Cao et al., 2018, ACPD, Adjoint inversion of Chinese non-methane volatile organic compound emissions using space-based observations of formaldehyde and glyoxal

General Description of manuscript:

The authors use satellite observations of glyoxal and formaldehyde to estimate a range in emissions of non-methane volatile organic compounds (NMVOCs) in China for 2007 using an adjoint inversion. Results from their inversion are discussed in the context of other top-down estimates for China and the a posteriori NMVOCs emissions are used to simulate surface ozone. The updated ozone concentrations increase consistency between the model and observed surface ozone concentrations in winter (December) and summer (July).

General Comments:

What are the implications of the updated NMVOCs emissions on organic aerosol (and hence $PM_{2.5}$) over China?

Why use such a coarse resolution version of GEOS-Chem (5x4), when higher resolution versions of GEOS-Chem are available for the globe (2.5x2) and nested over China (0.667x0.5 for GEOS-5 meteorology)?

What is the effect of the updates to the model (Section 2.1) on simulated column concentrations of HCHO and CHOCHO?

Specific Comments:

Lines 74-75: Include Millet et al. (2006) as a reference for the high yields of formaldehyde from NMVOCs.

Lines 77-80: Biogenic emissions doesn't always dominate HCHO columns over the Amazon and Africa. Both locations include a large and often dominant contribution from biomass burning to HCHO.

Lines 81-82: "linearly proportional to the local biogenic isoprene flux during the growing season" seems odd, in particular when the HCHO columns are used to estimate isoprene emissions. Do you mean that the vegetation distribution and HCHO are spatially correlated?

Line 80: Marais et al. (2012; 2014) obtained isoprene emissions for all of Africa, not just the tropical portion.

Line 84: The chronology is odd. The line starts with "Later studies", but many of these studies precede the studies in the previous paragraph.

Line 102: "diffused" should be "diffuse".

Line 117: Is "anonymous" a typo?

Lines 163-177: This paragraph needs more context for readers not familiar with the array of GEOS-Chem model versions and chemistry mechanisms. Is this a separate branch of the

model that includes detailed carbonyl chemistry not included in the standard version? What exactly are the updates that are applied to GEOS-Chem in this work? Has this branch of the model fallen behind the other model versions and so is being updated in this work to include the isoprene chemistry that is currently in the standard version of the model?

Line 171: Is v10-01 correct? The isoprene chemistry of Paulot et al. (2009a; b) was added to v9-02.

Line 181: Provide the yield values for Fu et al. (2008).

Line 183: Bloss et al. (2005) was used above as the reference for MCM v3.1. What is the appropriate reference for MCM v3.2?

Line 187: Does "our model" refer to GEOS-Chem?

Line 188: What was the Henry's law constant updated from and to?

Line 220: Specify which version of MEGAN is used in GEOS-Chem.

Liner 245: Was MEIC also scaled to 2007? As written this isn't clear.

Lines 250, 252, 643: "burnt" should be "burned".

Lines 253-254: Is the CO flux scaled or is CO used to estimate (or perhaps scale) NMVOC emissions?

Line 308: Should "IMAGE" by "IMAGES"?

Lines 445-447: The sentence beginning "As biogenic emissions…" is challenging to follow. Seems there's a logical step missing.

Line 464: "OMI formaldehyde VCDs were higher" than what? The a priori?

Lines 574-575: What does "strong traction" mean?

Figures 5 and 6: Are ground-based observations sampled at the same time as the satellite overpass?

Figures 4,6: "Monthly mean formaldehyde" in the figure caption is deceptive if seasonal means are shown for the ground-based observations.

Figures 4-7, 10: Increase the size of the points showing the ground-based measurements.

References:

Bloss et al., ACP, 2005, doi: 10.5194/acp-5-641-2005.
Chan Miller et al., ACP, 2016, doi:10.5194/acp-16-4631-2016.
Fu et al., JGR, 2008, doi:10.1029/2007jd009505.
Marais et al., ACP, 2012, doi:10.5194/acp-12-6219-2012.

Marais et al., ACP, 2014, doi:10.5194/acp-14-7693-2014.
Millet et al., JGR, 2006, doi:10.1029/2005jd006853.
Paulot et al., ACP, 2009a, doi:10.5194/acp-9-1479-2009.
Paulot et al., ACP, 2009b, doi: 10.1126/science.1172910.