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Interactive comment on "Estimation of trace gas fluxes with objectively determined basis functions using reversible jump Markov chain Monte Carlo" *by* Mark F. Lunt et al.

Anonymous Referee #1

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Lunt and coauthors have written, and well written, an interesting paper about dimension reduction for atmospheric inverse modelling. The introduction of the dimension itself as an unknown directly in the Bayesian emission estimation is particularly original. I can only recommend it for publication, provided a few points are addressed:

- The authors have restricted the dimensionality problem to the 2D space, and seem to have forgotten that the problem has a temporal dimension as well. This question should be addressed somehow right from the start of the paper and in the pseudo-data example.

- P. 2, l. 10: the correlation is on emission errors, not on emissions.

- P. 2, l. 15: "that do not exist in the true field" actually applies to any flux estimate, since it remains uncertain.

- P. 4, l. 22: to be fair, the authors should also cite earlier publications like Michalak et al. (2005, doi : 10.1029/2005JD005970), Berchet et al. (2013, doi:10.5194/acp-13-7115-2013) or Wu et al. (2013, doi :10.3402/tellusb.v65i0.20894).

- P. 5, l. 25: "its".

- P. 6, l. 7: "unintelligent" sounds harsh and a softer word would be more appropriate.

- P. 7, l. 7: the authors should also refer to earlier studies.

- P. 7, l. 10: the validity of this assumption should be discussed. At first glance, it looks poor. For instance a large dependency in the case of natural CO_2 fluxes over land was shown by Chevallier et al. (2012, doi:10.1029/2010GB003974, their Fig. 5). More generally for instance, it is very likely that hyperparameters are not the same at city-scale and at country-scale.

- P. 9, l. 14: how can the prior location and emissions variables be independent of each other?

- P. 13, l. 7 and l. 9: why is there a notion of convergence (l. 9; like if we were looking for just the most-likely state) while the algorithm explores the space of the posterior pdf (l. 7 and 24)?

- P. 13, l. 19: what does "typically" mean here?

- P. 13, l. 27: why should the solution of the problem (independent of the resolution method) be smooth? In other words, is it an advantage or an inconvenient to generate a smooth solution?

- P. 15, l. 10: is "twice as small" significant here?

- P. 17, l. 8: how stable is the estimate with respect to the number of iterations?

- P. 18: the first paragraph on the page reminds of the discussion by Berchet et al. (2013, doi:10.5194/acp-13-7115-2013, their sections 3.1, 3.2 and 3.3) on the same topic. This may be acknowledged.

- P. 18, l. 11: "To avoid this, the. . ."

- P. 19, l. 6: the sentence is too trivial to be the last one.