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Atmospheric Measurement Techniques Discussions

Interactive comment on "Onboard measurement system of atmospheric carbon monoxide over the Pacific Ocean by voluntary observing ships" *by* H. Nara et al.

Anonymous Referee #1

Received and published: 4 August 2011

General remarks:

The manuscript describes CO measurement onboard commercial ship in the Pacific region covering a wide latitudinal and longitudinal range. It is a highly valuable measurement program with a potential to close an unavoidable gap in ground-based global observation networks. Hopefully these data will also become available to modelers in the future. One technical detail I particularly like are the daily reports, giving the scientists a good sense of what happens onboard the ship.

The topic is suitable for publication in AMT, and the manuscript is in general well written

and should be published after being revised.

Conceding that this manuscript presents the technical description of a measurement program, I still would like to see more scientific discussion of the data, e.g. seasonal variation, logitudinal and latitudinal gradients. By now a significant amount of data has been collected, and I recommend Section 5 (preliminary results) to be somewhat extended. The Western Pacific region has been studied comparatively well in the past using various platform types, especially in the northern hemisphere, and the new data could for example be compared to data from coastal stations in the region. To my knowledge there exist or have existed similar measurement programs deploying commercial ship in the Pacific that should be referenced.

The authors mention that besides CO also O_3 and CO_2 are measured. Why is none of this data shown? It is mentioned that commercially available instruments are used for this. What is the data quality of these measurements? Section 3.4 explains that CO_2 measurements are used for quality control of the data. How about CO/CO_2 correlations? Also, the flask samples seem to be analysed for a variety of other compounds that could help investigate CO source types.

Specific comments:

The expression "over the Pacific Ocean" on first reading implies measurements are performed onboard aircraft. Although it is clearly said, that these are ship based measurements, it should be "in the Pacific" or "in the Pacific region" or "in the Pacific boundary layer"

Is the same air intake used for all measurements (flasks, continuous CO, O_3, CO_2)? The position of the intake is mentioned a couple of times. Please make this clear in Section 2.1 and omit afterwards.

How much time is in between flask sample collection and GC analysis? What are typical O_3 values encountered? Has CO growth in the cylinders been investigated?

It is not clear to me what the different measurement time scales are.

P4507, L23–P4508,L4: To my knowledge CO measurements are also performed as part of the Japanese CONTRAIL program. If so, this should also be mentioned here. Yashiro et al in JGR 2009 also discussed a similar project of ship-based sampling that might be a suitable reference here because similar measurements are carried out in the same region.

P4510, L20/21: "including gases": Later calibration gases and the use of nitrogen are discussed, presumably only potentially poisonous gases are meant?

P4512, L22: At which time resolution are the different types of raw data recorded?

Section 2.2: The title is confusing because the term continuous system has been used before to distinguish between the continuous CO measurement and the flask sampling. The importance and length of this paragraph does not justify the separate treatment. It can be merged into Section 3. More details about the analyzers used should be given, e.g. what are the measurement techniques, detection limit, precision, time resolution... P 4511, L6: the term "air sample" should be used careful to avoid confusion with the flask samples.

P4511, L16: Why is the number of samples limited to seven? This is a very small number for the large distances traveled.

P4512, L4/5: What is the actual sampling time for one flask?

P4513, L5ff: Please mention that the continuous measurements are performed in addition to flask sampling.

P4514, L25: In section 2.1 it was mentioned that no gases were used onboard. Please clarify.

P4516, L22: 20 min zero-air injection time seems rather long. The daily calibration time is only 10 min. How long does the instrument need to stabilize after changing from sample to zero air? Is it ensured that flask sample collection takes place while ambient air is measured?

P4515, L25: Does that mean that a 40 min average is taken or is the mean only calculated for the drift correction? At which time resolution are the raw data recorded? This **needs** to be clarified.

P4519, L24: How about the fourth route (PX)? How many samples were collected?

Section 4.1: I suggest to skip this section. It does simply state that there is reasonable agreement between flask sampling and continuous measurements, the quantitative details of this are presented in section 4.2. It is no big surprise and does not need to be discussed in such detail that high resolution measurements capture more details than coarse flask sampling, and unsurprisingly this is more relevant in regions with high spatial variability.

P4520,L6: It is mentioned in section 2.2 that 10 s and 1 min data are reported, so why are 40 min mean values used? See also my question on the 40 min averaging above. I was unable to find the exact time resolution of the continuous instrument and I am not sure what the sampling time is, but it should be possible to calculate a well matching integral value from continuous measurements for each flask sample.

P4522,L2ff: "four distinct regimes" may be a better expression to use here. For better

understanding refer to the colours used in Fig. 6. The statement about the Asian monsoon circulation needs be clarified. In the current version the discussion of the FTW route winter cruise (P4521,L25 – P4522,L22) is very difficult to follow.

I suggest to merge Figures 1 and 9 into one figure and to include a table quantifying the number of cruises on each route.

Technical comments:

In general, the manuscript heavily uses a number of acronyms that are specific for this publication and not general knowledge. Overall readability could certainly be enhanced by trying to reduce this. Referencing the different travel routes should preferentially be done by using common geographic names rather than the vessels' names.

P4506, L6: change "cruising routes" to "cruise routes"

P4506, L6/7: Since all cruises are out of Japan, this can be shortened.

P4506, L15: Remove the part in parentheses, this detail is not needed in the abstract.

P4506, L7: Biomass burning is not exclusively an anthropogenic source.

P4507, L10: Give a range for the atmospheric lifetime.

P4507, L15: "concerning **the** global distribution"

P4507, L22: "in **the** upper troposphere"

P4507, L23: remove "along the flight routes".

P4507, L27: "started **the** Civil Aircraft ..."

P4508, L1: change to "This program is based on an airfreight container equipped ..."

P4508, L3: Change "was" to "is", the project is ongoing.

P4508, L17: "in **the** global distribution" (for one gas there is only one global distribution"

P4508, L29: change to "part of **the** program"

P4509, L20: "period of year": mention the exact time frame.

P4510, L1: Change "over" to "in" or "across".

P4510, L2: change to "in both hemispheres" or to "in both, the northern and southern hemisphere"

P4510, L3: change to "shows **the** current spatial"

P4510, L17: change to "The system **needs to be** robust because it runs..."

P4510, L20: change to "the use **of** dangerous substances"

P4512, L11: The abbreviation RGD has not yet been explained. Despite it being the common acronym for the detector type it needs to be expanded. Not all readers are familiar with gas chromatography terms.

P4512, L5: Use consistent pressure units throughout the paper.

P4515, L24: change to "ambient air temperature and humidity varied"

P4517, L13: A referwnce to Figure 5 would be appropriate here.

P4516, L12: Please explain the acronym VURF.

P4519, L9–11: Skip last sentence of this paragraph. What exactly do you want say here?

P4525, L33: change "Co" to "CO"

P4525, L25: change "if" to "of"

Fig. 7: Change axis labels to "CO [ppbv] (cont.)" and "CO [ppbv] (flask)".

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