

Atmos. Meas. Tech. Discuss., 5, C3592–C3598,  
2013

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**AMTD**

5, C3592–C3598, 2013

Interactive  
Comment

## ***Interactive comment on “Long-term greenhouse gas measurements from aircraft” by A. Karion et al.***

**A. Karion et al.**

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We thank both reviewers for their helpful comments and positive suggestions on improving the manuscript.

Responses to Reviewer 1 Comments

General Comments

R1: The paper describes the implementation of an automated cavity-ring-down device on-board aircraft for regular monitoring flights over Alaska. CRDS instruments onboard aircraft are still not frequently used and the project represents an important step towards more continuous high-frequency measurements at altitude, in particular in a

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remote region. The manuscript is well-suited for publication in AMT after some minor revision. It is overall well-written, however, some parts of the methods section are extremely detailed, but not well structured, so the reader gets lost in technicalities. This should be improved during the revision. There are several years of data now from this project already, therefore, although this is a technical paper about the instrumentation, I would like to see some measurement examples being presented, such as some vertical profiles for CO, CO<sub>2</sub>, and CH<sub>4</sub>.

A: The authors have edited the methods section of the document, adding organization and structure (we have added a subsection on the inlet system and combined the sections on temperature/humidity, gps logging, data logging etc).

We not added any measurement examples because we didn't feel they fit anywhere in this paper subject matter. We have added some extra discussion on the use of the data (also addressing the reviewer's remarks on the Conclusion). We have renamed that section Results and Conclusion.

#### Specific Comments

R1: In general, usage of chemical symbols and tracer names should be harmonized. As well the usage of pressure units.

A: We have harmonized chemical symbols and tracer names, and converted all pressure units to hPa.

#### Abstract

R1: The abstract is rather long and detailed. It might benefit from a bit of shortening. ACP permits paragraphs in the abstract, I suggest to start a new paragraph in line 16. -"AK" behind the name of places can be dropped. It's been made clear at the very beginning of the abstract that the flights take place in Alaska. -Line 12/19: move the explanation that the instrument is a CRDS analyzer to the first instance the device is mentioned (from line 19 to 12) - A: Suggested changes have been made.

## Introduction

R1: page 7344, line 2: how many aircraft are in operation?

A: There are four C130's operated by the USCG out of Kodiak. (detail is now in the text). Our inlet plate gets moved depending on which is flying the Arctic Domain Awareness (ADA) flight.

R1: page 7344, line 16: "in contrast to ..." I find this statement slightly misleading because it implies that the instrument described here would not be suited for campaign-style measurements. But an automated (or semi-automated) instrument would also be desirable for most measurement campaigns for exactly the same reasons, as the scientist may not be available at all times and seats for operators are often limited during campaign flights.

A: We have removed "in contrast to campaign-mode deployments".

R1: Will these measurements eventually be combined with those over PFA mentioned by Xiong et al., JGR 2010 ?

A: The flask data from ACG are already available from NOAA just as those from all the NOAA aircraft sites (by request). Continuous data is also available by request. Users of data will probably combine these data sets in any analysis of GHG in the Arctic/boreal region.

## Methods

R1: This section has a very long introductory part that would better fit into the actual Introduction (most text in 2.1. on pages 7345/7346 before subsection 2.1.1. ). The division into sub and subsub section is very detailed for 2.1. whereas 2.3. and 2.4. are extremely short and more of a side note. Think about possibilities to streamline and shorten 2.1.1. through 2.1.4 as they are very detailed (e.g. parameter names in log files), but in some passages lack structure.

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A: Section 2.1, which introduced the CRDS system, has now been moved into the main introduction (Section 1). We have also re-organized section 2 somewhat to address this comment and add structure. We have also re-organized the sections.

R1: How far do the inlet lines reach out from the aircraft and what type of tubing is used?

A: Text now includes this information. They reach out 0.2 m; Kynar tubing is used in the interior of the aircraft; stainless steel tubing on the exterior.

R1: page 7345, line 3: It will not be obvious to someone not familiar with the NOAA flask program that "flask package system" is actually a sample collection system. Please state that more clearly.

A: Done.

R1: page 7345, line 5: why is the ozone monitor excluded. Is there a reference for it? What measurement technique is used?

A: It is UV absorbance. We excluded it because we wanted to focus this manuscript on the GHG measurements; the ozone instrument has its own details that can be extensive and complex and did not fit into this manuscript. We added a sentence in the text explaining this.

R1: page 7345/7346 section 2.1.: please point out some of the special issues when the instrument gets deployed onboard an aircraft as opposed to operation on the ground

A: Several extra sentences have been added to the description of the CRDS and the plumbing arrangement to explain the differences in the two types of analyzers. Other issues are described throughout the text (such as vibration noise).

R1: page 7346: please add a brief description of how CRDS works before going into the details of plumbing.

A: This has now been added.

R1: page 7346, line 21, page 7347 line 7: explain Kynar line and expand OD (or drop it, as OD is the commonly given number anyway) – page 7346, line 21: convert psi to mbar – page 7347, line 9: use SI units for pressure only

A: The above changes have been made to the manuscript.

R1: page 7347, line 19: what orifice diameter is used in the described setup onboard the aircraft?

A: The CRDS analyzer comes with a critical orifice that determines the flow rate of the analyzer. However, we have customized one orifice in the laboratory to lower the flow rate of the recent four-species analyzer (S/N CFKBDS2007) from 550 sccm to 280 sccm. Therefore, several different diameters have been used for the different analyzers, depending on the flow rate and analyzer. For the current analyzer it is 0.051 cm.

R1: page 7350, line 1: SI units for pressure

A: (Done)

R1: page 7350, line 9: the WMO 2007 scale?

A: Yes, for CO<sub>2</sub>. Added to the manuscript.

R1: page 7350, line 10-13: how do these values compare to other instruments used onboard aircraft?

A: We were unable to find other reports of calibrations of aircraft analyzers over a period as long as one year. NDIR analyzer calibrations are typically performed often on the aircraft and their long-term stability is typically not addressed. We present these numbers for our CRDS system to show the variability of the analyzer calibration over time should a user choose to calibrate only infrequently (for example, deploy an instrument at a site and only calibrate every few months).

R1: page 7350, line 15: How many reference tanks are aboard and what are their mixing ratios for respective years; later it is mentioned that there are 3 tanks and the

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mixing ratios are in the figure, but it is on first mentioning that this information should be given. Perhaps add a table that you can refer to here?

A: We have added Table 2 to the manuscript, which includes the tank values and periods of deployment.

R1: page 7350, line 23 to page 7351, line 15: try to revise this paragraph, it is difficult to follow the line of thoughts.

A: We have edited this paragraph for clarity.

R1: think about skipping subsection 2.5, most of it is self-evident

A: Section 2.5 (now section 2.4.3) has been trimmed down but not removed. It describes the procedures and methods for synchronizing our systems and logging and downloading data. This is actually one of the more challenging aspects of operating an aircraft measurement system at a remote site without a scientist present, because our systems must be as automated and fool-proof as possible. Errors and uncertainties can be introduced if the instruments are not automatically synchronized in time, or if auxiliary sensor measurements are not logged and monitored; in addition serious data losses occur from software or user error in data downloading and transfer. We want to describe our current methods for tackling these problems for other groups that may be interested in solving these issues as well.

## Conclusions

R1: Please give a (very brief) outlook of how the data are going to be used / which scientific topics are going to be tackled based on this data.

A: The conclusions have now been renamed Results and Conclusions with some text addressing how the data will be used in the future and in conjunction with other measurements available in the Arctic region.

## Figures

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R1: Figure 1: remove "the 2012 season is currently underway".

A: Figure caption change has been made.

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