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Atmospheric Chemistry and Physics Discussions



# *Interactive comment on* "Multi-species inversion of $CH_4$, CO and $H_2$ emissions from surface measurements" *by* I. Pison et al.

**I. Pison et al.**

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Table 1: Is 'road transport and shipping' a biogenic emission? Also, some CH4 emission categories (e.g., soil uptake, termites) appear to be missing. What is 'QUANTIFY2 EU'? What is GFED-v2? Is 'GFED-v2' (used for CO) biomass burning inventory the same as 'van der Werf et al. (2006)' (used for CH4 )?
**The paragraph on emissions will be re-written to be clearer and Table 1 will be removed: "Two main datasets are combined to build the prior inventory:**

- **version 3 of the Emission Database for Global Atmospheric Research (EDGAR 3) inventory for the year 1995 for anthropogenic emissions (Olivier and Berdowski, 2001)**
- **version 2 of the Global Fire and Emission database (GFED-v2) (Van der**

**Werf et al., 2006) for monthly emissions due to biomass burning for the year 2004.**

**In addition, other sources are taken into account:**

- **emissions of $CH_4$ due to wetlands and termites are based on the study by Fung et al. (1991)**
- **the biogenic emissions of VOCs are provided by the ORCHIDEE vegetation model (Lathière et al., 2005).**
- **the biogenic emissions of $H_2$ are based on the study by Hauglustaine and Ehhalt (2002)**
- **an oceanic source of CO, equivalent to $\approx$20 Tg per year, is considered.**

**For MCF emissions, the inventory by Montzka et al. (2000) is rescaled according to an update of the study by Bousquet et al. (2006). Note that for the other species no effort is made here to adapt the 1995 EDGAR3 inventory to the year 2004. Since global economic growth occurred since 1995 and induced a modifications of the emissions (Ohara et al., 2007), in particular in Asia, the results of the inversions performed here combine both the corrections on the bottom-up emissions and the trends over the 1995-2004 period." The soil uptake is not an emission as such: it is calculated as a deposition with INCA, from which we get the pre-computed fields as for $H_2$.**

Table 2: It is better to consider observations as the reference and to calculate a bias as 'simulated minus measured', instead of the other way round.
**This is what was actually done, the caption is misleading, we will correct it.**
Table 2: Why is the median taken and not the mean?



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**We took the median because this indicator i) is more robust when there are outliers in the sample (which is small here because there are not so many stations) and ii) corresponds to a value that actually occurs in the sample (unlike the mean).**

Table 2: Is 'correlation' the (linear) correlation coefficient or the explained variance?

**The correlation here is the correlation coefficient, this will be added in the caption of the Table.**

Table 2: The percentual differences appear to be defined as: (abs(posterior)-abs(prior))/abs(prior). The caption reverses posterior and prior and does not mention that absolute values are used.

**This is right, this will be corrected in the caption of the Table.**

Table 3: Again the percentual differences are defined as posterior minus prior, instead of the other way round.

**This is the same mistake that will be corrected in the caption of the Table.**

Table 3: It would be instructive to add the initial burden and the accumulation during the year for each species. These numbers are referred to in the text.

**We will add two columns to the table containing this information: see Table 1 here.**

Table 3: The chemical loss of MCF increases (implying increased OH), whereas the chemical loss of CH4 decreases (implying decreased OH). How is this possible?

**Actually, prior 3D fields of the different gases (MCF, $CH_4$, CO, HCHO) are not in equilibrium with OH, which makes it difficult to analyse the changes in the losses between the prior and the posterior estimates.**

Table 4: The Bousquet et al. (2006) study considered the period 1984 to 2003. How can emissions for 2004 be quoted from this study?

**We actually used an update of the Bousquet et al. (2006) study using the same prior emissions, inverse system and assumptions but updated MCF and CH4 observations, that was run to 2007. This will be clearly stated in the text.**



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**Table 1.** Mass balances in Tg for the year 2004 [...]. Burden = average burden in the troposphere (up to level 12 of the model) ober the year. Accumulation = (emission+production)-(loss+deposition)

| Species | burden | | accumulation | |
|---|---|---|---|---|
| MCF | 0.399223 | **0.427202** | -0.068 | **-0.071** |
| CO | 337.3 | **373.1** | -13.2 | **14.0** |
| | *+10.6%* | | *+202.9%* | |
| $CH_4$ | 4334.2 | **4343.5** | -13.6 | **2.8** |
| | *+0.2%* | | *+120.6%* | |
| $H_2$ | 167.6 | **165.4** | 16.2 | **13.4** |
| | *-1.3%* | | *-17.3%* | |

Furthermore, the listed prior emissions for Bousquet et al. add to 707.9 Tg. This is an extremely large number and much larger than the 472 Tg (497 Tg minus 25 Tg soil sink) reported in the supplementary material of Bousquet et al.

**The column of the prior field in this Table should read as in Table 2 here.**

Finally, the total optimized and prior emissions from this study, as reported in the last two columns of Table 4, are not the same as in Table 3.

**In this Table, the emissions from the pixels which are not in the defined regions ('oceans') are not added so that the totals in the Table are smaller than in Table 3. There is also an error in the prior for Africa: Middle East was not added as it was in the other columns. This will be corrected.**

Table 5, caption: Change first sentence to 'Slope a and correlation coefficient r of linear regressions of simulated against observed CH4 and CO concentrations for different observation types.'

Table 5: It is much clearer to use 'ocean' and 'aircraft' instead of '2-D' and '3-D'. (Actually, the aircraft observations are 1-D (height dimension) rather than 3-D.)

Table 5: It would be instructive to add the number of observations for each observation



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**Table 2.** Total emitted $CH_4$ masses (Tg) during 2004 for the updated Bousquet *et al.* (2006) and this study.

| Area | Updated Bousquet et al. (2006) prior | **optimization range** | this study **optimized** | prior |
|---|---|---|---|---|
| North America | 71.3 | **59.4 - 77.5** | **67.7** | 67. |
| South America | 84.8 | **67. - 94.8** | **67.1** | 71.8 |
| Europe | 71.1 | **51.9 - 64.6** | **56.3** | 58.1 |
| Africa | 63.9 | **74.8 - 95.** | **64.1** | 61.4 |
| Boreal Eurasia | 29.2 | **22.3 - 28.1** | **28.5** | 32.3 |
| India+China | 121.6 | **113.9 - 149.6** | **162.6** | 152.4 |
| Australia+Indonesia | 40.3 | **38.5 - 54.9** | **44.7** | 45.1 |

type, and to provide also bias and standard deviation. This would make it possible to speak of over- and underestimations, about which the slope of the linear regression tells provides no information.

**All this will be taken into account as in Table 3 here.**

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**Table 3.** Slope $a$ and correlation coefficient $r$ of linear regressions of simulated against observed $CH_4$ and CO concentrations for different observation types. Bias and standard deviation between simulated and observed concentrations for the same samples. NO = number of observations. std dev. = standard deviation. BL = Boundary Layer, up to ≈1100 m in the model. NH = Northern hemisphere, SH = Southern hemisphere.

| Species | Type of measurements | | $a$ | $r$ | bias (ppb) | std dev. (ppb) |
|---|---|---|---|---|---|---|
| $CH_4$ | ocean data | First-guess | 0.97 | 0.96 | -2.1 | 11.5 |
| | NO = 456 | Analysis | 0.98 | 0.96 | -1.8 | 10.9 |
| | aircraft data (BL) | First-guess | 1.04 | 0.73 | -1.7 | 28.0 |
| | NO = 113 | Analysis | 0.86 | 0.7 | -4.3 | 21.2 |
| CO | MOPITT NH | First-guess | 0.63 | 0.57 | -12.7 | 19.2 |
| | NO ≈= 436500 | Analysis | 0.78 | 0.58 | 14.2 | 25.8 |
| | MOPITT SH | First-guess | 0.85 | 0.77 | -9.8 | 15.8 |
| | NO ≈=441500 | Analysis | 0.95 | 0.78 | -8.4 | 18.0 |



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