

Interactive comment on “Primary aerosol emission trends for China, 1990–2005” by Y. Lei et al.

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This is a valuable contribution to the discussion of PM emissions in China and I recommend publishing it. However, I would like to draw the attention of the authors to few issues that might require a revision of parts of the paper, including small recalculations for specific sectors; subject to discussion and I am happy to discuss further the specific comments make below (the order does not necessarily reflect importance):

1. When discussing comparison of the estimates with other work I miss reference to at least trends observed in ambient air. There exist measurements of primary and secondary components of PM for several urban areas in China and few rural locations and it might be useful to have a closer look at those to compare the trends in the last years (the measurements do not cover the whole period but at least the last years,

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say about 1999–2005). Incorporating this comment could result in modification of the statement on page 17157 (line 14) and possibly adding a small paragraph in section 5 (Discussion).

2. There is no mention of the off-road machinery (agricultural tractors, construction machinery, railways, etc.); typically this source is poorly controlled and its role in emissions in a strongly growing economy could quickly increase. I suggest adding brief discussion of these sources, especially in relation to the potential contribution to BC emissions owing to typically high share of engines in this sector using diesel fuel. Consider it in section 3 and 5 and depending on magnitude in sector 4.

3. Throughout the paper the authors refer to ‘power plant boilers’ but from the text I gather that respective sections might also include industrial boilers. If this is so, I would suggest making it more explicit and the international audience typically expects such distinction. Furthermore, this might have implications on discussion of impact of legislation that is typically different for power sector and industrial boilers since several of them are of smaller capacity. Sections 3.1, 4.2.1, and 5.1.2 would be affected.

4. One more comment on industrial boilers; in my own work I have been often confronted with opinion from Chinese experts that the knowledge on the actual number, coal use and operating practices of smaller boilers in industry was and is quite poor implying that this sector might be more important than often estimated but most of all more uncertain than some of the other sources.

5. On page 17159 (line 13); while nearly 10 years ago we indeed had no data to assume otherwise, there are measurements and papers showing that it is not the case and I would recommend to review this assumption and refer to the respective literature, for example for stoves please see Roden et al (2006; EST) and Rodaen et al (2009; Atmospheric Env); I do not remember immediately sources for transport.

6. On page 17163 (line 3) the authors refer to the BC and OC shares in PM_{2.5} in Bond et al (2004); I believe this is not correct, unless the authors made some additional

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assumptions that are not shown. Bond et al (2004) has developed BC and OC shares in PM1 and put this also in relation to PM10 rather than PM2.5. While for some sources it might not matter much, e.g., diesel engines or biofuel combustion, it does matter more for coal combustion in stoves and industry.

7. On page 17158 (line 9-11) the authors refer to the key innovation of this work. I believe that few previous studies had a similar approach, actually already Bond et al (2004) made assumptions on technology penetration, although distinguishing only few key elements and lacking the level of detail you are presenting. However, some other papers, e.g., Zhang et al., 2009 or Klimont et al. (2009; Tellus B) have used several sectors and technologies and in the latter paper discussed also evolution over time. I'd suggest to add a reference to the Klimont et al. 2009 in general as well as Bond et al 2007 (on historical emissions) [both could be mentioned already in the introduction; see page 17156 as well as in further discussion and comparisons, specifically for BC and OC as they do not present PM2.5 or PM10]. However, I am not questioning that this paper does not an innovative/valuable component, quite the contrary, it goes beyond the mentioned papers as it adds new material, its detailed evaluation, improved spatial resolution, annual time-series, uncertainty analysis.

8. On page 17163 (line 4) I would suggest to add also reference (and actually look into the paper too) to the Atmospheric Environment paper (Kupiainen and Klimont, 2007); it contains some more discussion of emissions factors and some updates and was peer reviewed.

9. Page 17158 (line 8); please mention for clarity that Hong-Kong is not included and why.

10. Page 1712, section 2.2.4.; One could add few references here where legislation and legislation issues in China has been discussed, e.g., Xu et al., 2009 (Energy & Environmental Science) [it is a SO2 paper but the mechanisms are discussed and I feel it could be used here] and also Zhang et al, ACP, Intex paper; and also mentioned

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earlier Klimont et al (2009; in Tellus B). Finally also the IEA Coal database does give information on implementation of PM abatement in power sector.

11. Page 17167, line 15-20; I wonder if there is any substantive evidence for these trends, something could be quoted or there is nothing and the authors choose to reply on the assumptions of others.

12. Page 17167-17168; section 3.6; Maybe a brief discussion of the enforcement of legislation in transport and its regional variation can be added. Both will have impact on emissions, specifically its spatial distribution. By enforcement I mean, how (if at all) you consider deterioration of vehicles, especially if annual testing is not required and in some areas regular maintenance might be of poorer quality.

13. Page 17169, line 12; 'small plants' do they include also small industrial boilers (not just kilns in two mentioned sectors) in other sectors?

14. Page 17170, line 13; I believe the authors could refer to the more recent sectoral assessments since Bond et al work was for 1996 before strong growth in transport; examples could include Ohara et al., 2007 (JGR), Zhang et al (2006, 2009), Klimont et al (2009).

15. Page 17170, line 21; I personally do not think that stressing this regionalization of strategy is very relevant here since nowhere else in the paper there is any more extensive discussion of potential strategy. What's more, while importance of key 3-4 activities does vary from region to region, there are principally always the same sectors that are key and so a nationwide legislation might be the right way to go while there is space for local incentives so that some measures could be taken quicker in specific regions.

16. Page 17170, line 6; coking industry estimates for BC and OC are very, very uncertain as there is virtually no measurements of emission factors and the share of production in different type of ovens are also pretty uncertain; maybe something one

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could stress here. However, the most problematic issue is referring to the emission factors used (table 6) for this sector (in fact also for brick kilns). You refer to the study from 2002 (of which I am the lead author) and at that time we had to extrapolate from very general emission characteristics to arrive at the BC and OC shares in PM for coking plants; what's more in Europe coke ovens are not an important pollution source anymore and therefore the impact of the possibly inappropriate emission factor is practically invisible. Based on the more recent information, or newer informed judgement and discussion between several groups, including Tami Bond, we have concluded that these emission factors are very likely to be inappropriate and use in current versions of models very different values. I suggest contacting me for discussion of this issue and I will share with the authors the more recent estimates of emission rates for carbonaceous aerosols from coke making; however it should be stressed that this sector for China is contributing significantly to the overall uncertainty. . . we still wait for a comprehensive set of measurements which as a matter of fact are in progress.

17. Page 17173, line 1; is there a reference that could be added for the change in the types over time? Also are there any local measurements of PM on coke plants? It would be important to say that.

18. Page 17173, line 13; I believe one should add a statement about the specific (higher) uncertainty associated with estimates of fugitive emission in industry; they cannot be directly measured and true practices are largely unknown.

19. Page 17174, line 19; possibly one could add here that the stringency of road transport legislation varies across provinces with specific laws in some cities.

20. Page 17177; line 19; suggest to include in the comparison also Klimont et al., 2009 (Tellus B)

21. Page 17177, line 23-24; indeed these might be important sector but what I miss in the paper is discussion of the transformation in brick industry, similar in a way to the coke sector that took place in China over last decades. According to a number of

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Asian experts and several industrial or NGO reports countries like China, Vietnam were successful in eliminating the most primitive kilns (e.g, the ones still used in India or few other South Asian countries; often referred to as clamp kilns) and replacing them with vertical shaft kilns as well as Hoffman kilns which are much more efficient and cleaner, although often no specific abatement has been attached to them.

22. Page 17178, line 7-8; As a matter of fact the impact of the uncertainty in biofuel activity data has been discussed and estimated in the Klimont et al (2009) study that considered the variability in reported activity data from different assessment. And yes, I agree it is a very important aspect and potential source of error.

23. Page 17179; line 24-26; I cannot agree more but maybe also adding a sentence about the off-road machinery and small industrial and residential boilers would be useful.

24. Page 17179; Conclusions; I think that apart from listing trends for different PM species it would be very good to add something about the successful implementation of measures in few sectors that led to a slow down or even reversed trend for emission of PM species which has certainly health benefits. At the same time the efforts have to be accelerated to efficiently control remaining sources as PM is still an important pollutant (one can make here a reference to the concentrations measured in the cities and compare it to the WHO standard); just suggestions.

Editorial comments: Language is generally fine but few lines could be revised as well as few other small things corrected/improved, e.g.,

- Page 17157, line 23; suggest replacing 'very difficult' with 'even more difficult'

- Page 17158, line 20; since the authors refrain from using full indexing in Fig 2 I'd suggest to add more explicit description of the EF (y,z), for example instead of saying 'for a given technology m' say 'for a given combustion/production technology m in sector j'

- Page 17162; line 16-20; I think that instead of referring to IIASA in line 16 and then 20,

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one can simply refer to the paper, saying Klimont et al (2002) have summarized. ...also at the end of line 17 you can add 'in Europe and US' as the US experience and size specific efficiency plots from US measurements were used too to establish the profiles at the time.

- Page 17167, line 18 'lineally' replace with 'linearly'
- Page 17174, line 2-3; please review this sentence, there is something wrong with it.
- Page 17175; line 17; Suggest revising the title of the section 5.1.1
- Page 17179; line 14; suggest replacing 'presented' with for example 'taking place'
- Page 17179; line 15; I think this is an error, the '15.1 Tg' should be '1.51 Tg'

Interactive comment on Atmos. Chem. Phys. Discuss., 10, 17153, 2010.