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Hydrology and Earth System Sciences Discussions

Interactive comment on "Evaluation of 1-D tracer concentration profile in a small river by means of Multi-Layer Perceptron Neural Networks" *by* A. Piotrowski et al.

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We would like to thank Anonymous Referee #1 for his detailed discussion of the general assumptions of the paper. We are of course ready to make improvements in the final version according to the referee's suggestions. We are happy that the referee also appreciated the novelty of the paper.

The referee asked why there is a need to use this modular approach. The paper does not provide any indications about the type of results which can be obtained using a non-modular approach (i.e. single ANN to predict the whole time profile).

We attempted the non-modular approach, but, unfortunately, it didn't work very well. It

turned out to be impossible to properly evaluate concentration-time profiles at different cross-sections from one neural network, or any regression method. This was especially true when seeking a model that evaluates proper timing and concentration of the peak, reasonable shape of the whole concentration-time profile and good mass conservation. Some practical issues are worth mentioning. For example, it is important to note that if using one network to predict the whole concentration-time profile, a small timing error (i.e. phase shift of the profile) would in many cases have a rather negative impact on the objective criterion. This is likely because the error based on the difference between measured and predicted concentrations is much more sensitive to phase errors than to errors in shape of the profile. In addition, since the structure of the networks used for the evaluation of the rising and falling limbs was different to the structure of the network for evaluating the time of the peak, e.g. they have a different number of input variables and different (limited) ranges of output variable

The referee argues that, although in the Introduction we claim that this approach requires very little information about the river system, the counter argument is that the ANN models need a significant number of measured concentration-time profiles. Thus, what are the advantages?

We believe we have discussed both arguments in the paper, see parts 1 (Introduction) and 3 (Model input variables). For example, we suggest in part 1, that the proposed method may be of rather limited applicability in the present form. However, we indicate that the work reported is only a first step aimed at judging the feasibility of the approach. As this first step turned out to be relatively successful, we found it worth publishing as it may encourage other researchers to follow similar routes of working on data-driven models for these purposes. More importantly, in calibrating and validating any solute transport model, it is necessary to compare the model predictions against observations. Hence concentration-time profiles can be expected to be available whilst other measurements, for example, of hydraulic and morphological parameters may not exist. Hence, basing a model purely on concentration-time profiles would seem to have

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some practical advantages compared to ones that require additional data. Ultimately, of course, this argument would also need to consider how much effort is required to collect the necessary data for different modelling approaches.

The referee suggests that the paper does not provide the details of the procedure used for selecting the sets of input variables used in the study.

It should be noted that we made a detailed argument of using each input variable in part 3 (Model input variables) of the paper, referring to the scope of the paper, relations between different variables and the quality of the data. But we did not discuss in such detail why variables typically employed in previously published work on mixing processes (e.g. channel dimensions, roughness etc) were not used. The response to the previous referee's comment helps to justify this, such parameters were not relevant to the approach being used. In addition, in this first approach we excluded all morphometric variables because data from only one river were considered, hence variables like sinuosity or river width (in the absence of over-bank flow during floods, would be constant. The flow depth would be a function of flow and water velocity, both of which can be estimated from the concentration profiles. For predictive purposes we wanted to use only easily available information as inputs, as a result variables like shear velocity, which are difficult to evaluate, were excluded.

The referee noted that, although we compared the predicted peak concentration and its timing with another existing method, no such comparison was made for the rising or falling limbs. The referee suggested a comparison with a multiple linear regression approach using the same input variables as our approach. At this point we would like to stress that linear as well as nonlinear regressions may be treated as particular cases of neural networks. When linear regression is considered for the given experiment and the same input variables please note that the concentration depends linearly on time which does not promise reasonable results.

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