Observations of extreme dust and smoke aerosol plumes during 2018-2022 over the Eastern Mediterranean

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Introduction

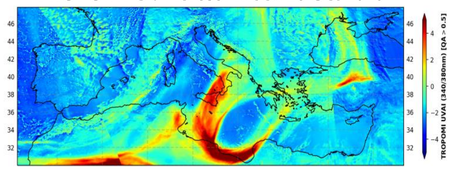
Various types of aerosol can be found in the Eastern Mediterranean, mainly desert dust, originated from the Sharan desert, pollution particles, marine aerosol and smoke particles, produced by seasonal summer forest fires. Three typical days during the period **2018-2022**, with sufficient aerosol load over Mediterranean were selected to illustrate the performance of the TROPOMI aerosol products over scenes with strong aerosol load. These cases refer to Potenza, Athens and Antikythera, lidar observations during extended dust and smoke events. The selected cases include: (a) a smoke aerosol plume transported on 26th of October 2020, originated from the large wildfire episodes in the California region (N. America), (b) a Saharan dust outbreak over eastern Mediterranean on 16th, March 2022 and (c) a smoke plume on 8 August 2021, during Greek summer wildfires.

- This study highlight the importance of synergistic use of passive and active remote sensing techniques in combination.
- The measurements allowed to monitor the evolution of aerosol plumes, in terms of their vertical distribution as well as to analyze its optical and geometrical properties.
- **ATLANTIS (LAP AUTH)** automated tool is used for the aerosol monitoring and data processing.

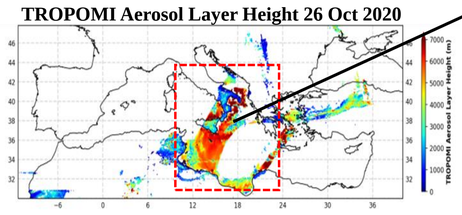
Case I: Californian smoke plumes over Mediterranean (26 Oct 2020)

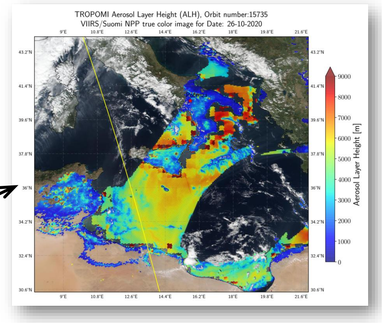
In mid-October 2020, a series of wildfires took place in Northern California resulting in thousands of square kilometers of boreal forest being burned and causing a huge amount of smoke to enter the atmosphere. The emissions caused extreme air pollution conditions with poor visibility throughout the area for several days. The TROPOMI sensor has been monitoring these wildfires and tracked the smoke as it travelled all the way across North America and the Atlantic Ocean to arrive in Mediterranean.

TROPOMI UV Aerosol Index 26 Oct 2020

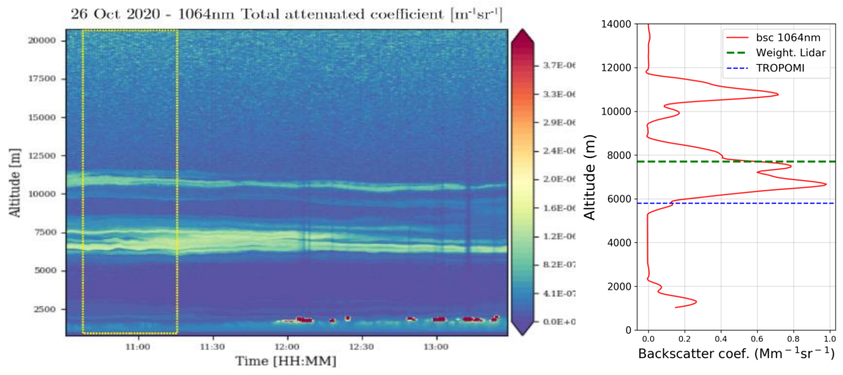


TROPOMI Aerosol Layer Height 26 Oct 2020





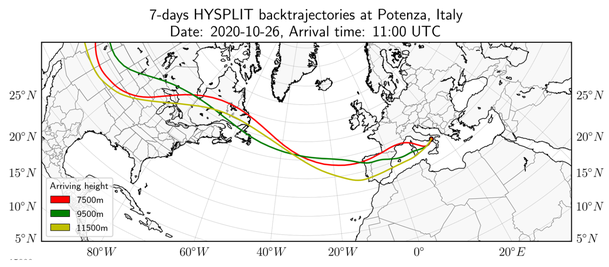
The yellow solid line represents the ground track of CALIPSO orbit.



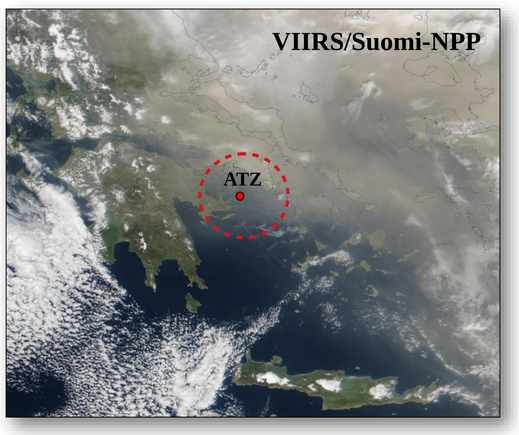
- The closest in time backscatter profile is used in order to extract the ALHbsc and compare against TROPOMI ALH retrievals.
- The averaged backscatter profile at 1064 nm, for the time period from 10:15 to 11:40 UTC on 26 October 2020 is shown.
- Two optical elevated thick layers with a thickness of ~2km were detected with TROPOMI detecting this layer at **5650m** while the calculated ALHbsc the lidar profile, places it at **7800m.**

- Temporal evolution of the total attenuated backscatter signal from the MUSA lidar system at 1064nm, on 26 Oct 2020, showing the detection of the smoke cloud.
- This case of very high-altitude smoke from intense biomass burning in North America shows a notable difference with lidar measurements, revealing a possible limitation of the current operational **S5P L2_AER_LH** product.

7-day HYSPLIT back-trajectories arriving at Potenza, Italy on 26 October 2020

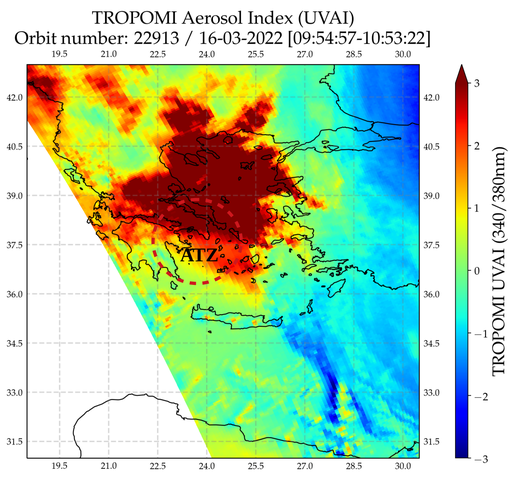


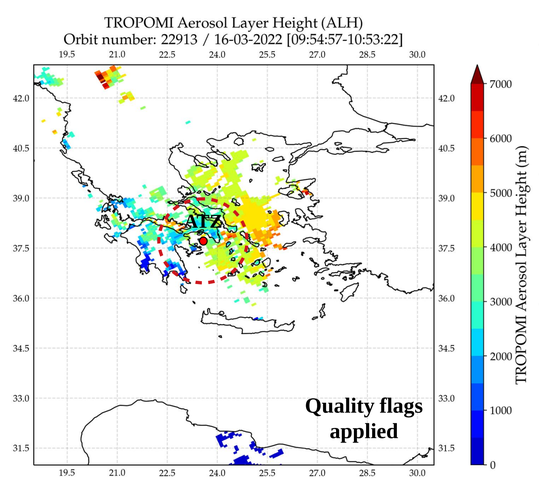
Case II: Dust event over Greece, 16 March 2022



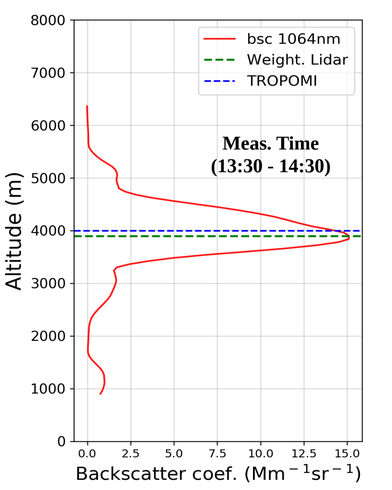
The dust plume can clearly be seen, over Greece from the VIIRS/Suomi-NPP true color image for this day. The corresponding aerosol index image for this day provides insight how much of a wider region may also affected by dust in the atmosphere.

- On the 16th of March 2022, the Eastern Mediterranean was affected by a strong dust episode originated from North Africa. On this day, the TROPOMI overpass over Greece is between ~10:00 and 11:00 UTC.
- Comparing the TROPOMI product maps to the VIIRS image, it is obvious that the large positive UVAI pixels and elevated aerosol layers are located at the detected plumes.
- A lofted layer of dust was also clearly observed by the EOLE system at NTUA (Athens) station on the same day.

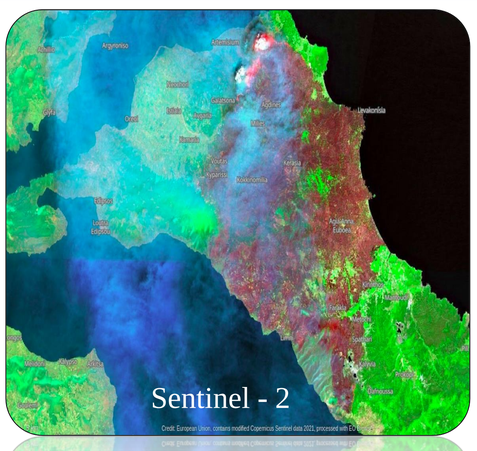




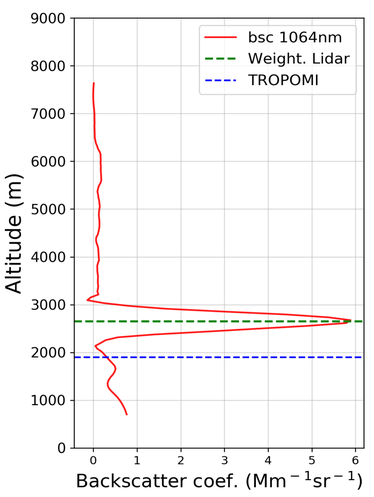
- A single optically thick layer with a thickness 2000m was detected by EOLE lidar.
- TROPOMI detects this layer at **4082m** while the calculated ALHbsc places it at **3940m**.
- An **agreement within 200m** between the satellite and ground-based lidar system is found for this clear aerosol scene, within the target requirement for the TROPOMI ALH product.

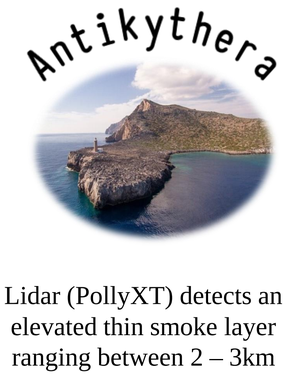


Case III: Greek wildfires, 08 August 2021

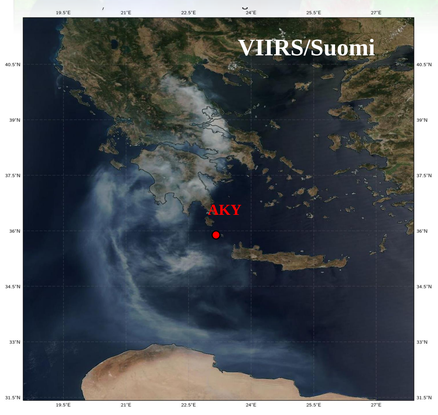


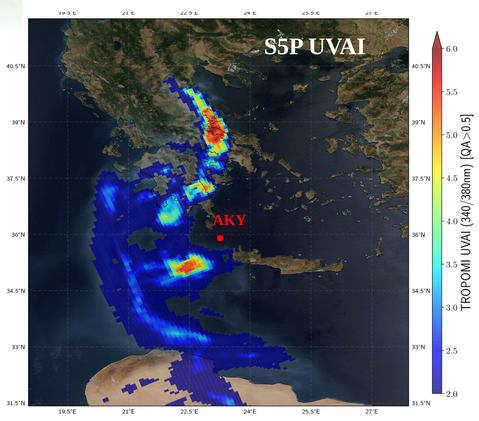
- In the first two weeks of August 2021, Greece has suffered a series of wildfires that have burned a large area (50,000 hectares) of the island of **Evia** and several areas of the **Peloponnese** and **Attica**.
- We use TROPOMI aerosol retrievals for describing the spatial distribution of smoke aerosols emitted during the extreme large-scale wildfires occurring over Greece. The record –breaking Greek fires caused a catastrophic impact on the population health and biodiversity. Massive amounts of smoke were injected into the upper troposphere.
- Also, ground based measurements from Antikythera – PANGEA lidar station are used. The measurements allowed us to follow the vertical profile of fresh smoke aerosol as well to analyze the optical and geometrical properties.
- An image, acquired by one of the Copernicus Sentinel-2 satellites on August 8, shows the ongoing wildfire on the island. According to data from the Copernicus Atmosphere Monitoring Service (CAMS), carbon emissions generated by fires in Greece are the highest in 13 years.

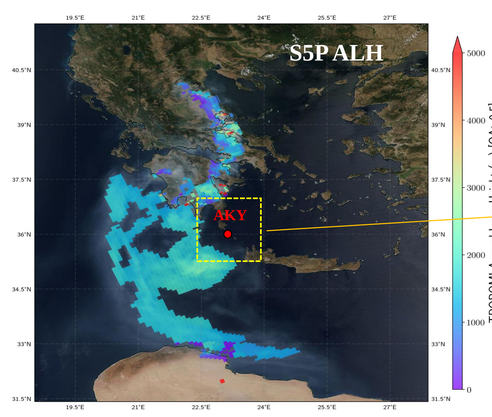


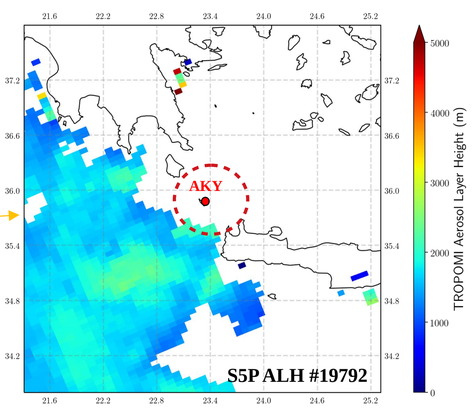


Lidar (PollyXT) detects an elevated thin smoke layer ranging between 2 – 3km









- The temporally closest backscatter profile is used to extract the ALHbsc and compare against the TROPOMI ALH retrievals.
- The average backscatter profile at 1064 nm, for the time period from 09:00 to 11:00 UTC on 08 August 2021 is shown.
- The TROPOMI observations report an averaged layer at **1980m**, while the calculated ALH from the lidar profile places it at **2660m**

Difference (TROPOMI – Lidar ALH) < 1km

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