Atmos. Chem. Phys. Discuss., 11, C11644–C11649, 2011
www.atmos-chem-phys-discuss.net/11/C11644/2011/

Atmospheric Chemistry and Physics Discussions

Interactive comment on "Assessing filtering of mountaintop CO_2 mixing ratios for application to inverse models of biosphere-atmosphere carbon exchange" *by* B.-G. J. Brooks et al.

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Received and published: 9 November 2011

We thank and appreciate the comments from anonymous reviewer 2 and offer in reply some additional explanation and plans on improving the paper.

Station lapse rates vs. modeled lapse rates. Review 2 addresses several shortcomings of the present version of this manuscript and offers useful suggestions that can be integrated. The larger issue brought up was that of coarse tracer-transport models like CarbonTracker and their smoothed representations of terrain, which leads to large elevation mismatches and incorrect vertical transport in the mountains. This contributes to discrepancies when applying lapse rate limits calculated over $\sim 10^2$ meters

to station lapse rates calculated over $\sim 10^1$ m. Higher resolution/better-resolved atmospheric transport models are indeed preferred for lapse rate filtering when tower height is small. Despite this we chose to use CarbonTracker as an example tracer-transport model. This was a decision guided by access to a model that 1) already incorporated RACCOON CO_2 data, and 2) relied on filtering strategies that excluded significant fractions of data and therefore could be improved upon.

CarbonTracker (CT), as a global inversion model, has its merits and we sought to take advantage of some of them. Global inversion models can produce results "cheaply" and quickly compared to high resolution inversions that can be limited in space and/or time (e.g., Göckede et al., 2010). Sometimes and in some locations coarse grid models provide good approximations of CO_2 exchange, particularly when the boundary layer is very well mixed. At other times though the coarse grid system leads to large model-data-mismatches exemplifying that the model framework has failed. (Some research about information content at multiple spatial scales was just published by Wu et al. 2011, http://dx.doi.org/10.1029/2011JD016198) In the case of this paper the discrepancy in the length over which lapse rates were calculated for CT vs. RACCOON data was ~40-90 meters, which is an issue worth investigating further. We could, for example, include an error analysis of the lapse rate filter's sensitivity to lapse rate error (i.e., geopotential height error in the model atmosphere), which would give us an idea of how many more or less observations would be included/rejected due to height misrepresentation.

Also recommended was a reworking of Figure 9, which could be used to clarify the lapse rate length differences. A redesigned Figure 9 could show the difference in lapse rate lengths between CT and RACCOON stations (for example see first attached figure), as well as indicating which observations would to be rejected. The latter could be displayed using a straight-forward scatter plot of lapse rates vs. CO_2 mole fractions (for example see second attached figure). Although the difference in lengths (over which lapse rates are calculated) is an issue for RACCOON towers and the CT atmosphere other readers with intentions of practical implementation might combine a different model and different stations, for example applying CT lapse rate limits to tall tower CO_2 data calculated over a comparable lengths.

Supplementary spreadsheet. The suggestion of including a supplementary spreadsheet is great idea that should help to simplify our exposition of filtering protocol and description. This should significantly increase the paper's clarity and make it easier for readers to test the filters themselves. Another supplementary spreadsheet for comparison of the Carr and Niwot data can be prepared as well.

Airborne data from Carr ($\sim$2000 masl) vs. Niwot Ridge ($\sim$3500 masl). We set as a baseline for comparison all time points from Carr when CO_2 in the lower 1,500 m varied by less than +/- 1 ppm. This criteria removed all but about 20 of the 250 possible sampling points. The +/- 1 ppm criteria is strong but ensures surface layer similarity to air aloft, which makes the comparison of airborne data over a lower elevation site (Carr) to a high elevation station tenable and more likely to represent well mixed conditions. We don't know/expect near surface CO_2 variability at Carr (over the plains) to follow Niwot (ridge top), so we searched for the most likely times/conditions. We did try a comparison between more relaxed criteria, but ultimately chose a tighter constraint and stronger basis for comparison to increase the likelihood of surface similarity.

Gross over-estimates of near surface CO_2 in CT. Another problem pointed out was that of the large mismatches in complex terrain between surface CO_2 mole fractions in CarbonTracker and the in situ measurements. We looked at the CT CO_2 mole fractions across atmosphere levels in the vicinity of the RACCOON stations and noticed values were oftentimes 100 ppm too high. However, it was the RACCOON data that had the larger lapse rates, which we show (though admittedly unclear) in Figure 9. Additionally some work will be done on this manuscript to make it clear that the lapse rate limits

from the model are broad guidelines that show what the model atmosphere is capable of reproducing at a given time of day. The lapse rate filter does not use the model lapse rate limits from the same exact time of day from the model to filter data from the tower. The lapse rate filter, as do many such filters of CO_2 data, still leaves the ultimate decision about whether or not an observation can be utilized by and inversion system up to the internal data assimilation filters.

Interactive comment on Atmos. Chem. Phys. Discuss., 11, 25327, 2011.

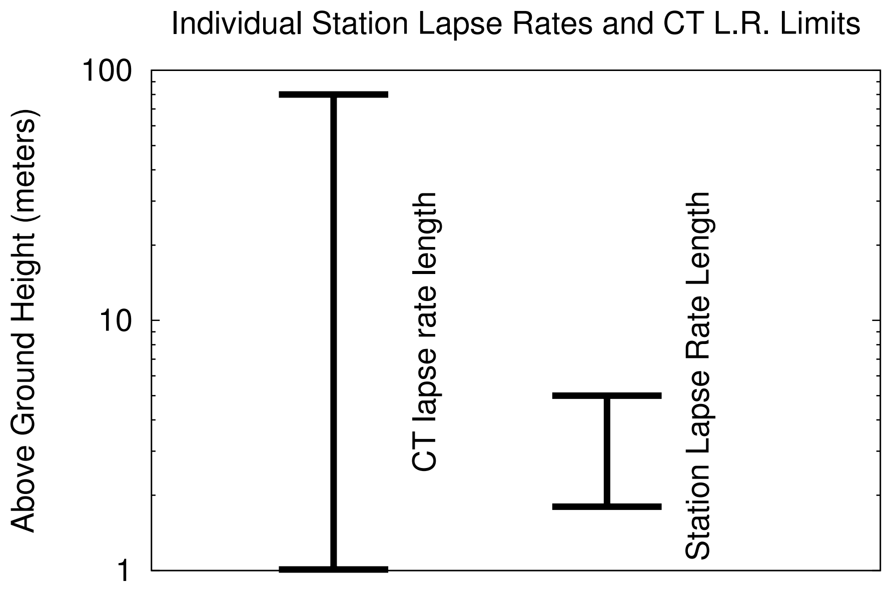
Individual Station Lapse Rates and CT L.R. Limits
Above Ground Height (meters)
100
10
1
CT lapse rate length
Station Lapse Rate Length

Fig. 1.

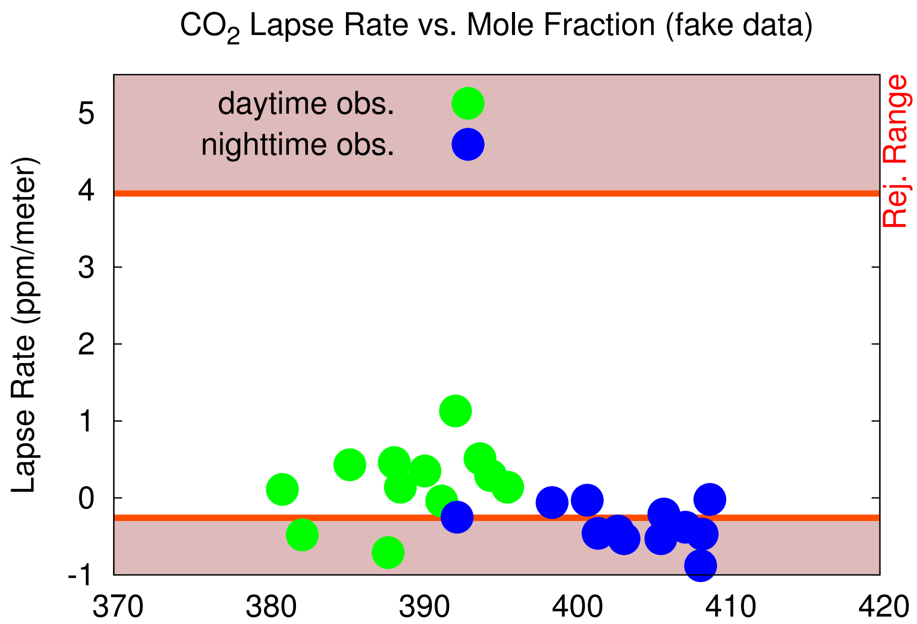
CO2 Lapse Rate vs. Mole Fraction (fake data)
Lapse Rate (ppm/meter)
daytime obs.
nighttime obs.
Rej. Range
5
4
3
2
1
0
-1
370
380
390
400
410
420

Fig. 2.