

## ***Interactive comment on “ESM-Tools Version 4.0: A modular infrastructure for stand-alone and coupled Earth System Modelling (ESM)” by Dirk Barbi et al.***

**Dirk Barbi et al.**

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Dear Sir/Madam,

First of all we would like to thank you for the detailed comments you provided for our manuscript, they were much appreciated and we hope that we were able to improve the paper by carefully re-writing the mentioned sections. We especially tried to give a clearer overview, partly by adding extra explanations to the description chapter, partly by re-arranging paragraphs from the discussion to earlier parts. Also, we included several more examples of YAML configuration files, to make it clearer what we are talking about.

Concerning the detailed comments, let me shortly answer those point by point:

**\*\*SPECIFIC COMMENTS\*\*** (P: page, L: line or lines) Agreed, we added requested reference. Agreed, we tried to make that clearer by explicitly mentioning that ESM-Tools does not help with the coupling at all, but with the application of already coupled models. Agreed, we elaborated on provenance tracking and reproducibility. 4. We rephrased that to make it clearer. Additional comments to different parts of the manuscript:

"Abstract" - P1 L4f: The reason is that even though starting from the same model component, scientists develop their own version with additional features, that might or might not end up back in the development trunk. E.g. echam-wiso, echam with concurrent radiation, etc. Added a sentence to the abstract. - P1 L5f: Changed sentence "This procedure not only leads to a strongly growing number of available versions of model components and coupled setups, but also to model- and system-dependent ways of obtaining and operating them." to "This procedure not only leads to a strongly growing number of available versions of model components and coupled setups, but also to model- and HPC-system dependent ways of obtaining, configuring, building, and operating them." - Agreed, done. "Introduction" - P1 L20: Changed sentence "Earth System Models (ESMs) are widely used for studying past, present and future climates. They can include several model ..." to "Earth System Models (ESMs) are widely used for studying past, present and future climates, processes in the different Earth system compartments (e.g., atmosphere and ocean), as well as the interactions between them. Therefore, ESMs can include several model ..." - P1 L21: Changed list "atmosphere, ocean, land and sea ice, land biosphere, ocean biogeochemistry" to "atmosphere, ocean, ocean biogeochemistry, land and sea ice, land biosphere, hydrology" - P2 L23: Moved the sentence "Since the ESMs are usually written for a specific purpose, they often lack modularity." a bit further down. And changed it to: "Since the ESMs are usually written for a specific purpose that e.g. require a specific coupling and/or tailored ESM components, they often lack modularity.. This lack of modular-

ity ...” - P2 L48: Added the mentioned reference and cited in line 49. - P2 L44ff: Added an list item for ESMF: “\item The \textit{Earth System Modeling Framework}, ESMF\footnote{\url{http://earthsystemmodeling.org/}} is a standard software platform for Earth system models \citep{Hill2004}. It provides different structures for the inter-connecting between model components and provides a standard support library for the construction of components. The emphasis of ESMF is to ensure a standard infras-structure of component coupling and may require code adaptation in order to fit into its framework.” - P3 L83: I changed the sentence “The ESM-Tools emphasize the needs of researchers for such a software and fills this gap by fulfilling the specified criteria.” To “The ESM-Tools emphasize the needs of researchers for such a software and fills this gap by fulfilling the criteria such as user-friendliness, modularity, portability, main-tainability, extendabilty (see also Section~\ref{sec:yamlconf}).”

"ESM-Tools Description" - Moved the part from the discussion here, and added a more detailed overview. - P4 L93ff: See comment above, tried to make that clearer in the text and with examples. - P4 L98: Rephrased that. - P4 L110: Explained that in more detail, and added a YAML snippet - P5 L113ff: Elaborated on that, and included another YAML example - P6 L137ff: Explained that in detail, also added that to the “modu-lar” section. Added the sentence: “In contrast to other software described above, e.g. MESSy or ESMF, ESM-Tools are designed to help scientist to build and run different standalone models as well as coupled setups without any need of code adaptation. To ensure this, all ESM components need to have a dedicated coupling already imple-mented.” on page 4 line 88. - P7 Fig1: We explained that in the first part of description now. - P8 Fig2: Nah, I like the figure, but we added an explanation to the text of it - P7 L165ff: I don’t think that esm\_runscripts and the mentioned workflow tools are com-parable. What esm\_runscripts tries to do is to provide a common interface - common “runscripts” so to say, even if no scripting is involved anymore - to a growing number of model components and coupled setups, to make the application of ESMs easy and unified across the ESM community. Even though we naturally try to cover more and more of the workflow involved, we are far from workflow managers like the ones men-

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tioned by the referee, of which we will be able to learn much in the future. - P8 L175f: We referred to a future publication, that will include more topics on data processing with ESM-Tools. - P8 L185ff: The tool `esm_master` does, and the GUI just displays the information `esm_master` has anyway. - P9 L192ff: see above, comment P6 L137 - P9 L200: Elaborated on that a bit, not sure if I understood the comment correctly. - P10 Tab3: We added a column for the coupler of the setup. - P11 Fig4: We deleted the Figure 4 (old numbering) and removed the sentence: "Figure~\ref{fig:models} illustrates how these models can be coupled together, resulting in various models and coupled systems which are supported by the ESM-Tools." Page 9, line 198. - Done that, added several more examples. "ESM-Tools Development" - P11 L209: No, we don't. Even following SCRUM is a bit over-the-top for this, we call our approach SCRUM-light. . . Maybe a development plan should be implemented in the future. Added the sentence "The ESM-Tools software is currently hosted and developed on GitHub (see also \textit{Code availability})." Also: Can you provide any recommendations in software development, which are worth being shared? Not really, except what is mentioned in the paper already. In our opinion, a structured project management is fundamental to a successful software development. In scientific context though, the need to react to user problems, changing HPC environments, new model developments etc makes it really difficult to go "full SCRUM", which is why we adapted the philosophy of SCRUM, while not taking it too seriously at times. SCRUM light, if you want to call it that way. "Discussion" - P13 L252ff: Done. - P14 L295ff: Agreed and done.

I hope we could include all suggestions of the referee, and want to thank him/her again for the kind help. Dirk Barbi, for the ESM-Tools team

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