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Interactive comment on "The implementation of a MiXed Layer model (MXL, v1.0) for the dynamics of the atmospheric boundary layer in the Modular Earth Submodel System (MESSy)" *by* R. H. H. Janssen and A. Pozzer

Anonymous Referee #3

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General comment

The manuscript clearly describes the MXL model implemented in MESSy. The manuscript is well written and the objectives are clearly included in the subjects treated by GMD.

In spite the title of the manuscript, the paper is mainly devoted to explain not the implementation of MXL in MESSy but the structure of the mixed–layer model, which is not a

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new model at all.

Most of the manuscript is devoted to explain the mixed–layer model. This model, as it is mentioned in the manuscript, has been developed, and its description already published by previous authors (e.g. van Heerwaarden, 2011, or some of the works by J. Vilà among others).

On the contrary, the novelty of the work, which is the implementation of MXL in MESSy, is only described in one and a half pages (7219–7220).

Finally, the authors use only two pages to show the results of the new MXL/MESSy and how these results compare with observations recorded during the DOMINO campaign and MXLCH numerical simulations obtained by van Stratum et al. (2012). In this comparison, I cannot see what is the improvement of the inclusion of the MXL submodel in MESSy.

For these reasons, specially considering that most of the manuscript is devoted to describe the MXL, a model not developed by the authors, the manuscript cannot be published in GMD in its present form, and intensive major changes are needed.

Major comments

1. Keeping in mind that authors did not develop the MXL model, I have serious concerns about the publication of the manuscript in its present form. More than 75% of the manuscript (section 2, the largest one) is devoted to explain the MXL model, something that has been already published by several authors. The authors are perfectly ware about this fact, and, for this reason, they include many references where the model is described and used for different boundary–layer studies.

   To my opinion the manuscript should avoid most of the explanations about the MXL model, focus on its implementation in MESSy and check the improvements

of this implementation by comparing the results against additional observations, and MESSy/without MXL and MXLCH numerical simulations.

2. If I'm not wrong, the authors never mention how MESSy worked before the inclusion of the MXL submodel. For instance, how the boundary layer depth was estimated? To my opinion, it would be necessary to clearly show the improvement of the model a comparison for the same data set of MESSy with and without the MXL submodel.

3. Regarding the results obtained for the DOMINO campaign (section 4), I cannot see a clear improvement when MESSy results are compared against MXLCH (see Fig. 6 of the manuscript). I cannot see any comment about this point. Moreover, to my opinion, it would be necessary to compare more than one day or dataset to check the validity of the model.

Minor comments

1. The title is not a description of the content of the manuscript because most of the pages are devoted to explain the MXL model and not to explain its implementation in MESSy.

2. Page 7202, lines 15–20, eq. 3. I don't understand why you need to introduce ? in your notation. If $\omega = Div(\mathrm{U})$, please use only $Div(\mathrm{U})$. Note that you use also U for the velocity module, which includes also the convective velocity (see eqs. 21, 41, and 60).

3. Page 7204, line 1: please include any reference for the choice of the value of the entrainment flux ratio.

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4. Page 7207, eq. 21. You are using the same symbol (U) for two different definitions of the velocity (compare with eq. 3 and the lines below).

5. Page 7212, line 9. Please introduce in the text $z_{sl} = 0.1h$ to define the surface layer as you did in page 7213.

6. Page 7218, line 12. I'm quite sure Vilà–Guerau de Arellano et al. (2015) were not the first, or the only ones to suggest the parameterization of the momentum surface fluxes. Please include previous references, for instance Stull (2000).

7. Page 7219, line 9. Figure 4 is referred before Fig. 3. Please change the order of these figures.

8. Page 7220, line 26: include "(see Table 1)" after "... despite the positive latent flux ...".

9. Page 7221, line 11: "MESSY/MXL" to "MXL/MESSy".

10. Page 7221, line 23. "a.m" to "LT".

11. Page 7222, line 7. This is not a new result at all. Previous works (de Arellano et al., 2004; Casso–Torralba et al., 2008 among others) have already pointed out the importance of morning entrainment on the mixed–layer concentration of compounds. Please comment.

12. Caption Fig. 2. "Typical midday mixed–layer profiles ...". Please clarify that the arrows don't mark the actual direction of the fluxes.

13. Figure 7. Superscripts are needed for the units of the y–axis.

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