Atmos. Chem. Phys. Discuss., 11, C16325–C16331, 2012
www.atmos-chem-phys-discuss.net/11/C16325/2012/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Automated ground-based remote sensing measurements of greenhouse gases at the Białystok site in comparison with collocated in-situ measurements and model data" *by* J. Messerschmidt et al.

J. Messerschmidt et al.

janina@caltech.edu

Received and published: 7 April 2012

Response to the review from referee #3 by Janina Messerschmidt

First of all we would like to thank the referee for the informative review. The comments and remarks helped to improve this paper.

General comments

1. The manuscript contains a very lengthy description of the FTS instrument and the installation at Bialystok, in which some aspects are described in detail, such as the

Full Screen / Esc
Printer-friendly Version
Interactive Discussion
Discussion Paper

automation concept (section 2.2) but other details such as the measurement precision and accuracy as well as the frequency of data recording are missing. I would suggest moving the description of the PLC and PC i.e. sections 2.1.1 and 2.1.2 to section 2.2 and overall making the description of the automation system more concise. For instance the description the different operation modes is perhaps extraneous here and could be removed, also Fig. 2 and 3 could be combined into a single figure. On the other hand, more details about the measurement precision and data recording and flagging should be provided, e.g. are all raw interferograms stored and at what frequency? It is also not clear how the weather station data are used – e.g. what criteria are used to determine if a measurement should be made? Also what is the percentage of data coverage considering instrument down-time and weather conditions?

Answer: The describtion of the automation was moved to the appendix. In this way, anyone who is interested in the automation can read it in length, but is not hampered by it at the beginning of the article. We followed the suggestion to make the whole description more concise and combined Figure 2 and 3. We did not focus on the precision, data recording, flagging, as we perform TCCON measurements. Information on the precision, on the flagging of TCCON measurements are given in much greater detail in other publications (e.g. "The Total Carbon Column Observing Network", Philosophical Transactions of the Royal Society - Series A: Mathematical, Physical and Engineering Sciences, by D. Wunch et al., 2011). Within the section about the Hatch system, the main criteria for the weather station are given: "The hatch is opened and the seals are vented when the system shall perform measurements and the weather conditions allow this. When opened, the solar tracker can point into the position of the sun and measurements can be carried out. The hatch is in an interim \textit{close temp} state, when the weather conditions are not good enough (not sunny), but are uncritical (no rain, low wind speed). The hatch is closed hermetically by pressurizing the seals when no solar measurements should be done, e.g. in the night or when the weather conditions do not allow to vent the seals, e.g. during rain or high wind speeds." The data coverage varies day by day and year to year and it is hard to give an informative num-

ACPD
11, C16325–C16331, 2012

ber. However, the FTS CO2 timeseries gives a good impression for the data coverage in the first 20 month of operation.

2. Section 3 mentions the vertically resolved a priori information used to obtain the FTS CO2 profiles, however, only column integrated CO2 data are presented. Is this because the uncertainties for vertically resolved CO2 are too large? This should be discussed, i.e. what potential is there for vertically resolved profiles, what are the uncertainties and how strongly do these depend on the prior information?

Answer: TCCON needs a priori information of the vertical gas profile, but TCCON does not do a vertical profile retrieval. The software calculates only the total column abundances. The retrieval of a vertical profile is in principle possible from TCCON measurements, but not yet realized within TCCON. Therefore vertical profile retrievals are not discussed in this paper.

3. Considering that this paper has been submitted to ACP, more emphasis should be made on the results, the model-measurement biases and the contribution of these measurements to improving the constraint on the continental CO2 budget. Perhaps an investigation into the possibility of vertically resolved CO2 FTS profiles could be added.

Answer: The authors followed the suggestion by moving the description of the automation to the appendix. As described above, TCCON does not provide vertically resolved CO2 profiles. By now only TCCON retrievals were done for Bialystok and vertically resolved CO2 FTS profiles can not be added. Apart from this, total column measurements have their own potential. We tried to emphazise on this in the introduction.

4. One limitation of the model-observation comparison is the low resolution of the atmospheric transport model (only 19 vertical layers and a horizontal resolution of 4 x 5 degrees). It would help strengthen the paper by including comparisons with a regional model (run with the same optimized fluxes) with higher vertical and horizontal resolution.

ACPD

11, C16325–C16331, 2012

Answer: We agree with the reviewer, that the analysis of a regional model would be of great interest. The present paper does not claim to cover all possibilities what can be done with the Biaystok dataset. The present paper is meant 1) to introduce the FTS, 2) to show the possibilities of the Bialystok mulitple data sets and 3) the good performance of the Jena CO2 inversion despite the limitation of the 19 layers.

Specific comments

Introduction:

1. More background into FTS measurements should be given, e.g. link to in-situ, aircraft and satellite measurements and their respective advantages and disadvantages.

Answer: Information are included especially in the introduction and Section 2.

2. p32247, line 23: It is not evident that by including total column measurements the estimation of the spatial and temporal distribution will improve. It should reduce biases introduced by e.g. incorrect vertical transport in models, this should be emphasised rather than the former. Also a reference should be given.

Answer: Information are included in the introduction.

3. p32248, line 7: how often are aircraft profiles made?

Answer: Information are included.

4. p32248, line 9: This is not only true for measuring so-called background concentrations, tall tower measurements are also influenced by strong fluxes in the near-field such as those from the biosphere (e.g. CO2).

Answer: Part in the sentence, "for measuring background concentration", was deleted.

Section 2:

1. p32252, lines 2-5: what is the importance of the line shape – more explanation should be provided

ACPD

11, C16325–C16331, 2012

Answer: Reader who are interested in the line shape should refer to the given reference.

2. p32252, line 11: should be “scanner frequency”

Answer: The authors would like to keep the term "scanner velocity", even if it it not given as velocity, but as frequency, because this is the common name.

Section 3:

1. p32257, line 13: “a priori”

Answer: Word was corrected.

2. suggest that the averaging kernels (Fig. 7) be referred to in this section

Answer: The authors agree and the Figure was moved to Section 2.1

3. p32258, line 6: “airmass” should this rather be “mass of air” to avoid confusion p32258, line 7: empirical should be “empirically”

Answer: corrected.

Section 4:

1. p32259, lines 20-24: this description is not strictly correct and should be re-written, e.g. “CO2 concentration” is not transported but rather “CO2”, it would be more accurate to state e.g. “: : :the vertical temperature gradient leads to unstable conditions and thus a deepening of the planetary boundary layer (PBL). Since the PBL is well mixed (including air from the former nocturnal layer) the decrease in CO2 concentration at the surface (from uptake by the biosphere) is attenuated.” Also it is not the “CO2 sources” that accumulate but rather CO2 itself and “lower troposphere” is too broad – CO2 accumulates in the nocturnal boundary layer.

Answer: Paragraph was totally rewritten.

2. p32260, line 2: “diluted” is not strictly correct, it is the change in CO2 concentration

ACPD

11, C16325–C16331, 2012

that is attenuated by long-range atmospheric transport or advection of air masses that are not influenced by terrestrial biosphere fluxes.

Answer: Suggestion was implemented.

3. p32260, lines 5-7: should point out why in Fig. 6 the strongest nighttime vertical gradients are in summertime – i.e. because the respiration flux is stronger in summer than in winter

Answer: Paragraph was revised.

4. p32260, lines 12-14: it is evident that the best agreement between the tall tower will be when the vertical gradient is the smallest (i.e. deep PBL) but an explanation of the offset (up to 5 ppm in summer) should be given

Answer: Explanation is added.

5. p32260, lines 21: should state which networks were used

Answer: In total, measurements of nine institutions were used. The description of all these institutions would be too long and are described in detail in the given reference.

6. p32261, lines 11-13: should provide a brief explanation of this method

Answer: A brief explanation is given.

Section 5:

1. A more detailed examination of the sources of error and uncertainties in both the JC model and the FTS measurements is required, e.g. suggestion of possible reasons for the temporally varying error (Fig. 8). Are these errors correlated in time and if so how? What possible explanations are there for this? How does this error in the column total translate into errors in CO2 fluxes?

Answer: Sources of error in the FTS measurements are discussed in detail in the given reference of Wunch et al., 2011. Here the standard deviation was given as error

ACPD

11, C16325–C16331, 2012

estimation. Errors and uncertainties in the JC model are given in detail in the given reference of Rödenbeck et. al (2005). Reasons for the temporal varying errors are manifold and complex. In order to analysis the reasons, a longer timeseries covering at least two fully years would be necessary.

2. p32263, lines 1-2: it is not surprising that the JC model cannot reproduce the CO2 accumulation at the lowest level, since the JC model has only 19 vertical layers for the whole atmosphere. What is the height of the lower-most model level? It is even possible that the lowest model level even lies above the nocturnal boundary layer height, thus from this comparison it is not possible to make any inferences about the vertical mixing or the surface fluxes. How different are the 30, 90 and 180 m levels from those at 5 and 300 m? Perhaps from the vertical CO2 profile, one can approximate the height of the nocturnal boundary layer and, depending one the model levels, compare the CO2 concentrations within and above the nocturnal BL?

Answer: To adress these questions firstly more information on the height of the model levels were given and secondly the CO2 concentration at 90 m was discussed in addition to the 5 m and 300 m. As already mentioned, no vertical CO2 profile information are available.

3. p32264, line 3: should explain how the aircraft profiles were extended.

Answer: A brief explanation is given.

References/ Figures - corrected

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 32245, 2011.

ACPD

11, C16325–C16331, 2012