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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Observation and analysis of spatio-temporal characteristics of surface ozone and carbon monoxide at multiple sites in the Kathmandu Valley, Nepal" *by* Khadak Singh Mahata et al.

Anonymous Referee #2

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The manuscript "Observation and analysis of spatio-temporal characteristics of surface ozone and carbon monoxide at multiple sites in the Kathmandu Valley, Nepal" by Mahata and co-authors provides an analysis of CO and O_3 measurements carried out at 4 sites in the Kathmandu valley during the course of one year. Due to this good data coverage the analysis allows for a more thorough analysis than previously possible and also provides some valuable CO emission estimates. The paper is well written and organised and after minor corrections suitable for publication in ACP.

Minor comments

L46 and elsewhere: Here a strong statement is made about the significant contribution of brick kilns to the observed CO concentrations. However, there is little actual proof of this shown in the manuscript. This could be improved by indicating the location of the kilns in relation to the measurement locations and a more thorough analysis/description of the nighttime wind pattern. Both of which would allow for a more creditable source attribution. Since there were also other atmospheric tracers measured at Bode, couldn't one of them (e.g. SO_2 also be used to support the kiln contribution?

L50,51: Please mention in which way meteorology played a key role.

L72: Please split this number into casualties due to indoor and outdoor pollution. The first number seems to be the more important one in the light of your study.

L83ff: Please also mention the special topographical and meteorological conditions (poor ventilation) that characterize the basin and further deteriorate air quality.

L96: "CO is a useful tracer of urban air pollution". In the light of large contributions to CO from forest fires and agricultural waste burning (discussed later in the text), you should mention this important source as well.

L122: How does the CO emission estimate by Shrestha et al. (2013) compare with your emission estimate? Please add to the discussion in Section 3.5.

L206 and for following sites: Where was the inlet mounted? What is the total height above ground of the inlet? Repeat from table 2.

L254: These IR CO analyzers usually show a strong drift with lab temperature. Did you assure that lab temperatures varied as little as possible (AC) or did you use some additional drift correction? Once daily zero checks would probably not be sufficient. Can you rule out that part of the observed diurnal cycle of CO is due to instrument errors?

L258: What was the result of the span check? Did the instrument drift since the last span check?

L283: What are the given uncertainties? Standard deviation of hourly observations? Uncertainty of the mean?

L302: Can you mention a bit more about what is know about the kind and timing of trash burning? Are these small scale fires (individual households) or larger scale (communities/neighbourhood)? Are there any regulations on this kind of waste treatment? It is mentioned elsewhere that this happens at night? Why? Seems to be a rather simple process to tackle to improve overall air quality.

L335: "support turbulent vertical diffusion". Although this statement is absolutely true, this is already reflected by the deeper mixing layer during daytime. I suggest to reformulate in such a way that the reasons for a deeper mixing layer are given in the first sentence (heating of surface by incoming solar radiation and (secondary) higher horizontal wind speeds and turbulence production). Then only mention the flushing effect of the increased wind speeds in the second sentence. In the end, the increased horizontal wind speeds are caused by the growing mixing layer height as well, so buoyancy production of turbulence is the real cause for the increased ventilation of the surface layer, but the above discussions seems to be sufficient.

Section 3.2.1: You could also comment on the distinctly different shapes of the nighttime increase at Bode and Bhimdhunga. Bode shows an almost linear increase, which may indicate continued emissions into the local stable boundary layer, whereas Bhimdhunga shows a more isolated peak during the morning transition phase. So it would indicate that slope winds bring part of the polluted valley boundary layer up to the pass even in the early morning, which seems well possible considering the east facing slope above which the site is located. The same influence can be seen in O_3 at the site.

L351f: The argument about decreased forest fires and agricultural waste burning should be clarified a bit. Up to this point in the manuscript one had the impression that most of the CO at Bode was due to the brick kilns. But now the big difference between the seasons is explained through the absence of forest fires, etc and the brick

kilns are only mentioned at the very end. When and why do they actually stop production? Due to the precipitation in the monsoon season?

L360: Why is this apparent? Even if the kilns operate at night you should show that there is a direct link to the site in terms of advection direction? Isn't residential heating the more likely candidate?

L368: There is also a distinct shift in the morning peak visible at all 3 sites for the different seasons. Can you please comment on this? Probably it is just due to an earlier onset of the morning transition in Mar-Apr, but maybe changes in local emissions may play a role as well.

L393 "data means": Not clear which parameter is referred to here. Mean CO for the whole period or at a specific time of day?

L473: The comparability of the old time series with the recent may also be hampered by the difference in location and sampling height as well as a general difference in instrument calibration. These points should be mentioned as well.

L499ff: Isn't the prolonged afternoon peak due to the same regional scale transport that was responsible for elevated CO? Free tropospheric contribution alone would not explain the difference between winter and pre-monsoon. Why not carry out the same kind of analysis as for CO in Figure 5.

L505: The dip in O_3 in the morning transition hours once more indicates the origin from the polluted stable boundary layer.

L536 and equation 1: Why give t in hours? Why not just use seconds? Would save the conversion factor in the equation and is a better SI unit anyway!

L542ff: One additional important limitation of the method is that of regional representativeness. As is said in the text, wind speeds are low so the observed CO increase at Bode may be rather localized and the emission estimate only valid for a small area and not for the whole city or valley. This is especially important when comparing the results

with those from emission inventories that average over relatively large grid cells.

L555: Was the method actually applied to every night that had sufficient CO data? Or did you filter for low wind speed, constant MLH conditions? In which case it should be mentioned for how many nights per month the estimate was possible.

L574: Can you provide a realistic uncertainty for this estimate?

L587, the statement in brackets: Statement unclear? What do you mean by "averaged for the valley as a whole"? Did you apply the method also to other sites? Or just to Bode?

L633: Again: mention the potential larger scale advection of polluted air masses (as for CO). See comment above.

Figure1: Instead of this 3D view, it would be more beneficial to have a plain 2D map with a scale indicator that would allow to identify the distances between sites. In addition, it would be a benefit to see the location of the large point sources (kilns) in such a map as well. Topography could still be included as isolines or shading. Main traffic routes would help as well.

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