Technical note: temporal change in averaging kernels as a source of uncertainty in trend estimates of carbon monoxide retrieved from MOPITT

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We thank referee #1 for the valuable comments.

Answers to the specific comments raised are listed on the supplement.

Specific comments from Anonymous Referee #1

P.20321, l. 26: I suggest to change "uncertainty" in "error".

-> It has been replaced by "error".

P.20321, l. 26: I suggest to delete "using AKs" (it seems that the trend estimation somehow uses the AKs, I think that the authors refer to the error on the trends when the AKs are not taken into account).

1 -> **It has been deleted.**

2

3 *p. 20322, l.26: "temporal resolution: 1 month" seems referred to Fig.1, that is an*
4 *average from 2001 to 2010 (so it cannot have a temporal resolution of one month).*
5 *Probably the distributions that have been averaged have a temporal resolution of one*
6 *month. I suggest to specify this aspect.*

7 -> **The original sentence has been changed into "Figure 1 shows the global**
8 **mean distribution of monthly surface CO products (spatial resolution: 1°×1°)**
9 **from 2001 to 2010.".**

10

11 *p. 20325, Eq.(3): dx0/dt(I-A) has be to replaced by (I-A)dx0/dt.*

12 -> **It has been corrected as follows:**

13
$$\frac{\partial \hat{\mathbf{x}}}{\partial t} \cong \frac{\partial \mathbf{x}_0}{\partial t} + \frac{\partial \mathbf{A}}{\partial t}\left(\mathbf{x} - \mathbf{x}_0\right) + \mathbf{A}\frac{\partial}{\partial t}\left(\mathbf{x} - \mathbf{x}_0\right) = \left(\mathbf{I} - \mathbf{A}\right)\frac{\partial \mathbf{x}_0}{\partial t} + \frac{\partial \mathbf{A}}{\partial t}\left(\mathbf{x} - \mathbf{x}_0\right) + \mathbf{A}\frac{\partial \mathbf{x}}{\partial t}.$$
(3)

14 **Corresponding to this,** $\frac{\partial \mathbf{x}_0}{\partial t}\left(\mathbf{I} - \mathbf{A}\right)$ **on p. 20327, l.22 has been additionally**

15 **replaced by** $\left(\mathbf{I} - \mathbf{A}\right)\frac{\partial \mathbf{x}_0}{\partial t}$ **.**

16

17 *p. 20326, l. 15-17: the authors should specify more in detail the procedure of how the*
18 *linear trends reported in Fig. 5 have been calculated. They say that these trends*
19 *have been calculated making the assumption that the true state is 50% more (or*
20 *less) than the a priori state. Did they simulate the MOPITT measurements with this*
21 *assumption and they calculated the trends of the surface CO retrieved by the*
22 *simulated measurements? Or did they somehow use Eq. (4) to calculate these*
23 *trends?*

24 **The trend in Figure 5 was derived using the simulated MOPITT surface CO (i.e.**
25 $\hat{\mathbf{x}} = \mathbf{x}_0 + \mathbf{A}\left(\pm 50\% \times \mathbf{x}_0\right)$**) with the assumption, not using Equation (4). The equation**
26 **was shown to enhance the understanding how the temporal change in**
27 **averaging kernels can influence on the satellite-derived trend. We have**

clarified how to derive the trends in Figure 5 as follows: "Nevertheless some significant trends of the hypothetically retrieved CO ($\frac{\partial \hat{\mathbf{x}}}{\partial t}$) at the surface are present, ranging from -10.71 to +13.21 ppbv yr^{-1} (-5.68 to +8.84 % yr^{-1}) in Figure 5. They are derived using Equation (1) on the hypothetically retrieved MOPITT surface CO (i.e. $\hat{\mathbf{x}} = \mathbf{x}_0 + \mathbf{A}\left(\pm 50\% \times \mathbf{x}_0\right)$)."

p. 20327, l. 18: I suggest to specify that "the anomaly of surface a priori CO" is the difference between the a priori and the seasonal mean.

-> It has been clarified as the modified sentence, "The anomaly of surface a priori CO (i.e. the difference between surface a priori and seasonal mean) includes an inter-annual variability and a net distinction in 2005.".

p. 20328, l. 9-12: The sentence "However, since at higher altitudes .....than for the near-surface layers" is not clear. The uncertainty caused by time varying AKs is generated by the temporal variation of the AKs and by the difference between the true and a priori states. How the two points ((a) and (b)) determine smaller uncertainties at higher altitudes?

-> We would argue that the uncertainties of both AK and concentrations are highest at the source, i.e. the ground (e.g. if a power plant is missing in the model), but dampened in the free troposphere due to dilution. To make it more clear, the original sentence has been changed into "However, the related uncertainties at high altitudes are expected to be smaller than for the near-surface layers because of smaller difference between the true and a priori state.".