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Interactive comment on "Validation of lake surface state in the HIRLAM NWP model against in-situ measurements in Finland" *by* Laura Rontu et al.

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In response to your

Interactive comment on "Validation of lake surface state in the HIRLAM NWP model against in-situ measurements in Finland" by Laura Rontu et al. Jason Williams (Editor) williams@knmi.nl Received and published: 21 February 2019

Dear Editor,

thank you for your comment and the possibility to improve our manuscript as well as to clarify our points of view in the open discussion. We appreciate your effort to maintain the high level of the journal. It is of crucial importance also for us, and the other authors from the lake modelling community, who initiated and contribute to this joint

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Discussion paper

special issue (GMD + HESS) on lakes in NWP and climate models.

However, we do not agree with your main conclusion: "As it stands, the model data used for this paper has a significant drawback in that an error exists which directly affects the parameters under investigation. This significantly weakens any conclusions that can be taken away, resulting in a study which is not robust." In fact, we did not agree either with the comment of the reviewer: "Due to this bug the model data related to ice behaviour and spring LSWT tem- perature became unrealistic and therefore the corresponding results and discussions are of very limited interest." Our mistake was not to reply clearly enough to this point. We will now explain viewpoint in detail.

The aim of our paper was to validate HIRLAM, which introduced FLake parametrizations in 2012. For this purpose, we gathered data from the archived at FMI operational HIRLAM output for more than six years 2012-2018 and compared them with a significant set of observations on lake surface state, as explained in the manuscript. Our results indicated, in particular, that according to the operational HIRLAM forecasts, the lake ice tended to melt too early in spring. We then started to analyse possible reasons for this. We found that there was no predicted snow on most of the lakes, in particular on those we selected for a deeper study and comparison with the ice thickess and snow depth observations. The next step was to try and understand why was this. As we happen to have access to the HIRLAM reference code and the code that was modified for the operational usage at FMI, we were able to see that in the code one value of a coefficient, that regulates the start of accumulation of snow on lake ice, was too large. In earlier experiments more than five years ago we had seen that the original value suggested by the FLake authors should be used instead of this value which was tried during preliminary testing.

Thus, the whole "bug" was this: instead of the original

h_Snow_min_flk = 1.0E-5_ireals , & ! Minimum snow thickness [m]

a test value value

h_Snow_min_flk = 1.0E-3_ireals , & ! Minimum snow thickness [m]

was by mistake left in the FMI operational version (and in the tagged version of HIRLAM v.7.4). This was corrected in the development code of the reference HIRLAM in 2014 but the correction never entered into the official v.7.4. It was perhaps our mistake to call this unsuccessful coefficient value a bug or technical error, which could give basis for a misunderstanding.

To summarize: we validated operational HIRLAM in extensive model-observation intercomparison. We found some results which did not correspond well to observations - the forecast lake ice tended to melt too early every year. In the HIRLAM data, we found almost no forecast snow on lake ice. We discussed the physics related to the role of snow on ice, which indicated that the missing snow may enhance melting of the ice in spring conditions. We were even able to suggest a probable reason for the missing snow, namely a too large value of a minimum snow thickness coefficient, which effectively prevented accumulation of snow on lake ice.

Now, after all this work, we were surprised do hear that the paper cannot be published because the results of HIRLAM using integrated FLake parametrizations did not correspond well the observations about melting of ice in spring! Our aim was to compare observations and model results, not to ensure that the (past) HIRLAM forecasts were ideal. As authors of a validation paper, we cannot undo six years of operational forecasts (which have by the way served well the weather service in Finland all these years) nor redo them. It is simply not our task. Once more: we have not run experiments, we have validated operational weather forecast model results on lakes. We have not run stand-alone FLake forced by HIRLAM output, but we have reported comparison against observations of the operational HIRLAM that contains integrated FLake parametrizations. None of the reviewers has suggested that our validation methods, or the way to extract model and observation data for the comparison were erroneus. In our opinion, our validation results are not of a limited interest. They give an important message to all developers of FLake and NWP models that snow on lake ice should be

treated carefully.

You suggest two solutions of the "problem": use data from earlier experiments or wait till summer 2019 to see if the HIRLAM forecasts improved after the correction of the coefficient value. Unfortunately, the HIRLAM experiment data used e.g. for the papers of 2014 are not available anymore. The published papers did not discuss the snow and ice depth in detail so it is not possible to refer to them more than we already did. We only found output files from one, unreported test experiment for January 2012 where within a month, maximum of 17 cm snow accumulated on ice of our lakes. Waiting till summer 2019 is not a good alternative for a couple of principal and practical reasons: 1) as stated earlier, we are not responsible for the FMI operational HIRLAM updates, and do not know if our suggested correction was made early enough to ensure improvements in this spring, 2) we cannot guarantee that this single correction will solve all problems of lake ice forecast in spring - based on earlier experiments we would say that the correction is a necessary but possibly not a sufficient condition for more exact lake ice break-up forecast, 3) waiting till the summer would mean that we might submit the corrected manuscript not before early autumn 2019, hoping that the correction entered the operational system early enough (if not, wait one more winter till summer 2020 ...).

In addition, we would like to remind that parametrization of the snow cover on lake and sea ice is perhaps the most complicated issue for the relatively simple ice schemes that are applied within the NWP models. In HIRLAM for example no snow parametrizations at all are applied over sea ice. Originally, also FLake was recommended to be applied on lake ice without the snow parametrizations. In our first experiments, reported in 2010, this was indeed the case, as it still is in some other applications of FLake in NWP models.

Now, in response to your concerns, we suggest this solution:

1) Through the manuscript, we corrected our unfortunate formulations related to "bug"

and "technical error" in order to avoid creating misunderstandings.

2) We wrote a short discussion section about snow on lake ice, with proper references with respect to the current results. We coordinated the conclusion section and the new discussion section to avoid overlap.

3) We checked the whole manuscript in order to make it crystal clear for the editors, reviewers and readers that we are validating operational model results, aiming at detecting problems and suggesting improvements for further developments.

At the same time, we took the opportunity to modify and add a few references, improve the terminology concerning the lake ice melting and freezing and make a few minor text corrections.

We would be grateful if you shared this reply with the three reviewers, too.

21.3.2019 Laura Rontu Kalle Eerola Matti Horttanainen

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