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Interactive comment on "Quasi static ensemble variational data assimilation" *by* Anthony Fillion et al.

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The authors have performed a thorough study of the applicability of Quasi-Static (QS) variational data assimilation schemes on an ensemble Kalman smoother (EnKS), leading to the iterative ensemble Kalman smoother (IEnKS). The QS algorithm has been shown to be crucial by Pires et al. (1996) in 4DVar DA on nonlinear chaotic models. That procedure keeps the analysis error within the region of validity of the linear tangent approach, which nearly corresponds to the cost-function attraction basin including the true model state.

The manuscript is very well written, structured, rigorous, and presents some novel results, being thus well suited for publication in NPG. There are only a few aspects

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which would be worth to mention or discuss which could still improve the manuscript.

1 In section 3 (Quasi Static algorithms) it is worth to mention and to put into context the 'Sequential Quasi Static Variational Assimilation' (section 4.2 of (Pires et al. 1996)) as a variation of the QS scheme. There, the QS scheme is only applied to the very beginning DAW. Then, as time progress, the long DAWs move forward by small steps but at the expense of overlapping with previous DAWs. In the subsequent DAWs, a single 4DVAR-DA is performed using the first guess provided by the DA issued from the previous DAW. Therefore, in a sequential DA scheme the QS scheme is not necessary if a substantial overlapping of the DAWs holds (observations assimilated multiple times). However, the cost may be larger or comparable to QS with large jumps of the DAW.

2 In the discussion of upper triangles of Figs. 8 (L95) and 9 (L63), showing the average smoothing and filtering errors, the authors should discuss how far it is useful to increase the DAW length. In Pires et al (1996), it is presented the concept of useful assimilation window $\sim$ -ln(0.01/(2 Lambda-max), beyond which the DA is not useful anymore where Lambda-max is the Largest Lyapunov value. Giving the steps delta-t and lambda-max, the authors may provide the largest useful DAW length Lmax.

3 In the discussion and conclusions, the authors should add a small paragraph on the limitations of extending the DAW length in DA with nonperfect models (refer to Swanson et al 1998).

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