Review of "Hybrid Levenberg-Marquardt and weak constraint ensemble Kalman smoother method"

by J. Mandel, E. Bergou, S. Gürol, S. Gratton, and I. Kasanický

27 December 2015

1 General impression

The manuscript has been very significantly revised and improved. In my opinion, the treatment of the literature is now satisfying. The choice made in giving a focused and detailed algorithm of the EnKS-4DVAR in pages 8 and 9 is, I believe, a good idea. The added value of the paper remains in the inner loop being solved by an EnKS and the use of a stochastic variant in the family of the four-dimensional EnVar methods. The numerics seem now detailed enough although the outcome are not entirely convincing. But this cannot be required with this first attempt.

Overall I believe the paper is now acceptable, with a few very minor comments/suggestions listed below.

2 Minor comments

1. l.30: "gaussian" $\longrightarrow$ "Gaussian"
2. l.50: the "e.g." should be in the parentheses.
3. l.118: "For background...(2003)." I don't understand what the purpose of this sentence is.
4. l.123: please explain that L refers to a time index.
5. l.151: "N(m,A)": explain - at least once - that N is the Gaussian distribution.
6. l.174-175: "This technique is commonly used...(2009)." This is indeed a very well-known trick at the heart of the EnKF. Citing Chen and Snyder (2007) and Mandel et al.(2009) is really inappropriate. I believe that for such a very well known property, you either don't cite anyone (implicitly referring to Evensen, 2009), or you cite one of the earlier papers by Houtekamer and Mitchell who introduced/emphasized it.
7. l.235: "gaussian" $\longrightarrow$ "Gaussian"
8. l.325: You should mention the time-step while referring to the Runge-Kutta method.
9. l.337: 0.1 as a time-step seems too large for me. This is definitely too large for the 40-variable Lorenz model. The Lorenz-63 model can be even more sensitive. Did you perform a sensitivity analysis?

10. l.369-373: You reach the same conclusion as in Bocquet and Sakov (2014) (τ is really the same parameter as ϵ) which shows there is a comfortable range of safe values. This is worth mentioning.

11. l.387: "6 observations" $\longrightarrow$ "6 observation vectors"

12. l.405: "into Object" $\longrightarrow$ "into the Object"

13. l.406: "developed by European" $\longrightarrow$ "developed by the European"

14. l.480: "N=30000" that is very, very large. Especially for 1600 state variables. Why such a choice?

15. l.505: "For smaller...small": Did you intend to split the sentence?

16. l.530: "those of obtained" $\longrightarrow$ "those obtained"

17. l.550: "there is nothing to prevent the use" $\longrightarrow$ "there is -a priori- nothing to prevent the use" would be so much closer to the truth...

References

Bocquet, M. and Sakov, P.: An iterative ensemble Kalman smoother, Q. J. R. Meteorol. Soc., 140, 1521–1535, doi:10.1002/qj.2236, 2014.