

Interactive comment on “First long-term and near real-time measurement of atmospheric trace elements in Shanghai, China” by Yunhua Chang et al.

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Review of: “First long-term and near real-time measurement of atmospheric trace elements in Shanghai, China” by Yunhua Chang et al

Overview The rapid development and industrialisation in China during recent decades has resulted in increased emissions of many pollutants leading to high levels of particulate matter in the atmosphere with severe effects on human health. Amongst the pollutants emitted, heavy metals are of particular concern due to their toxicity at high air concentrations. The problem is of specific regional concern as in other parts of the world (i.e. many European countries) concentrations of heavy metals in the at-

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mosphere have decreased dramatically since their peak values to values which are now well below limit values considered to pose a threat to human health. The study focuses on Shanghai which is a mega-city and a centre for heavy industry. The paper suggests that metal concentrations are one or two orders of magnitude higher than in north America and Europe which is a highly significant conclusion as this indicates that a large population is exposed to multiple and serious threats to human health in the region. An extensive data set has been analysed which includes both a large number of species and high frequency measurement. The chemical analysis covers 18 heavy metal species which allows grouping of metals into different source categories. The hourly measurement of the data is of particular significance as such high temporal resolution of measurements for a full year of monitoring combined with detailed chemical analysis is quite rare and allows analysis using the conditional probability function and bivariate polar plots. The manuscript is well referenced and the text is logically constructed. The experimental set up is clearly described and graphical representation is put to good use to investigate seasonal, weekly and diurnal variation in metal concentrations. Some of the plots (i.e. figures 2 and 12) have details which are in very small print. However I think this is probably necessary due to the large number of metals to be simultaneously displayed and, as the graphs are of high resolution, the information can be read easily using the zoom function. I have a few queries about interpretation of the results which are raised below. The English is of a reasonable standard. However the language needs checking as there are various minor grammatical errors in the text (i.e. use of the article a / the) and some inappropriate / unclear expressions for a scientific publication, a few of which (in the early part of the text) are mentioned below. I am pleased to recommend the paper for publication following attention to the comments below.

Examples of minor corrections: Abstract: - “...with poorly constrained on its abundances and sources ...” Change to: “... which have considerable uncertainty associated with the source and magnitude of their atmospheric emissions”

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- “collocated” should be “co-located”

- “Besides, various mathematical methods and physical evidences were served as criteria to constrain various solutions of source identification.” Change to: “A variety of mathematical techniques were employed with high frequency monitoring data to identify sources for metal emissions.”

Main text

- “Among the chemical components relevant ...” Long sentence. Break into two. - Line 70 – 80. Health effects of some metals are mentioned here as human carcinogens. However there are many other individual effects on human health (i.e. brain, lungs, reproduction, kidneys(?) for individual metals which could also be mentioned here. Recent American studies have even linked Pb concentrations to criminal behaviour.

- Line 135: “... Shanghai is home to nearly 25 million people as of 2015, marked as the largest megacity in China” should be “... making it the largest mega-city ...”

- Line 150: “Meanwhile, most available source evidences were inferred based on filter sampling and off-line analysis, which were not necessarily representative of actual origins.” The statement is unclear and needs re-wording

- Line 184: change ‘multitudinous’ to ‘a multitude of’

- Line 199 ‘resulted’ should be ‘resulting’

- Line 203 ‘producing’ should be ‘produced’

- Line 246: ‘were followed’ should be ‘followed’

- Figure 3 caption: ‘A quick glance of the mass concentrations of 18 trace elements measured ...’. Change to ‘Mass concentrations of the 18 trace elements measured ...’

- Line 338 ‘which accounting for’ should be ‘which accounts for’

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- Line 362: 'because certain emission sources may make a pause or reduction during weekends' Change to 'because certain emission sources may be paused or reduced during weekends'

- Figure 4: 'The gray line indicates one two standard deviations.' Needs correcting

Specific comments

- To me the title, whilst accurate, is a little awkward. I think 'first' is unnecessary and could be removed as we can argue that all scientific publications are in some way a first. How about "High frequency monitoring of atmospheric trace elements in Shanghai, China"? 'Monitoring' implies long term measurement. A longer version could be: "High frequency monitoring of atmospheric trace elements in Shanghai, China, and source attribution analysis"

- Mean and variance values of concentrations are quoted to 4 or even 5 significant figures. I think it is unlikely that this degree of accuracy can be attributed to the measuring system. 2 significant figures (or a maximum of 3) would be more realistic.

- Figure 1: Include (a) , (b), (c), (d), (e) next to individual figures

- Line 402: "This can be used to explain that the weekly (monthly) lowest impact of shipping emissions in Shanghai was occurred during Sunday (Fig. 6c) (February (Fig. 6d))." Check this statement. February doesn't appear from Figure 6(b) to be the month with the minimum concentrations

- Line 410: "As demonstrated in Fig. 8d and Fig. 9d, there is an evident drop in the concentrations of Si, Ca, Fe, Ba, Mn and Zn after entering weekends." The minimum concentration in Figures 8(d) and 9(d) appears to be on Tuesday. Can the two day delay between the weekend and peak concentrations be explained? If this is following a weekend dip in activity then perhaps it suggests long range transport?

- Wind speed is associated with long range transport in the text. However high wind speeds also cause production of sea salt aerosol and re-suspension of surface dust

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particles, both of which can contain heavy metals and base cations. The text refers to high concentrations of metals in top soil but doesn't include correlation of metals concentrations in air with high wind speeds. In some European countries, re-suspension of surface dust makes a major contribution to heavy metal concentrations in air which can be even higher than primary emissions (see i.e. Travnikov et al, 2012 and other reports from MSC-east). I suggest that re-suspension of surface dust during high winds is considered in the analysis of the relationship between metal concentrations in air and wind speed / wind direction.

Travnikov O, Ilyin I, Rozovskaya O, Varygina M, Aas W, Uggerud HT, et al. Long-term changes of heavy metal transboundary pollution of the environment (1990–2010) EMEP contribution to the revision of the Heavy Metal Protocol; 2012 [Available at: <http://www.emep.int/publ/>]

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