

Atmos. Chem. Phys. Discuss., referee comment RC1  
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## Comment on acp-2021-548

Anonymous Referee #1

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Referee comment on "Atmospheric observations consistent with reported decline in the UK's methane emissions (2013–2020)" by Mark F. Lunt et al., Atmos. Chem. Phys. Discuss., <https://doi.org/10.5194/acp-2021-548-RC1>, 2021

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### General comments:

Authors use two different inverse modeling systems (although based on the same transport model) to estimate methane emissions and emission trends in UK during 2013–2020. They use data from a 6-tower network and other observations, to test the influence of the observing system configuration on the estimated emissions and find the emissions estimates and decreasing trends (in the better-constrained part of the domain, eg without Scotland) are stable against the changes in model setup and the observing network configuration. The ability to match inventory to within 10% and its changes with time with both inverse models is a notable achievement. The paper is well written and can be accepted, after applying technical corrections/minor revisions taking into account the reviewers' suggestions.

### Detailed comments:

Line 156 Written as 'To ensure that the prior assumptions did not influence our derived emissions trend, our prior emissions did not vary with time' – This could be true only in case there is no impact of prior on final estimates, otherwise, no trend in the prior would lead to damping of the posterior trend. Just stating the prior emission trend is set to zero could be an alternative.

Line 180–200 [for the unfamiliar reader,] the description of rj-mcmc algorithm can be extended by adding few sentences of general introduction, explaining terms like region, parameter, hyper-parameter. Also, mentioning a need for applying Monte Carlo would be helpful (due to lognormal PDF?).

Line 263 The uncertainty is set to '10% of a pollution event' (amplitude?). Is it about simulated or observed? Would be useful to discuss somewhere how well this uncertainty compares to the posterior mismatch and does this factor vary between sites?

Line 276-277 A reason for degraded performance under stable conditions over flat terrain could be the miscalculation of PBL height (related to surface temperature and nighttime surface heat balance) – not mentioned here.

Technical corrections:

Line 120 Should one read 'mole fractions' as 'simulated mole fractions'?

Line 547 Do authors mean 'greenhouse gas reduction' or 'greenhouse gas emissions reduction'?