Reply to:
Interactive comment on "Inverse modelling of European N_2O emissions: assimilating observations from different networks" by M. Corazza et al.

Anonymous Referee #2
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P26327: Other stations than Schauinsland may also – but less visibly – suffer from local influences. Have the authors thought about a strategy to deal with this in a more general way than for this specific station?

Representation of sub grid phenomena is an important issue. In part, we are taking into account the impact of local sources by estimating the uncertainty related to the sub grid variability of emissions (as described at page 26334, Δy_{BL}), based on a scheme developed by Bergamaschi et al. (2010). However, this scheme is expected to provide realistic uncertainties only if the emissions are not 'very local' (i.e. very close to the monitoring stations). Also in case of very pronounced point sources (as for the industrial N_2O emissions) this scheme may significantly underestimate the model representativeness error (e.g. in cases, when the emissions of this point source are directly advected to the monitoring station).

P26334, L14: Why choose an observational error of 0.3 ppb if the repeatability of NOAA air samples is 0.4 ppb (1 sigma)?

As stated above, large part of the uncertainty associated to the observations is related to fractions related to the sub grid scale phenomena and to the characteristics of the atmospheric transport (page 26334).
We defined the measurement uncertainty as the standard deviation obtained considering the available parallel measurements, averaging over time. This method in general provides a value for the estimated uncertainty slightly smaller than the average of the absolute differences. The chosen value of 0.3 ppb is therefore consistent, also taking into account the fact that we are using this value as average for different measuring networks.
We also performed a sensitivity simulation setting the observational error equal to 0.4. Results (not included in the manuscript) are very similar to those of S1, in particular over Europe, with a very small difference in the total emissions, comparable in amplitude to that between S4 and S1 (Fig. S-6).

P26336: The general picture is that the a priori simulation underestimates the observed concentrations in the course of the year. This is corrected with a considerable overall increase of posterior emissions compared to the prior. As the authors state, for the stations ALT and BRW this leads to a significant overestimate in the posterior simulation. Could this indicate that European increments have been too strong? Might there be an issue with modeled transport (e.g., strat-trop exchange at high latitudes)? Or is there a

different explanation?

We presently do not have a clear explanation of this issue that will be addressed in future work. We added a sentence in the text to remark that this discrepancy could point to some inconsistencies in the simulations of the stratospheric-tropospheric exchange, or in the emissions, and needs to be further clarified in subsequent studies.

P26343: Perhaps it could be added here that systematic comparisons of standards and measurements are also necessary to avoid time-varying biases, which are probably much more difficult to be quantified by the inverse modelling system.

We added a sentence in the conclusions following the suggestion of the Referee.

Table 2: Why are the numbers for Mace Head bias and Ochsenkopf standard deviation different from Fig. 1?

We thank the Referee for noting this inconsistency. We corrected the values compiled in the Table (The values reported in the Figure are correct).

Table 6: Could the authors provide more details on how the potential additional model error has been estimated?

Potential additional model errors reported in Table 6 are estimated using preliminary results from the model intercomparisons performed in the framework of the NITROEUROPE Integrated Project. The statistical analysis of the results provided by the five groups involved suggests uncertainties associated to differences between models of the order of 30%.

Technical comments

P26340, L2: of the order of should be on the order of. Done.

Table 1: Why are there two 'number 1' CHIOTTO stations: TT1 and HU1? In case of the CHIOTTO towers the number in the last letter of the short name indicates the level of the measurements. For TT1 and HU1 only one level is available, therefore the measurements are indicated at level 1.

Fig. 4: Reduction should start with lowercase. Done.