Reply to Referee#2

Thank you for your helpful comments and suggestions on the discussion paper. We have attempted to address your suggestions as follows:

It is clear that the observations give different results using different methods given the individual uncertainties of each method and all the constraints given from the retrievals. It is really a great opportunity to have these patterns, which can be associated to pollution. However, I missed a bit a statement on the uncertainty of the absolute amount of ozone or the reliability of the results. Since the data as described in the paper might be of particular value for model evaluation or air quality standards and might motivate future satellite missions some statements on the uncertainties should be included. Are these data appropriate for quantitative analyses or can this be expected for the future?

Thank you for pointing this out—the uncertainties are important if we are to delineate the urban plumes with a degree of confidence. Since we are interested in capturing the difference in the ozone or NO_2 between the plume and the background, it is the precision with which the tropospheric columns are determined that is more important than the accuracy or absolute error in the calculated amounts. At any rate the biases may be assumed not to vary too much in the vicinity of the city. For TCO monthly means and mean ozone VMR climatologies (5 year mean) presented in the paper, we have estimated an uncertainty of about 1 DU and 1 ppbv respectively. These are small compared to the urban signatures shown here with anomalies of about 5-10 DU(ppbv). Fishman et al. (2003) estimated the TOR uncertainties for a test case of a pollution event on 8 August 1980 and found that about 83% of the enhancement from the pollution episode was captured in the TOR methodology. We have added brief discussions on the uncertainties in the appropriate places.

While this work was motivated by eventual application of these data for possible air quality applications, we believe more work will be needed before this can be done. One intriguing problem is the sporadic detection of these plumes. We have mentioned several possible reasons for this, which will also depend upon the specific urban area under consideration. In a few cases like Mexico City, Fresno/Visalia etc. the associated plumes show up quite persistently. Further work is clearly needed to resolve these important issues. However note the clear seasonal signatures in the time series for the various cities with often enhanced values during the summer months (Figure 10), as might be expected for photochemical ozone production. Thus these data should be amenable for quantitative analysis or possible model evaluation.

The results would gain much more evidence, if the authors would include some ground based observations (e.g. climatological diurnal cycles from monitoring sites or air pollution net works) for at least one of the cases in and outside the plumes, for example in st. Joaquin valley, Yosemite).

The observations of high ozone over Sequoia and Yosemite is very interesting, but the reason for this remains speculative, since no further evidence is given (e.g. NO2

observations, ground based measurements) or other ozone sources are discussed.

While it is important to validate these observations of tropospheric ozone column plumes, there may be caveats in directly comparing with the ground based ozone measurements, because the ozone plume often forms at somewhat higher altitudes above ground and also at a distance from the urban centers. In a generally polluted region with several urban centers, attribution of sources and merging of plumes may also complicate matters. In any case, following your suggestion we have added a discussion of the ground based ozone observations at Fresno and at the Turtleback dome in Yosemite National Park. In the new Figure 9 we have shown the climatological diurnal ozone variations (averaged over the years 2005-2008 for June) from these two stations. The ozone mixing ratios are higher at Turtleback dome for much of the day. The tropospheric column ozone over these areas will depend upon the shape of the ozone mixing ratio profile which will in turn depend upon vertical mixing at these locations.

Following your suggestion we have also added a new figure showing the NO_2 levels in the San Joaquin valley. The SCIAMACHY tropospheric NO_2 columns in June for 2005-2008 (new Figure 8) indicate isolated plumes near Fresno/Visalia and Bakersfield and a stronger plume near the San Francisco Bay area. As pointed out by Burley and Ray (2007), back trajectories from Yosemite often indicate air transported from the Bay area but most of the pollution entering the Yosemite National park is injected during the passage through the Central Valley. Therefore it is likely that the ozone plume seen persistently over Yosemite and Sequoia could be resulting from photochemistry in aged plumes transported from the Bay area as well as Fresno/Visalia area. A proper investigation of the source of high ozone VMR over Yosemite and Sequoia would require high resolution regional scale modeling including topographic venting, which is beyond the scope of this exploratory study. In this paper we have only pointed out the possibility of detecting these tropospheric ozone plumes around urban centers. In future work we plan to do case studies around single cities like the Mexico City using multi-species data along with ground based observations and possibly modeling of the shape and location of the plume.

Further the acronyms should be explained.

These have been taken care of in the revised version.

References:

Burley, J. D. and Ray, J. D., Surface ozone in Yosemite National Park, Atmos. Env., 41, 6048-6062, 2007.

Fishman, J., Wozniak, A. E., and Creilson, J. K.: Global distribution of tropospheric ozone

from satellite measurements using the empirically corrected tropospheric ozone residual technique; Identification of the regional aspects of air pollution, Atmos. Chem. Phys., 3, 893-907, 2003.