreal Env. Res., 15, 218-230.

line 13 "artificially limited to 40-60 m depth". Is not artificial. Flake is not able to simulated deep lakes, as it consider only two layers. To lakes deeper than 40 meters it will be necessary to consider one third layer below the termocline.

page4 line 3. Only 1 station for all the lake?

page 5 line 10: T at which station, at which level?

line 15 – Why not use data from analysis (From ECMWF, for example)

Section 2.3 In my opinion, this section should identify the time periods in which Kd MERIS images were available. This information exists in a dispersed form in section 3.1.2..

line 26 – 31. It is not clear which Kd is used: in a spectral band (which ?), broadband ?

page 6 Section 2.4: In this section, the set-up of the simulations should be clearly presented, namely: - How were the FLake prognostic variables initialized? - The model integration period (start and end) - The temporal resolution of the forcing and the time step of the simulations.

lines 14/11 In this paragraph the ice parametrization used should also be introduced as it was activated. (maybe also the snow scheme).

line 18: what means “The setup conditions”?

line 19/20- depth of the water temperature measurements: why is it included here? The water temperature is not a forcing parameter...

line 21: why use the local depth (12.6 m) and not an averaged depth, maybe of the western basin? line 21: “to configure” means force initialize, or both?

page 7 line 11 (Eq. 2) and line 30 – Equation I don’t understand the process to adjust a relation between K_d and SDD. The equation Eq 2 indicate an inverse proportionality, but the expression obtained is not linear..

page 8 line 8: “can explain”? or can detect?

line16: $K_d = 0.87 \text{ m}^{-1}$: is a satellite-derived value or was in-situ measured? By the way, are there any in situ measurements on the selected day?

line 18: “on a monthly-basis for one year” but only four months were considered.

Figure 6 shows only particular days and not average values, but the text refers to monthly average values. This question is valid also for the discussion of the results presented in Figure 7. It should be indicated how the averaged values were calculated.

Figures 5, 6 and 7. With the chosen color scale, most of the field is in the same color. I think it would be better to use a color scale with higher resolution especially in lower values (could be a non-linear scale, possibly logarithmic). Also, the color scale should have a more detailed legend.

line 21/22 and 30: the values of K_d are satellite-derived values or were measured in-situ?

line 23 “full coverage of Lake Erie were only available in May of two consecutive years

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(2008 and 2009)”, but figure 6 show a map for May 2010. Contradiction?

page 9 Neither in the section 2.4, nor here, the start of the simulations were indicated.
line 18 and 20: Which depth were used in the Avg and Merged simulations?

In the Figure 9, results for 2007 there are plotted values for K_d for fall. Why are this values not shown in table 2 and not used in the merged simulation?

Analysis of figure 9: Some explanation for the strange spike that occurred in mid-September 2006 in the avg simulation? A less pronounced effect also occurred in mid-

page 10 line 3. It seems strange to defend that year average can be more representative of K_d variations than monthly averages...

line 5 “Turbid waters in these months simulate colder LSWT”. this statement must be explained. In my opinion, the reason is not on the fact that during those months the waters are turbid, but because the water was more turbid before, during spring and summer, reducing the heating of deep water. This should be discussed further, in particular by analyzing the evolution of deep temperature and column mean temperature (Flake variables)

line 11 “This can be explained” → “this is due to”.

line 12 The conclusion that “a realistic lake depth and K_d value will improve model results” is obviously correct, but, specially concerning the depth, could not be demonstrated using only the two depth values considered.

Figure 10 a and b: An hypothesis: If different colours were used for spring and summer-fall it may be possible to see and then discuss two different behaviours

Caption of figure 10: the means of a,b,c,d should be indicated

line 16/17 I do not agree with:”It is possible that the extent of K_d variations is best represented by the yearly average value”. Maybe the problem is that the errors in the

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determination of monthly mean values may result in a worse simulation...

line 24-26: I would be less categorical, adding for example at the beginning of the statement something like: “In the absence of reliable values of the temporal evolution of K_d , ...”

Considering that 12.6 m is the realistic lake depth must be better justified. see my comment (page 6 line 21)

line 33: The sensitivity of FLake to LSWT, MWCT, MLD, isotherm, ice phenology and thickness???

page 11 lines 2/4: which depth were used in the sensitivity imulations?

lines 4/5 More than the depth, what is important is to indicate the value of K_d in the RCM-12.6 simulation.

line 7 (maximum or Max) → Max will be enough.

line 8 The world faster does not seem the most appropriate in: “solar radiation is absorbed faster in turbid waters”.What happens is that the radiation is more absorbed in the water surface layer, as explained by the authors afterward.

line 9 “This shallow layer exchanges heat faster with the atmosphere”, is correct but should be explained, In my opinion the main reason has to do with the fact that the as the surface water temperature is higher the sensible and latent heat fluxes increase.

line 12/13 “However, in fall the loss of energy to the atmosphere is also faster due to the shallow mixing depth” This will not be the main reason. In my opinion the main reason has to do with the fact that the deep (and the mean) water temperature is lower.

line 14: “least turbid water” The use of the word “least” here can be confusing, as it is less turbid than what considered in the CRCM-12.6 simulation

line 15: “Min” is enough.

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line 18: “FLake is not significantly sensitive to LSWT” It is not correct in terms of English

line 25: Please delete the sentence: “For both clear and dark waters, LSWT is warmer than the MWCT, due to being exposed to more intense solar radiation.”. The reason is the density! (for water temperatures over 4°C)

lines 25/28. In this discussion it will be interesting to compare also with the FLake deep temperature.

page 12 line4 “two turnover”. In my opinion the first period without stratification should not be identified as a turnover. As I can imagine, the Flake were initialized with a constant temperature profile.

line 8/9 “As a result, the water column in clear water reaches the temperature of maximum density (4°C) much faster than turbid water ...”?? is not what we can see in Figure 11 (bottom) and in Figure 14!

lines 10 / 15 The average values over the whole period does not seem to be relevant in this discussion.

line 10 “In the turbid” → “In the more turbid”

line 13 “distribute to” “be absorbed in” or “distribute energy to”

line 16: We can not say that “The MLD is influenced by the water column thermal structure”. The MLD is itself a parameter used by Flake to characterize the water thermal structure...

Caption of figure 13. Please, improve the wording... The 4 individual figures should have the same caption.

line 19: “but also warmer” is not valid for the whole period. I think it will be more correct to say something like: “warmer in spring and summer, and colder in fall”

line 19/ 20: the sentences: “The reason is that solar radiation is mostly absorbed at the

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upper layers in turbid water. Thus, the radiation is used to warm up a thinner layer in dark waters leading to higher temperatures.” are correct but the argument is repeated some times on the text. In my opinion, it will be better to explain in a more integrated way, based on physics of course, the differences between clear and turbid waters.

line 21: “shows that the deepening of the thermocline layer in clear waters is monotonic”. I can not see this. Can you be more precise.

line 29: before the “increased effect of cooling from the layers below” it should be noted that as the surface temperature of the turbid lakes is higher, the radiative losses to the atmosphere are greater. So, during the heating period, a turbid lake as a whole, loses more energy by radiation and therefore stores less energy..

page 13 (before Summary and Conclusions) It is difficult to analyze the discussion contained in this page without knowing the details about the initialization of the simulations. And about observations? When occurred the break-up and the freeze-up?

line 13. “Dark waters store more heat in a shallower depth.” The sentence may be misunderstood. First consider change “depth” by “layer”. But if one consider the whole water column, dark waters store less heat. “Therefore, in the winter time”. In my opinion the “in the winter time” should be deleted, as this is also valid in summer and autumn (and may be more important during these seasons)

page 16 line 21. Arkady Terzhevik should be added to the list of co-authors

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