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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

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Second reply to anonymous referee 3

First of all I would like to thank the authors for the quick answer to my first comments. Second, I'm satisfied with the all answers gave to my comments except regarding point 1, which was my main concern to the manuscript. The authors are right when describing the parts of the model already shown by van Heerwaarden and Vilà. However, my point was that all the equations presented by the authors were already described not in

a single paper but in different previous works. Consequently, keeping in mind that most of the present manuscript is devoted to the MXL model, this is more a MXL review than a paper explaining how MXL is implemented in MESSy and how it works. In this sense, I totally agree with the authors when they say ' working with MXL/MESSy may find it helpful to get an overview of all equations used in this model in one paper. Besides, : : :' However, to my opinion this will be totally fulfilled if a technical report is included in the distribution of MESSy, as many models do.

To clarify this point, besides some general books, I refer some previous research works (some of them already cited by the authors) where the different parts of the MXL model have been already described. 1. Heat budget: Tennekes (1973), Tennekes and Driedonks (1981), Pino et al. (2006). 2. Moisture budget: van Heerwaarden et al. (2009, 2011) 3. Momentum budget: Fedorovich (1995), Conzemius and Fedorovich (2006), Schröter et al. (2013). 4. Nonreactive species: Culf et al. (1997), de Arellano et al. (2004), Casso-Torralba et al. (2008), Wyngaaard (2010), Pino et al. (2012, 2013). 5. Chemistry: Vilà-Guerau de Arellano et al. (2009), Ouwersloot et al. (2011), Vilà-Guerau de Arellano et al. (2011), van Stratum et al. (2012), Ouwersloot et al. (2012). 6. Land surface and model: van Heerwaarden (2009, 2010, 2011)

Finally, I can imagine that Vilà et al. (2015) don't only provide a general description of the MXL, or only deal with momentum parameterization (this work is only referred at pages 7200 and 7218 of the manuscript). Could the authors clarify what is the detail of the MXL model given by Vilà et al. (2015) in their book (in press)? I suspect that in this reference all the equations regarding MXL model are already included and explained in detail. If I'm right, I cannot accept the paper as it is. To be accepted, the authors should rewrite it, avoiding most of the description of the MXL and focusing on the comparison of the model results including the MXL module against some experimental campaigns. In this sense, I assume that working at MPI Mainz give the authors a large amount of observational data analyzing different aspects of the boundary layer, for instance, aerosols or chemistry.

We thank the reviewer for his/her second comment. We do see his/her point that every equation presented in the MS has been described in one or more previous papers/books. Nevertheless, this set of equations is for the first time presented homogeneously in the same manuscript. The mentioned book by Vilà et al. (2015, in press) indeed describes the equations of the MXL model, even in more detail as they are here (for instance by including derivations of the governing equations), but it also includes large parts (like modules for photosynthesis and clouds) which are not part of our implementation in MESSy.

A fundamental question here is if this journal could accept a manuscript presenting a new implementation of already well know algorithms/processes. We think that the idea of the GMD journal is to present new code, independently if the algorithm/process was already described in the past. Although we have not developed a new model, the implementation in MESSy is new, and this is the main point of the manuscript. Now, the MXL model can be used together with any present (or future) MESSy submodel, and we believe that this is the main novelty of our work. To make clear that we have not invented a new process description, we have included many references to previous work on the MXL model (which has further been completed by the reviewer). Compared to the MXL description, we have devoted little space to the novelty of the work. To make the paper a bit more balanced we will add a description of the MESSy structure.

To the argument of the reviewer that the equations could be published in a technical document, we argue that a paper in GMD basically is a technical document. Therefore, the standard procedure of the MESSy system is to publish all code in a technical journal publication, formerly in ACP (as a Technical Note) and nowadays in GMD, the journal founded for this purpose. In this MS, we describe the equations that are new to MESSy (i.e. the MXL equations), because other submodels that will be used in combination with MXL have already been published in the MESSy special issue (www.geosci-model-dev.net/special_issue10_22.html). Together, these papers form the technical document, which describes the MESSy framework and the submodels

that can be used in it.

Considering the evaluation of MXL/MESSy, we are planning to evaluate MXL in combination with different MESSy submodels in studies of specific processes. As mentioned in our previous reply, the MXL dynamics have been extensively evaluated against measurements and other models, and therefore the performance of MXL/MESSy depends on the other submodels with which it is coupled. For example, we are currently working on an in-depth evaluation of the organic aerosol submodel ORACLE (Tsimpidi et al., 2014) coupled to MXL and other submodels through the MXL/MESSy framework. However, such an evaluation would go into more depth than would fit within a GMD manuscript, because it involves many scientific rather than technical questions.

In conclusion, we believe that this manuscript fits well within the journal scope, despite the fact that MXL is not per se a new model. Nevertheless, in order to make more clear what can be considered novel in our work, we will expand Section 3, adding a more detailed explanation of the MESSy interface implementation.

We will add (p7219, line 2):
'MESSy is an interface to couple submodels of earth system processes, which offers great flexibility in selecting different geophysical and -chemical processes. In the first version of MESSy, only the General Circulation Model (GCM) ECHAM5 could be used (Jöckel et al., 2005). The second round of development also enabled the use of basemodels with different dimensions (Jöckel et al., 2010). For the current implementation, we used MESSy version 2.50.

Here, we give a brief overview of the MESSy structure, more details can be found in Jöckel et al. (2005, 2010). In MESSy, each FORTRAN95 module belongs to one of the following layers:

- Base Model Layer (BML): defines the domain of the model, which can be box, 1D or 3D. This can be a complex atmospheric model, for instance a General Circulation Model like ECHAM5 (Jöckel et al., 2005), but in our case it consists of two boxes stacked on top of each other (Fig. 3).

- Base Model Interface Layer (BMIL): this layer manages the calls to specific submodels, data input and output, and data transfer between the submodels and the base model. Global variables are stored in structures called 'channel objects'.
- SubModel Interface Layer (SMIL): the submodel-specific interface layer collects relevant data from the BMIL, transfers it to the SMCL and sends the calculated results back to the BMIL. The SMIL contains the calls of the respective submodel routines for the initialization, time integration, and finalizing phase of the model.
- SubModel Core Layer (SMCL): this layer contains the code for the base model-independent implementation of the physical and chemical processes or a diagnostic tool.'