

Geosci. Model Dev. Discuss., referee comment RC2  
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## Comment on gmd-2021-89

Anonymous Referee #2

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Referee comment on "SymPKF (v1.0): a symbolic and computational toolbox for the design of parametric Kalman filter dynamics" by Olivier Pannekoucke and Philippe Arbogast, Geosci. Model Dev. Discuss., <https://doi.org/10.5194/gmd-2021-89-RC2>, 2021

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This paper describes a new toolbox based on the authors long-term research on parametric Kalman filtering. This tool is rather complete and compute symbolically the time evolution of parameterized covariance model and simultaneously integrate the resulting equation numerically. It leverages the power of a well-established CAS tool (SymPy) which provide a guarantee of longevity to the work done.

First, I commend the authors for their nice description of the package and methods, with code usage details. I also appreciate the release of their code on github which allows people to contribute on the project.

Nonetheless, I concur with reviewer 1 that there is an issue with the narrative at the section 2.3. Therefore, I suggest to accept the manuscript upon a major revision.

### Major comments

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My main comment is that the authors jump directly from section 2.3 into the example of VLATcov models without detailing further the theoretical framework of PKF, making it hard for the reader to conceptualize the approach. For instance, maybe this is a notation issue, but it took me some times to realize that  $V$  and  $s$  (or  $g$ ) were the set of parameters  $p_i$  of section 2.3.

The idea of explaining things with an example is of course a good one, but here I think that simply giving the references at line 123 for the theoretical framework is not enough. Also, the organization of the sections forces the reader to go back and forth between section 2 and 3 to understand what is going on.

I suggest to the authors to rewrite sections 2 and 3 in a more streamlined fashion.

#### Intermediate-order comments and questions

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\* Line 73: "The connection between the Markov process and the parameter dynamics is obtained using the Reynolds averaging technique."

Could you provide a citation for the Reynolds averaging technique?

\* Sentence line 185 to 187: "In contrast to the matrix dynamics of the KF, the PKF approach is designed for the continuous world, leading to PDEs for the parameter dynamics in place of ODEs Eq. (8) for the full matrix dynamics."

What if Eq. (2) is used instead of Eq. (1)? Is there still an advantage to use PKF in this case? More generally, the authors seems to consider also systems like Eq. (2), but then only focus on PDEs. Does that means that SymPKF don't handle such kind of systems? If it does, I would have like an example with a system like Eq. (2). In particular, how to handle SymPKF in this case? Maybe that could be shown in an Appendix.

\* line 187: "For the above mentioned scalar fields, introduced is the computation of the algorithmic complexity in section 2.1, the cost of Eq. (16) is  $O(n)$ ."

Please check this sentence. Also I think that the algorithmic complexity is not mentioned in Sec. 2.1 but rather in Sec. 2.2.3

\* Section 4.3.2 :

Can the closures considered be related to closures found in parameterization scheme?

#### Minor comments

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\* line 310: 'Latter' ? Please check this sentence.

\* line 445: 'lager' -> 'larger'

Recommendation about the code

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This is not part of the article review but rather a few technical comments about the code to make it better in the long end:

\* I advise the authors to develop a proper documentation for their package API. This will encourage and help further collaboration on the code.

\* In the same vein, the code could be more systematically commented.