Review of Zhu et al.

General comments

The authors develop a new chemical mechanism, RACM2B-VCP for WRF-Chem that can better represent VCP sources in the urban environment. They evaluate their model against observations from the RECAP-CA airborne campaign and the SUNVEx ground and mobile lab campaign. The authors find that 52% of the VOC reactivity and 35% of the local enhancement of MDA8 ozone come from anthropogenic VOC emissions, and 50% of this is attributable to VCP emissions. This manuscript is a helpful description of model implementation and analysis of VCP emissions and chemistry and should be accepted for publication after minor revisions described below.

The authors discuss the difficulty in comparing absolute concentrations from WRF-Chem to ground site measurements. Could the authors use emission ratios or other chemical coordinates to better take advantage of these measurements and use them to constrain the performance of the VCP mechanism? The authors describe adding 8 VOCs to the model. The paper would be more beneficial to policy-makers and other modelers if they could discuss which VCPs are most contributing to ozone production. Is ethanol the key player? Or are there significant contributions from other species?

Specific Comments

Line 35 – The statement that VCPs are an 'emerging source' could be read to mean that VCPs are a new source. Is that what you mean? It is my understanding that VCPs have always existed? Or do you mean 'recently recognized' or something similar?

Line 50 – Can you explain why this is: "reduced NOx results in higher ozone at low temperatures"?

Supplement – The chemistry for eucalyptol is not listed in the supplement.

Line 189 – What is the vertical resolution of the model?

Line 209 – Are the emissions monthly? Do you apply diurnal or weekend/weekday scale factors to the emissions?

Line 247 – Can you explain what you mean by micro-scale and middle-scale environments? Are these sites near am emissions source? Or do you mean to imply something about the geography?

Figure 2 – Can you clarify which site is in Figure 2?

Figure 2 – It looks like WRF-Chem RACM-ESRL-VCP has higher nighttime ozone than WRF-Chem RACM2B-VCP. If so, could you explain why this might be? Do you see a reduction in model nitrate aerosol formation that improves comparisons with observations?

Line 373 – The bias of 59% for D5-siloxane is high to be called 'good agreement'. Can you comment more on the possible reasons for this bias and what it might imply about the VCP inventory?

Line 377 – Toluene and C8 aromatics can have a source from solvents (https://doi.org/10.5194/acp-21-6005-2021). Can you look at a weekend/weekday analysis for species you attribute to traffic or does changes in their lifetime make this too difficult?

Line 378 – I have heard some discussion of anthropogenic sources of isoprene. Have you looked at whether isoprene correlates with any anthropogenic tracers to support the statement that it is solely biogenic?

Figure 6 – It looks like the model overpredicts acetaldehyde even though it underpredicts ethanol, a major precursor, by a large amount. Is there a large primary source of acetaldehyde in the model?

Line 414 – Should some VCPs that evaporate have a temperature dependence (such as solvents) or is this effect small? Could you discuss expectations for temperature dependence of VCPs a little more here?

Line 424 – Here could you look at PAN vs. acetaldehyde to look at whether the chemistry is producing PAN at the correct rate even if it is underestimated due to model resolution etc?

Line 429 – Can you provide any reason for the model underestimate of nitrate aerosol, particularly given that the model correctly simulates sulfate and ammonium? Could the model NOx be too low? Or the model RH be incorrect etc? Why does the model both underestimate nitrate but also simulate negligible nitrate variability?

Line 482 – Can you discuss the implications of the model underestimate in VOC reactivity (Fig. 6 & 7) but the overestimate in D5-siloxane on your findings in this section? What further constraints are needed to improve the inventory or the model? For example, do you think the large monoterpene underestimate is biogenic or from VCPs? Could this be a good place to discuss D5-siloxane in ratios to other species emitted from adhesives and personal care products? Or are VCP species like ethanol spread across too many sources to perform this type of analysis?

Line 499 – What do you think the cause of these model underpredictions of monoterpenes, ethanol, and acetaldehyde could be?

Line 508 – The statement "Updating the biogenic emission inventory, particularly over urban regions." in the conclusions is unclear. It would be better if the authors wrote out the reasoning behind each bullet point. For example, "Our study shows we need to update the biogenic emission inventory because of model underestimates in isoprene and monoterpenes"?

Figure S9 – How do VOCs contribute to NOx?