

## ***Interactive comment on “Towards the sequential assimilation of SAR-derived water stages into hydraulic models using the Particle Filter: proof of concept” by P. Matgen et al.***

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This paper by Matgen et al. reports a “proof of concept” study regarding the use of particle filters for the assimilation of SAR derived water stages into hydraulic models. While the topic is undoubtedly of interest and relevant for HESS the study presented has limitations that are not recognised in the text by the authors. These act as significant qualifiers on the conclusions. The paper is generally well written, though the presentation could be more concise. At points the use of equations rather than, or along with, textual description would add greater clarity.

Scientific Comments:

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1. Pg 1787 Line 25 – Pg 1788 Line 10: Some comment on the relative level of accuracy of the two techniques, and why one may be preferred over the other in certain situations would be useful.
2. Pg 1788 Line 20 “As a matter of fact, . . .” This isn’t fact. All observations of the system being modelled contain useful information – the difficulty is extracting it appropriately. If the uncertainties of a given observation are greater the simulation uncertainty, this suggests; if there is no other information (including a priori information) then your simulation uncertainties may be too small.
3. Pg 1788 Line 25 – Surely also because on smaller catchments satellite passes are too infrequent? Also water level observations are probably still the most accurate observation available at a given point. More a case should be made for combining both.
4. Pg 1789 Line 23 – Parameter updating has a significant history beyond the referenced paper. A more complete discussion would be useful, why prefer state updating to this? Are they actually different? The references in Smith et al. 2008 may be of use.
5. Pg 1790 Section 2.1 – A proof of concept experiment should be representative enough of the real problem for any conclusions drawn to (hopefully) be transferable. Two immediate limitations of this experimental design are:
  - (a) The same model is calibrated as is used to generate the data; there is therefore no structural error.
  - (b) Failure to recognise potentially non-stationary bias and variance in the observational error structure.

These limitations are not even mentioned until the final paragraph of the conclusions, then only in passing without commentary as to their impact on the results presented.

6. Pg 1792 Section 2.2. – The presentation of the particle filtering algorithm is far too basic given this is a substantial part of the ‘novelty’ of the paper. Note the SIR still suffers from particle degeneracy. I suggest the authors revisit some of the recent particle filter literature, for example the references in Smith et al. 2008 or Fearnhead 2002, and prepare a more detailed description.
7. Pg 1793 Line 5 – You presume errors are uncorrelated in space and time. In reality this would appear highly optimistic. This and the above comments suggest your experiment suggest to me that this something of a best case scenario for how well the technique can perform.
8. Pg 1794 Line 12 – Here and elsewhere (e.g. Pg 1799) model ‘re-initialization’ is mentioned. What do you mean by this? Is it the simple substitution of new water levels into the model or is the model allowed to process them in some way to stabilise itself?
9. Pg 1976 Section 2.4 – this means of ensemble generation makes some significantly different assumptions to those in the formal Bayesian particle filter? State these. How do you combine the two approaches? Is this the best way to go or should the flow observations be assimilated into the hydrological model that is being used to drive the hydraulic model in a consistent fashion?
10. Pg 1798 Lines 15 – what were the magnitudes of the other corruptions e.g. to the input data. Maybe these should be set out in Section 2.1. Was the variance presumed known in the data assimilation? You could integrate out the variance in the analysis. This could be done with an informative prior distribution based on published values and analytically given your simple error model. The posterior distribution could then be commented on.
11. Pg1801 - Interesting gain type correction. Does it fail systematically, for example on rising limbs of the hydrograph where the ratio of errors may change rapidly,

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particularly if the model or input has timing errors.

## Textual Comments:

1. Abstract is too long. Some of this would be better in the introduction.
2. Pg 1790 Line 10 – “need to untap new ways” should be rephrased.
3. Pg 1795 Section 2.3 – Maybe a map would be useful and allow the volume of text to be reduced?

## References

Smith, P. J.; Beven, K. J. Tawn, J. A. *Detection of structural inadequacy in process-based hydrological models: A particle-filtering approach* Water Resources Research, 2008, 44

Fearnhead, P. *Markov chain Monte Carlo, sufficient statistics, and particle filters* Journal of Computational and Graphical Statistics, 2002, 11, 848-862

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