We thank the reviewers for their additional feedback. Reviewer comments are italicized followed by our responses.

Referee # 1

The authors have thoroughly replied to the issues raised in the first review and have made the corresponding changes in the paper. Therefore, I recommend this paper for publication after a few minor issues have been addressed.

L8: state what the prior estimate is based on

Lines 7- 9 now state: '…and found our derived UK estimates to be generally lower than the a priori emissions, which consisted primarily of anthropogenic sources and with a smaller contribution from natural sources.'

L12: insert "annual mean" before "N2O emissions"

Annual mean has been inserted

L25: missing hyphen "100-year"

Hyphen has been inserted

L118-120: while it is wise to remove data with very strong local influence, the explanation for doing so should be improved. The authors state that the data were removed because these data were "more likely to be affected by local processes due to the more stagnant air". The main problem with these data, however, is that due to deficiencies in the model, i.e., accuracy of atmospheric transport, spatial and temporal resolution of both the transport model and the fluxes, these data cannot be represented by the model. This, and the fact that the influence on observations at these times is very strong, would result in large errors in the model, which would lead to errors in the retrieved fluxes.

Lines 118-125 now state: 'Measurements corresponding to times when there was a high sensitivity of mole fractions to emissions from the nine grid cells surrounding the station (at 25 km resolution) were identified as being likely to be affected by local processes due to the more stagnant air. Local processes act on scales that are smaller than the spatial and temporal resolutions of the model and therefore would not be captured by the model. Furthermore local processes tend to have a high impact on observations and would therefore lead to large errors in retrieved fluxes. For these reasons, measurements considered to be prone to local effects were removed from the analysis.'

L122-123: there appears to be a verb and preposition missing in this sentence: "…the measurement uncertainty was described by the variability…"

Line 127 changed to: "the measurement uncertainty was described by the variability"

L191: missing hyphen "30-day"

Hyphen has been inserted

L193: replace "that air" by "from which air"

Line 199 changed to 'Multiple boundary conditions were estimated to represent the variable levels and directions from which air enters the domain'

L196: this sentence could be made clearer, suggest: "…originate from the southern outer domain boundary"

Line 202 changed to: 'e.g., winds that enter the inner inversion domain from the west sometimes originate from the southern outer boundary'

L197: replace "formed by" by "comprised of"

Line 203 changed to '…concentrations entering the inner inversion domain are comprised of the concentrations on the outer boundaries….'

L312-314: suggest changing this sentence to "A difference in natural emissions…" since the posterior estimated fluxes include the natural fluxes (it is the total flux that is estimated). The current formulation suggests that the posterior flux estimates exclude natural fluxes.

Line 322 now states 'A change in natural emissions, which are only 5-12% of the prior for both gases, may explain some of the difference but are likely not large enough to account for all of it.'

L322-323: perhaps the difference between the Bergamaschi et al. 2014 results and this study is due to the different observation dataset. In Bergamaschi et al., the new UK stations were not included.

Lines 332-333 now state, '…and while could be attributed to the additional measurement stations used, likely also point to large systematic differences between models.'

L383: insert "ratio" after "signal-to-noise"

Line 295: 'signal-to-noise ratio' has been inserted.

Referee # 2:

P4 L120-121: The percentages of data filtered for CH4 are given here only; the data amounts filtered for N2O (17, 15 and 9%; Review Response P7) should also be included.

Text on line 125 now states, 'Approximately 17 (16), 14 (16) , 8 (8) and 4% of data was filtered from MHD, RGL, TAC and TTA for CH4 (N2O), respectively.'

Review Response P10, relating to comment on P869 L24: The authors have provided the information requested by the reviewer, but this should actually be

included in the text (at P10 L327 of the revised manuscript).

Text starting line 337 now states, ‘Uncertainties were on average approximately 36% larger on UK CH4 emissions during January-May 2013 and 50% larger on UK N2O emissions during December 2013- January 2014, than the average of months sampled by the full network.’

Review Response P12, relating to the comment on P874 L16: The sentence regarding isotope measurements (P14 L460-462), even with the newly added reference to Rigby et al. (2012) should not be included in the conclusions of this study – no new information was provided in the paper at all to support the use of isotope measurements. The authors could rather refer to this by concluding that they could only poorly resolve source processes, thus highlighting the limitations of concentration-only measurements, and they may then tentatively suggest the utility of isotope measurements – although no simulations were performed to show that this would help in the present case.

We have added an extra sentence in the conclusions to support the use of isotopologue measurements in regions with poor source separation. The citation Rigby et al., 2012 shows how isotopologue measurements would be used in the context that we describe. Text starting line 478 states, ‘One limitation of this study is that source processes could only be identified based on differences in spatial distribution. For regions without this separation, such as Ireland, additional measurements would be necessary for source apportionment. The inclusion of CH4 isotopologue measurements at these sites could provide an additional constraint into the gas, landfill and agricultural source partitioning, as has been shown in Rigby et al., 2012.’

Regarding natural N2O emissions: It is unclear whether the technique of multiplying Saikawa et al. natural soil emission estimates by the proportion of natural land is valid, even considering the limitation of the Saikawa et al. estimate – because natural N2O emission can still occur as a `baseline` from agricultural lands ie. Some of the N2O from these lands is due to fertiliser and thus anthropogenic, and some would occur regardless. Similarly, deposition of N (eg. From NH3) on natural soils means that not all emissions from natural lands are natural emissions.

The way the authors have dealt with this, ie. To multiply the estimate by the proportion of natural land, is adequate because it is close to impossible to estimate natural and anthropogenic soil emissions more accurately with present information. However the authors should be more careful in highlighting this problem in both their prior, and in their posterior estimates of natural vs. anthropogenic soil emissions.

We have added two additional sentences in describing the prior and in the conclusions: Test starting line 300 states,’ While there are additional complexities with classifying emissions from land as natural or anthropogenic, we assume that this scaling approach will, to first-order, correct for overestimation in natural inventories.’

Text starting line 470 now states, ‘The small natural sources in the UK are not likely large enough to account for the full discrepancy between the prior and posterior emissions. Our designation of natural sources is based on land cover statistics.

There are additional considerations to be made when classifying land as natural or anthropogenic (e.g., anthropogenic N deposition on natural land), which were not accounted for here.'

Referee # 3:

Overall the authors have addressed thoroughly most of the comments which I had raised in my review.

However, I have the following remaining comments:

It is not clear to me, why the authors consider the difference between their posteriori CH4 emissions for the UK and the priori 'statistically significant' anthropogenic prior: 2.42 +/- 0.48 Tg CH4 yr-1 (Reported CH4 emissions +/- 20%) natural : according Table 3: 7-9 % of total emissions, e.g. ~0.2 Tg CH4 yr-1 (but I would assume a very large uncertainty for this estimate, in the order of ~100%) total posteriori CH4 emissions 2.09 (1.65–2.67) Tg CH4 yr-1 i.e. the total prior is just at the upper end of the total posterior, but still within the given 5%/95% range of the posterior. In addition, for the statement of statistical significance also the uncertainty of the prior should be taken into account.

The calculation above is slightly inaccurate. The annual mean of the prior was 2.72 Tg/yr (see Figure 3 and now additional information in table 3). The 2.72 Tg/yr lies just outside of the 5-95th percentile range of the posterior solution (the metric of statistical significance). Text starting line 320 states, 'The difference in average annual CH4 emissions from the total prior is statistically significant (with the annual average prior emissions lying outside of the uncertainty of the posterior) but the N2O difference is not significant when accounting for uncertainties.'

Table 1/2: 'A priori values used': Only the inventories are listed but not the values (i.e. CH4 / N2O emissions UK / Ireland)

Values are now included in Tables 3 and 4.

Table 3/4: would be useful to include here also the absolute CH4 / N2O emissions UK / Ireland (if not included in Table 1/2)

Values for each source sector are now included in Tables 3 and 4.

'Wetlands and rice' : I assume there is no significant rice cultivation in the UK / Ireland ?

Rice cultivation in the UK is not significant but because there are some (i.e. not zero) emissions, we have kept the original labeling of the inventory, which treats the two in aggregate (i.e. satellite based analysis).

update reference [Bergamaschi et al., ACPD, 2014] to [Bergamaschi et al., ACP, 2015]

The reference has been updated.