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Atmospheric Measurement Techniques Discussions

Interactive comment on "Development of a new JMA flask sampling and trace gas measuring system for observation on a cargo aircraft C-130H" *by* K. Tsuboi et al.

Anonymous Referee #2

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The paper by Tsuboi et al. presents the flask sampling procedures onboard a cargo aircraft. The authors make use of the newly available laser-based measurement techniques to displace the older flask analysis techniques at JMA. They present a measurement comparison between the old and the new equipment as well as an evaluation of the aircraft flask sampling with a ground station. The manuscript describes the currently used setups at JMA and gives some quantitative data comparisons.
In my eyes, there is no completely new measurement development presented (Laser-based instruments in a similar setup are used elsewhere already), and the observed differences to the existing setup are scientifically not sufficiently interpreted. Because

there is no data from the measurement campaigns presented here, the paper might rather be changed into a Technical Note to describe the current JMA calibration system. However, the changes in the measurement procedures should be better motivated and investigated in greater detail; the manuscript needs major revisions. The main topics to work on are the correction of isotopic effects (between instruments and in calibration gases), motivation of metal flask usage, and storage effects.

Specific comments (page/line):
7069/21: The title might be changed to "Technical Note: The JMA flask sampling and trace gas measurement system"

7068/20: The introduction gives an overview about the gas measurements in East Asia. Except the last paragraph, it does not give insights into the used measurement systems. However, for this paper, the location of the air sampling plays a minor role (it is not even used to argue about the observed differences at MNM station). It would be more interesting to give an overview about the flask sampling techniques that are currently used by different groups. At page **7069/22** I miss a discussion about the advantages and disadvantages of flasks over continuous measurements as a motivation for the whole paper. Why do you not use the instrumentation directly onboard the aircraft? What are the expected advantages and disadvantages of the new analyzing system?

7071/11 etc.: Please give the full name and location of company names throughout the manuscript: KNF, Swagelok, Picarro, Los Gatos, Licor, Aerolaser, Twinboard, JSP, ... And please add the full model number (e.g. for Stirling coolers and Valco valve (which rotator material is used?))

7071/12: The air is sampled through the air conditioning system. In the current news I have heard about problems with contaminated air in commercial passenger aircraft. Do you expect a similar effect in the cargo aircraft? Have you checked for potential pollution?

7071/23: Do you see pressure effects e.g. on CO_2 by the magnesium perchlorate? How long is the inlet flushed before sampling?

7071/27: Why do you use Titanium flasks, not glass or other material?

7072/2: Please give a reference that proves the smaller drift. Silicon may have surface/storage effects on CO_2?

7074/11: "auto pressure controllers": How do they work? What was developed that has not been there before?

7073/15f: What happens to the ice in the cooler under vacuum conditions?

7075/8: The sentence implies that the ground station also has flask samples, although it is continuous [Wada, 2007].

7075/15ff: Please avoid formulations like "nearly agree", "correlate reasonably well", "agree well", "relatively constant". Use quantitative measures instead and give numbers in comparison to previous published results.

7075/18ff: Why are the differences and uncertainties so large? Please compare to the analytical precision of your and the ground based measurement. Why do you use hourly ground-based data only? What is the expected natural variability within > 1000 m distance between aircraft and station (you write: "slight difference in sampling height")? Do you try to consider the wind direction to decide at which time you compare to the ground based data? How does the comparison look like during the operational flight since February 2011?

7076/1ff: Repetition. Shift to section 2.2.

7076/7: Did the pressure inside the flasks change during the storage?

7076/9ff: The numbers are quite large and extremely noisy, and therefore insufficient to judge on storage effects. With the given numbers you cannot exclude a maximum drift of 0.012+0.017 = 0.029 ppm CO_2/day; then the CO_2 drift exceeds 0.1 ppm change

already after 3 days! It is similar for the other species. Given the targeted accuracy of the measurement the storage test does not give valuable information. Moreover, it would be very interesting to know the storage effect on longer time scales of weeks to months. That would allow the usage of the data also after a longer interruption due to transportation delays or instrumental problems.

7076/25: Is there any reason why you use so many cylinders? You stated before the excellent linearity of the systems; thus, 1 or 2 cylinders might be sufficient. Are there Allan Variance tests that prove how often the system has to be calibrated? Please, scientifically motivate and explain the sentence on page 7076/26f.

7077/12: How did you measure the H_2O? How has the instrument been calibrated for the low water vapour amounts? 0.01% H_2O is still 100 ppm H_2O, it does not fully cancel the dilution + broadening effect on CO_2 of about 0.05 ppm.

7077/20: The values do not really give the "reproducibility". They are an estimate of the analytical precision, not even the accuracy of the instrument. The requirements of the WMO include the uncertainties of the calibration scale + cylinders, the errors of the instrumentation, etc.

7079/1ff: Would it be possible to use calibration gases with natural isotopic composition?

7079/12f: Do you correct for this isotopic error? I suggest an isotopic measurement of the used calibration gases. Given the high measurement quality standards of WMO it is also difficult to follow your discussion at page **7081/6f**, where biases of up to 0.16 ppm in CO_2 are not further commented.

7083/15ff: Before widely using the instrumentation, some of the observed biases might need further discussion. A bias of 0.1 ppm CO_2 in a global network changes the net carbon amount by 0.2 PgC in the atmosphere.

Table 1: It is not clear to me, what A and B stand for. From my understanding, the

conventional method uses NDIR for CO_2; thus, the values in the first columns should be the same, shouldn't they? The difference between A and B in the CO_2-WS-CRDS column are quite high.

Figure 1: I am puzzled by the cooler/heater setup: How is it possible that the sample air can flow through the cooler first and then be heated up again in the shown circle? How do you remove the frozen ice? If you use two setups alternately, do you see differences between the setups?

Figure 3: Units for the gas components are missing. Maybe it would be more informative about the instruments responses to show calibrated data rather than raw data (that should be also clarified in the Figure description).

Figure 5: Especially CO and CH_4 show obviously skewed distributions. What are the reasons for these; isotopic composition?

Minor corrections (page/line):
7071/19: you mention the diameter 1/4 inch 2 times. Skip one.

7072/8: 24 flasks "are divided" into 4 packages sounds strange. "are distributed" might be better.

7072/24: "by a special operational program in PC" - What does it mean?

7073/14: "." missing

7074/2: "maintained in a JMA calibration system" - ? - Please, rewrite.

7077/26ff: references missing

7077/28: output signals > raw signals

7078/4: What does "re-calibration" mean?

Interactive comment on Atmos. Meas. Tech. Discuss., 5, 7067, 2012.