Geoscientific Model Development Discussions

Geosci. Model Dev. Discuss., referee comment RC1
https://doi.org/10.5194/gmd-2022-69-RC1, 2022

Comment on gmd-2022-69

Anonymous Referee #1

Referee comment on "A local particle filter and its Gaussian mixture extension implemented with minor modifications to the LETKF" by Shunji Kotsuki et al., Geosci. Model Dev. Discuss., https://doi.org/10.5194/gmd-2022-69-RC1, 2022

I think this is an interesting article, which shows the potential of particle filters (and particularly two flavours of localised particle filters) in large scale atmospheric applications. The authors build on an existing LETKF computational frameword to implement and experiment with these localised particle filters. The implementation is very nicely detailed with schematics and direct comparisons of the algorithms, including step-by-step contrasts, and quantifying the computational costs.

I have some minor corrections and questions I would like to have answered before I can recommend this article for publication.

Short summary:
-- Quantifying millions of observations does not mean much if one does not quantify the number of state variables. I would eliminate 'millions'.

Introduction:
-- Cite van Leeuwen 2021 (a consistent interpretation of the stochastic EnKF) when discussing perturbed observations.
-- Cite Wang et al 2004 next to Bishop 2001. After all, it is the symmetric transform variant which is used in practice.
-- Line 62. Even PFs with proposal densities collapse, although at a slower rate.
-- Line 69. How do local PFs ensure continuity between particles in different regions? Maybe mention something brief on this regard.

Methodology
-- Lines 96-97. The sentence 'Transform matrix...' could be rephrased to avoid word repetition.
-- Line 147. Why write H(x)-y in the Gaussian likelihood. You had used y-H(x) when

describing the EnKF. It is better to keep consistency in the paper.
-- Line 205. Can there be a similar 'adaptive inflation' as Miyoshi's (and previously Anderson's) for the weights of the LPF?
- Line 225. Does the LPFGM reduce to the LPF when \gamma->0?
-- Figure 2 is really nice an illustrative of the differences between the LPF and the LPFGM.

Experimental settings
-- Line 298. There is an incomplete sentence starting with 'Although... '
-- Line 805. Are these identical twin or fraternal twin experiments? I.e., is there model error?
-- Line 825. Why was this specific variable chosen to tune the localisation scales?
-- Line 830. Why was T chosen? I would think that, if you want to exploit the PF advantage, you would choose a variable like relative humidity.
-- Line 880. In the regular PF, the number of particles to avoid filter collapse has to be of the order exp(Neff^2), where Neff is the effective size of the problem, according to Snyder et al 2008. Then van Leeuwen and Ades (2013) showed that Neff is proportional to the number of independent observations. I therefore thought that filter collapse would happen with the sparse observation network. It is clear that filter collapse and filter divergence are different then. Could you explain the difference and the mechanisms leading to them?
-- Line 890. Why does frequent resampling lead to filter divergence? Does this have to do with the space-wise continuity of the fields not being ensured?