Review of article '*TRAILS - A novel framework for time-height-resolved attribution of long-range transported wildfire smoke*' https://doi.org/10.5194/egusphere-2026-718 **by Roschke et al submitted for publication in Copernicus AMT Journal**

General Comments

This work introduces the Trajectory-based Identification of Lofted Smoke (TRAILS) tool for the identification of smoke plumes. The article describes a method to generate time-and-height-resolved identification of wildfire related Smoke Occurrence Fraction. It integrates 10-day backward trajectories from FLEXPART model with a multi-sensor satellite detection algorithm.

The most important contribution of this work is the development of a statistically significant linear relationship between satellite-derived Ultraviolet Aerosol Index (UVAI) associated with carbonaceous aerosol layers and smoke plume height. The UVAI is obtained from near-UV observations by ozone Nadir Mapper (NM) instrument which is a component of the multi-sensor Ozone Mapping and Profiler Suite (OMPS) on the NOAA Suomi NPP satellite. Smoke plume height is obtained from CALIOP observations and collocated OMPS-NM measurements. The positive identification smoke-related UV-absorbing aerosols (as opposed to UV-absorbing mineral dust aerosols) is carried out by comparisons to ground-based fluorescence lidar measurements (MARTHA and Polly-XT) in 2023.

Results show that TRAILS adequately recreates both the vertical distribution and temporal evolution of long-range smoke layers, with a 76% detection rate for fluorescent aerosol layers.

Except for the introduction section, which contains numerous inaccurate statements, the paper is generally well written and should be published after the comments below are addressed.

Specific Comments

Line 49. The upper-troposphere to lower-stratosphere self-lofting mechanism during the 2017 British Columbia fires was documented with both observations and model calculations by Torres et al (2020a).

Line 55. The authors seem unaware of available relevant literature. There have been publications suggesting the occurrence of self-lofting in the troposphere. See de Laat et al, 2012 and references therein.

Line 58. Replace *speculated* with *suggested.*

Lines 63-64. This can be achieved from sensors ' *that measure the absorption of radiation by aerosols in quantitative terms such as single scattering albedo (SSA) and aerosol absorption optical depth (AAOD), and qualitatively such as the UV Aerosol Index, UVAI (Herman et al., 1997; Torres et al 1998)*

Line 65 – 70. The listing of UV-capable sensors should include relevant information such operating agency, resolution, retrieved aerosol-related parameters, and relevant references. Most listed sensors retrieve the same quantitative parameters, aerosol optical depth (AOD), single scattering albedo (SSA), and the qualitative UV aerosol index (UVAI). The TROPOMI and EPIC sensors also include Oxygen-A and Oxygen-B observing capability that allows the retrieval pf aerosol layer height, an important piece of information for the accurate retrieval of near-UV aerosol properties.

It is suggested that the sensors be listed chronologically and mention their algorithms and retrieval products:

-Ozone Monitoring Instrument (OMI, 2007 – present) on low Earth orbit (LEO) Aura satellite, 13x24 km pixel size. Two aerosol algorithms: OMAERO developed by KNMI (Torres et al., 2007) and OMAERUV developed by NASA (Torres et al., 2007, 2013). Since about 2007 OMI observations have been affected by the row anomaly (Torres et al, 2018).

- The Ozone Mapping and Profiler Suite Nadir Mapper (OMPS-NM) on the Suomi National Polar-orbiting Partnership (SNPP) satellite, deployed in 2011, reports the UVAI parameter at 50 km resolution (Kramarova et al., 2014)

-Earth Polychromatic Imaging Camera (EPIC) on the National Oceanic and Atmospheric Administration's Deep Space Climate Observatory (DSCOVR) platform at the Lagrangian 1 point. The EPICAERUV algorithm retrieves, near UV AOD and SSA (Ahn et al., 2021) as well as Oxygen-B based aerosol layer height (ALH) at 18x18 km (Xu et al., 2019, , Torres et al., 2025)

- Tropospheric Monitoring Instrument (TROPOMI) on European Space Agency (ESA) Sentinel-5 Precursor (S5P) satellite. NASA's TROPOMAER aerosol algorithm [Torres et al., 2020b] derives aerosol properties at 5.5X3.5 km resolution. It reports UVAI ,AOD, and SSA retrieved from near-UV observations as well as ALH from Oxygen-B band observations.

Lines 70-71. The statement on EPIC observations *'...polar coverage cannot be reached and thinned aerosol layers are not detectable over more than two weeks'* is incorrect and unsupported by the listed Torres et al.,2020a reference. EPIC measurements from the Lagrangian 1 point attain full coverage of both polar regions most of the year except for a few weeks during their respective winter seasons. Also, the statement that '*thinned aerosol layers are not detectable over more than two weeks*' (also not supported by the cited reference) does not sound like a major limitation of a nadir-looking space sensor. As a matter of fact, any nadir- looking satellite-borne sensor will have difficulties detecting thinned aerosol layers after two weeks. The two statements above are inaccurate and misleading . They should be either removed or properly backed up with specific references.

Line 72-76 A TROPOMI aerosol algorithm is discussed by the authors without providing any references. It is not clear if they refer to the NASA TROPOMAER product (Torres et al., 2020, discussed above in this review). Please discuss the connection between the mentioned TROPOMI-KNMI aerosol product (add a reference) and the aerosol layer height product associated with the listed Lambert et al. 2024 reference.

Lines 77. The authors refer to an *OMPS sensor* on the Suomi NPP satellite. The OMPS (Ozone Mapping and Profiler Suite) acronym does not refer to a sensor. OMPS consists of two instrument modules: a combined ozone Nadir Mapper (NM) and ozone Nadir Profiler (NP), and a separate Limb Profiler (LP), for a total of three sensors (Kramarova et al., 2014). In addition to total column ozone, OMPS-NM observations are used to calculate the UVAI parameter. Limb Profiler (LP) observations of scattered solar radiation in the 290–1000 nm spectral range are used to retrieve high vertical resolution (1.8 km) ozone and aerosol profiles. OMPS-LP provides daily global measurements of the vertical distribution of spectral aerosol extinction from cloud top up to 40 km (Loughman et al., 2018).

Lines 78-80 The statement *'A comparison between OMPS and EPIC shows…'* is ambiguous as it does not indicate which parameter, and from which of the sensors of the OMPS suite, is compared to which EPIC retrieved parameter.

Line 83 Clarify to what OMPS sensor the sentence '…with global smoke layer information derived from UVAI measurements from OMPS' is referring to.

Line 85 There are two MODIS sensors. Specify which MODIS sensor this statement refers to. Also define and/or provide a reference for the *Suomi NPP Data Exploitation Level 2* product or database.

Line 86. How are absorbing aerosol layers above clouds dealt with? See related comment on line 187.

Line 153-154 The statement '….nominal at-launch spatial resolution of about 50km × 50km with an imagery resolution of the final data output of 2km' makes no sense. Please correct and provide a reference.

Line 154. At 50km×50km resolution there is a large probability of cloud presence either at the same altitude as the aerosols or beneath the absorbing aerosol layers. The latter would result in an UVAI increase unrelated to either aerosol amount or aerosol layer height. Discuss how this UVAI increase is dealt with without explaining it as a spurious aerosol layer height effect. See comment on line 187.

Line 159 It is OMPS-NM

Line 173 Add Torres et al 2020b reference on ALH dependence of UVAI.

Line 175. Add the Ginoux and Torres (2003) reference on parameterization of UVAI based on model calculations.

Line 183 It is OMPS-NM

Line 187. Absorbing aerosol layers are often located above highly reflective water/ice clouds. A bright cloud background increases the UVAI value of an aerosol layer in relation to what should be under cloud-free conditions. This increase depends on both the aerosol and cloud optical depths (Jethva et al., 2018). How is that effect handled in the proposed UVAI to height adjudication?

Line 190 Which MODIS sensor?

Line 203 Provide a reference for Suomi NPP Data Exploitation Level2 document.

Line 361 It is OMPS-NM in Figure 6 caption

Line 609 It is OMPS-NM

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