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***Interactive comment on “Satellite- and ground-based CO total column observations over 2010 Russian fires: accuracy of top-down estimates based on thermal IR satellite data.” by L. Yurganov et al.***

**Anonymous Referee #2**

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General Comments

The manuscript by Yurganov et al. uses satellite and ground-based CO total column data to estimate the emission of CO and depth of the polluted boundary layer during wildfires in Russia in 2010. The ground-based data are further used to quantify the error in space-based CO total column observations from the thermal IR sensors. The authors present a novel way to account for the deficiencies of space-based CO measurements, which is especially important in the data-poor Russian region, and the method and results presented here provide valuable insights that can be applied to

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other fires over Russia and elsewhere. The paper is appropriate for publication in ACP once the following specific comments have been addressed. I have also highlighted a number of typos and grammar mistakes that, when corrected, should increase the clarity and readability of the manuscript.

### Specific Comments

Pg 12208, Line 17: This estimate of 40 Tg CO seems like a major result. I suggest you highlight it rather than hide it in parentheses.

Pg 12208, Lines 21-22: Are the Holloway and Duncan estimates for the same year? Do the two estimates agree within the stated error of 100 Tg/yr? I would expect interannual variability and trends to lead to different estimates if they are looking at different years.

Pg 12208, Lines 27-28: You should state that the previous estimates and uncertainties you describe are for bottom-up estimates, in contrast to the top-down estimates you are proposing.

Pg 12209, Line 5: You state here that “CO is now measured operationally by 3 satellite-borne sounders”, but a few lines down you list more than 3 so this appears inconsistent.

Pg 12210, Lines 6-8: I could be mistaken, but I was under the impression that the NIR data from MOPITT was better than SCIA (or at least had fewer problems), but here it sounds as though they are plagued by the same issues. Can you double-check this point?

Pg 12210, Line 10: Do you mean MOPITT TIR here?

Pg 12210, Line 23-25: I find this wording confusing, especially the “added by MCO”. Perhaps you can rephrase by starting the sentence with something like “MCO was added to the CO burden. . .”

Pg 12211, Lines 11-12: Please add a reference for the underestimate of CO during wildfires in both v3 and v4.

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Pg 12211, Lines 3-12: It's unclear from this discussion whether you use the v3 or v4 MOPITT product. Please clarify this somewhere. Also, does the v4 product include the NIR retrieval? Since you bring it up in the intro, it might be worth adding a sentence here that specifies whether it is included, and if so, whether it is used in this analysis.

Pg 12212, Line 4: Do you mean Warner et al. (2007) rather than (2006)?

Pgs 12213-12214: Why is the IASI information in the section on ground-based spectrometers? I suggest moving Pg 12213 Line 3 – Pg 12214 Line 21 to section 2.1 or making it its own section; it doesn't make sense where it is.

Pg 12216, Lines 16-17: Can you clarify how you perform the normalization of AKTN? What do you mean by "divided by the corresponding vector  $t$ "? How is this different from AKP?

Pg 12218-12219; Figs. 3-4: Why is IASI-ANN not included in the discussion and figures of the validation?

Pg 12218, Line 1: As you point out, this comparison between sounders is "highly important"; as such, it would benefit from a more quantitative analysis. Can you provide some statistics validating your claim that the sensors are "very close"? (for example, correlation coefficient ( $r$ ) and mean bias, perhaps separated by season. . .)

Pg 12219, Line 1: IASI-ANN doesn't look systematically lower to me the way AIRS does.

Pg 12219, Line 4: You mention the background CO burden for the first time here but don't explain it. I think the text would be clearer if you either describe what it means here or don't mention it until you do describe it.

Pg 12219, Line 18: Are those days with instability excluded from the figure?

Pg 12219, lines 19-25: There seems to be too much detail regarding the Alaska data, and it distracts from your points. I suggest removing some of the details in this para-

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graph to only include what directly matters to your study and/or making clearer comparisons between the two cases.

Pg 12219-12220; Fig. 8: Can you comment on why there is a difference of  $\sim 2$  ppm between the two VMR measurements?

Pg 12220, Lines 5-29: Why did you choose to use MOPITT data for the computation when there was no data for this specific date? Wouldn't it make more sense to use IASI? I don't think you need to redo the calculation, but perhaps you could justify the choice. Also, why do you compare to a different date for Zvenigorod (4 August rather than 9 August)? Again, justification rather than additional work is required.

Pg 12221, Line 25: Can you show the box for the Moscow area (54-57N, 36-38E) in Fig. 5 as well?

Pg 12221-12222; Fig 10: Why do you show only one day (8 August) in Fig. 10 to justify your choice of threshold value, but then later do the extrapolation for a full week? Is there a reason not to show all days in 2-9 August in Fig. 10? Also, can you justify your choice of 8 Aug as representative for both 2009 (no fires) and 2010 (fires)? Will it be influenced by synoptic patterns? Using a full week would avoid some of these issues.

Pg 12222, Lines 5-6: With respect to the lower pollution at Zvenigorod, one thing I've wondered about throughout the paper is whether Moscow is affected by fossil fuel emissions. Can you comment somewhere on the differences between Moscow and Zvenigorod when there are NO fires?

Pg 12222, Lines 3-11; Fig. 11a: Why is IASI not included in this discussion/figure?

Pg 12222, Line 13: AIRS grid cells with no data are identified as "cloudy pixels", but AIRS does cloud clearing – are clouds really the main reason for no data?

Pg 12222, Line 17: Again, you discuss the background here but haven't yet described how it is computed. It would be useful to discuss that here.

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Pg 12223-12224: Can you explain where the idealized fire source of 1.11 Tg/day comes from? Can you also explain why you choose 5 day periods? I'm a little confused about what this means – do you emit constantly over every 5-day period?

Pg 12225, Lines 28-29: I'm not sure what you mean by “for both cases.” I thought you were referring to AIRS vs MOPITT, but you just stated that the AIRS depth was larger than for MOPITT, so it doesn't make sense to give one representative value. Do you mean something else?

Pg 12226, lines 10-12: This is an interesting idea, but more justification is needed. Are the bottom up inventories for CO and CO<sub>2</sub> constructed in the same way? Do you have any reason to believe you would see the same biases for bottom-up and top-down? I don't doubt that there are errors in the bottom-up inventories, but it is not obvious to me that the biases would necessarily be in the same direction as for the top-down inventories.

Pg 12227, line 1: It would be good to explain again here what is meant by “missing CO” (i.e. CO that is missing from the satellite retrievals) to make the conclusions stand alone.

#### Technical Corrections

Pg 12210, Line 15: change “by CO plume moved from” to “by a CO plume from”

Pg 12210, Line 16: east and southeast do not need to be capitalized

Pg 12210, Line 21: remove the comma after CO TC

Pg 12214, Line 26: change “W from” to “west of”

Pg 12215, Lines 2-3: singular/plural agreement – you need to change to either “with a thermoelectrically cooled PbSE detector” or “with thermoelectrically cooled PbSE detectors”

Pg 12215, Line 14: please change “in the BL surface VMR” to “in the a priori BL surface

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VMR” to clarify

Pg 12215, Line 23: add either “was” or “is” before “located”

Pg 12216, Line 15: please include units of coefficient 2.12E13

Pg 12216, Line 15: (P2-P2) should be either (P2-P1) or (P1-P2)

Pg 12218, Line 17: change “whole Russia” to “all of Russia”

Pg 12218, Line 18: Sentence beginning “Averaged and smoothed CO TC . . .” would fit better at the beginning of the next paragraph than at the end of this paragraph.

Pg 1220, Line 9: I think it will be clearer if you specify “the ground-based spectrometer” instead of just “the spectrometer”

Pg 12221, Lines 1-2: change “is working” to “works” and “is not working” to “does not work”

Pg 12221, Line 19: I think this would be clearer if you replaced “low limit” with “threshold”

Pg 12221, Lines 22-23: change “just few numbers of measurements” to “few measurements”

Pg 12222, Line 2: The term “less justified” here is confusing – I think it would make more sense if you said “more stringent” or “more conservative”

Pg 12222, Line 15: remove “up”

Pg 12223, Lines 13-14: change “is connected with” to “are connected to”

Pg 12223, Lines 13-21: It would be clearer if you used the Greek letter tau rather than spelling out TAU.

Pg 12223, Line 19: “blowing out CO” is confusing – I assume you mean “CO loss from transport”?

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Pg 12223, Line 26: change “it relaxes” to “they relax” and “e-fold” to “e-folding”

Pg 12224, Lines 1-5: here TAU is just TAU\_TRANS, right? Can you specify that in the text?

Pg 12226, line 3: change “with” to “where”

Pg 12226, Line 19: remove “on”; specify that the CO VMR is higher during the fires

Pg 12238, Fig. 2: I assume the IASI curves are for IASI-SFA; can you please specify in either the legend of the caption?

Pg 12247, Fig. 11: change “for 500 hPa” to “at 500 hPa” in caption. Fig. 11b seems to never be discussed in the text, especially for the IASI retrievals.

Pg 12248, Fig. 12: unless I missed it, the variable “S” for plume area never appears in the text, so it seems strange to introduce it here. Also, in (a), it would be useful to specify that the computed plume area is based on the AIRS data. I’m not sure I understand the point of plotting the differences (S130-S150 and S150-S170) – they obscure the figure and are easily intuited from the other lines.

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Interactive comment on Atmos. Chem. Phys. Discuss., 11, 12207, 2011.

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