

We thank the reviewer for their helpful questions and comments. The original reviewer questions and comments are shown in italics, while our responses are shown in plain text.

This is a potentially important study of glyoxal and formaldehyde in low-NO_x rural conditions, and the effects of short-term perturbations from pollution events including a wildfire. The authors make the case for the ratio of the concentrations of these species, termed R_{GF}, being a useful indicator for the type of air mass that is being observed, particularly when combined with the absolute concentrations. The paper is clearly written (very few typos – see below), and appropriately illustrated, with quite a bit of additional material in the Supplement. Given the high degree of interest in glyoxal as an indicator of photochemical activity, and as a source of secondary organic aerosol, these measurements in a comparatively unexplored environment are important. I recommend that the paper is published, after the authors consider the points below.

It is remarkable that the R_{GF} values are quite constant even when air masses change substantially, or when there is a perturbation such as a rain shower (when, as stated in the paper, one would have expected R_{GF} to change because of the very different solubilities of glyoxal and formaldehyde). The most significant change to R_{GF} is a solar dependence, with a peak around noon. The authors use this fact to promote the idea of using R_{GF} as an indicator of air mass type, particularly the influence of anthropogenic pollution. But how reliable is this likely to be, given that biogenic emissions (both primary and secondary) in different environments affect R_{GF}, combined with the observation that the ratio is not very sensitive? Surely there are simpler (and more reliable) ways to tell if there is anthropogenic pollution in a rural setting?

The idea that we are proposing in this work is not that R_{GF} is a tracer of anthropogenic pollution. We propose that R_{GF} is a tracer of reactive anthropogenic or biogenic VOCs and, together with the absolute amounts, also reflects the degree/type of processing. The apparent lack of sensitivity of R_{GF} during these campaigns can be attributed to the constant, dominant BVOC reactivity of these sites. This is supported by the sharp change in R_{GF} upon the arrival of air masses containing fresh anthropogenic emissions, indicated in part by the presence of phenol (C₆H₇O⁺). Thus, R_{GF} contains information on reactive VOC origin, and the absolute amount contains information on the degree of processing (e.g. high vs low NO) which is directly related to ozone production and anthropogenic influence on rural pollutant formation. The difference in this case of only measuring NO_x or VOCs is that while these measurements may contain the degree of processing of specific VOCs, they do not contain information on the overall degree of processing (or reactivity). We do not believe there is currently an alternative available tracer that yields such general information about the overall VOC reactivity sources and processing other than R_{GF}. We agree that R_{GF} is expected to vary between different biogenic VOC mixtures, (e.g. it should be higher at BEACHON than BEARPEX) as MBO, which dominates reactive VOCs at BEACHON for HCHO and Gly has a (relatively) higher Gly and lower HCHO yield than isoprene, which contributes significantly during BEARPEX. We have added text to the manuscript reflecting this latter point.

Another concern is the disagreement with satellite observations of R_{GF}. The paper makes the point that the ratio of column abundances observed from space over rural areas should, if anything, be smaller because of production of formaldehyde in the free troposphere, whereas it is larger than measured at the ground in these field campaigns. The satellite observations have the possible advantage that both species are measured by DOAS, whereas these ground-based measurements use different spectroscopic techniques to measure glyoxal and formaldehyde. Is it possible that the glyoxal is systematically underestimated? The only discussion related to this point is a statement that when R_{GF} was measured at an urban site (Bakersfield), the ratio was similar to that measured in other

urban areas. I think a more convincing discussion about the absolute accuracy of the glyoxal (and formaldehyde) measurements would be welcome.

We suggest that satellite column R_{GF} should be if anything smaller than boundary layer R_{GF} due to the emission of primary formaldehyde, not production in the free troposphere. As measurements at the Bakersfield site were obtained via the same method, directly preceding the BEACHON campaign, this suggests that even if either glyoxal or formaldehyde (or both) were systematically underestimated, the trend in biogenic vs. anthropogenic and biomass burning R_{GF} would persist. We have added a brief discussion of the accuracy and precision of both glyoxal and formaldehyde measurements, as well as of the accuracy in R_{GF} :

“Calibration uncertainties (accuracies) were 20% for Gly and 30% for HCHO during both campaigns. Sixty second median precisions for Gly measurements were 8.9% and 11.5% during BEARPEX and BEACHON-ROCS, respectively, while thirty second precisions for HCHO measurements were 11.1% and 0.37% during BEARPEX and BEACHON-ROCS, respectively. This results in an R_{GF} accuracy of ~36% and R_{GF} median precisions of 15.6% and 11.6% during BEARPEX and BEACHON-ROCS, respectively.”

This propagated accuracy of ~36% in R_{GF} does not influence the major points of this manuscript. Finally, a manuscript in preparation of Gly intercomparisons will confirm an accuracy of no worse than 20% in our Gly measurements.

Minor corrections:

Page 6058 Line 15 – insert “the” before campaign

Page 6064 Line 26 – change “between” to “by”

Page 6065 Line 7 – remove “significant”

Page 6067 Line 5 – change “peak” to “peaked”

Page 6067 Line 6 – change to “near doubling of R_{GF} ”

Page 6067 Line 7 – remove “or deviation” (redundant)

Page 6068 Line 3 – insert “the” before source

We thank the review for noting these errors and have made the necessary corrections.