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Interactive comment on "Reduction of predictive uncertainty in estimating irrigation water requirement through multi-model ensembles and ensemble averaging" *by* S. Multsch et al.

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Reply to "Geosci. Model Dev. Discuss., 7, C2866–C2868, 2015"

Referee 2: The authors analyses the uncertainty in estimating irrigation water requirement by applying six models for ETpot and 5 Kc values (in total 30 simulations). They found that the uncertainty caused by different model approaches is much larger that uncertainty caused by Kc values. Furthermore, they state, that multi model ensemble prediction provide reliable estimates which can be used for management.

Referee 2: In principle study this is an interesting, well conducted study. Nevertheless, I do have some concerns with respect to the general approach. Six different ETpot models were applied and tested against class A pan data although it is well known that class A pan data may not be the best method to measure ETpot and not for all stations pan-coefficients were available. Therefore, uncertain class A pan data were used in an uncertainty study assuming that class A pan data are certain.

Authors: We are aware of that the utilization of class A pan data in our manuscript comes along with uncertainties and we did not assume that the data are certain. But isn't this the case for every kind of measurement? The alternative is not to calibrate and verify models and apply them in an unobserved fashion (which is most often done when evapotranspiration is being simulated in hydrology). Class A pan data at least provide insight into patterns and evaporation behavior. Another reason for using Class A pan data is that there are no other measurements at hand, which we could use instead. This is a general problem in simulations of evapotranspiration. Despite that this water balance component significantly contributes to the total balance, researchers often simulate it without any data for calibration or validation at all. Knowing that there is not one perfect model, reliability ensemble averaging (REA) utilizes the information provided by several models of the cohort. Finally, the idea of using the REA method is, that one component of REA, i.e. RB, weights the different models concerning how good they match observed values. Hence, an estimate of the natural background variability (i.e. of the bias) of the target variable (as stated on 7535, lines 4-6) is needed. This is the reason why we have used Class A pan data in the course of our REA experiment.

Referee 2: Furthermore, all other uncertainties related to climate (radiation, temperature, rainfall, . . .) and uncertainty related to regionalization of the punctual information are ignored.

Authors: We agree that the forcing data itself introduce additional uncertainties. However, this is not part of this study and it would clearly go beyond the scope of our work presented here. Nevertheless, on the long term we think that more research needs to be put in the investigation of the global predictive uncertainty of models, where all sources of uncertainty are evaluated, i.e. spatial input data uncertainty (e.g. soil and land use information), model forcing data uncertainty (e.g. climate data), parameter uncertainty, and model structure uncertainty. This would allow to distinguish between the different sources and identify those components that contribute most to the predictive uncertainty of modeling (e.g. Exbrayat et al. 2014). We will extent the discussion and discuss other sources of uncertainty as well, i.e. regionalization, class-A pan data and forcing data.

Referee 2: The six ETpot methods differ in data demand and representation of the underlying processes. Some of them use empirical parameters (like PT). These parameters were taken as certain although they are also uncertain. One could have calibrated the empirical parameters of the ETpot equations using the class A pan and studying the effect on IRR. An interesting question would also how the selection of the ETpot method (there are much more in literature, see Bormann) do effect the findings.

Authors: Yes, we could have used more ET functions, but we have restricted our analysis to the most commonly applied methods in the region as described in the introduction (page 7530 lines 13-25). The consideration of other ET functions would have extended the picture drawn in this manuscript, but the overall message would have remained the same. Further, we did not want to calibrate each method. This is almost never done when ET is simulated on large scale. Moreover, the idea of the REA approach is not to identify one best model and improve it, but to use the information of several models in a statistical way. Here we show that this concept is straightforward to use and helps to improve predictions of water requirement on the large scale.

Referee 2: It seems that the authors assume that nothing is known concerning the applicability of different ETpot methods to specific regions like the MDB. For me the argument is not convincing that many models do use these approaches because in this case one has to train the user to apply only models applicable to specific questions and regions.

Authors: We argue that in many studies, in particular in macroscale or global studies, the choice of the ET function is not validated in a regional context, in particular if the crop coefficient concept is applied as described in the introduction (page 7529, lines 15-25, page 7530, lines 1-12). We recommend to compare different methods in such a case and suggest to apply a method to reduce the uncertainty, e.g. by reliability ensemble averaging.

Authors: Yes, but in addition to calculate the uncertainty of a single model or a model parameter, we show an option to reduce the uncertainty by using a method (REA) which is commonly applied in climate sciences. Again, our objective is not to find one best model, but rather use the information content of several models. In that sense, we show that the REA concept is a helpful method in geospatial model applications.

Referee 2: If the main message is that ensemble averaging improves the prediction of IRR than I wonder if all ETpot models should be considered although it is clear that some of them are not reliable. If the argument is that it is not clear for other regions which ETpot model is reliable (I would not agree with such a statement) then one has to consider much more approaches as used by Bormann.

Authors: We agree that Bormann (2011) gives a more complete picture of the structural differences between ET methods. Instead of using all methods presented by Bormann (2011), we have considered the most commonly applied methods in Australia. We think that the consideration of more functions would not have changed the outcome of our work.

Referee 2: I recommend repeating the uncertainty analysis but leaving out the two ETpot methods evaluated as poor. Furthermore, I recommend to "calibrate" the empirical parameters of the ETpot data using class A pan data and discuss regionalization as well as other uncertainties.

Authors: The elimination of one ET method for whatever reason is subjective. The reliability ensemble averaging method gives an objective criterion to weight the different models, so that models with a poor performance (weighting factor RB) or models which

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differ in a large extent from the simulated ensemble average (weighting factor RD), receive a lower weight. By doing so, REA automatically punishes poorer performing models – there is no need to act as suggested by the referee due to the method we apply.

Referee 2: The paper is well written. I only wonder why the authors discuss CO2 dependency (pages 7542-7543) because this is a very specific aspect not covered by the paper. I would delete this part.

Authors: Will be deleted.

Literature

Bormann, H.: Sensitivity analysis of 18 different potential evapotranspiration models to observed climatic change at German climate stations, Climatic change, 104(3), 729–753, 2011.

Interactive comment on Geosci. Model Dev. Discuss., 7, 7525, 2014.