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Interactive Comment

Interactive comment on "A framework to utilize turbulent flux measurements for mesoscale models and remote sensing applications" *by* W. Babel et al.

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We thank the editor for his constructive comments. We modified our paper according to the editor's and the reviewers' comments. Nevertheless, we also want to give a reply to the editor's comment for clarification of some issues.

1. Scale: *"The paper needs to emphazize more clearly which scales are adressed and especially where the limits of the applied method are. In their response the authors argue that their method is not applicable to areas of size of 25 km^2 , but claim at the other hand that it should provide a useful approach for the validation of satellite flux* *estimates. They given MODIS data with 1 km^2 size as a reference here. However I agree with reviewer 1 that it is of high interest if the method is applicable also on larger scales, like for instance thermal infrared data from geostationary satellites. Given the fact, that the Lindenberg observatory is oper- ating a scintillometer with a path of approximately 4 km length, it is an interesting question if this data could be of any value to validate a 4x4 km^2 satellite pixel for instance. Shortly speaking, it is not clear where the limits of the method are to the authors opinion. I would therefore recommend the authors to carefully investigate the potential and especially limits of their method in a revised version of the manuscript. I could imagine that this could be done with a synthetic experiment, running a SVAT model at different spatial resolutions."*

The spatial limitation for the application of the method is given by the errors of the area averaged flux. If this area averaged flux has an accuracy significant lower than the eddy-covariance measurements (classes 4 and 5 in Table 7), it makes no sense to use such an area as ground truth. In Central Europe this may be about 1 km^2, while in more homogeneous areas like deserts, bush land and some boreal areas this may be larger up to 25 km^2.

The application of large aperture scintillometers was excluded from our investigation, because they measure an area averaged flux with a very specific footprint (Meijninger et al., 2006). That means, the LAS flux is only comparable to the grid cell flux, if the grid cell shows the same contributions of each land use type as the footprint of the LAS. It is very difficult to disentangle pure fluxes of the land-use types from the LAS measurement. The accuracy depends strongly on the applied universal function for the calculation of the surface flux from the structure function (Foken, 2008, Appendix p. 253). For the proposed method we wanted to use a direct measuring method (eddy-covariance) and no indirect method. The problem of application of scintillometer measurements for area averaged fluxes is discussed in Foken et al. (2010) and Meijninger et al. (2006). Furthermore the commercially available scintillometers do not measure the evapotranspiration, which is the highly interesting parameter.

The used SVAT model is a single column model, using mean meteorological standard data with a half-hourly time step. This data as well as the parameters are not available as effective parameter on different scales. Without such data, the use of this model does not show new information on different scales. Moreover we think, that the limits can be well explained with the error analysis made in the paper. We pointed this out in the revised version, as it was not formulated explicitly before.

2. Applicability: *"Both reviewers did criticize the application of the method on rather homogeneous targets and criticized that this is an oversimplification of a real application. The authors respond that the testing of the method is only applicable in case of homogeneous areas and it is understood that this is the best way to start with the validation of the approach. Nevertheless, the reader will not know in the end if the suggested method is also applicable for more complex surface conditions. Again, where are the limits of the method? What is driving the limitations? Can authors give a threshold on the maximum degree of complexity where the method is applicable?"*

This question is related to the first paragraph of our answer on the first topic. It will be made more clearly in the revised paper. Furthermore the degree of heterogeneity depends on the model to be validated (meso-scale, flux calculation from remote sensing data). If it is highly non-linear, the heterogeneity should be low for the evaluation of the model code.

3. Model-data synergies: *"Reviewer 1 did criticize that the authors use a suboptimal approach to balance between the information content from the observations and the model simulations and suggests to use data assimilation as a method to combine the two. The answer of the authors is unsatisifactory to my opinion, which might be due to a misunderstanding of the reviewers suggestions. Authors respond that DA can not be used, as a) only a few point like FluxNet stations are available worldwide and b) models often do not support DA. To my understanding, the reviewers intention was to use DA with the used model to get a best estimate of the mesoscale surface fluxes, weighting* *the uncertainties of the model and observations. It sounds like a durable approach and I highly recommend the authors to pursue or at least discuss DA in a revised version of the manuscript."*

We see, that data assimilation is an approved strategy, where information of observations and simulations can be merged. Nevertheless, in our case we do not believe, that implementation of DA gives us any benefit. We could imagine some opportunities, which might have been addressed by reviewer #1 and the editor, but for our opinion, this is not suitable:

The used SVAT model is a single column model which runs for each time step for which input data are available. Because we compare model data with eddy-covariance data the time step of the model calculations is identical with the typical averaging period of eddy covariance data (30 minutes). Therefore no statistical averaging method is needed for this issue.

DA could be combined with the tile approach to calculate the grid representative flux. This approach has the disadvantage in our opinion, that measurements were mixed with model results in any case. However, the purpose of the grid representative data is mesoscale model validation, and this should be done with unaltered measurements as long as possible. Therefore it is straightforward to conduct the spatial integration only above a threshold, i.e. when the differences in fluxes between land-use types exceed measurement and model uncertainty. The usage of classified quality features and error margins is typical when dealing with eddy-covariance measurements and thresholds were frequently used for EC data processing (Falge et al., 2001; Foken et al., 2004; Papale et al., 2006). Therefore we use the tile approach without DA, as applied e.g. in Beyrich et al. (2006), which is still state of the art for such problems.

At last, assimilation of the only sparsely available eddy-covariance data in mesoscale models of different types is not usual from our point of view. For this purpose model simulations were compared with eddy-covariance data for single grid elements, where

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such data are available, as done e.g. in Bastiaanssen et al. (1998); Boegh et al. (2009).

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