Review of paper acp-2021-970

The paper proposes a method based on the use of MODIS and CALIPSO data to assess several parameters of oil-burning plumes. I think that the topic is relevant, but perhaps the title of the paper is misleading as one gets the feeling that, more than demonstrating the usefulness of the method, the authors reveal limitations that should be overcome before it can be customarily applied. In my opinion the paper should be revised in order to present the results in a more organized way and make clearer for which events a true synergic (MODIS and CALIPSO) study could be carried out. Just as an example: the authors list in table 1 thirty oil-burning events whose plumes have been observed by MODIS instruments, which, they claim, they have examined (line 741). It's understandable that not all the events are specifically presented, but, if they have been examined, are there general conclusions that can be drawn from these observations? How many of these events could also be observed by CALIPSO? Along the text, based on examples, some hint is given that not all the plumes exhibit similar characteristics, but, after applying the methods described, can they be classified according to some typing criterion?

General remarks

1. In my opinion the authors should improve the organization of the paper and help the reader in understanding the rationale of some choices made. For example, what's the reason for the order in which the events are listed in table 1 (certainly not chronological)? I would suggest that the events discussed in detail in the text are referred to by their numbering in the table; otherwise it is sometimes difficult to understand which event the authors are discussing, especially because sometimes they allude to them with a name different from the location given in table 1. For example, in line 133 it is said that "only the event in Kiev was analysed by different techniques". One has to guess that the referred event is number 14 in the actual numbering of table 1. The Caspian sea event (No. 8 in table 1) is also referred to as the Gunashli event (line 435); the reader needs to be a geography expert to realize that the authors are talking about the same event.
2. Which events have been studied in a really synergic (MODIS + CALIPSO) way? Only one? ("The only event which was captured by both MODIS and CALIPSO retrievals showed a large level of discrepancy", lines 698-699). If this is so, I would strongly suggest that the title is modified. Both the MODIS-based and the CALIPSO-based analyses are worth being presented, but in that case the "synergic" term in the title would be too strong in my view.
3. The rationale after which some events are discussed in particular should be given to help the reader understand the reason why these events, and not others, are discussed. For example, the case of Ra's Lanuf and As Sidr is properly introduced ("We selected a successful retrieval to better describe the method used for our analysis", line 342), as it is the SOCAR Platform in the Caspian Sea ("Next, we examined the smoke plume from SOCAR's Platform No.10 fire in the Caspian Sea as an "atypical" event based on the fuel type and plume albedo", lines 374-375), but the reason why

the next events described in section 3.1 (Deepwater Horizon, JX Nippon, Ra's Lanuf again, Puerto Sandino, Escravos…) are chosen is unclear.

Main specific remarks

1. I think that the abstract is too specific in giving values of AOD and AE obtained from MODIS and CALIPSO and discussing the discrepancies between MODIS and CALIPSO retrievals for the (yet unidentified in the abstract) event of Ra's Lanuf on 6th of January 2016. Although this is debatable, in my opinion the abstract should highlight the contributions of the method, rather than the results obtained.
2. In section 1.2 (Event synopsis), why only a few events are discussed? What's the rationale for their selection?
3. The sentence in lines 302-304 sounds confusing: "Focusing on the plume bins we used the extinction coefficient to backscatter ratio to determine the plume averaged lidar ratios if the plume was not identified as a distinct aerosol feature." But the extinction coefficient to backscatter [coefficient] ratio is the lidar ratio. The explanation looks circular.
4. The events in table 2 and 3 are difficult to identify based only on the date. Note in addition that in table 3 there is a row more than in table 2. Didn't MODIS in Terra retrieve values for the event of 04.01.2018? The same remark on the inconvenience to identify events based on the date apply to tables 4 and 5. Moreover, in these tables the events coincident with events in table 2 and 3 should be pointed out. The event on 21.10.16 doesn't seem to be listed in table 1. Is the date correct? Should it be 21.01.16?
5. Apart from the issues mentioned in point 3, I had a lot of trouble following section 3.1. The initial discussion (lines 342 – 362) refers to figure 2. However, in lines 362 – 363, tables 2 and 3 are referred without saying that they include data from other locations, described in figure 3 and in the subsequent text. In addition, figure 3c is quoted twice ("Figure 3c shows a plume specific AOD values 390 ranging from 0.06to 0.23", lines 390-391; "Figure 3d shows AOD values as high as 0.24 over the average AOD background level for the plume originating at Ra's Lanuf.", lines 391-392), but the second time should be probably figure 3d. Then figure 3d is cited again in line 394. It would be better to group together all the discussion referred to given event. One has to guess, moreover, that the Ra's Lanuf oil field pertains (probably, not sure) to the Surt district of Lybia (line 394).
6. In figure 3, the color scale seems to correspond to the plume specific AOD. This should be indicated in the legend of the color scale to avoid confusion with the total AOD. Please check also what is represented in the color scales of figure 6.
7. Perhaps related to the last part of point 5 above, an event in As Sidr is mentioned in table 1 (No. 19), but with no date. Is it the same event as No. 20?
8. Referring to figure 6, it is said (line 476) that "The cases form Saudi Arabia, Iran and Iraq show no values retrieved over the plume areas". What's the reason to say that in the case of panels a and b? Where should the reader expect the plume? By the way it would be helpful to say that these cases correspond to figures 6a, 6b and 6c.

9. Relating to the Ra's Lanuf plume on 6th of January, there are statements on the retrieved lidar ratio values that should be clarified: it is said on the one hand that the lidar ratios of 109 sr at 532 nm and 86 sr at 1064 nm (lines 513-514 and table 6) are obtained. Then, in lines 541-543 it is stated that: "It should be mentioned that this event was an optimal case for constrained lidar ratio retrieval since the feature was surrounded by clear air. However, due to the fact that the plume feature was completely opaque, the lidar ratio could not be obtained from a constrained solution via the two-way layer transmittance". This should be clarified as, at first sight, it looks contradictory. I suggest that the CALIPSO retrievals of lidar ratio on opaque layers is briefly discussed or, at least, mentioned and referenced.

Minor specific remarks

1. Line 30: "agreeance". I couldn't find that word in the dictionary. Probably the authors mean "agreement".
2. Lines 41-42: "CALIPSO measurements are heavily dependent on lidar ratios which are not directly measured if plumes within the planetary boundary layer". The sentence sounds strange. Perhaps "are" is missing after "if"? Please check.
3. Lines 81-82: "Most sensors cannot retrieve a wide variety of aerosol properties thus relying on inversions techniques and complex radiative transfer computations". The meaning of this sentence is unclear. Can or cannot the sensors retrieve aerosol properties? Please check.
4. In table 1, the cause of event id left blank for some events. It would be better to state "unknown" (if this is the reason for the blank space).
5. Line 188: "construct" → "construction".
6. Lines 313-314: "Based on the particulate total backscatter coefficient (532 nm) we defined the plume cross section as in each range bin, the plume values were at least 2 times higher than background values". This sentence sounds strange. Please check the wording.
7. Line 375: what does "n.d" mean in the reference "(Business-humanrights, n.d.)"?
8. Line 385: "This is evident in the plume albedo from MODIS true colour images". A figure should either be provided or said that it is not shown.
9. Lines 421-422: "Plume values close to 0 were retrieved near the event while average values registered two to three times lower than the local background". The sentence is not clear. Where are those values reported in the paper? Does this refer to the 0.34 and 0.74 values cited in line 419?
10. Lines 506-507: apparently referring to figure 7b it is said: "The average plume thickness was approximately 920 m ranging from 2700 m to 3300 m." But 3300 – 2700 = 600. In addition, the backscatter coefficient profile shown in fig. 7b does not go below 3100 m or so.
11. Lines 510-511: "average particulate backscatter (532 nm) values measured 510 0.015 $km^{-1}sr^{-1}$ while values at 1064 nm measured 0.17 $km^{-}1sr^{-}1$." The value for

1064 nm should be 0.017 $km^{-1}sr^{-1}$. Moreover, I think that the values measured for 532 nm and for 1064 nm are essentially indistinguishable, as they fall within the uncertainty interval of each other.

12. Table 6: are there not uncertainty intervals for the PDRs and the lidar ratios? Note in addition that the date for the Qayyara, Iraq event (10.21.2016) is certainly wrong. Why these Qayyara events not listed in table 1? Were they not observed my MODIS?
13. Line 666: "AOD values ranged significantly…" What does this mean?
14. Lines 680-681: "The smoke plume was also captured in RGB images as seen in figure 6g". But figure 6g does not seem to correspond to an RGB image.
15. Line 683: "Figure 12d shows the daily evolution of AE with values between 0.45 and 0.9". At which wavelength?
16. Line 709: "did not reached Kiev" → "did not reach Kiev".