

## ***Interactive comment on “Biomass burning combustion efficiency observed from space using measurements of CO and NO<sub>2</sub> by TROPOMI” by Ivar R. van der Velde et al.***

### **Anonymous Referee #1**

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**General Summary** This study investigates spatiotemporal efficiency of fire combustion using emission factors of NO<sub>x</sub> and CO as a proxy for combustion efficiency to distinguish flaming from smoldering combustion. TROPOMI retrievals of CO and NO<sub>2</sub> column are used to quantify relative enhancements of CO and NO<sub>2</sub> over different fire-prone regions to find spatial and temporal patterns in  $\Delta X_{NO_2}/\Delta X_{CO}$  ratio that point to distinct differences in biomass burning behavior. The authors find that fraction of surface smoldering combustion is much larger for the boreal forest fires in upper NH and peatland fires in Indonesia. High spatial resolution of TROPOMI is also found to enable detection of spatial gradients in combustion efficiency at smaller regional scales especially in South America where the authors were able to distinguish higher combus-

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tion efficiency for savanna fires than for nearby tropical deforestation fires. It was an exciting read and I recommend the paper for publication in ACP with minor revision. My specific comments are listed below.

**Specific comments:** The authors designed four synthetic WRF-Chem experiments driven by different biomass burning scenarios representative of different regions but all the simulations were performed over South America. Since the chemistry and weather of boreal forests, Africa, and Australia are different than South America, the simulated NO<sub>2</sub> and CO columns could have been different for boreal forests, Africa, Indonesian, and Australian fires had the WRF-Chem domains been set-up over each region representing a different biomass burning characteristics because meteorology and chemistry over each biomass burning region is different from South America. I suggest the authors to include a discussion on this aspect.

While it was interesting to learn about TROPOMI's ability to distinguish between different biomass burning characteristics, I felt the paper should also have included a discussion on the crop-residue burning. Is it difficult to perform a similar analysis for crop-residue burning (e.g., in China or northern India) because of the limited sensitivity of TROPOMI NO<sub>2</sub> retrievals to PBL?

Section 2.4: Are the fire emissions subjected to plume rise in WRF-Chem?

Line 432: Based on legends of Figure 5, I think 2.77 should be replaced with 2.97.

Line 508: Change “EF in GFED4s” to “EF in neither GFED4s”

Line 553: remove “the” before “efficient”.

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