Atmos. Meas. Tech. Discuss., 8, C3343–C3346, 2015
www.atmos-meas-tech-discuss.net/8/C3343/2015/

Interactive comment on "Study of the regional CO₂ mole fractions filtering approach at a WMO/GAW regional station in China" *by* S. X. Fang et al.

S. X. Fang et al.

fangsx@cams.cma.gov.cn

Received and published: 19 October 2015

Thanks for the comment. The main propose of the manuscript is to find the most appropriate method to filter the observed CO2 data series at stations like LAN. It is essential for the study of regional CO2 characteristics and the determination of variations of sources/sinks strength. An improper data filtering method can lead to large bias on these studies (see e.g. the BC method used in this study). In the revised manuscript, we corrected the statement.

Detailed comments: 1. P.7061. Authors stated that CO2 mole fraction was previously

estimated to be 404.2ppm and also Pu et al. gave another value (407ppm). This time even though they applied four kinds of filter, they did not give us the explanation about the relation or evaluation to such previous values. They should try some.

Reply: Thanks for the suggestion. The main reason for the difference is because Pu et al. (2014) used all the data both including day and night time. Moreover, the BC method applied in the present study slightly differs from the Pu et al. approach. In section 4, we clarified the reason for the different numbers by adding the statement "...It should be mentioned that the BC method in Pu et al. (2014) is different to the one in the present study. Besides using different wind speeds as filter criterion (2 m s-1) and excluding outliers, they used all data including both day and night time. The emissions from local vegetation and accumulation in the shallow boundary layer in the night definitely enhanced the filtered CO2 mole fractions and induced higher annual values than those in our study...". We also compared with the results in our previous study (Fang et al., 2011) and explained the cause as "...However, it may also induce errors when evaluating the regional CO2 mole fractions, e. g. overestimating the regional values. In a previous study (Fang et al., 2011), we concluded an annual average of 405.3 ppm in 2009, which was apparently higher than those in this study (Table 1)..."

2. P7061. Recent inverse modeling use much more fine data (e.g. 1hr average), not regional average for a certain time period. So, 3 ppm difference between the average methods may not always bias the model simulation.

Reply: Thanks for the comment but we tend to disagree with the reviewer's opinion. A difference pf 3 ppm is in the range of the North-South gradient across the whole Northern hemisphere and single stations showing a bias in this range might create visible artefacts in inverse models However, we changed the wording of the respective sentence to make the statement less strict. "The difference ($\sim$ 3 ppm) between these two methods can induce biases on the estimation of CO2 abundances in the regional scale as well as on the calculation of source/sink by inverse models."

3. P7067 and P7070. Annual increase rate should be rather consistent with global or regional background. For example, you can compare with Yonaguni as a nearest WMO site. Even globally, we observed over 3ppm/y in 2010. If you compare the increase rate from 2009 to 2010 using Table 1, growth rate for REBS and AUX are too small (i.e. 2ppm/y), showing existing of some bias. On the other hand, increase rate from 2010 to 2011 for three methods except BC, showed too large values. Globally increase rate decreased to below 2ppm/y. Could you explain any reasons for that?

Reply: Thanks for the suggestion. In the revised manuscript, we studied the absolute CO2 increase from the four methods, and analyzed the possible reasons based on variations of total CO2 emissions from fossil fuel combustion in China. Please check the revised manuscript for more. The filtered CO2 mole fractions at LAN can only be used to represent the conditions in Yangtze Delta area in China. In Fang et al. (2014), we found the annual CO2 growth rate at the three WMO/GAW regional stations in China varied from 2.7 to 3.7 ppm yr-1. Because the CO2 observations at these stations are influenced by respective regional sources/sinks, we can only get the "regional" CO2 information instead of the "background". The Yonagunijima is an island station. The influence of regional sources (e. g. from Taiwan) is usually negligible because the most frequent wind direction is northeasterly (from the Pacific Ocean) except in summer (Tsutsumi et al., 2006). Thus the CO2 data series at this site can be separated into local, regional, and background. In the revised manuscript, we discussed the growth rate in BC as: "the absolute increase ($\sim$ 0.7 ppm) is too small compared to those from the other methods, as well as the global means. For example, the globally absolute CO2 increases are 2.3 ppm in 2009 - 2010 and 2.0 ppm in 2010 - 2011 period from WMO/GAW's statistics (WMO, 2011; 2012) or are 2.39 ppm in 2009 - 2010 and 1.71 ppm in 2010 - 2011 period from NOAA's network (Dlugokencky and Tans, 2015). Considering the global CO2 growth rate and the increasing emissions of CO2 in China (CDIAC, 2015; Tohjima et al., 2014), it is unlikely that the regional CO2 mole fractions at LAN almost remain constant from 2010 to 2011. In fact, the long-term trend in the BC method (polynomial part of the curve fitting function) decreases from February in

2011 (data not shown), which opposites to the variations of total CO2 emissions (or black carbon) from fossil fuel in China with increasing value from 0.15 P g C in 2009 - 2010 period to 0.21 P g C in 2010 - 2011 period (CDIAC, 2015). As the BC method uses a fixed black carbon concentration (5000 ng m-3 in this study) as threshold to filter the CO2 record, a large proportion of high regional CO2 mole fractions in 2011 may be flagged as local events, and consequently, a decreasing long-term trend was acquired. The absolute CO2 increases from the other three methods indicate smaller values in 2009 - 2010 period and lager values in 2010 - 2011 period, roughly reflects the total CO2 emissions in China."

4. P7071. Local signal showed both higher bias and lower bias than regional signal. If you average these values as local CO2 events, it is hard to explain their characteristics. Could you evaluate these bias separately?

Reply: Agreed. We separated the local CO2 mole fractions into "REBS-P" and "REBS-D". The "REBS-P" represents local data points in or above the regional CO2 band (the blue band in Fig. 3), and the "REBS-D" represents local events below regional CO2 band. We explained the characteristics of both in section 3.3 as "...The local CO2 mole fractions in REBS-P are always higher than for the other methods, as most of the events in it are observed during night time (0 - 8 LT) when local emissions are strong and the boundary layer becomes lower. Contrarily, the CO2 mole fractions in REBS-D are mostly observed in midday (12 - 16 LT) and are apparently lower than the other methods, reflecting the strong absorption by very local vegetation. Thus it can be seen that at LAN station, the REBS tends to define medial band of the CO2 record as regional representative..."

Interactive comment on Atmos. Meas. Tech. Discuss., 8, 7057, 2015.