

Interactive comment on “An improved infrared carbon monoxide analyser for routine measurements aboard commercial airbus aircraft: Technical validation and first scientific results of the MOZAIC III programme” by P. Nedelec et al.

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Received and published: 24 September 2003

Answer to Referee Comment from D. Parrish on "An Improved Infra-Red Carbon Monoxide Analyser for Routine Measurements aboard Commercial Airbus Aircraft : Technical Validation and First Scientific Results of the MOZAIC III Programme" by P. Nedelec et al.

On General Comments :

The authors are grateful to David Parrish for his comments and improvements on our paper.

On Specific Comments :

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1) Regarding to the O₃ trap used in the instrument, laboratory tests have been performed during the technical development to ensure that the MnO₂ trap has no interference (positive or negative) to CO measurements. The sentence written in the first version of the paper is not clear and can be subject of misunderstanding (In addition, the first months of MOZAIC measurements in the stratosphere have clearly shown no correlation between measured CO and stratospheric ozone values in the range 400–1000 ppbv). A negative correlation between O₃ and CO is seen in the stratosphere from the MOZAIC data, this will be described in a following paper. This sentence is removed from the text and is replaced by: The MnO₂ filter has also been tested in laboratory to ensure that it has no interference (positive or negative) on the CO measurement.

2) The corresponding paragraph is modified concerning the discussion on the instruments airborne comparisons.

The linear regressions and correlation factors calculated for the three inter-comparison (see figure 4) show the good agreement (slopes near unity) between the MOZAIC IR instrument (5ppbv, 5%) and the two other methods by resonance-fluorescence (5 ppbv, 2.5%) and gas chromatography (5 ppbv, 2%). For resonance-fluorescence and gas chromatography series 1, the samples were done in a limited range between 75 ppbv and 125 ppbv, resulting in a lower accuracy of the linear fit. But the calculations ($y = 0.97x$ and $y = 1.08x$ respectively) fit roughly into the cumulative precisions of the methods (10 ppbv, 7.5% and 10 ppbv, 7%) respectively. For the gas chromatography series 2, the samples range from 80 to 270 ppbv and the linear fit is better ($y = 1.05x$) within the cumulative precisions of the methods (10 ppbv, 7%). These intercomparison under aircraft operational conditions clearly show that this new instrument is highly suitable for making measurements of CO in the atmosphere.

3) We agree with the analysis by David Parrish that relative variations of O₃ and CO within the fold (Fig. 6) are closed to what is expected. Our analysis was wrong because of incorrect stratospheric values of O₃ and CO we have taken to interpret Fig. 6. The

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new discussion below replaces the paragraph §The difference in the relative variations of tracers inside the layer, \tilde{E} \tilde{E} and in the free troposphere.Ŧ near the end of former section 3.1 The relative variations of O₃ and CO tracers inside the fold are closed to be self-consistent despite the difference of integration time between the O₃ analyser (4 sec) and the CO analyser (30 sec) leading to about 40 m and 300 m vertical resolution, respectively. The hypothesis that the mixing ratio of ozone and of carbon monoxide inside the fold result linearly from a mixing of stratospheric and tropospheric air gives $\text{VMR}_{\text{fold}} = a \text{VMR}_{\text{stra}} + (1-a) \text{VMR}_{\text{trop}}$, where a is the percentage of stratospheric air inside the fold and VMR is a volume mixing ratio into either the tropopause fold (fold), or the stratosphere (stra), or the troposphere (trop). From Fig. 6, we have ($\text{VMRO}_{3\text{-trop}} = 50$ ppbv ; $\text{VMRCO}_{\text{-trop}} = 143$ ppbv) and ($\text{VMRO}_{3\text{-fold}} = 95$ ppbv ; $\text{VMRCO}_{\text{-fold}} = 117$ ppbv). According to Fig. 10, stratospheric air has about $\text{VMRCO}_{\text{-stra}} = 37$ ppbv when $\text{VMRO}_{3\text{-stra}} = 320$ ppbv. It agrees with a statistical analysis done with the whole MOZAIC dataset over winter 2002 indicating that the linear relationship between stratospheric O₃ and CO is described by ($\text{VMRCO}_{\text{-stra}} = -1/5 \text{VMRO}_{3\text{-stra}} + 98$; $R = -0.7$) where the belonging to the stratosphere comes from a threshold on the potential vorticity ($PV > 2$ pvu, Hoskins et al., 1985) deduced from ECMWF analyses. It follows that $a = 0.17$ or $a = 0.24$ depending on whether the relationship on volume mixing ratio is solved for O₃ or for CO, respectively. About 20% of the air inside the fold comes from the stratosphere. Using $a = 0.17$ for CO gives $\text{VMRCO}_{\text{-fold}} = 125$ ppbv, which in comparison with the observation represents a difference of about 7% still closed to the instrumentŦs accuracy. Therefore, the difference of integration time between the two MOZAIC analysers does not seem to prevent fine scale interpretations that are needed for the validation of present mesoscale numerical models studying the budget of trace gases in the planetary boundary layer and in the free troposphere.

New Reference :

Hoskins, B. J., Mc Intyre, M. E., and Robertson, A.W., On the use and significance of isentropic potential vorticity maps, Quart. Journal of the Royal Met. Soc., 111,

8770946, 1985.

On Technical Corrections :

All technical corrections recommended by the reviewer are now included into the text.

Interactive comment on Atmos. Chem. Phys. Discuss., 3, 3713, 2003.

ACPD

3, S1593–S1596, 2003

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