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Interactive comment on "A regional carbon flux data assimilation system and its preliminary evaluation in East Asia" *by* Z. Peng et al.

Anonymous Referee #2

Received and published: 8 September 2014

Major comments:

The authors developed a data assimilation system to analyze CO_2 surface flux (i.e., emission) with an EnKS and CO_2 concentration (i.e., initial condition) with an EnKF. The system performance was evaluated with an OSSE framework by assimilating GOSAT CO_2 retrieval observations. This review found that the subject is interesting and the method and results are valuable. However, the presentation of the manuscript needs to be improved before it can be accepted for publication. Below are specific comments in detail.

1. Paper Title: you are not only doing CO_2 flux, but also doing CO_2 initial condition. Should the title reflect this?

2. P20346, Line 2: what do you mean by "finer scales"? Your OSSE is done with 64km x 64 km resolution, hard to justify "finer scales". Maybe just say "grid scales".

3. Line 4: "simultaneously assimilating . . .". Should use "analyzing". The word "assimilation" should be applied to observations, not quantities to be analyzed.

4. Line 4: "simultaneously". This is not really true because flux and concentration are analyzed sequentially. It is more appropriate to directly say here that EnKF for analyzing CO_2 initial conditions, EnKS for analyzing CO_2 flux.

5. P20350, Line 23: GOSAT XCO should read "XCO2"?

6. P20351, Eq. (1): The statement here is confusing with the OSSE part, where F_0 is referred to as the truth. Overall, superscripts/notations used in the paper are confusing, not all consistent. "prior", "background", and "forecast" typically represent the same thing in the data assimilation framework. Also, does surface flux have vertical variation? If not, it should just be the function of (x,y,t), not (x,y,z,t). If so, it needs to be stated clearly.

7. Line 12: "exchanges", why not use the word "fluxes". It sounds like you are talking about a different quantity.

8. P20352, Eq. (2) uses "M", but figure 2 uses "M+1".

9. P20353, Line 4: not very clear what is the "signal-to-noise" problem, an how it is resolved in this study.

10. P 20358, Line 20: does simulated observations consider observation error?

11. Eq. (22): do you need ensemble of F_b, like in Eq. (1)? Not clear how initial ensemble was created for EnKF/EnKS.

12. Line 25: "random number" needs to be more specific, distribution, mean, variance etc.?

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13. P20359, Line 5: why so big number "70" for Beta inflation factor? Any explanation?

14. "Lag-window", is that same as "smoother window"?

15. Line 9: needs to specify the year of OSSE.

16. Better to state that the goal of OSSE is to retrieve the true flux F0 from given true observations and "wrong" flux Fb.

17. What is the frequency for EnKF cycling? How frequent GOSAT data are available?

18. P20360, Line 18: "near" should read "close"; "trues" should be "true".

19. Line 24,25: no experiment was performed without EnKF step. It is not clear how you can separate impact of EnKF step (concentration analysis) and EnKS step (flux analysis).

20. Line 28: "prior true . . .", strange wording.

21. P20361, Line 6: when you say Fa and Fb (and Ca and Cb), do you refer to the ensemble mean values? Need to be clearly stated.

22. Line 20,21: from 0.5 to 0.65, here should point out that these values are consistent with F0/Fb=1.8+delta.

23. Line 22, 23: ratios should be strictly related to 1.8+delta, why related to strong diurnal variation?

24. P20362, Line 12-13: ". . . excessive impact of assimilation", this sentence is not clear.

25. P20363, Line 8: you state ". . . similar to Kang et al. (2011, 2012) and Tian et al. (2013)", but not very clearly describe what is really new in your work.

26. Fig 3: there are two (d).

27. Fig 4, Fig 5, Fig 7, Fig 8, Fig 9: need to use better font for color bar to display

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