

# ***Interactive comment on “On the efficiency of the hybrid and the exact second-order sampling formulations of the EnKF: A reality-inspired 3D test case for estimating biodegradation rates of chlorinated hydrocarbons at the port of Rotterdam” by M. E. Gharamti et al.***

## **Anonymous Referee #2**

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Review of the paper titled "On the efficiency of the hybrid and the exact second-order sampling formulations of the EnKF: A reality-inspired 3D test case for estimating biodegradation rates of chlorinated hydrocarbons at the port of Rotterdam" submitted to Hydrol. Earth Syst. Sci.

The paper presents an assimilation approach to subsurface contaminant transport problem inspired by the port of Rotterdam in the Netherlands. A multi-dimensional and multi-species reactive transport model is coupled to simulate the migration of contami-

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nants within subsurface flow model. The biodegradation chain of chemicals is modelled for five decades. An artificial measurement data for the concentration is build using a synthetic setup and then used for updating the concentration and degradation rates in presence of model and observational errors. An adaptive hybrid ensemble Kalman filter is evaluated along side the exact second-order sampling formulation introduced by one of the authors in an earlier publication. The paper is well written and the presented numerical results are interesting. However, the test setup assumed perfect knowledge of the distributed subsurface parameters (permeability and porosity) which is generally unknown except at few locations.

I find the results convincing but would recommend that the authors add the following to the numerical study:

1- The utilized models and state parameter estimation techniques are limited to online updating systems which in many cases are known to under-perform iterative schemes (ensemble smoother where all the data is assimilated at once) specially within an annealing framework in what is known as ensemble smoother with multiple data assimilation. Can the author include that in their numerical study.

2- Could the authors re-run the model with the estimated parameters from the initial time step without data assimilation to assess the quality of the estimated parameters.

3- Uncertainties in spatial parameters (permeability and porosity) is a very interesting topic. Can the authors include some elements of that in their study even in a simplified way?

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