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Interactive comment on "A Model for Urban Biogenic CO_2 Fluxes: Solar-Induced Fluorescence for Modeling Urban biogenic Fluxes (SMUrF v1)" *by* Dien Wu et al.

Anonymous Referee #2

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This paper proposes a new model for estimating biogenic carbon fluxes from urban areas. This model, called SMUrF uses a new global solar-induced fluorescence product (cSIF) and biome specific GPP-SIF relationships to create a temporally and spatially explicit flux product specifically turned for urban vegetation, which is notoriously difficult to model accurately. Respiration is also carefully considered in this new model, using a neural net approach. The paper does an excellent job of describing the intricate (and very numerous) processes involved and the model, and the result is a truly exciting work that is sure to be of great interest to the flux modelling community. Although the SMUrF model contains a large number of assumptions (as any model of this scope does), and will likely be refined in the future, the authors cleverly acknowledge that this

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is only the first iteration of the SMUrF model by referring to this version as “v1” in the main title.

The model relies on an assumption that GPP and SIF have a linear relationship, and that the slope of this relationship (alpha) is only a function of biome type. The plots for these calculations are buried in the supplemental, and for many of the biomes, the relationship does not appear to be linear. It is unclear if this non-linearity in addressed in the uncertainty analysis. This is the one part of the analysis that I wish was discussed in more detail.

In an effort to relate the SMUrF model output to XCO2 observations from OCO-2, the X-STILT transport model was used to generate total-column footprints. The assemblage of Boston area footprints shown in Figure 12a. shows a satellite overpass that occurred while the winds were out of the NNE along the flight track. The forward model results shown in Figure 12b seem ok, but the plots in 12b,c are confusing, because they are not XCO2, they are the spatially explicit contributions to the XCO2 concentrations for the satellite observations. The analysis in Figure 12e seems problematic, particularly for the treatment of the background concentration. The background value chosen appears somewhat arbitrary and taken from a region downwind of the city. The correlation between the binned OCO-3 observations (black triangles) and the full model result (purple line) is not particularly strong. The author states that the additional of SMUrF to the analysis is an improvement over just using a fossil fuel inventory, but other papers (such as the cited Sargent, 2018) spend a lot more time dealing with incorporating the biosphere with these types of transport models. While SMUrF represents an important step forward in assimilating SIF measurements into a biosphere carbon flux model, the STILT analysis at the end is incomplete, and, in my opinion, the paper would be better off for dropping this part entirely. Many researchers will surely be eager to explore the use of SMUrF with transport models to compare with satellite data, but these comparisons will need to spend a lot more time on dealing with subtleties such as determining the background. Because XCO2 anomalies are so small over cities (typically a few

ppm at most), a careful error analysis would also be needed, which is lacking here.

The manuscript contains a large number of figures, many with numerous subplots. While this isn't uncommon for GMD papers describing a new model, this particular work would benefit from slimming down some of the figures. I've discussed a few of the figures individually below:

Figure 1: This is a really well laid out flow chart. It took me a while to get through it all, but it was really helpful in understanding the model, and I like how it was labeled with section and figure references.

Figure 2: Subplot c needs units for alpha values. Also, subplots are not labeled.

Figure 6: This figure is way too complicated. In addition to their being too many cities, I can't easily discern what the take home message is supposed to be from all of these plots.

Figure 7: Again, too many subplots. It would be easier to read if thier were fewer cities selected. To me, the interesting information in this figure is both the magnitude of max NEE for different cities and the timing of when that max NEE occurs. Perhaps it would be more impactful to show a different type of plot. Perhaps a scatter plot with the x-axis being day-of-year for the NEE peak and the y-axis being peak magnitude? You could then pack a bunch more cities into one plot, and label the cities in the scatterplot.

Figure 8: These time of day plots are nice, but the half-circle makers are hard to see.

Figure 10: Again, too many panels.

Figure 11: This is great. I wish there was more urbanVPRM comparisons with other cities. A real test of the usefulness of SMUrF is its performance compared to other models, especially those also tailored for urban areas.

Overall, this is an impressive manuscript. The model described is sure to make an impact in the community, and I know that I and other researchers look forward to working

with it.

Specific line-by-line comments (mostly grammar stuff) are below:

p.6 L3 Grammar (“. . .by trained on. . .”)

p.6 L10 “Laser” capitalized

p.6 L12 punctuation

p.6 L28 Underline on part of “(Sect. 3.2).”

p.13 L34 “than” -> “rather than”

p.14 L26 Why? Please add a sentence of explanation.

p.15 L12 “prediction” -> “predictions”

p.15 L13 “as” -> “of”

p.15 L19 “amount” -> “amounts”

p.16 L15 “comparison” -> “comparisons”

p.16 L15 “insights on” -> “insight into”

p.16 L25 “turns” -> “turn”

p.16 L26 “GPP,” -> “GPP as well as”

p.16 L31 Confusing sentence, please rewrite.

p.16 L32 “grids” -> “gridcells”

p.17 L11 “examine” -> “examined”

p.18 L25 “how” -> “how a”

p.18 L25 “bio-gradient” -> “gradient”

p.20 L6 “on-board” -> “onboard”

p.20 L28 “10” in “Q10” shouldn’t be italicized

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