Answer to RC 1:

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)

1.   Agreed, we added requested reference.

2.   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.

3.   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 modularity …"

- 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

interconnecting between model components and provides a standard support library for the construction of components. The emphasis of ESMF is to ensure a standard infrastructure 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, maintainability, extendablilty (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 "modular" 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 implemented." 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 comparable. 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 mentioned 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 iin 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 out 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.

Answer to RC 2:

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

p2l2: Rephrased that to make it clearer..

p2l39: Explained that, and added Paul Gierz's SCOPE paper as reference

p2l44: The author is right, and I tried to explain why.

p3l68ff: Explained that this is our experience as model supporters, avoided the criticized language

p3l83:Rephrased that:

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, maintainability, extendablilty (see also Section~\ref{sec:yamlconf})."

p4l94: Addressed the comment by adapting the paragraph

"To achieve this, the code of the ESM-Tools is organised so that all information about models (e.g., HPC systems, input datasets) are contained in YAML\footnote{\url{https://yaml.org/}} configuration files, while the actual program, i.e. the commands to be performed using this information, is in itself entirely independent of the models or HPC systems used, and has been fully re-coded in Python."

Changed to

"To achieve this, the software architecture of the ESM-Tools is structured so that all information that are mandatory for an experiment (e.g., HPC systems, input datasets) are contained in separate YAML\footnote{\url{https://yaml.org/}} configuration files, while the actual program, i.e. the commands to be performed using this information, is in itself entirely independent of the models or HPC systems used. For this purpose, the ESM-Tools software has been fully re-coded in Python (see also Section~\ref{sec:python}) compared to previous versions."

p4l96: Removed the reference to a previous version due to other referee's comment

p5l113: Made that clearer, meant coupled setup.

p5l124ff: Changed LaTeX 'itemize' environment to 'description' environment.

p6l131ff: Added a figure and explanation

p6l43: If external packages are included with ESM-Tools (and the fact mentioned in the article), it should be mentioned which and why. That is just how python works… Yes, we include expernal packages, but a well-written setup.py makes sure that all dependencies are met during the installation process. I don't agree with the statement that a list of packages should be included as it doesn't add information about our product - I don't think the reader needs to know in this instant which YAML reader we use, for example. And there is always the documentation for these detailed questions....

p7l165: Added the half sentence "…in terms of functionality."
Changed the sentence: "This tool consists of optimized implementations of all the functionalities to run an ESM." to "This tool consists of optimized implementations of all the functionalities to set up all required phases to run an ESM simulation."

p8f2: added an explanation on the caption of the figure

p8l174: Included reference to a future publication

p8l188: This refers to the repositories of the supported models. Added "… of the models" here.

p9l191ff: Added some text, also two figures with yaml

p11f4: It is supposed to show that we warp different compilation strategies.

p12l231ff: This is a misunderstanding. The code is hosted and developed on Github. Added the sentence on page 11, line 214: "The ESM-Tools software is currently hosted and developed on GitHub (see also Code availability).". Also changed paragraph at page 12, line 135 by adapting the sentence to "This can be done by contributing to the development on GitHub (e.g., by pull requests). Furthermore, users can suggest a "wish-list" of missing functionalities (e.g., via issue tracker)."

p12l298: This is a misunderstanding. Both, code and configuration are hosted and developed on Github. See also comment above. Made that clearer in the text.

Technical corrections

p7f1: Changed figure: esm_master get-model1 -> esm_master install-model1 and added other tasks.

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