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Atmospheric Chemistry and Physics Discussions

Interactive comment on "Signature of tropical fires in the diurnal cycle of tropospheric CO as seen from Metop-A/IASI" *by* T. Thonat et al.

Anonymous Referee #1

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Review: Thonat et al., Signature of tropical fires in the diurnal cycle of tropospheric CO as seen from Metop-A/IASI

General comments: Thonat et al. assessed the diurnal cycle of IASI mid-tropospheric CO and showed that the signals observed relate well to biomass burning events. Moreover, they hypothesize that the diurnal cycle of CO observations may reflect the smoldering and flaming phases of those fires. Although the results presented in this study have some great potential to help the bottom-up fire modeling community to better understand fire emissions and their variability, the paper could be improved by addressing the comments below.

Specific Comments: * In general, the level of scientific writing could be improved.

Please try to avoid subjective terms like 'very good' and 'extremely high' in the text. Moreover, the quality and readability of some of the figures needs to be improved. Examples are provided in the 'Technical Corrections' section.

* The inventory-based comparison should be extended, since it now only focuses on GFEDv3 and MODIS BA (which is actually used in the GFEDv3 modeling framework and therefore the overlap between both datasets in not surprising at all). From a bottom-up perspective, it would be interesting to add inventories that rely on other methods as well, like e.g. the Global Fire Assimilation System (GFAS; based on fire radiative power (FRP)) and the Fire Inventory from NCAR (FINN). Extending the comparison with these inventories could give more insight in the processes that explain the discrepancy found with the diurnal cycle of IASI CO, and might bolster your hypothesis on the contribution of changes in the flaming and smoldering phase.

* Throughout the paper, the authors emphasize the importance of transport of CO emissions, e.g. "the excesses of CO in the troposphere are not located above the burned areas, highlighting the transport of the CO emitted by fires and then transported by convection and general atmospheric circulation". To cancel out background conditions and focus on local fire CO emissions only, the day-night difference in CO is therefore used. Although the mechanism that explains the use of this diurnal CO cycle is briefly described in the paper, I have some further questions: - How confident are the authors that the mechanisms described for the boreal forest fire case (P17L1-7) are valid for Africa savanna fires or deforestation fires in South America? - In contrast to the 9.30am measurements, I guess that the 9.30pm measurement can be affected by transport from other regions? If so, the diurnal cycle will be impacted by CO transport from other regions as well. An atmospheric transport model could be used to check whether transport does play a role in this diurnal cycle, or, at least, provide the reader with some references to convince that this is not the case. In general, more discussion on the role of transport is important, especially regarding the comparison of the different regions (vegetation types) in Africa. If transport does play a role, interpreting those

results does not make sense. - Instead of July 2008, how does the boundary layer behave in southern Africa in the months of August-November? - How does the boundary layer behave in South America in the fire season? - What would be the impact of deforestation fires in South America on the diurnal CO signature of IASI? These fires are often started in the afternoon (>9.30am), and represent a significant part of CO emissions in the South American Continent. The same counts for Indonesia.

* Besides the fact that the diurnal CO signal may reveal some interesting findings with respect to the temporal variations in fire emissions, the method could be potentially useful above regions where other sources of pollution occur, like e.g. Asia. I'm wondering why, in the global analysis (Figure 7), Asia is left out of the analysis. Indonesia and Southeast Asia are important tropical regions from a biomass burning perspective, and given the proximity to anthropogenic pollution sources the method could be specifically useful in these regions.

* I miss some discussion on how to proceed with this method in future. Are there other sensors or upcoming missions that could be used? What about sensors with surface sensitivity to CO, like MOPITT? Could the work directly be combined with CO2 observations? In general, I miss a sort of guidance here.

Technical Corrections: P2L2: IASI → Infrared Atmospheric Sounding Interferometer (IASI)

P2L6: who . . . emissions → who found a relation between daily tropospheric excess of CO2 and biomass burning emissions

P2L7: very good agreement → agrees well

P2L8: Global Fire Emission Database → Global Fire Emissions Database version 3

P2L9: Which MODIS BA version is used? Please provide version in text, including a reference

P2L9: daytime or nighttime → day- or nighttime

P2L12: in → for

P2L12-14: A linear. . .(R2∼0.6). → A linear relationship (R2 = ∼0.6) between the. . . and . . . was found for the. . .

P2L12: The whole tropical region? This is not the case in Figure 7, so please be more specific.

P2L17: Please spell out 'LT'

P2L19-23: This is quite a statement/conclusion, and I don't think that this study actually has proven yet that flaming and smoldering mechanisms are causing the discrepancies found.

P2L25: By. . .components → Both natural and anthropogenic biomass burning emissions. . .

P2L26: 'Indeed' could be removed

P3L3: Besides van der Werf et al. (2010), please refer to at least one other study and provide a range of emissions instead. This is important to highlight the uncertainty regarding bottom-up emissions estimates, and to show the usefulness of new approaches as described in the study.

P3L14: Please provide a reference wrt cloud coverage

P3L15: Please provide a reference wrt precipitation patterns

P3L23-25: Provide the reader with a bit more detail on the different terms of the Seiler and Crutzen equation. How are they defined?

P3L26: EFs and Fuel Load are mainly based on field measurements

P3L27-29: You can state this differently by saying that uncertainties are significant, and therefore top-down approaches could be helpful to improve the understanding of fire emissions and their variability.

P4L5: Thermal Infrared (TIR) sounders

P4L8: Measurements of Pollution in the Troposphere (MOPITT)

P4L10: Atmospheric Infrared Sounder (IASI)

P4L16-23: Please rewrite this part since it is rather vague now. Try to avoid sentences with many commas

P4L27: TIROS-N Operational Vertical Sounder (TOVS)

P5L1: remove 'the ones of'

P5L10-11: This result was theoretically confirmed with a pyro-thermal plume model (Rio et al., 2010).

P5L17: Making it easier to measure → providing a clearer signal with respect to fires

P5L18-19: . . .on tropical biomass burning regions in the years 2007-2012.

P5L23: From a CO perspective fire emissions are not particularly strong in southern Africa. Deforestation fires in the Amazon and South-East Asia, and boreal wildfires have in general stronger smoldering components and therefore a stronger CO signal

P6L3: You already spelled out IASI before.

P7L4: Please spell out ECMWF

P7L21: Remove 'good'

P8L2: IASI day- and nighttime

P8L5: 30°N-30°S

P8L7: Why not take the average of 2007-2012 instead of 2008 only?

P8L9: delete the second 'by'

P8L9-10: same → similar

P8L9-10: Looking at Figure 1, I'm not that sure that the distribution and seasonality of CO by day and night are exactly the same. This can be due to missing pixels (quality flag issues).

P8L11: Delete 'extreme'

P8L11: Delete 'superior to'

P8L12-13: It might be more useful to use months instead of terms like 'boreal winter' and 'austral winter'.

P9L9-10: We now focus on southern Africa (20°S-0°, 0°-53°E), which is an important region from a biomass burning perspective.

P9L11: as opposed → in contrast

P9L19-20: three times 'evolution'

P9L27: Please provide the version of MODIS BA and give a reference.

P11L3: Unlike the evolution → In contrast to

P11L4: in very good agreement → agrees well (does it actually?)

P11L5-6: 'The day-night signal is observed just above fires'. Is it? I'm not sure when looking at Figure 3?

P11L19-20: difference is large, fire activity is low

P11L20-21: Please rewrite 'The decrease. . .of fires'

P12L4: To study the diurnal cycle. . .in more detail, we

P12L5: Looking at Figure 5, I'm not convinced that these defined regions actually capture a certain vegetation type. For example, H9 seems very heterogenic.

P12L12: Not sure how good agreement is.

P12L19: Null → no

P12L21: where most fire activity is observed

P13L5-11: Please rewrite this paragraph since it is rather vague now.

P13L18: Could the use of this factor 16 be explained in more detail?

P13L26: So did you include these areas to derive the r2 of 0.6? If not, make clear in the text.

P16L6: As said → As stated

P16L11: I think there is more to that: What about different vegetation types? And the spacing of different fuel types?

P17L1-17: This is the case for a boreal fire, which is in general quite different than a savanna, cropland or tropical deforestation fire. How would the pyroconvection and natural convection work for a savanna fire in southern Africa?

P17L11: CO emissions happening → Nighttime CO emissions

P25Table1: Remove 'limits in'

P26Table2: Remove 'limits in'

P27Figure1: The colorbar is hard to read. Provide one large colorbar below the figure?

P28Figure2: Latitudes and longitudes are not readable. What is the unit of Burned Area?

P29Figure3: What are the units of GFED3.1? What belongs to the secondary y-axis?

P30Figure4: What are the units of GFED3.1? What belongs to the secondary y-axis?

P31Figure5: It is difficult to distinguish gridlines and regions. Maybe a dashed grid line could be used?

P32Figure6: Make clear what belongs to the first and secondary y-axis.

P33Figure7: It is difficult to distinguish gridlines and regions. Maybe a dashed grid line could be used?

P34Figure8: Unit of x-axis is missing

P36Figure4: What are the units of GFED3.1? What belongs to the secondary y-axis?

Interactive comment on Atmos. Chem. Phys. Discuss., 14, 26003, 2014.