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Atmospheric Chemistry and Physics Discussions

Interactive comment on "What can we learn from European continuous atmospheric CO_2 measurements to quantify regional fluxes – Part 2: Sensitivity of flux accuracy to inverse setup" *by* C. Carouge et al.

C. Carouge et al.

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Reply to reviewer#1 on "What can we learn from European continuous atmospheric CO2 measurements to quantify regional fluxes, Part 2: Sensitivity of flux accuracy to inverse setup."

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Comment 1 p.18623, line 4: When using "the density of the network", we are not referring to several networks. But we summarize the conclusion of Part 1 that the fluxes could only be reasonably implied on Western Europe because of the relatively high

density of the network over this region. Over other European regions, the improvement in fluxes was much lower because of the scarcity of stations.

Comment 2 p. 18623, line 17: There doesn't seem to be an ambiguity here. A gridcell of a model is a region as is a country. Where we need to be specific we think this is clear.

Comment 3 p. 18623, line 27: Indeed the context would suggest to use only temporal correlations. However, the knowledge of correlations for fluxes at this scale is very poor. One study only was published to study the correlations at the scale studied in this paper. We think there should be correlations between flux errors but we still do not know what kind of correlations. A sentence was added to the text to reflect the lack of knowledge on this question.

Comment 4 p. 18627: We now explain the relative value of the correlations compared to the case S0 with the presentation of each case and not any more at the end.

Comment 5 This experiment represents a case artificially favorable to the inversion. To see this imagine an extreme case with a prior covariance with only one eigenvector, representing the difference between the prior and the truth. It is technically possible but uninteresting to generate such a covariance. The prior covariance acts as a filter on the inversion so that in this extreme case the inversion can only move the flux directly towards or away from the truth (one hopes it would move towards). By choosing relatively short windows and basing prior covariances on the difference between the prior and truth we have tried to approximate this. It did not work. This suggests that the apparently sensible strategy of choosing physically-based prior covariances is, at least, harder than it seems. This explains our tentative conclusion in favor of simple prior error structures.

Comment 6 p. 18628, lines 20-24: An explanation of the variability between stations has been added to the text. We explain that the variability is linked to the seasonality of the Planetary Boundary Layer and depends on the homogeneity of the CO2 sources

around each site.

Comment 7 p. 18631, line 26: Addition of "but weaker"

Comment 8 p. 19631, lines 27-28: One can argue over the word "dramatically" but the NSD is a widely-used and logical measure of model performance in many fields and has, indeed, improved.

Comment 9 p. 18632, lines 21-23: We completed the sentence with "but a deterioration at small spatial scales ($<$ 300 km)". Comment 10 p. 18632, lines 25-26: By "true residual variances" we are refering to the variances of the residual of the true fluxes (ORCHIDEE) calculated for the different aggregations. In the text we now refer to "variances of ORCHIDEE true residual fluxes".

Comment 11 p. 18632 end-p. 18633 begin: The sentence was changed to "Overall, at small spatial / small temporal scales, the NSD improves similarly in space and in time in SP4".

Comment 12 p. 18634, lines 10-13: It is an assumption built only on the figures for each sensitivity case. Of course, it needs more investigation to validate or reject it. We give it as a possible setup to explore in the future to try to improve the results and we do not pretend it would definitely work. To emphasize the fact we are making an assumption, we add the sentence: "It could be interesting to study a correlation matrix with cross-correlations in future work to estimate the validity of this assumption".

Comment 13 Section 3.4: The variances used in the calculation of the error reduction come from the prior and posterior flux error covariance matrices from the inversion. In a statistically ideal observing system simulation experiment, the difference between the posterior flux and truth will be one realization of a random variable with mean 0 and covariance given by the posterior covariance matrix. Thus, it is correct to use the term error reduction. At the same time, the majority of the papers written on CO2 inversions use the posterior flux error standard deviation as an estimate of the posterior

flux uncertainty which is somewhat confusing. It is true that the truth is not explicitly used in the error reduction calculation but it is implicit in the definition of the flux error covariance matrices. And thus, the truth does not need to explicitly appear in the equation. Comment 14 p. 18637, line 10: See previous response to same concern.

Comment 15 p. 18638, lines 10-12: The twofold increase means we have a larger transport model error at continental sites than at marine sites. We add a sentence to explicitly mention the difference in transport model error: "This implies a model error twice larger at continental stations than at marine sites."

Comment 16 We expanded the conclusion by adding a summary of all sensitivity cases studied and the major conclusions given by these sensitivity cases.

Comment 17 A table of all stations used is added.

Comment 18 All experiments have been listed in the table.

Comment 19-20 The captions and the text are now consistent.

Technical corrections p. 18624, lines 1/2: The symbol "/" was replaced by ")" p. 18625, line 18: The reference was corrected p. 18629, line 1: The spelling was rectified p. 18631, line 2: The reference was added. p. 18631, lines 12-13, p.18632, line 22, p.18638, line 15 and line 20: Changes suggested by the reviewer were done. p. 18640, line 27: the 2006a is an error from editing Table 1: "tau" is replaced by "lambda" Figure 2: The left hand side 1 was changed to -1 in the colorbar. Figure 3: In this study, we measure the performance of the inversions by the distance to 1 of the correlation and NSD of the flux residuals. Thus, we consider inversions perform as well if they give NSDs of 1.05 and 0.95 for example. The symetry of the NSD is not true for null NSD but no inversion gives such small NSD in our study. We think,then, a symetrical colorbar which gives the same visual effect for NSD lower and higer than 1 is appropriate. Caption figure 4: "than" was replaced by "as"

Interactive comment on Atmos. Chem. Phys. Discuss., 8, 18621, 2008.