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Atmospheric Chemistry and Physics Discussions

Interactive comment on "IASI measurements of tropospheric ozone over Chinese megacities: Beijing, Shanghai, and Hong Kong" *by* G. Dufour et al.

Anonymous Referee #1

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The paper of Dufour et al. presents tropospheric ozone measurements from IASI onboard MetOp-A (sun-synchronous orbit, 9.30 am descending mode). The paper focusses on monthly mean tropospheric ozone observations over Beijing, Shanghai and Hong Kong for 2008 analyzing the respective seasonal cycles of partial columns and mixing ratios below and above 6 km and at selected levels comparing these with a climatology by Mc Peters et al (2007) in adjacent latitude belts. The differences between the cycles at different locations and altitudes are discussed in combination with the vertical ozone cross sections and maps over the three megacities. The authors speculate on possible origins of the tropospheric ozone enhancements such as ozone production from pollution and its interplay with circulation patterns and wind

fields. They also try to link daily variations of the partial tropospheric ozone columns to stratospheric origins on the basis of vertical profiles.
The data are of clear interest to the scientific community and particularly the maps and the seasonal cycles seem to demonstrate the capabilities of the instrument. The paper is fluently written and figures show a lot of interesting details demonstrating a high quality of the IASI ozone observations for the lower troposphere.
However, concerning the explanation and scientific interpretation of the ozone observations the paper remains speculative and just scratches the surface. Particularly the separation and discussion of upper tropospheric ozone values seems to be critical without a discussion of the tropopause altitude given the averaging kernels of the instrument in the upper troposphere. Lower tropopauses lead to a stronger influence of stratospheric ozone considering the strong ozone gradient at the tropopause and the width of the kernel.
Even if the main intention of the authors is to present the potential of a relatively new observational data set, they should support their hypotheses with meteorological informations. Particularly for the discussion of stratospheric influence this is important. Since the degrees of freedom in the troposphere are typically smaller than 2, observations of upper tropospheric ozone can be artificially enhanced due to a broad averaging kernel.
As presented here, I doubt that the evaluation and discussion of upper tropospheric cycles makes sense without additional data. Therefore I recommend to the paper for publication after the following points have been adressed.

p.8: Vertical cross sections and seasonal cycles (Fig.5 and 6,8,10):
The authors show vertical cross sections of ozone (Fig.5) and conclude that phase shift of the cycles at different altitudes in the troposphere can be resolved by the observations. Of course the cycles around 3 km and between 7-10 km are different, but I doubt that these differences are of tropospheric origin. A close inspection of Figure 5 and the upper cycles (Figs 6,8,10: black curves) reveal, that the cycles

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seem to be related to the location of the tropopause (taking the strongest change of color gradient from orange to yellow in Figure 5 as proxy for the ozonopause). Due to the kernels as shown in Figure 2 the upper tropospheric values can be affected by stratospheric ozone even if no transport, mixing etc. takes place. Therefore the discussion of sources of ozone for the upper cycles is at least ambiguous. I'm not convinced that the upper cycles can be undoubtfully used to conclude on ozone sources between 6-10 km without additional informations (e.g. other tracers like CO, meteorological data, long-range transport and trajectories etc.). This could be easily tested, when including the respective tropopause altitudes (e.g. PV, thermal tropopause from analysis data) into Figure 5.
Further: Why are the 'upper' ozone cycles in Figs. 6,8,10 are taken at different altitudes (8,10, and 12 km, respectively)?
Why are occurrences of maxima of the the Beijing ozone cycles (Fig. 6) different from Ding et al., 2008 (i.e. what is special in 2008 compared to the 1995-2005 period in Ding et al.?)

p.13 and discussion of Figures 12,13,15:
The authors try to explain the ozone changes at the lower layers over the three megacities with variations of circulation and winds. It is speculated about wind directions at different levels at the different locations, but no further evidence for these hyptheses is given. It would be very easy to overlay the daily wind fields from e.g. ECMWF over the maps of regional variations of ozone at the three locations. This would give the speculations much more meteorological evidence and therefore confidence in the ozone observations. In particular the daily maps (Figs. 12,13, 15) would benefit from a discussion of the wind, since it is suggested that the observed variations in the PBL are partly related to different air masses (e.g. in April).
Similarly, the variability of the daily ozone profiles, which is linked to downward transport from the stratosphere is performed without additional information. The authors suggest, that 'decent of stratospheric air' has influenced the tropospheric ozone sig-

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nal. What is meant by this statement? Do the authors suggest downward mixing (in the sence of irreversible exchange)? A transient tropopause fold, associated with a low tropopause, could also cause high ozone columns, but not necessarily tracer exchange across the tropopause. Since the degrees of freedom are less than 2, how does this affect situations with a low tropopause? I would expect the stratospheric ozone signal affecting tropospheric column values stronger than during high tropopause conditions. To increase the credibility of the observations the authors could very easily support their hypothesis with maps or crossectio ns of PV and ozone and the related temporal evolution of the synoptic situation.
Further: What is the role of tropospheric long range transport from other sources (e.g. fires) or convection with regard to the daily vertical profiles?

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