**Atmospheric
Chemistry
and Physics
Discussions**

Interactive comment on "Multi-annual changes of NO$_x$ emissions in megacity regions: nonlinear trend analysis of satellite measurement based estimates" *by* I. B. Konovalov et al.

Anonymous Referee #2

Received and published: 15 June 2010

1 Overview

The research described in this manuscript includes a novel method for using observations to estimate the trend in NO$_2$ emissions. By using a chemical transport model and statistical techniques, this method can estimate the emissions trend despite substantial noise in the observations and year-to-year variability in the chemical and meteorological conditions. This method is applied to a collection of mega-cities and reveals interesting results. I recommend this manuscript be published in *Atmospheric Chemistry and Physics*, pending sufficient attention to the comments below.

2 Major Comments

- *Inverse modeling* An assumption in Section 3.1 is that there is a linear relationship between the NO$_x$ emissions and the NO$_2$ column density. This is demonstrated in Figure 3 quite nicely. However, London seems to have rather low noise and pretty consistent downward trend. It would be valuable to show that this is true for all of the mega-cities investigated here.

- *Method description* I think this paper could be more effective if the text describing the methods for calculating the trends, especially Section 3.2.2, included enough detail for someone to replicate the approach. The value of these improved methods are a significant strength of this work. My specific questions are

  1. How is the neural network configured?
  2. A standard perceptron network gives binary values, but the approach described here yields real value – explain?
  3. What happens to β_0 and β_1 in Equation 5? These terms disappear from the right-most expression.
  4. The mega-cities are divided into those where a linear trend can be estimated and those where only a non-linear trend can be estimated. How is this determined? And how is the green line marked "interannual change" estimated? How is this different than the purple line marked "retrieved trend"?

- *Noise estimates* Equation 10 describes the method for estimating the noise. To what extent is this tied to known uncertainties in the satellite retrieval or errors in the inverse modeling? I appreciate that this question is beyond the scope of the paper, but is there anything that can be interpreted from the site-to-site differences in the estimated noise? It seems like this in an area where this method could also make an important contribution. Also, the uncertainty bounds on the

retrieved trends in Figure 7 seem quite small. Can you show that if the method is repeated using the surface observations, the trend falls within the bounds shown in Figure 7? Is there a different way to falsify or evaluate the quality of the retrieval uncertainty?

3 Editorial Comments

- **10928:10** It is preferable to refer to the original definition of megacities, rather than wikipedia. I think you can simply say "as defined by the United Nations".

- **10930:23** What is the meaning of "preliminary convoluted" here? Is it preliminary in that a more complete analysis is performed in a separate part of the method? If this is a technical term, please provide a reference that describes the method.

- **10931:12** This sentence is unclear: "Such an evaluation of s_c implies that the change of NO_x emissions between the years 2002 and 2003 may be disregarded in comparison with the maximum change of emissions during the whole period of 13 yeas." What are the units of s_c? Grid cells? Later in line 20: "about 95 percent of the signal" how does this follow from the calculation described above?

- **Section 2.2** Please describe method of NO_x measurement. The most common technique is chemiluminescence, which has been shown to have biases in urban environments (Dunlea et al., 2007). If applicable, how do you interpret your results in light of these errors?

- **Table 1** Please correct inconsistent capitalization in "Monitor's Type" column.

- **anyway** Please consider removing the use of "anyway" and "besides" as a transition between thoughts. It is distracting, because in conversation, "anyway" is

often used to transition to a different line of reasoning. In most places they can be removed without any loss of meaning.

- **Equation 7** I am having a very difficult time parsing the vertical bars in this expression. Are the vertical bars around w for absolute value? What are the other vertical bars for? What does "const" mean in this context? I'm confused because while w_{max} is a constant, $p_a(w)$ is not, correct?

- **10942:19** "It does in fact not influence their calculation" whose calculation? Awkward sentence, please re-phrase.

References

Dunlea, E. J., Herndon, S. C., Nelson, D. D., Volkamer, R. M., San Martini, F., Sheehy, P. M., Zahniser, M. S., Shorter, J. H., Wormhoudt, J. C., Lamb, B. K., Allwine, E. J., Gaffney, J. S., Marley, N. A., Grutter, M., Marquez, C., Blanco, S., Cardenas, B., Retama, A., Ramos Villegas, C. R., Kolb, C. E., Molina, L. T., and Molina, M. J.: Evaluation of nitrogen dioxide chemiluminescence monitors in a polluted urban environment, Atmospheric Chemistry and Physics, 7, 2691–2704, doi:10.5194/acp-7-2691-2007, http://www.atmos-chem-phys.net/7/2691/2007/, 2007.