Referee comment 1.

The paper needs an extensive language revision. It is necessary to check the writing, grammar and typos.

Authors reply 1.

We undertook an extensive English language revision by a native speaker.

Referee comment 2.

It is necessary to reduce the length of the paper, especially the results section. There are too many study cases analyzed in detail, but the main conclusions of the different analysis get lost in the text and are not clear. The number of figures should also be reduced. According to this comment, it is also necessary to improve the last part of the abstract. The authors provide a large list of numeric values, but it is not clear the message and conclusions that we can infer from these data.

Author's reply 2.

The overall paper has been extensively modified resulting in a general reduction of length (approx. 9 pages) and a reduction in the number of figures presented (from 12 to 9) while maintaining the overall essence of the results and findings. On the topic of detailed cases studies we focused only on the events in Libya as they were seen by both MODIS and CALIPSO. This effectively translates to 3 events detail as MODIS successful retrievals and 3 events detailed as CALIPSO retrievals. The remaining cases studies are discussed on a general basis regarding the results and conclusions of the study.

To better identify the events described in the paper and to better respond to the issues raised by the referee we updated table 1 as follows:

- We added the column "*event ID no.*", as suggested by referee 2, and in text we addressed each event by this number for consistency reasons. This column was also added to tables 2 to 7.
- The former columns entitled "Date" and "Number of observations (days)" have been merged into a single column "*MODIS observation interval*". This new column contains the dates for the "*first day*" and the "*last day*" in which MODIS RGB images showed oil smoke plumes. Some events, i.e. event 3 and 14, are listed as having more than one location. We have grouped all locations within a single event based on the fact that they share the same cause (same armed conflict) which generated the events on the same "*first day*". For these events, the coordinates for each location (oil installation involved in a fire) in particular are given.

Please find the revised version of table 1 below:

Tab. 1 Major industrial events leading to observable smoke plumes seen in MODIS RGB images

Event ID No.	Location	MODIS observation interval		Coordinates	Cause of event	Type of installation	References
		Start	End				
1	Qayyara, Iraq	13.06.2016	27.03.2017	35.83 N ; 43.21 E	armed conflict	oil wells	(Tichý and Eichler, 2018)
2	Omidieh, Iran	06.05.2019	06.05.2019	30.84 N ; 49.65 E	human error	oil pipeline	(Financial Tribune, 2019)
3	Haradh, Hawiyah, Uthmaniyah, Shedgum, Buqayq; Saudi Arabia	14.09.2019	26.09.2019	24.05 N ; 49.20 E 24.80 N ; 49.35 E 25.18 N ; 49.31 E 25.64 N ; 49.39 E 25.92 N ; 49.68 E	armed conflict	oil processing	(Khan and Zhaoying, 2020) (Reuters, 2019) (New York Times, 2019)
4	Caspian Sea, Azerbaijan	06.12.2015	18.12.2015	40.20 N ; 51.06 E	extreme weather	oil and gas platform	(Necci et al., 2019)

5	Gulf of Mexico, USA	21.04.2010	21.04.2010	28.44 N ; 88.21 W	equipment failure	drilling rig	(Gullett et al., 2016)
6	East China Sea, China	14.01.2018	14.01.2018	28.37 N ; 126.08 E	human error	oil tanker	(Li et al., 2019) (Qiao et al., 2019)
7	Houston Texas, USA	18.03.2019	19.03.2019	29.43 N ; 95.05 E	equipment failure	storage tanks	(An Han et al., 2020)
8	Jaipur, India	30.10.2009	08.11.2009	26.77 N ; 75.83 E	Human error	storage tanks	(Vasanth et al., 2014)
9	Sendai, Japan	12.03.2011	13.03.2011	38.27 N ; 141.03 E	earthquake, tsunami	storage tanks	(Krausmann and Cruz, 2013)
10	Vasylkiv, Ukraine	09.06.2015	10.06.2015	50.16 N ; 30.32 E	sabotage	storage tanks	(Kovalets et al., 2017) (Reuters, 2015)
11	Ra's Lanuf, Libya	19.08.2008	25.08.2008	30.45 N ; 18.49 E	human error	storage tanks	(The Telegraph, 2011)
12	Ra's Lanuf, Libya	12.03.2011	14.03.2011	30.45 N ; 18.49 E	armed conflict	storage tanks	(BBC, 2011)
13	As Sidr, Libya	26.12.2014	31.12.2014	30.60 N ; 18.28 E	armed conflict	storage tanks	(BBC, 2014)
14	Ra's Lanuf, As Sidr; Libya	05.01.2016	07.01.2016	30.45 N ; 18.49 E 30.60 N ; 18.28 E	armed conflict	storage tanks	
15	Surt disrtric, Libya	14.01.2016	14.01.2016	30.02 N ; 18.50 E	armed conflict	oil pipeline	(Tichý and Eichler, 2018) (Tichý, 2019)
16	Ra's Lanuf, Libya	21.01.2016	23.01.2016	30.45 N ; 18.49 E	armed conflict	storage tanks	
17	Ajdaviya district, Libya	01.02.2016	01.02.2016	29.68 N ; 20.54 E	armed conflict	oil pipeline	
18	Ra's Lanuf, Libya	17.06.2018	21.06.2018	30.45 N ; 18.49 E	armed conflict	storage tanks	(Reuters, 2018)
19	Puebla, Mexico	19.12.2010	19.12.2010	18.96 N ; 98.45 W	illegal tapings	oil pipeline	(Biezma et al., 2020)
20	Escravos, Nigeria	04.01.2018	05.01.2018	5.45 N ; 5.35 E	bush fire	oil pipeline	(Bloomberg, 2018)
21	Puerto Sandino, Nicaragua	18.08.2016	19.08.2016	12.18 N ; 86.75 W	unknown	storage tanks	(Ahmadi et al., 2020)
22	Gulf of Oman	13.06.2019	13.06.2019	25.39 N ; 57.38 E	armed conflict	oil tanker	(BBC, 2019)
23	Catano, Puerto Rico	23.10.2009	24.10.2009	18.41 N ; 66.13 W	human error	storage tanks	(Vasanth et al., 2014)
24	Punto Fijo,Venezuela	27.08.2012	27.08.2012	11.74 N ; 70.18 W	equipment failure	storage tanks	(Schmidt et al., 2016)
25	Butcher Island, India	07.10.2017	08.10.2017	18.95 N ; 72.90 E	lightning strike	storage tank	(The Indian Express, 2017)

To further address the improvements in the organization of the paper we rearranged the results section, as suggested by referee 2, to better illustrate the analysis method and the overall results. The current format of the results section includes:

Section 3.1 **Case study illustration** – we examine one event to illustrate the analysis method. This section includes the results from: one MODIS successful retrieval (event 14, ocean retrieval), one CALIPSO retrieval (event 14) and, one MODIS unsuccessful retrieval (event 13, land retrieval).

Section 3.2 **MODIS successful retrievals**
In lines 298 – 303 we address how many successful retrievals were analysed:
"*Based on the information given in table 1 we filtered a total of 375 days in which oil smoke plumes were observed by the MODIS sensors. After applying the selection criteria for the MODIS sensor we obtained a total of 10 days with successful retrievals. The majority of oil plumes resulted in unsuccessful retrievals, 70.7%, while 26.7% of plumes were screened out due to high percentage of cloud coverage. When applying the selection criteria for CALIPSO we obtained a number of 6 plume sections suitable for analysis. Table 2 shows the dates for both MODIS and CALIPSO retrievals suitable for analysis*."

A list of MODIS successful retrievals is given in table 2 as follows:

Table 2. List of successful MODIS retrievals and CALIPSO overpass dates

Event Id. Nr.	MODIS (Terra and Aqua) Successful retrieval date	CALIPSO retrieval date

		01.07.2016
1	-	17.07.2016
		21.10.2016
4	08.12.2015	-
5	21.04.2010	-
9	11.03.2011	-
11	-	22.08.2008
	28.12.2014	-
13	29.12.2014	29.12.2014
	30.12.2014	-
14	06.01.2016	06.01.2016
16	21.01.2016	-
20	19.08.2016	-
21	04.01.2018 (only Aqua)	-

Section 3.2 shows general MODIS results together with a more detailed discussion of the events in Lybia, event 13 and 16 (event 14 was previously discussed in section 3.1). The reasoning behind the more detailed discussion of these events is given in line 423: "*We choose to describe in detail the events from Libya as they are also analysed based on CALIPSO retrievals*"

Section 3.3 shows general results from **CALIPSO retrievals** together with detailed discussion of the events in Lybia.

Section 3.4 is now the **AERONET case study** and,

Section 3.5 is now **Data comparison between methods and other similar studies.** This section has been extensively revised to better illustrate how the methods compare to one another and to similar studies. Uncertainty intervals have been added to our results and, to the extent of which they were addressed in similar studies, uncertainty intervals were also added to the reference values in table 8:

Table 8. Oil smoke optical properties from ground based and flight measurements along with the scientific reference.

	LIDAR					
Reference	**AOD 532 nm**	**AOD 1064 nm**	**AE 550/1064 nm**	**PDR 532 nm**	**LR 532 nm (sr)**	**LR 1064 nm (sr)**
This study CALIPSO	0.025 ± 0.010 – 1.526 ± 0.804	0.023 ± 0.017 - 1.430 ± 0.473	- 0.03 – 0.39	0.11 ± 0.43 - 0.32 ± 0.48	37 ± 15 - 109 ± 47	37 ± 15 - 86 ± 10
(Okada et al., 1992) Ground based lidar	-	-	-	0.14 – 0.18	-	-
(Ross et al., 1996) Airborne lidar	0.2 - 0.6	-	-	-	38	-
(Laursen et al., 1992) Airborne lidar	0.05 – 1 ± 65%	0.05 – 1.2 ± 85%	-	-	-	-
(Ceolato et al., 2020) Ground based lidar	-	-	-	0.058	-	-
(Ceolato et al., 2021) Ground based lidar	-	-	-	-	125.3±5.0 sr	-

	Radiometer			Sun photometer		
Reference	**AOD 550 nm**	**AE 550/860 nm**	**R_{eff} (µm)**	**AOD 500 nm**	**AE 440/870 nm**	**R_{eff} (µm)**
This study MODIS and AERONET	- 0.04 – 0.16 ±(0.05 + 0.20 × AOD)	- 0.18 – 1.25	0.29 – 1.73 µm	0.28 – 0.68 ± 0.01	0.45 – 0.90	-
(Pilewskie and Valero, 1992) Airborne radiometer	0.82 – 1.92 ± 2% (500 nm)	-	-	-	-	-

(Nakajima et al., 1996)	-	-	-	1.5	0.7 ± 2.5 %	-
(Mather et al., 2007)				0.3 – 1.6 (440 nm)	0.09 – 0.42	0.45 – 1.40 μm

To address the referee's concern regarding the improvement of the abstract we revised the section in question to better reflect the contributions of the method and the overall findings of the study. Lines 23 – 37 reflect these changes:

The analysis method in this study was developed to better differentiate between oil smoke aerosols and the local atmospheric scene. We present several aerosol properties in the form of plume specific averaged values. We believe that MODIS values are a conservative estimation of plume AOD since MODIS algorithms rely on general aerosol models and various atmospheric conditions within the look-up tables which do not reflect the highly absorbing nature of these smoke plumes. Based on this study we conclude that the MODIS land algorithms are not yet suited for retrieving aerosol properties for these types of smoke plumes due to the strong absorbing properties of these aerosols. CALIPSO retrievals rely heavily on the type of lidar solutions showing discrepancy between constrained and unconstrained retrievals. Smoke plumes identified within a larger aerosol layer were treated as unconstrained retrievals and resulted in conservative AOD estimates. Conversely, smoke plumes surrounded by clear air were identified as opaque aerosol layers and resulted in higher lidar ratios and AOD values. Measured lidar ratios and particulate depolarization ratios showed values similar to the upper ranges of biomass burning smoke. Results compare well with studies that utilized ground-based retrievals, in particular for Ångström exponent (AE) and effective radius (R_{eff}) values. MODIS and CALIPSO retrieval algorithms disagree on AOD ranges, for the most part, due to the extreme light absorbing nature of these types of aerosols. We believe that these types of studies are a strong indicator for the need of improved aerosol models and retrieval algorithms.

Referee comment 3.

The methodology section is also quite long and confusing. It will be useful to use one of the cases as an example to illustrate the methodology.

Authors reply 3.

To the suggestions of the referee we have revised section 2.3 and we have reorganized the results section with one example, event 14, to better illustrate the methodology. We have added **Section 3.1 "case study illustration"** which contains one event of a synergic use of the analysis method. This section includes the results from: one MODIS successful retrieval (event 14, ocean retrieval), one CALIPSO retrieval (event 14) and, one MODIS unsuccessful retrieval (event 13, land retrieval).

Section 2.3 "Synergic approach" has been reformulated and reduced for avoiding any confusing text. The section at lines 240 - 293 now reads:

Figure 1 summarizes the steps of the analysis in detail. Events reported in scientific literature as well as events that drew significant media attention within a period of 12 years (2008-2019) were selected, a period for which both MODIS and CALIPSO were operational. MODIS (aboard Aqua and Terra satellites) RGB composite images are used to visually identify the plume. Plumes larger than 500 km^2 were only studied to ensure sufficient pixel count. Subsequently, cloudy scenes, with over 50% cloud coverage, were discarded. Next, aerosol retrievals were grouped into successful and unsuccessful based on the AOD values. Successful retrieval is considered when the

AOD values of the pixels that are flagged as smoke yield some degree of variation (for at least 50% of pixels, the AOD differences should vary at least by 0.01), whereas unsuccessful retrieval is considered when either AOD values are below 0.1 or are constant throughout the plume (over 90% of plume pixels with a fixed AOD value of 0.09 as seen in figure 3). We used successful and unsuccessful retrievals to highlight the capabilities and limitation of MODIS. The MODIS 6.1 collection was used in this study (MODIS Atmosphere Science Team, 2017a, b) and the algorithm for the AOD was selected based on surface type (DT over ocean and land) and locations (DB over desert and arid areas) for both successful and unsuccessful retrievals. We took advantage of the higher resolution 3 x 3 km^2 level 2 AOD products for statistical relevance in successful retrievals over ocean. For unsuccessful retrievals we used the 10 x 10 km^2 level 2 AOD products (DB over desert and arid areas) and the 3 x 3 km^2 level 2 AOD products over land.

Aerosol properties were only analysed for successful retrievals. The following aerosol properties were used in our analysis: AOD at 0.55 µm, AE and R_{eff}. For successful retrievals, we developed an averaging technique to remove background aerosol from the identified smoke plume. Since both RGB and AOD images show a clear transition from background aerosol to oil smoke areas, as seen in Figs. 2a and 2b, we identify the plume edge based on the AOD pixel gradient. Conversely, the plume edge pixels have AOD values different from the neighbouring background pixels by a value of at least 0.03, a value that has been decided with a simultaneous inspection of RGB and AOD maps. The averaged AOD within the plume edge is called "total plume AOD" and comprises oil smoke and background aerosols. The "plume specific AOD" is a result of subtracting the local background AOD from the "total plume AOD". The local background AOD is defined as the average AOD from a smoke-free area, this area needs to contain between 3 to 10 times the pixels of the smoke plume. This decision stems to the local geography and meteorological conditions (see Fig. 7a, event 13, on 29.12.2014, for high pixel count and Fig. 7.a, event 16, on 21.10.2016, for low pixel count). In section 3.2, detailed discussions of successful MODIS retrievals are presented.

CALIPSO is used complementary as it provides important insight into the plume monitoring, being an active sensor. Moreover, CALIPSO flies as part of the A-Train constellation and follows MODIS/Aqua observations by 2 minutes, thus similar atmospheric volume is sampled. The particulate backscatter coefficient (532 nm), is used to define the extent of the plume cross section. Smoke plumes have higher backscatter values than the background aerosol and are easily identifiable in the backscatter profiles. The minimum plume horizontal extent is set to 5 km as this is the standard level 2 data output (Winker, David, 2018). For daytime, Aqua/MODIS RGB images prior to the CALIPSO overpass are used for visual confirmation. Whereas, for nighttime, one MODIS image before and one after the CALIPSO overpass are used to assess the plume spatial continuity.

To retrieve detailed information on the aerosol optical properties, we use CALIPSO Level 2 data - 5 km Aerosol Profile (532 and 1064 nm), standard version 4.20 (Winker, David, 2018). The methodology to quality-assure the CALIPSO profiles is mostly similar to the rubric used by Tackett et al. (2018). For cloud-free scenes, only aerosol profiles with a cloud-aerosol-discrimination (CAD) score of $-100 < \text{CAD score} < -20$ are selected. Furthermore, aerosol profiles directly below any type of clouds are discarded as these may be affected. Smoke plumes above 4 km (mean surface level) in contact with ice clouds were discarded to prevent misclassifications as cirrus fringes. For the extinction coefficient filtering procedure, QC flag values not equal to 0, 1, 16, or 18 are discarded as low-confidence retrievals. Extinction coefficients where the uncertainty is equal to 99.9 km^{-1} are rejected as well as the values in bins directly below this range.

In this analysis, the particle backscatter coefficient is used to identify the geometrical properties of the smoke plume. The plume is defined as the area where the values are at least 2 times higher than the background, which *is considered as an area of identical thickness located either above or below the plume. The plume AOD (532 nm and 1064 nm) is calculated by integrating the particle extinction coefficient in the plume region, and the plume mean AOD is the average of the individual (i.e., 5-km) plume AODs that comprise the plume. Additionally, the plume extinction-to-backscatter (i.e., lidar ratio), Ångström (532/1064 nm) exponent, and particle depolarization ratio are assessed to investigate the type-dependent characteristics of the plume and whether oil smoke presents distinctive intensive properties.*

AERONET observations, when available, are also investigated and compared with the satellite measurements. Lastly, in case of events that have already been investigated by means of ground-based or airborne observations, we compared the published results with our methodology reflecting on the implications of oil smoke plumes that have on current satellite retrieval capabilities.

Referee comment 4.

From Sections 3.4 and 4, it is concluded that there is no agreement between the different approaches and even with the literature. Even though the differences are explained, how can you validate the method you propose in this paper? What is your reference? In this section, it is necessary to include the uncertainties in order to make the comparison.

Authors reply 5.

There is no "**overall**" agreement between the different approaches and the cited literature. The differences are explained here to better highlight the complex nature of these cases and the wide range of values that could be obtained from different conditions, events and sensors. This section also supports in detailing some of the limitations presented by this method. However we agree that the first draft of **section 3.4** does a poor job of explaining which reference studies agree and which do not agree well with the findings in this paper. To this extent we revised **section 3.4**, now **section 3.5**, and **section 4** to indicate the mentioned similarities and differences. **Section 3.5** is now **Data comparison between methods and other similar studies.** This section has been extensively revised to better illustrate how the methods compare to one another and to similar studies. Uncertainty intervals have been added to our results and, to the extent of which they were addressed in similar studies, uncertainty intervals were also added to the reference values in table 8:

Table 8. Oil smoke optical properties from ground based and flight measurements along with the scientific reference.

	LIDAR					
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(Okada et al., 1992) Ground based lidar	-	-	-	0.14 – 0.18	-	-
(Ross et al., 1996) Airborne lidar	0.2 - 0.6	-	-	-	38	-
(Laursen et al., 1992) Airborne lidar	0.05 – 1 ± 65%	0.05 – 1.2 ± 85%	-	-	-	-
(Ceolato et al., 2020) Ground based lidar	-	-	-	0.058	-	-
(Ceolato et al., 2021) Ground based lidar	-	-	-	-	125.3±5.0 sr	-

	Radiometer			Sun photometer		
Reference	**AOD 550 nm**	**AE 550/860 nm**	**R_{eff} (µm)**	**AOD 500 nm**	**AE 440/870 nm**	**R_{eff} (µm)**
This study MODIS and AERONET	- 0.04 – 0.16 ±(0.05 + 0.20 × AOD)	- 0.18 – 1.25	0.29 – 1.73 µm	0.28 – 0.68 ± 0.01	0.45 – 0.90	-
(Pilewskie and Valero, 1992) Airborne radiometer	0.82 – 1.92 ± 2% (500 nm)	-	-	-	-	-
(Nakajima et al., 1996)	-	-	-	1.5	0.7 ± 2.5 %	-
(Mather et al., 2007)				0.3 – 1.6 (440 nm)	0.09 – 0.42	0.45 – 1.40 µm

Please keep in mind that not all studies in table 8 presented estimated uncertainty intervals. We directly compared our CALIPSO results to studies which utilized lidar measuring techniques, either airborne or ground based. Similarly we compared our MODIS and AERONET data to similar studies utilizing sun photometers or air borne radiometers (only one study was found). Please find the revised section 3.5 at lines 560 – 621 and section 4 at lines 632 – 661.

Referee comment 5.

Why didn't you use SSA? The analysis of the SSA (or the AAOD) will add a great value to the study since one of the interests of studying smoke lies on its absorbing capacity. Data from a different sensor, such as OMI, could be of interest.

Authors reply 5.

We agree that these properties would have been of great interest and value to our study and we would like to assure the referee that the potential of adopting SSA and AAOD was thoroughly considered and investigated. Unfortunately there were no overlapping SSA or AAOD pixels from the OMI sensor which would correspond to any of the case studies found. The OMI product would also not be of much statistical relevance as the pixel size is too large and the retrieval would effectively describe a large contribution of the local background values and not so much the smoke plumes themselves. Other similar products, such as Tropomi, may have smaller pixel size products but they lack the temporal coverage. As current satellite missions progress and advancements to sensor retrievals develop over time, we express our commitment to further analyse smoke plumes to better understand these types of aerosols.

Specific remarks

Referee comment 1.

Line 265: What is the information obtained from the analysis of the unsuccessful retrievals? It is useful for the study or even reliable?

Authors reply 1.

The cases that are found to have unsuccessful retrievals are significant in highlighting the limitations of MODIS sensor when judging these smoke plumes. However the unsuccessful retrievals are not used to extract plume aerosol properties, and to this extent we agree that the discussions from lines 470 – 496 can be reduced. In this regard we kept one unsuccessful retrieval to discuss in detail and to better highlight the methodology. This case is now part of section 3.1 at lines 336 – 349 and now reads:

Figure 3 shows an example of an unsuccessful retrieval of the land algorithm for the event 13 plume on 30.12.2014. We can distinguish the plume from the RGB image over the Gulf of Sidraa while also observing AOD values over land where the smoke plume drifted E-NE towards the island of Crete. However, there seems to be no distinguishable AOD gradient, over land, in the plume section. A further inspection suggested that all pixels showed values of 0.095 which suggest that the lower radiance values did not match well with pre-existing LUT values. Consequently, the region is classified as "clean atmosphere" and thus, a unique AOD value is assigned to all the pixels. Conversely, the ocean algorithm retrieved AOD that varied between 0.1 and 0.37. Since these heavy smoke plumes are the result of extreme scenarios they are rarely observed and may not end up being a subject of research. Thus, we believe there are no cases within the LUT values describing extremely low atmospheric transmission and radiance values, highly absorbent aerosol, low SSA and low reflectance values over a large spectral range including MODIS bands 1 through 7.

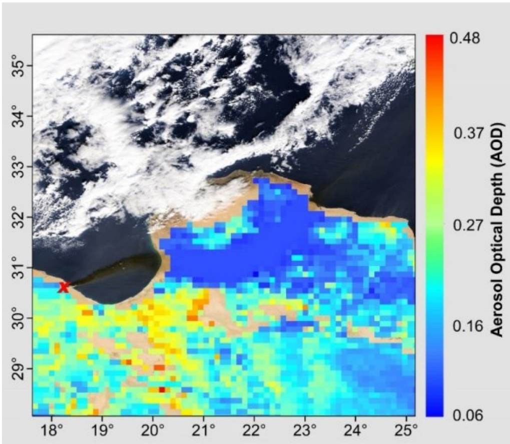

Figure 3. Retrieval of plume (unsuccessful) and background AOD values: event 13, 30.12.2014. The red coloured "x" indicates the event origin.

Referee comment 2.

Tables 2, 3, 4 and 5: A column with the name of the oil fires will make them easier to identify in the tables.

Authors reply 2.

All tables describing plume events have been updated with a column containing the "event ID no." as suggested by referee 2, and in text we have addressed each event by this number for consistency reasons. This column is added to tables 2 to 7.

Referee comment 3.

Figure 3: Use the same scale for the AOD to ease the comparison among the different figures (this comment can be applied to all the figures)

Authors reply 3

We have modified all AOD figures to which this scale applies. Formerly know figures 3, 4, and 5 have been merged with respect to the events discussed in detail. The merger has resulted in figure 7. Please find the revised figures bellow:

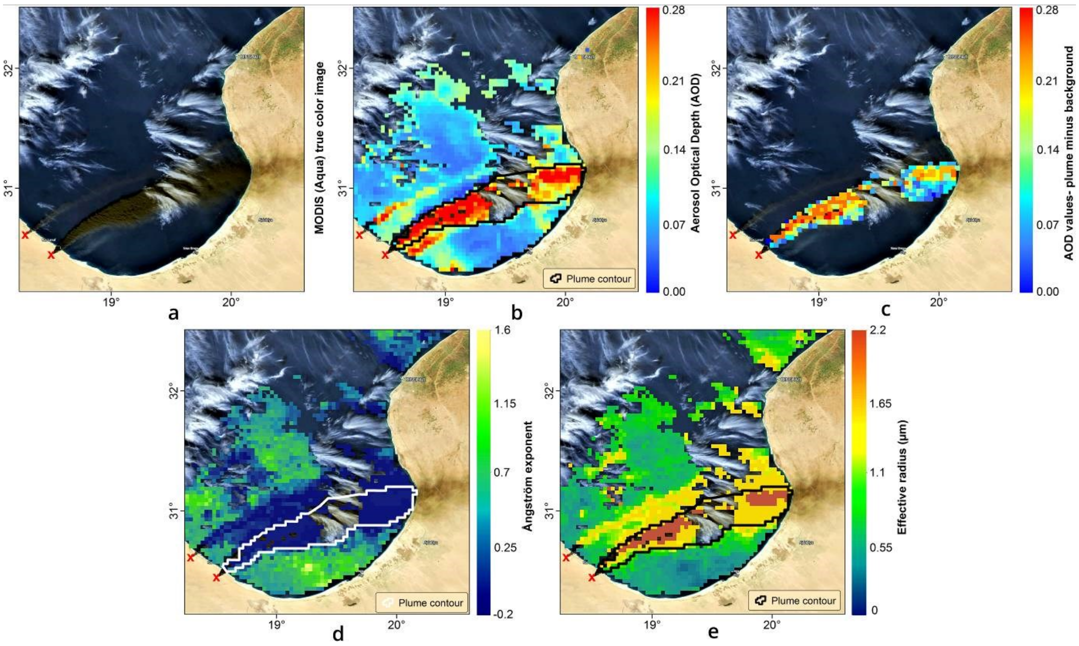

Figure 2. Visual representation of the analysis method for MODIS data: (a) - plume captured in true color; (b) - AOD retrieval over the plume area and background (Gulf of Sidra); (c) - AOD retrieval as a result of plume minus background values; (d) – Angstrom exponent for plume and background area; (e) – Effective radius for plume and background area. The red coloured "x" indicates the event origin.

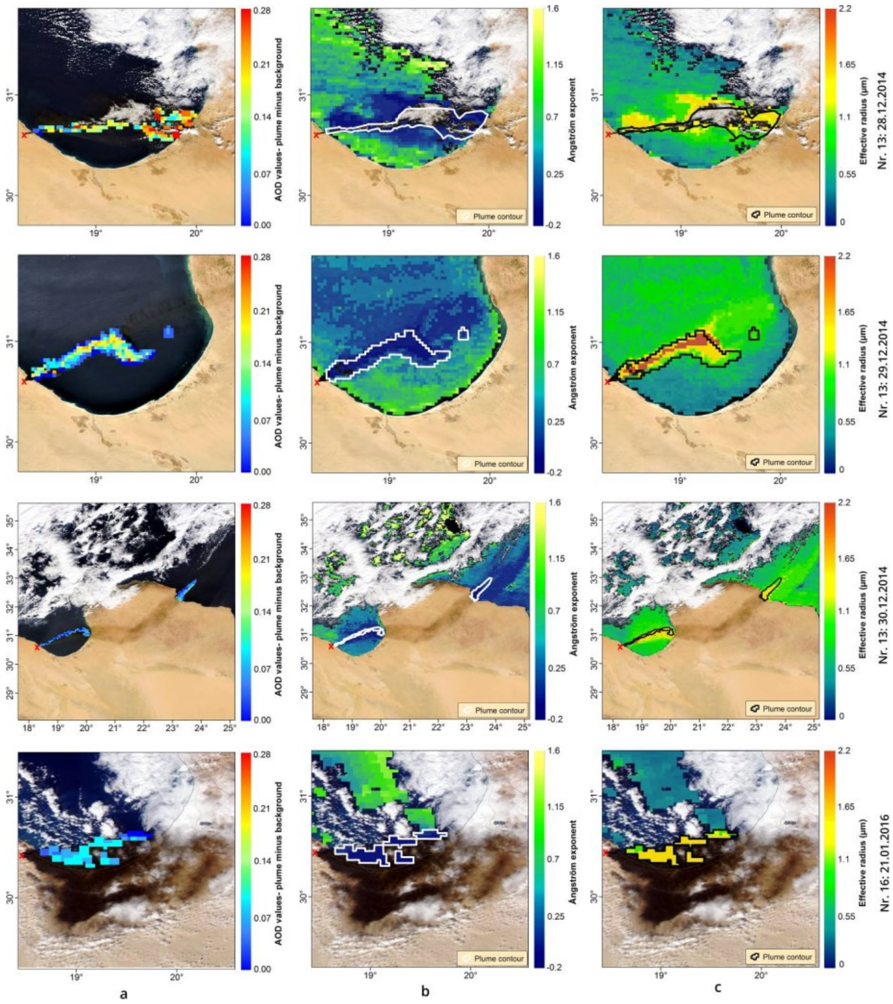

Figure 7. (a) Successful retrievals of aerosol properties for events 13 and 16. Plume specific AOD; (b) AE values for plume and the local background; (c) R_{eff} values for plume and the local background. The red coloured “x” indicates the event origin.

Referee comment 4.

Line 385: You indicate that “This is evident in the plume albedo from MODIS true colour images.”, but the RGB images are not included. Include them or rephrase the sentence.

Authors reply 4.

After reducing the overall results section, this sentence is no longer found in the revised manuscript.

Referee comment 5.

Line 507: In figure 7b there are no data below 3150 m, how do you identify the plume base and top?

Authors reply 5.

We used the Particulate backscatter coefficient (532 nm) 5 km Aerosol Profile to determine the layer top and base. The values are cut off below 3150 m, for this specific backscatter profile, due to the sensitivity of the backscattered signal being reduced or lost because of the strongly attenuated two-way transmission. This case was treated by CALIPSO as an opaque aerosol layer. In this case the same values for the plume top and base, are also found in the variables “Layer_base_altitude” and Layer_top_altitude” part of the 5 km Aerosol Layer product. Lines 353

– 355 now read: *The average plume thickness was approximately 920 m. The layer base was situated between 2600 and 3100 m above the Gulf while the top was measured between 3300 and 4200 m*.

Referee comment 6.

Line 553: What does imply for this study that the SIBYL algorithm failed to detect the plume area and level 2 products averaged 20 km were used? Is the information obtained accurate for the study of the smoke plume?

Authors reply 6.

Based on the specific conditions of the 29th of December 2014 at As Sidra we concluded that the low background AOD values in conjunction with the narrow plume section led to a larger averaging scheme, from 5 km to 20 km. There is a discernible difference between the background and plume section. In this sense the information does reflect the presence of additional aerosols in the study area. However due to this larger averaging scheme we suspect that these values represent a more conservative estimate as opposed to the other case studies where the averaging scheme was done at 5 km. The sentence was rephrased and now reads: *The SIBYL algorithm level 2 products were averaged over a larger 20 km area, as opposed to the 5 km averaging resolution, thus plume values are harder to distinguish from background aerosol levels.* Lines 452 – 454.