We would like to thank reviewer #3 for his/her reviews. We addressed each comment below and highlighted our answers in red, the referee's comments are black.

This manuscript presents the first analysis and evaluation of smoke injection heights retrieved from TROPOMI, using fires in North America from June to August 2018. The Authors compare the TROPOMI smoke height retrievals with MISR and CALIOP observations
and plume heights derived from the CFFEPS. The manuscript presents results that are of interest to the readers of Atmos Meas Tech and the scientific community overall. As the Authors highlight, TROPOMI offers an additional smoke height plume product with higher spatial and temporal resolution than MISR and CALIOP, and with almost near real time availability. These characteristics are valuable for the modelling community, to forecast air quality impacts and for aviation safety, for example. I have added some comments and notes that will help improve the manuscript; I hope theAuthors consider them during the revision process.

*Introduction. The discussion about differences between the satellite needs to be clearer. I agree MISR and CALIOP are different instruments and use different methods to retrieve smoke heights. For example, MISR has a swath of 380 km common to all cameras, and global coverage is obtained every 9 days at the Equator and every 2 days at the poles. CALIOP swath is about 70 m wide, not kilometres as state in the manuscript, and this provides a global coverage every 16 days. However, they are at the same time complementary as they observe fires at different times and CALIOP is able to retrieve smoke from optically thinner plumes, whereas MISR offers a larger sample size, near the fire source.

We have changed the sentence on p.2 accordingly.

From:

"However, these two instruments have the disadvantage of very limited coverage where most fires are missed […]."

To:

""However, these two instruments have the disadvantage of very limited coverage where most fires are missed […]; MISR provides global coverage about once per week (8 days near the equator and every two days near the poles) and CALIPSO provides global coverage about every 16 days."

We have changed the sentence on p. 5:

"…and has a very narrow swath width of just a few kilometres. In this study, we use the daytime aerosol layer product v4 (``Layer_Top_Altitude'', ``Layer_Base_Altitude'') (McGill et al., 2007; Vaughan et al., 2009) which provides the top and base height of aerosol layers detected (between the surface and 30 km) averaged to a 5 km horizontal resolution,…"

To:

"…and has a very narrow swath width of just a hundred meters. In this study, we use the daytime aerosol layer product v4 (``Layer_Top_Altitude'', ``Layer_Base_Altitude'') (McGill et al., 2007; Vaughan et al., 2009) which provides the top and base height of aerosol layers detected (between the surface and 30km) averaged over 5 km along the 100 m wide swath,…"

And on p. 15:
"those two satellites have a narrow-swath with a global coverage every week and 16 days, respectively."

To address the last point, we added the following to the instruction to highlight that MISR and CALIOP are complementary because they observe fores at different times and with different methods:
"The time of observation and method used to determine the height of the plume is very different for these two instruments, making them complementary. Because the observation methods are different, it is important to…"

*Page 3-Line 9. The planetary boundary layer tends to be higher later in the afternoon and that may contribute to the difference between MISR and CALIOP smoke heights.

We have changed the sentence to:
"…difference of approximately 2 h can create additional challenges for comparing the plume heights, as the fire is expected to increase in intensity throughout the morning with the peak fire activity being in the early afternoon as well as changes in the planetary boundary layer that tends to be higher later in the afternoon…"

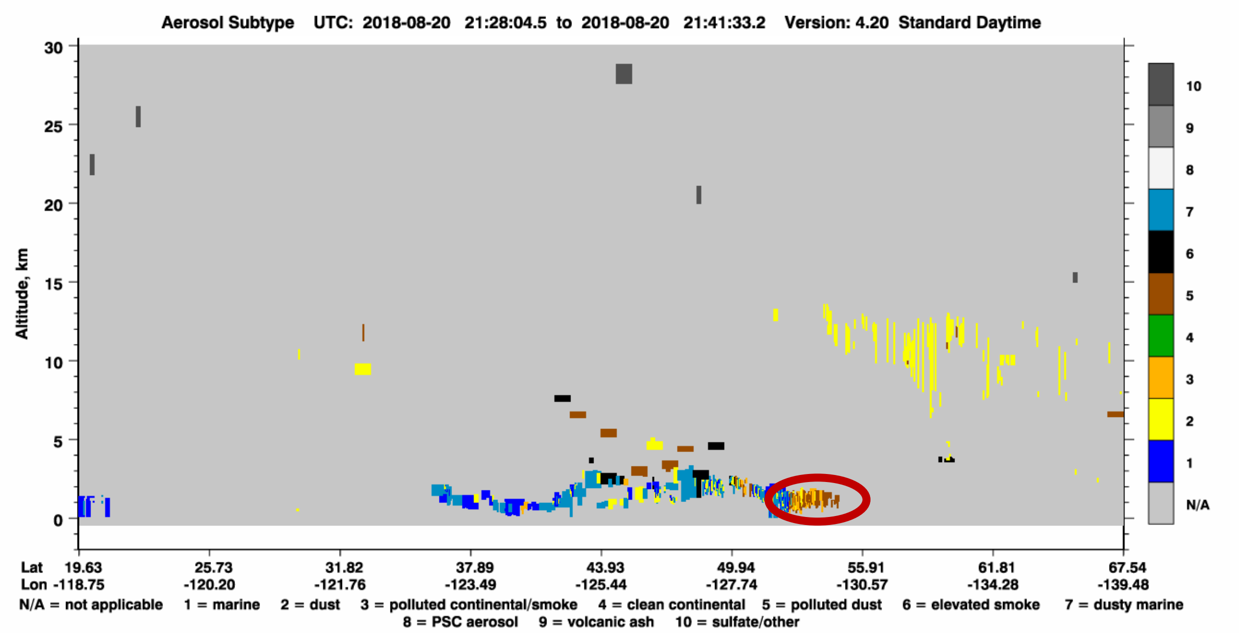
*Page 4- Line 25. I don't understand the TROPOMI quality flag. Does this flag provide an indication of retrieval quality, or is it simple to define if there is a smoke plume retrieved?
We have changed the description to the following to make the meaning of the quality flag a little clearer:
"In general, the OFFL product should perform better and is a better choice if timeliness is not an issue. Here, we evaluate the OFFL version only, as the NRTI version was not available for the time period that we investigated. As a first indication, the quality of each successful ALH retrieval is indicated by a quality assurance values (qa_value). If the input data or measurement configuration becomes close to a predefined limit, first the qa_value is lowered, if another limit is crossed, the pixel is filtered. E.g. all pixels with a solar zenith angle below 60º should have a good quality retrieval. However, for SZA > 60º the curvature of the Earth and the long photon path through the atmosphere may compromise a good retrieval. Above 75º, no retrievals are attempted. However, between 60º <SZA<75ºthe retrieval is performed, but the qa_values is lowered by 80%, to indicate to the user to use caution. This is done for all pixels with a (small) cloud fraction (qa lowered by 50%), small AAI (50%), high surface roughness (50%), and within sunglint and south Atlantic anomaly regions (50%).

Apart from the quantitative layer height, the quality flag provided alongside can be useful by itself. Just this quality flag can be useful to locate and identify presence of aerosol plumes and its vertical shape.”

*Page 5 Line 31. Why do you consider CALIOP aerosol plumes with polluted dust? The evaluation is for ‘smoke’ plumes.

We consider plumes containing either (or both) smoke or polluted dust. Looking at a few examples with clear contamination from fire plumes and we found that these can sometimes be classed as polluted dust rather than smoke; primarily we wanted to exclude all other aerosol types that cannot be from fires such as clean marine, dust, polluted continental, clean continental.
We changed the wording in the manuscript slightly, to:
“For the comparison between CALIOP and TROPOMI, only CALIOP plume heights over North America are retained and filter out (``Feature_Classification_Flags") the ones from clean marine, dust, polluted continental, clean continental, thus, only plume heights containing smoke or polluted dust were selected (we found that fire plume aerosols are classed as either smoke or polluted dust).”

Here is an example from 2018-08-20 over British Columbia, Canada that was filled with smoke from fires, in the aerosol classification this plume appears as smoke (3, orange) and polluted dust (5, brown).



*Page 6 Line 5. MODIS can also miss fires under high dense smoke.
We modified the text to reflect this.
From:
“Note, that fires can potentially be missed due to cloud cover.”

To:
“Note that fires can potentially be missed for several reasons: due to cloud cover, under thick smoke plumes, as well as if the FRP signal is too low (e.g. small fires).”

*Page 6 Line 5. Do you use all MODIS thermo anomalies pixels or only those pixels with some confidence level that indicate active fire?

We use clustered MODIS thermal anomalies. We search for all thermal anomalies, with a confidence over 75%, the summed FRP of all thermal anomalies must be at least 1000 in the area (up to 5km radius) to be considered. We use these locations just as a starting point, of where potentially fires are. This results in a bunch of potential fires each day. Then we look at these spots if MISR overpasses these areas and use MINX to trace the plume.
We use this list of dates and locations of fires for multiple things, however, we realized that for this study, we actually only used the MODIS fire anomalies to find potential fires in MINX, thus we have revised the MODIS section and moved it into the MISR description.
The text has been changed to:
“The MODIS thermal anomaly product (MOD14) (Giglio et al., 2003, 2006, 2016) is used here to locate the wildfires. We searched for clusters of thermal anomalies with a confidence of at least 75%, and a minimum summed FRP (within a 5km radius) of at least 1000. These locations were then used to search for plumes using the MINX package. There are currently two MODIS instruments in space, on NASA's Terra and on NASA's Aqua satellites. Daytime measurements of Terra and Aqua are around 10:30 and 13:30 local time, respectively. For the MINX analysis, we utilized the thermal anomalies from MODIS Terra. Note that fires can potentially be missed for several reasons: due to cloud cover, under thick smoke plumes, well as if the FRP signal is too low (e.g. small fires).”

*Page 6- GEM-MACH. It is not clear to me what type of smoke injection height scheme CFFEPS uses. A brief description indicating the parameterization and key drivers will really help.

We included the following in the manuscript to describe how the CFFEPS (GEM-MACH) injection height is estimated, in Sect. 2.5 GEM-MACH:

“Fire plume injection height in GEM-MACH is parameterized in the CFFEPS module with hourly modelled meteorology as detailed in Chen et al. (2019). The injection height is determined based on the balance of estimated plume buoyancy and the modelled environmental lapse rate at fire location. Total heat flux from fire is determined from modelled fuel consumed per area and the heat of combustion of dry wood fuel (Byram, 1959). The fraction of energy that enters the plume for convection is further parameterized based on thermodynamic energy balance accounting for heat lost to fuel, moisture, radiation, conduction and incomplete combustion. The hourly plume injection height is determined based on the dry adiabatic equilibrium of the buoyant plume and the modelled environmental lapse rate at fire location. “

*Page 11 Line 27. Again, CALIOP profiles are selected with smoke and polluted aerosols (aerosols, not dust?).

We meant dust, not aerosol and corrected it in the manuscript. See explanation above as to why we included polluted dust as well.

*Page 12 Line 10. How does your definition of CALIOP smoke height (method 3) differ/compare from Huan et al., (2015) and Gonzalez-Alonso et al. (2019)?

Similar to Gonzalez-Alonso et al. (2019), we use the CALIOP Level 2 version 4 data, with the difference that we only use daytime (closest to the TROPOMI overpass), and that we filter for smoke and polluted dust (instead of just smoke). Our approach is different to that from Huang et al. (2015), since we do not define the plume heights from aerosol extinction profile itself, but use the L2 averaged plume height product.

We included the following in the manuscript, p. 12 l.19-20:
“Similar to Gonzalez-Alonso et al. (2019), we use the top and plume base from the CALIOP L2 product (aerosol layer product v4), which are on a horizontal resolution of 5 km…”

*Page 12 Line 14. How do you define ‘thick’ and ‘thin’ plumes? Is it by size or by density?
Here, we are referring to geometrical thickness and included this (“geometrical”) in the manuscript to make it clearer.
We also describe on p.12 l.26 how this geometrical thickness is defined. We have looked at optical thickness using the AOD within Caliop and TROPOMI, but couldn’t find the same decreasing differences for increased AODs as found for the geometrical thickness. We believe this is likely due to the not very good AOD product from TROPOMI and Caliop.

*There is a Table S1 (Supplementary Materials), but it is not referenced within the Manuscript
We included a reference to the table as suggested, Sec. 2.5 p.7 l.1 :
“Differences between the operational and experimental version of GEM-MACH can be found in the supplement, Table S1.”

*The Authors mention the near-real time smoke plume height retrievals, but there is not mention within the text where the TROPOMI smoke height can be downloaded. A refence will be very useful for the readers.

We included a data availability section to the manuscript, pointing to the locations where TROPOMI, Caliop, MISR, MODIS and the GEM-MAXH plume heights can be downloaded.

References Gonzalez-Alonso, L., Val Martin, M., and Kahn, R. A.: Biomass burning smoke heights over the Amazon observed from space, Atmospheric Chemistry and Physics, 19, 1685–1702, https://doi.org/10.5194/acp-19-1685-2019, https://www.atmos-chem-phys.net/19/1685/2019/, 2019.
Huang, J., Guo, J., Wang, F., Liu, Z., Jeong, M.-J., Yu, H., and Zhang, Z.: CALIPSO inferred most probable heights of global dust and smoke layers, J. Geophys. Res.-Atmos., 120, 5085–5100, 2015.