General comments:

This paper introduces a new technique for estimating the covariance inflation factor needed to help mitigate the problem of filter divergence often encountered when using EnKF data assimilation methods. Their approach is novel in the sense that computes these estimates by minimizing an objective function based on the concept of generalized cross validation, a technique commonly used in the machine learning literature. There is considerable overlap between the fields of data assimilation and machine learning and I appreciate that the author is trying to bridge the gap between these two fields. In my opinion, there is much that we can learn from one another

However, the paper falls short of offering good comparisons for their new technique. Rather, it is more a proof-of-concept that this technique works better than the basic EnKF, which is known not to work well without inflation. There are a few additional questions that I would like to see answered:

1. How does it depend on the ensemble size and the number of observations?
2. How does it compare with other the inflation schemes mentioned? What are the computational tradeoffs?
3. What does the time series of the inflation factor look like? Is it smooth?
4. Does it prevent the problem of ensemble divergence?

I understand that some of these questions fall under the future work category. But I do think it should be explicitly stated that this paper is intended just to show proof-of-concept, and that a more thorough comparison will be forthcoming in the near future.

The paper also needs considerable grammatical revision. In my following comments, I have tried to be as explicit as possible in offering suggestions.

Specific comments:

1. P3 L3-13: The author implicitly assumes the existence of a `true' underlying state of the system. While this assumption is common, it is still an assumption. Also, be careful about saying: "are more close to the true state than either of them..." and "can be technically easily obtained by minimizing a cost function...". The former is not necessarily true, the latter depends on what you mean by `easy'. While it it is easy enough to run an optimization algorithm to minimize the cost function, you have no guarantees that the solution is unique when the models are nonlinear. Finding the most appropriate analysis state (i.e the global minimum) is a much more difficult problem.

2. P5 L1: Would leave-one-out cross validation be applicable to data assimilation, where the data is a time-series?

3. P5 L4-16: Why is Generalized Cross Validation better? What makes it generalized? What are these "favorable properties" of "consistency of the relative loss"? I understand it has not been used much in data assimilation, but I think this should be more explicitly motivated, as it is the core method of this article.

4. P5 L17-19: I don't understand these statements. What does it mean to be "inflated properly"? How does it "reassign the weights"? The segway to analysis sensitivity does not follow logically to me.

5. P9 L9: Please specifically state how you actually compute lambda_i. I assume you minimize the GCV as an objective function?

6. P10: If $S^f = I - S^o = I - A_i$, then can't the GCV_i function be interpreted as minimizing the normalized forecast sensitivity?

7. P14 L2: Any motivation for setting the ensemble size at 30?

8. P14 L15: Are there other examples in the literature to compare this correlation coefficient to? Should ideally it be as close to 1 as possible?

9. P15 L22: Can you be more precise than this: "seems to be a good objective function"?

Technical corrections:
1. Title: An estimate of **the** inflation factor and analysis sensitivity in **the** ensemble Kalman filter
2. P2 L7: Why does it "need" to be inflated? What happens otherwise?
3. P2 L10: I would say the method is "tested" not "validated". Validation to me implies a more thorough comparison.

> My suggestion for the abstract:
>
> **The Ensemble Kalman Filter is a widely used ensemble based assimilation method, which estimates the forecast error covariance matrix using a Monte Carlo approach that involves an ensemble of short-term forecasts. While the accuracy of the forecast error covariance matrix is crucial for achieving accurate forecasts, the estimate given by the EnKF needs to be improved using inflation techniques. Otherwise…?**
>
> **In this study, the forecast error covariance inflation factor is estimated using a generalized cross-validation technique. The improved EnKF assimilation scheme is tested with the atmosphere -like Lorenz-96 model with spatially correlated observations, and is shown to reduce both the analysis error and its sensitivity to the observations.**

4. P3 L3-13: This paragraph needs some revision. See scientific comment 1 above.
5. P4 L1: What does it mean "gradually important"? I also think this needs a more motivation about what why inflation is used. Assume the reader has never used an EnKF before.
6. P4 L1-15: Past tense seems more appropriate here: "tune" -> tuned, "select" -> selected
7. P4 L5: **However, such methods are very empirical and subjective.**
8. P4 L8: How does moment estimation "facilitate the calculation"?
9. P4 L10: "obtain a better **estimate of the inflation factor**, but…"
10. P4 L16: **The idea of cross validation was first introduced in linear regression and spline smoothing.**
11. P4 L20: **In cross validation, the data is divided into subsets, some of which are used for modeling and analysis while others are used for verification and validation.**
12. P5 L21: "sources"
13. P5 L22: Replace "The quantity can be introduced…" with: **In the context of statistical data assimilation, this quantity describes the sensitivity of the analysis to the observations, which is complementary…"**
14. P6 L3: **This study focuses on methodology that can be potentially applied to geophysical applications of data assimilation in the near future.**
15. P6 L14: **dynamical forecast model**
16. P7 L4: series of analysis **states**
17. P8 L16: "~~The~~ multiplicative inflation"
18. P8 L18: **by estimating the inflation factors \lambda_i**
19. P9 L16: In **the** EnKF, "can be treated" -> **is**
20. P9 L17: and forecast. **That is,**
21. P10 L14: **detailed** proof
22. P10 L14-15: Why quotes? Should there be a reference?
23. P10 L15: "degrees of freedom for **the** signal"

24. P10 L16: Reference for its interpretation as "amount of information"? Is this heuristic or in an information theoretic sense?
25. P11 L5: … states **usually underestimates** the true forecast…
26. P11 L6-10: **This will cause the analysis to over rely on the forecast state, excluding useful information from the observations. This is captured by the fact that for the conventional EnKF scheme the GAI values are rather small. Adjusting the inflation of the forecast error covariance matrix, alleviates this problem to some extent, as will be shown in the following simulations.**
27. P11 L22: I would say **Numerical Experiments**
28. P12 L2: validated -> tested
29. P12 L4: performance~~s~~
30. P12 L12: Cyclic boundary conditions
31. P12 L13: ~~to be~~
32. P12 L15: are analogous to
33. P12 L18: performance~~s~~
34. P12 L20: **The time step for generating the numerical solution is set at 0.05 non-dimensional units, which is roughly…**
35. P13 L1: I would maybe move this sentence up, before you discuss the time step.
36. P13 L10: correlate, which is **common in applications involving remote sensing and radiance data.**
37. P13 L20-22: **Modifying the forcing strength F changes the model forecast considerably. For values of F larger than 3 the system is chaotic. To simulate model error, the forcing term for the forecast is set to 7, while using F=8 to generate the `true' state.**
38. P14 L5-7: **The increase in GAI from 10% for the conventional EnKF to 30% for the EnKF with forecast error inflation indicates that the latter relies more on the observations. This is important because…**
39. P14 L8: **To evaluate the resulting estimate, …**
40. P14 L10-11. … values of the GCV functions **decrease sharply** … right?
41. P14 L12: I don't understand this statement. Did you mean to say "The **variance** of the analysis? "
42. P14 L15: **…which indicates that the GCV function is a good criterion to estimate the inflation factor.**
43. P15 L3-6: **Accurate estimates of the forecast error covariance matrix are crucial to the success of any data assimilation scheme. In the conventional EnKF...**
44. P15 L7-8: **But limited ensemble size and large model error often cause it to be underestimated. This produces an analysis state that over relies on the forecast and excludes the observations, which can eventually cause the filter to diverge.**
45. P15 L10: Begin new paragraph with this sentence. **The use of multiplicative covariance inflation techniques can mitigate this problem to some extent. Several methods have been proposed in the literature, each with different assumptions. For instance, the moment…**
46. P15 L16: …**but requires computing high dimensional matrix determinants**.
47. P15 L18: but **is limited to spatially independent**…
48. P15 L19: **is estimated using generalized cross validation.**
49. P16 L2-7: These sentences are perhaps better suited for the introduction, say on p5.
50. P16 L11: … compared with the conventional EnKF scheme.
51. P16 L13: **This suggests that this method of minimizing the GCV works well for estimating the inflation factor.**
52. P16 L15: What do you mean by "varieties"?
53. P16 L16: "The influence matrix…" this does not need to be restated.

54. P16 L19-22: **The time-averaged GIA statistic increases from about 10% in the conventional EnKF scheme to about 30% using the proposed inflation method. This illustrates that the inflation mitigates the problem of the analysis depending excessively on the forecast and excluding the observations.**

55. P17 L1-2: What do you mean they are "more reasonable"?

56. P17 L3: **It is also worth noting that the inflation...**

57. P17 L4-5: **Forcing all components of the state vector to use the same inflation factor could systematically overinflate the ensemble variances …**

58. P17 L7: Start a new paragraph here. **The examples shown here using the Lorenz-96 model illustrate the feasibility of this approach for using GCV as a metric to estimate the covariance inflation factor.**

Comments on Figures:

1. Figures 1 and 2 are not really that instructive for me.

2. Figures 3 - 5 would benefit from using different colors to distinguish between the traces.