

Second review by Bob Yokelson

Steps I took for my second review. I skimmed the responses to all the posted comments when they were first posted and did not notice any issues. When asked to re-review, I almost just okayed the article based on the responses, but I decided to read the track-changes document to double-check implementation and I do have some minor suggestions based on this second reading. I did not re-check the SI or the revised Excel spreadsheet, but could if requested.

Overview/summary:

1/ The authors are familiar with a large array of products at various spatial and temporal resolution, but the average reader may find this hard to sort out. I think I realized in the second reading that the new product is basically monthly and 0.25 degree resolution? Is that right? If so, maybe highlight that bottom line in the abstract and mention any plans to increase resolution in future in the conclusions.

2/ The fire terminology is “corrected,” or at least I suggest how to harmonize with how it is implemented by US fire managers.

3/ There’s a few places with repeated sentences or awkward flow.

4/ Earlier studies targeted a most representative single EF. This led them to attempt conducting random sampling of fires of opportunity using aircraft at the peak of fire season in the most active areas. There’s little opportunity for detailed measurements at the burn in this approach. The approach the authors adopted here targets dynamic EFs, but then also relies on fires set by scientists rather than local farmers in order to facilitate collection of data pre and post burn on site. That adds a layer of uncertainty about how faithfully scientists reproduce native practices. It’s also true that events can derail the accuracy of this higher resolution approach at the single fire level. I.e. if it rains one day in a dry month that will effect DM and EFs with successively less impact over the next few days.

Line by line on the track changes ms.

P, L# comment:

2, 28-9 How about: “Thus current global inventories are not designed to quantify any variation in average emissions at the local or monthly scale.” Maybe replace “local” with something more quantitative? In general, this region of the paper could be a good place to integrate the first part of overview comment #4 above. The part of that comment about fire authenticity might be part of the fire description text in the methods.

2, 31 Add “weather,” before “climate change”?

3, 4 Change “measuring EF measurements” to “measuring EFs”

4, 8-12 The same sentence appears twice in a row

5, 28 I think this was in first set of comments and might have been addressed in response. I wonder why NDVI is normalized to the previous year's range rather than a longer-term average. It seems a wet year could throw off the next year, but maybe that issue is not easy to fix?

6, 27 WA = weighted average? Check if already defined?

7, 15 CO EFs at 500 m resolution mentioned here is a bit confusing since the features often only have 0.25 res or in any case are not available at 500m

7, 18-24 It's still not explicitly clear how fine fuel moisture was computed. For instance, the daily cycle in fuel moisture could be important <https://www.nwcg.gov/publications/pms425-1/weather-and-fuel-moisture>. Typically fine fuel moisture could range from 15% in early AM to 5% in late afternoon. Is FFMC an average near 10%? If active fire products suggest burning peaks in afternoon, is the fine fuel moisture adjusted to assume afternoon conditions for every fire in a 0.25 degree grid box?

7, 24 So here is where we learn that this study is taking us from one static EF or an assigned EF for EDS and LDS to monthly EFs, but not higher?

7, 25 EFs, MCE, and DM consumed are all impacted by the environment. Does DM consumed vary based on these features or is that built in to GFED already?

8, 11 Not required but possible that this section could be a place to remind less experienced readers of the historical "one EF" motivation for simply reporting a study average measured on a big plane with lot's of instruments and a fast speed to access a lot of fires and operating from a base at the peak season/area.

8, 15 add any impact on MCE?

8, 18-19 isn't DM-consumed more important than burned area here?

8, 28 May have asked in round one, but how does measured fuel consumption compare to the fuel consumption predicted by GFED FC?

8, 30 "corresponding mixtures of fuel age" is a bit nebulous unless you define fuel age. Do you mean time since last burn, or something else? This fuel age concept comes up again on page 9, line 3.

8, 35-38 Here you seem to clearly indicate there was more RSC late in dry season, at least in the humid savanna. On line 38, I would move live foliage before the list of RSC-prone fuels. Have you defined RSC? You might find the Bertschi et al 2003 JGR paper useful for that. Or one could term this phenomenon as "post-frontal combustion."

9, 8 The dry Australian savannas had lower EFs, but was DM-consumed also lower or was that offset by longer fire-return intervals?

9, 9 One thing was obvious during our field work in Zambia. Within a radius of settlements, much of the woody debris is collected for household firewood. On the outskirts of Kaoma we saw people pushing bicycles with logs tied to the seat and handlebars headed to a local sawmill.

The landscape was clearly managed differently within say 50 miles of Lusaka compared to more remote areas.

10, 4 So to me, this means the MAE in MCE using static MCE is $\sim 1.62 * 0.007 = 0.011$. If that's not right, maybe explain more?

10, 24 Soil moisture may act more like a "long time-lag" (1000 hour) fuel?

10, 30 Again one wonders how common are grid cells that are a mixture of savanna and non-savanna? This may have been partly addressed in the added text about misclassification of savannas as cropland.

11, 7&10 I think it was decided in response to another reviewer that there's no such thing as "typical savanna"?

11, 25-26 There are no parentheses and two EFs have stdev of zero? The interannual variability seems low at $< 1\%$ maybe?, and certainly lower than real accuracy?

12, 11-13 & 17-19 same sentence twice

12, 16 As an alternative to saying fires get more intense, or as the probable cause, is the concept that "the fuels get more receptive."

12, 37-40 choose one version of sentence. I boycott the concept of "fires getting "hotter"" since no-one has ever defined how to measure the temperature or, much less, the extent of a "whole fire." This is in contrast to concepts like "flame temperature" or "combustion completeness", which have straightforward definitions. Also, you have already said there was more RSC in the wooded savanna in the LDS, which would lower the MCE.

13, 6-8 Standing alone this sentence could be interpreted to mean RSC is not a factor across the whole savanna biome. The previous sentence tries to qualify it, but with a new term "open savannas" Thus, I would qualify this sentence as follows: "We found that, in the xeric savannas, the composition ..."

13, 20-22 I recommend changing "Laboratory experiments described by Selimovic et al. (2018) showed that the CH₄ to CO ratio is strongly dependent on flaming or smouldering phases if the fire. Individual bag samples -which often hold emission from a single phase- therefore show much more variation compared to fire averages."

To "Laboratory experiments described by Selimovic et al. (2018) and others showed that the CH₄ to CO ratio is more complex and variable in real-time than at the fire-average level. Individual bag samples, which are closer to a spot sample from a single point in time therefore show much more range and variation compared to fire averages."

The version of Fig 9 in track-changes is not the same as the revised Figure in the response showing the fit to both spot samples and fire-average data. I like the new version with two fits better and thought the authors intended to upgrade?

13, 22-25 Indicate if this applies only to mesic or wooded savannas.

13, 25-27 This is a lot in a short sentence. How do you know if studies are skewed, how would that effect slopes based on first principles, how does FTC fit in? I'd either explain all these things in full or just delete the sentence since it may not be that important.

13, 29-33 Should this summary of analytical uncertainty go in the methods section?

13, 36 EESGT defined?

13, 35-37 could a higher elevation of African sites mean cooler temps and less evaporation than in Brazil?

14, 8-17 is Mg/ha better than tonne/ha? Line 17 missing word, add "was" before "grass"?

14, 19 Is grazing taken into account in GFED or IGBP cover types?

14, 22-24 Don't capitalize "New" or delete "This". Change "high" > "monthly". Are the burned areas new or EFs or both? I don't know what you're trying to say in this sentence, it needs major revision.

14, 32 and throughout. Technically there is no such thing as a "head fire"; it's "shorthand." Based on my four years as a wildland firefighter and with some back-up on terminology from: NWCG Glossary of Wildland Fire Terminology PMS 206

<https://www.nwcg.gov/publications/pms205> I think it's best to encourage using the following terms clearly and consistently among fire professionals:

Heading fire: a fire burning (advancing) in the same direction as the wind, often at high rate of spread and patchy, especially if also uphill.

Backing fire: (sometimes "backburn" in the Queen's English>): a fire advancing into and against an opposing wind, generally at a slower rate of spread and with higher MCE and combustion completeness, but less RSC

Backfire: This is a specific type of fire set under special circumstances. A backfire is lit inside the fireline and must be drawn into an approaching flame front by the local surface wind induced by the convection column of the approaching fire. When done properly it will deprive the approaching fire of fuel to facilitate control or, alternatively, increase the intensity of a poorly-burning prescribed fire.

Blacklining or burning out: These are narrow strips of fire set along and inside the fireline to effectively thicken the control line one strip at a time

In use: Typically a road or handline is selected as the control line or fireline. Then, if there is time and the fire danger warrants it, by burning increasingly broader strips along the fireline, the area deprived of fuel can be enlarged to widen the control line (this step called burning out or blacklining). A back fire is when the approaching fire, often a heading fire, but can be backing too, creates a local sea breeze affect drawing surface air into the convection column from all directions. Standing on the control line, facing the oncoming fire, one starts to feel a wind on their back. At this point, the backfire can be lit and it is drawn into the main advancing fire to

deprive it of fuel. Setting a backfire is best left to experienced personnel with high-level decision authority because a backfire attempted too soon or too late can be ineffective and endanger crew.

14, 34 suggest changing “backburning” to “backing fire”

14, 35 suggest changing “backfires” > “backing fire”

14, 36-37 RSC can be increased in a heading fire because the high rate of spread and patchiness leaves fuels smoldering further from the convection associated with the advancing flame front.

15, 4 Higher resolution weather might be even more important than increased spatial resolution. If it rains before your fire, that changes a lot for a few days at least. And the duration of the rain is more important than total amount in terms of soaking the fuels.

15, 11-13 Is this topic out of place here and maybe fits better elsewhere?

15, 23-24 I don’t think you mean these predictors worked better 20 years ago, but the sentence kind of gives that impression?

15, 28 can be, but were not, correct?

16, 10 It’s a good discussion, but one starts to wonder if the discussion jumps around a bit and might be better organized. Maybe worth a small effort to improve, but okay.

16, 18-19 You might want to say “have high confidence in” rather than “be sure about.” The part of the sentence after the comma doesn’t add much.

16, 36 “can” > “could potentially” subtly acknowledges the work involved

17, 1 “Conclusion” or “Conclusions”

17, 2 delete “on”

17, 4 measured > sampled

17, 5 “using a UAS platform.”

17, 9 could acknowledge impact of fuel receptiveness on fire intensity

17, 17 “dynamic EFs” > “monthly EFs at 0.25 degrees”? Or add specs in ()s after EFs. Retrievals > products?

17, 28 delete concept of “typical” savannas?

17, 30 RSC may not include live vegetation, which may burn better with more wind or more sustained ignition.

17, 39 “it’s significance” > variability. indicate > are