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Interactive comment on "On the numerical integration of the Lorenz-96 model, with scalar additive noise, for benchmark twin experiments" *by* Colin Grudzien et al.

Anonymous Referee #1

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The authors make a thorough investigation about the effects of numerical discretization error that practitioners often ignore in the data assimilation (DA) community. They study the bias, caused by the time-discretization error, on the ensemble-based statistics and filtering performance for twin experiments in the Lorenz-96 system with an additive noise. Three numerical schemes are investigated: the Euler-Maruyama scheme, a Taylor scheme of strong order 2, and a Runge-Kutta scheme, which are of strong order 1.0, 2.0 and 1.0 (also, weak order 1.0,2.0 and 1.0) respectively. The authors tested forecast ensemble statistics, and ensemble data assimilation with different levels of observational noise, with different levels of diffusion for all the tests.

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Discussion paper

The paper is well-written and pleasant to read. The results provide a guidance on designing twin experiments in data assimilation. I recommend its publication. The following are a few points that the authors may want to address before publication.

Suggestions:

- In Section 3.1, there should be an explanation on that, in the order tests with different time-steps, how the Taylor scheme in Section 2.5 is implemented. In particular, how the random vectors are added up to consistently approximate the multiple stochastic integral (which leads to the Taylor scheme).
- In the convergence order tests, three time-step sizes are used, and this is not very convincing, in particular in Figure 2. It would be more convincing to use about four or five time-step sizes. Instead of $\Delta = \{10^{-i}\}_{i=1,2,3}$, the authors may use other bases, e.g. $\Delta = \{2^{-i}\}_{i=5,...,9}$
- The conclusion seems weak and too specific (in particular, the time-steps in this specific test setting are presented without further analysis). It might be helpful to explore more on the balance between the level of diffusion and the right-hand-side of the equation, as well as the Lyapunov exponent of the system.
- there might be typos in the indexing of i, j, b in Eq.(15-16).

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