Interactive comment on "Ensemble Variational Assimilation as a Probabilistic Estimator. Part I: The linear and weak non-linear case" *by* Mohamed Jardak and Olivier Talagrand

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The paper in subject is a valuable addition to the ongoing debate on the best strategy to perform ensemble data assimilation. The Authors evaluate the performance of an EDA type system (which they call EnsVAR) as a probabilistic estimator in linear and weakly-nonlinear regimes for two toy models. This is new, as most of the previous literature on the subject had focused on its performance as a deterministic estimator or as a tool to compute error estimates for a reference unperturbed analysis system. I found the paper interesting and well-written. Before recommending it for publication i suggests that some aspects, which I detail below, be further improved or better clarified.

1) Lines 54-56: I am not aware of the paper by le Gland et al, 2009, and I am not sure it is generally available as it appears to be an internal research memo of a specific institution. Further, I do not think it is actually necessary in this context, if we take the view that the EnKF converges to the KF for large ensemble size and the KF is a consistent bayesian estimator for linear dynamics and gaussian errors;

2) Lines 64-65: "They exist in numerous variants, many of which have been mathematically proven to achieve bayesianity in the limit of infinite ensemble size". Please provide relevant references;

3) Line 102-105: The Bardsley et al. 2014 reference appears to be missing. Some further discussion of their method would be useful here, as the response of the EnsVAR method to nonlinearities is the central issue of this paper;

4) Lines 177-179: I do not understand this remark and the implied derivations behind it. Can the Authors please expand?

5) Lines 4337-438: "We have evaluated the Gaussian character of the ensembles...by computing their negentropy". I suspect the Authors have verified the Gaussianity of some marginals of the full pdf, not the Gaussianity of the full multivariate distribution. Can the Authors be more specific on this pooint?

6) Lines 444-447: Can the lack of sensitivity of the analysis pdf to the pdf of the observations be considered a consequence of the Central Limit Theorem, or do the Authors have an alternative explanation?

7) I think it should be made clear that the comparison with the EnKF and PF is only qualitative, as the EnKF/PF results are known to be very sensitive to localization/inflation and there does not appear to have been a lot of work in this paper aimed at finding the optimal valuues;

8) Regarding the EnsVAR and EnKF comparison, I would expect the two systems to give equivalent results in the purely linear case. Have the Authors verified that this is

the case, or if it is not why?

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