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Atmospheric Measurement Techniques Discussions

Interactive comment on "Accurate measurements of atmospheric carbon dioxide and methane mole fractions at the Siberian coastal site Ambarchik" *by* Friedemann Reum et al.

Anonymous Referee #1

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This paper by Reum et al., presents a new atmospheric observatory for CO2 and CH4 in the Siberian coastline. The presence of this new research infrastructure is a very valuable opportunity for the atmospheric science community, especially taking into account the possible role that carbon stocks in the artic region (i.e. permafrost melting) can play in the next decades under the current climate change.

Performing such high level quality measurements in remote regions is not an easy task and strong scientific and technical skills are necessary to obtain reliable data with dense time coverage (as needed to perform inversion for GHG emission studies)

The authors describe with good details the experimental set-up adopted for CO2 and

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CH4 measurements as well as methods for data correction and data screening. Very basic analysis of the first months of data are provided.

Even if the methods adopted in this paper are not innovative, I think that the availability of this new station (and related data-sets) is a matter of interest for the atmospheric community.

Personally, I have some concerns about the design of the gas handling system and the data screening. For these reasons, I ask the authors for providing more explanation or details for some specific points (listed in the following) before publication.

SPECIFIC COMMENTS

"2.3 Gas Handling"

Any kind of rain guard was mounted on the air inlet?

The air flow diagram presents a very complicate system, with a number of connections and valves which increase the possibility of leaks and dead volumes. Even if I do not see anything wrong in this set-up, nonetheless I'm wondering why a so-complex system was adopted. For this reason, I'm wondering if the authors performed specific leak test on the system. If yes, what kind of test have been carried out? Are these tests repeated routinely? By using two flushing pump for each sampling lines you would avoid the complex switching system downstream of the antiparticulate filters F4-F3. I'm also wondering why you didn't use a rotary valve with more inputs to manage also the ambient air: this would have the advantage of simplifying the system (less possibility of leaks) and use a larger part of sampling circuit for both ambient air and calibration/target gas measurements with clear advantages and effectiveness for application of calibration and evaluation of target gas results.

Please provide the residence time of sampling within the system.

No water traps are used along the ambient inlet lines. In the paragraph 3.2 you mentioned that "longer probing time of the first tank serves to flush residual water out of the

tubing". Do you mean that water are present in the tubing? Is this due to condensation or drizzle sampling? In both case this can represent a problem since the presence of liquid water can create artifact in the measurement. Please explain and comment.

"3.1 Water correction"

It is possible to add in the supplementary material more info about the water vapour test? E.g. plot of Concentration(wet)/Concentration(dry) ratios plotted as function of water vapour level for CO2 and CH4 or time series of CO2wet, CH4wet during the water correction experiment. I'm wondering which is the absolute difference (in ppm and ppb for CO2 and CH4) if the "classical" water droplet experiment is used instead the Reum et al. (20q8) procedure. I'm pretty sure that this difference is well lower than the WMO compatibility goals.

Line 19: Did you apply the same correction for all the data series by considering an average value of the correction coefficients derived during each single experiment? This approach will become unfeasible when many years of measurements will be available, I suppose. How much would change CO2 and CH4 corerction if results from single experiments are used?

Figure 4 and Figure 5: the WMO goals are wrong in these figures. They are +/- 0.1 ppm for CO2 and +/- 2 ppb for CH4.

"3.2 Calibration"

How many measurement cycles are carried out during each calibration event? Did you apply any metric to evaluate the success of the calibration (e.g. standard deviation of single injection or data coverage). Did you consider stabilization time after starting of the single cylinder injection? How do you handle the fitting of calibration parameters when discontinuity of data appear (e.g. instrument switch off/on).

Can you provide the time series of standard deviation (based on 1-minute averages) of single target measurements (a measure for the CMR) and the time series of the

standard deviation over 72 hours of the target gas injection means (LTR)?

Fig. C1:please express CH4 in ppb. The spread of intercept looks pretty high (for both CO2 and CH4). Please can you provide the time series of measurement results (expressed as average value of CO2 and CH4) for each single tank during the calibration events? Which is the typical value of H2O during the calibration for each tank?

"3.4 Data screening"

It is not clear if this check are performed automatically or manually. Please provide more details about the screening procedures here adopted (e.g. threshold values, which kind of air pollutants are considered,. . .)

-3.4.1 Analyser status diagnostic I'm rather surprised that the OUTLETVALVE parameter is not mentioned in this screening. In my experience this is a pivotal parameters to check the presence of obstruction (e.g. filter) in the system.

-3.4.2 Flushing of the measurement 30 sec is not sufficient as stabilization time. I think that a few minutes is more suitable.

-3.4.3 Contamination from local polluters I think that also CH4 need a proper spike detection. What about biological waste management of the base? Table 3: the statistic is referring to all data or the 1-4 PM selection? Looking to Fig. 6, it seems that WD has a strong seasonal variability. How the fraction of flagged data is shared among the different months of the year?

I would suggest to implement as soon as possible measurements for the monitoring of pollution emissions (CO, NOx or aerosol particle) to consolidate the detection of local pollution influence.

"Section 5.1."

Line 12. Please do not use "trend" for this short time period. Use "tendencies" or (when appropriate) "growth rate" (the same for CH4) Line 26: more than this "trend" along the

whole measurement period, a discussion of the annual growth rates could be more interesting. I do not agree that the attribution of the very high values of CO2 in December 2016 are outside the scope of the paper. They can indicate analytical/experimental problems or interesting phenomena can be investigated at the station. I strongly suggest to provide some sounding explanations.

"Section 5.2"

This section is really basic. The related goal is not clear to me as well as the method for deriving the background values of CO2 and CH4. Please explain better. No explanation or discussion are provided for the results from wind analysis in section 5.2.1 and 5.2.2.

"Section 6"

Line 14. I do not think that the WMO compatibility goal and your total uncertainty can be directly compared. Instead, the “compatibility goal” is not (better: may not be) your achievable total uncertainty but a specific value within which your measurements must agree (see GAW Report No. 206).

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