

Review of 'Development of "Physical Parametrizations with Python" (PPPY, version 1.1), and its usage to reduce the time-step dependency in the ICE microphysical scheme' by Sebastien Riette

General comments:

This paper gives an overview of a new python tool to evaluate parameterizations used in numerical models, and in particular to address the issue of time step dependency of results in the Meso-NH model. The tool is first used to evaluate the time step dependency in the cloud microphysical parameterizations of Meso-NH, and additionally several other microphysics schemes used in the WRF model. The causes of the time step dependency are highlighted and a revised version of the model is later evaluated. This is achieved through using the tool in 0D mode. Later, the tool is extended to a 1D simulation, where two sedimentation schemes are evaluated against a more sophisticated reference.

The paper addresses an important area – of changing behavior of numerical parameterizations when used with different timesteps, or with under different forcings. The area is becoming increasingly important within the area of Physics-Dynamics coupling. Therefore such a tool could provide great benefit to the community, especially because it enables the use of existing model code (in fortran), despite the tool being coded in python.

Overall, the paper is well written and clear. However, there are areas where more discussion would be very helpful for the reader (and potential tool user) – in particular in the introduction of the tool and description of how to apply it for existing model code. Additionally, I find the lengthy discussion of the errors and biases in sedimentation schemes in the second half of the paper to be too much. There are numerous papers that already evaluate a diverse range of sedimentation schemes and this paper needs not repeat some of that. It would be sufficient to demonstrate the applicability of the tool in such a situation. I strongly recommend the publication of this paper, after minor revisions.

Specific comments:

1. As a potential future user of this tool, I would appreciate a greater and clearer introduction of how the tool works. The language is still quite technical in places and certain terms (e.g. "objects", "libraries" and "decorators") are likely not well understood by future readers. While I acknowledge that there is extra information in the documentation of the tool, I suggest adding some more description to the paper. In particular I would like to see some more advice regarding the interfacing of the fortran code to the python tool. The current description sounds rather ad-hoc and I'm not clear how I would replicate this method.
2. There is no description in the paper as to how this tool was used to identify and fix the causes of the time step dependence. The findings themselves are listed on page 9. Some additional description of how this tool enabled these model parameterization errors to be found and fixed is needed. This is the main benefit of this new tool, so it would be useful to see how it should be used.
3. This paper is not the place to discuss in detail the merits of different (and in this case rather simple) sedimentation schemes, therefore I suggest shortening this section to allow for the above expansions.
4. The figures in this paper (which, I think, are produced by the PPPY tool itself) are missing units on all axes. Additionally, Figure 3 does not make clear which parameterization scheme is shown in which panel. There two failings need to be fixed. Ideally, not just in the paper, but also in the code of the tool itself (for future users benefit).

5. There seems to be inconsistent model forcing used for the different schemes (or inconsistent physics regarding condensation in the different schemes). Comparing figures 1, 2 and 3 – the water vapor content (black line) for the shortest time step (1s) converges on a value of around 8 g/kg after 180 seconds, whereas for the other schemes in figure 2 and 3, the water vapor converges on 6 g/kg. What is the reason for this difference? Can it be corrected? I understand that the microphysics schemes will give different results for the hydrometeor concentrations, but the simple balance between temperature, water vapor and condensed water should be more or less the same for all schemes. At the moment it is difficult to compare results between the different figures/microphysics schemes.

Minor comments:

6. page 5, figure 3. It is impossible to tell from figure 3 and the caption, which of the subpanels relate to which microphysics scheme. This should at minimum be added to the caption, and preferable to the figure panels too.

The label “Schemes (line styles)” in the top left of each figure could easily be replaced by (e.g.) the scheme name/abbreviation for each panel.

The comparison of different microphysics schemes in figure 3 is initiated with a rather unrealistic setup (approximate relative humidity is 165%). In full (3D/4D) model simulations, such supersaturation would never occur, and the microphysics schemes should not be expected to treat such situations fully realistically. Nevertheless, I find the differences between the schemes very interesting – I would be particularly interested to see how these same schemes performed in more realistic setups (e.g. with significantly reduced supersaturation at $t=0$ and/or when a constant cooling rate is applied)

7. page 8, bullet points lines 9-28. These are all very interesting findings, but how did the PPPY tool help you to discover these factors as being important. It would be good to show the benefits of the tool you developed in achieving these findings. Was it simply a trial-and-error process, or is there some aspect of PPPY that enables these errors to be determined more quickly?

8. page 8, line 27-29 please clarify what you mean by “the conversion rate of graupel into hail is now computed from the wet growth rate of graupel and not from the total content of graupel”. How large is this difference and why does it make such a difference?

9. Figures 11, 12 & 13. please make clear that the x-axis is timestep length (dt) – it could also be interpreted as timestep number (i.e. as a time-height plot)

Technical/language corrections:

- page 2, line 9-10. please provide more details about what differences were seen in the Meso-NH model when the time step was changed?
- page 3, line 9. what is a “tool package”. Where can the reader find it?
- page 3, line 13. “makes possible” → “makes it possible”
- page 4, line 1 correct to “consists of a python package written to ...”
- page 4, line 5 delete “which is the required”
- page 6, line 3 “needed to use the parameterization” → “needed by the parameterization”
- page 6, line 6 “that not exist” → “that do not exist”
- page 7, line 4 “to plug other” → “to plug in other”
- page 7, line 5 “one have to define” → “one has to define”
- page 8, line 2 “dependency on the simulation” → “dependency **of** the simulation”
- page 8, line 11 please quantify what you mean by “small time steps”

- page 8, line 18 it is not clear to me what you mean by “graupel growth mode”, please give more details
- page 8, line 23 “has melt into rain” → “has melted into rain”
- page 8, line 25 “insure” → “ensure”
- page 9, line 10 & 11. please use standard scientific notation (e.g. 1.0×10^{-5})
- page 9, line 11. please quantify the “substantial additional cost”
- page 9, line 16 “unique” → “single”
- repeated grammatical error (e.g. page 12, line 9; page 12, line 31; page 13, line 1, page 13, line 7):
“Longer is the time step, more this part is important” → “The longer the time step is, the more important this part is”
- page 12, line 31. What is the “it” in “it reaches around 11%”?
- page 13, line 5 “mean content is weaker” → “mean content is less”
- page 13, line 20 “by consequences” → “as a consequence”
- page 13, line 24 “this induces” → “this means”
- page 13, line 25 “larger to one” → “larger than one”
- page 14, line 3 “None of both schemes” → “Neither of these two schemes”
- page 14, line 9 “weaker” → “less”
- page 14, line 28 “whatever is the time step” → “whatever the time step is”
- page 14, line 32 “hypothesis done” → “hypothesis”
- page 15, line 2 “certainly reduce” → “certainly reduced”
- page 15, line 10 “This scheme allows to make fall the bigger drops quicker” → “This scheme allows the bigger drops to fall more quickly”