Extreme Aerosol Loadings from Iberian Peninsula Wildfires

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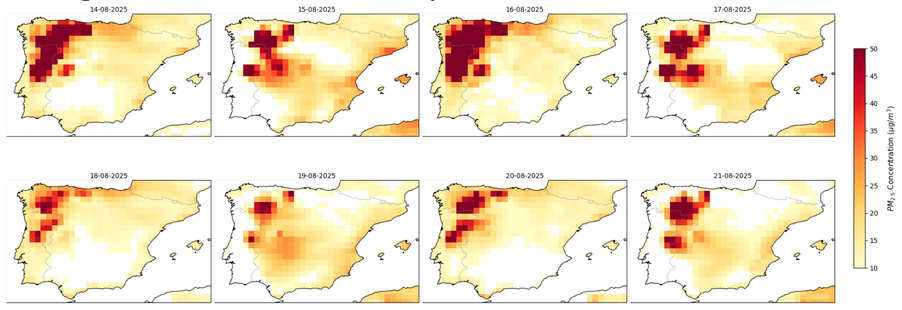
Summer 2025 Iberian Peninsula wildfires

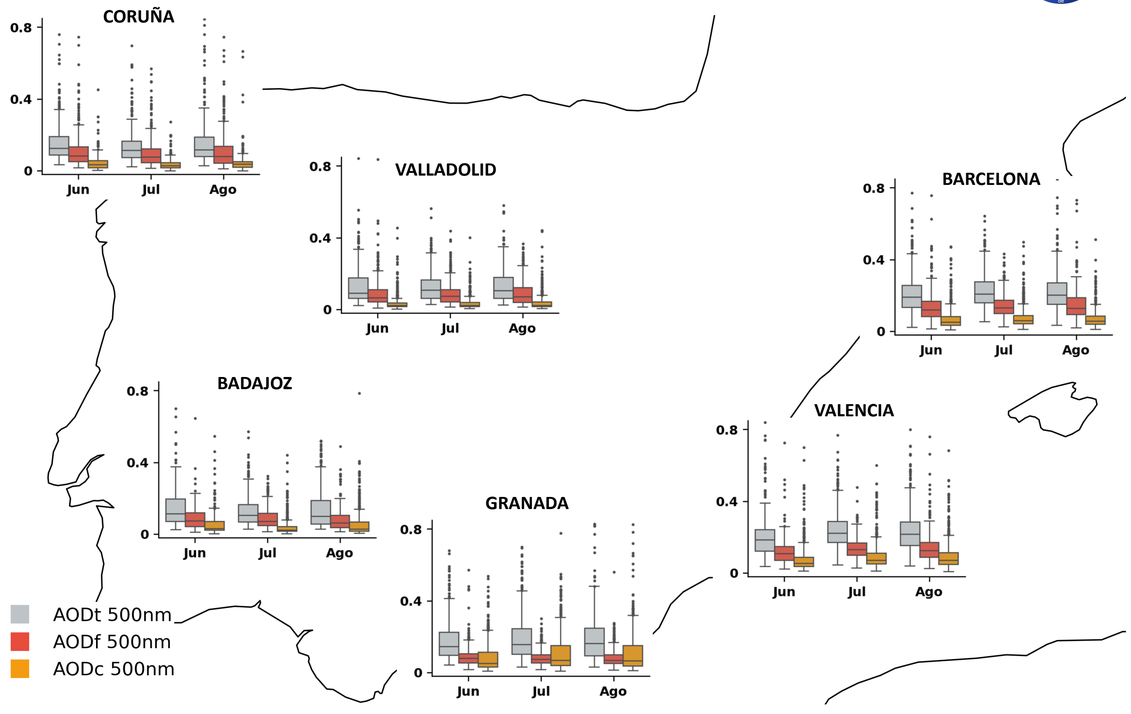
Intense wildfire events in 2025 over the Iberian Peninsula with 141 active fires compared to the monthly average of 38 (2006-2025). resulted in a total of 337,198 hectares burned during this single month.

This is reflected in extreme aerosol optical depth (AOD) values recorded by Cimel CE318-T photometers. Fine mode AOD reached peaks of 1.397 in Valladolid and 1.621 in Badajoz, exceeding the P95 percentile for these stations.

Based on long-term AERONET Level 1.5 records for each station, the summer aerosol load in the northwest (represented by Valladolid and Coruña) is dominated by fine-mode particles, indicating biomass burning influence as a more prevalent source than Saharan dust.

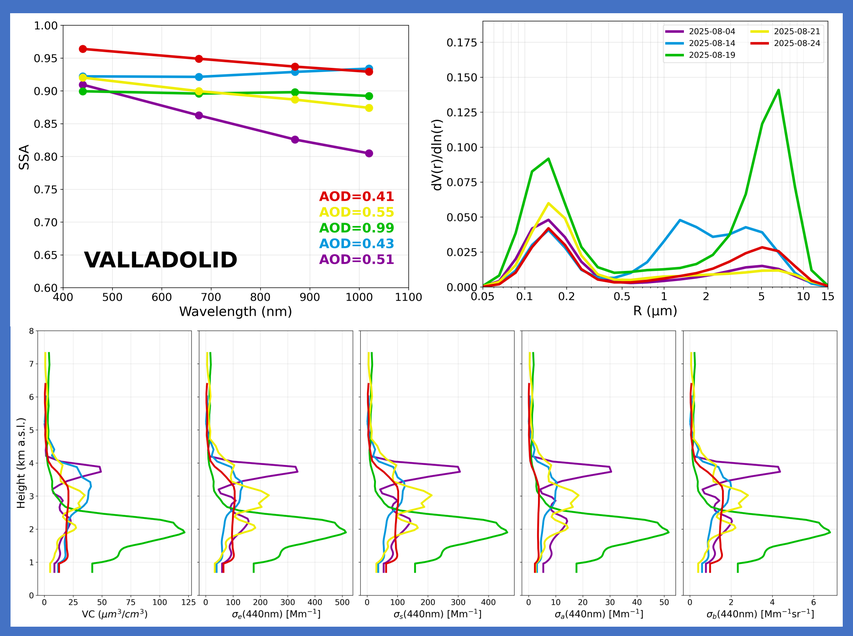
CAMS forecasts show PM2.5 values above WHO air quality guidelines across large areas, highlighting the widespread effects of the fires.

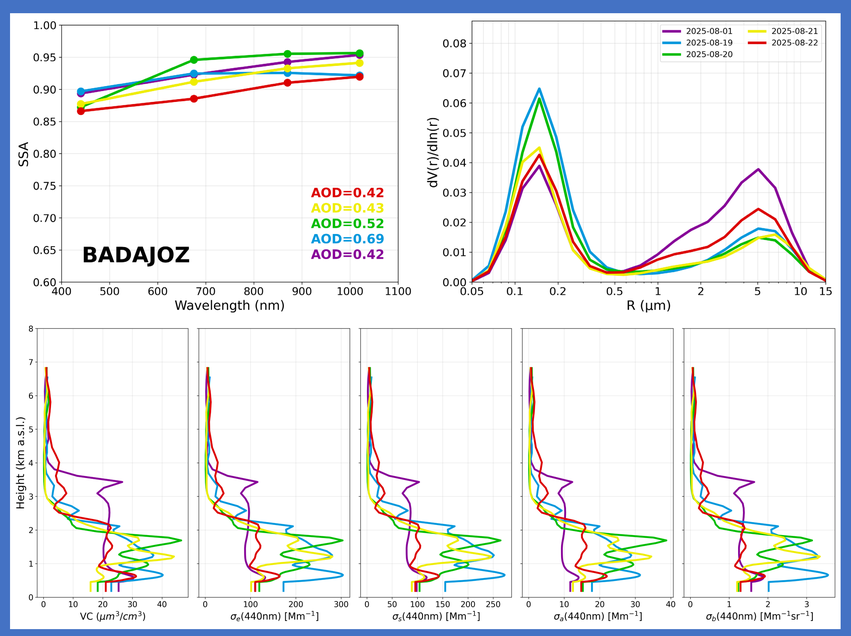


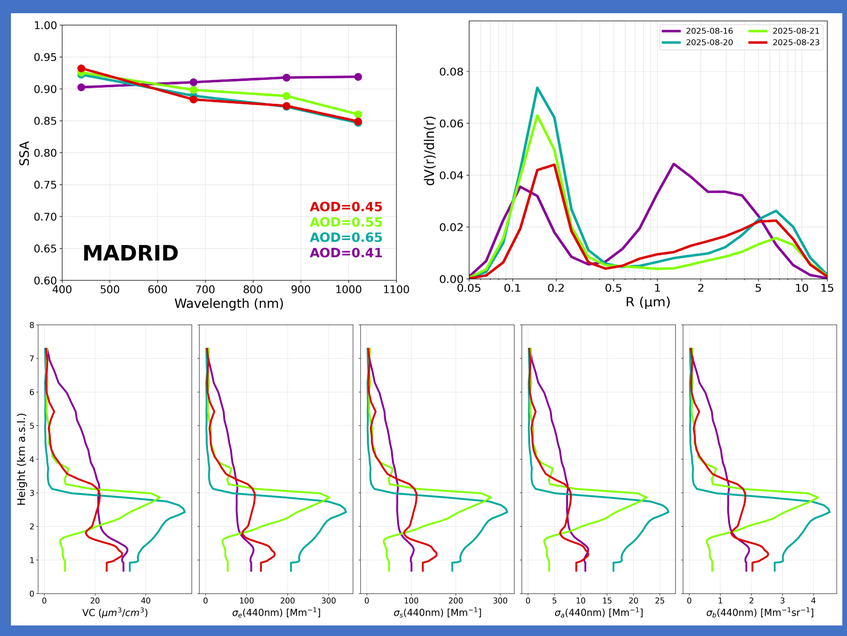


CAECENET: Monitoring for vertical & columnar aerosol properties (*Herrero del Barrio et al., 2024*)

Dayly means AOD>0.4 AE>1

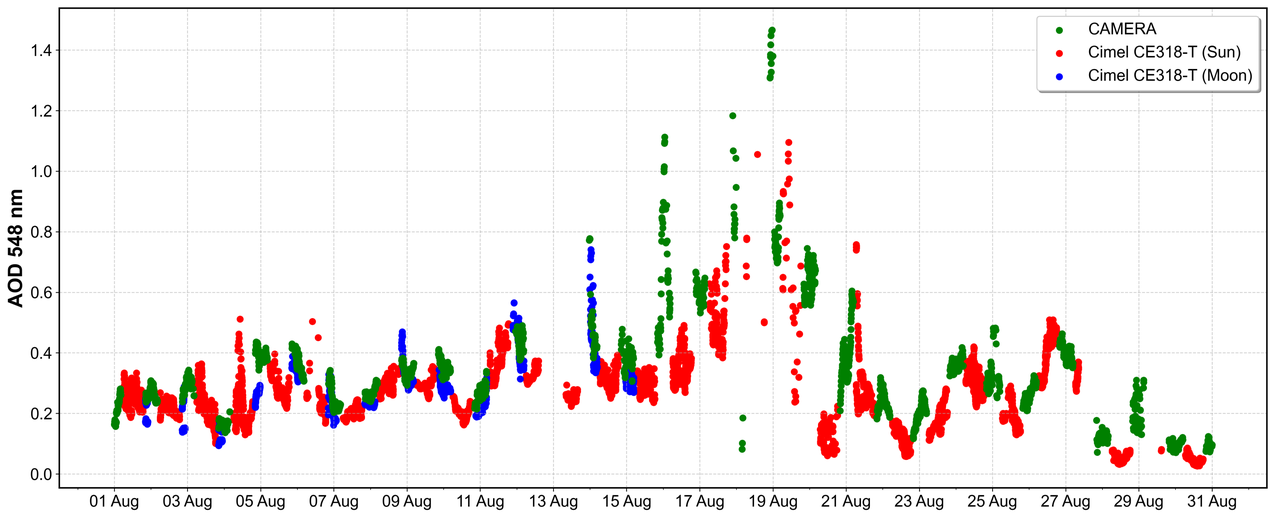






Predominance of fine mode aerosols across all stations. Valladolid has the highest volume concentrations corresponding to highest AOD value.
Inversions with high AOD and fine-mode dominance correlate with elevated absorption coefficients, confirming the presence of light-absorbing aerosols.
Smoke plume heights are similar and relatively low across all three stations, primarily confined to the lower troposphere.
Badajoz suggest potential aerosol mixing.
Maximum AOD in Valladolid (August 19) exhibits a distinct peak in the coarse mode. Caused by large ash particles injected by the nearby high-intensity wildfires.

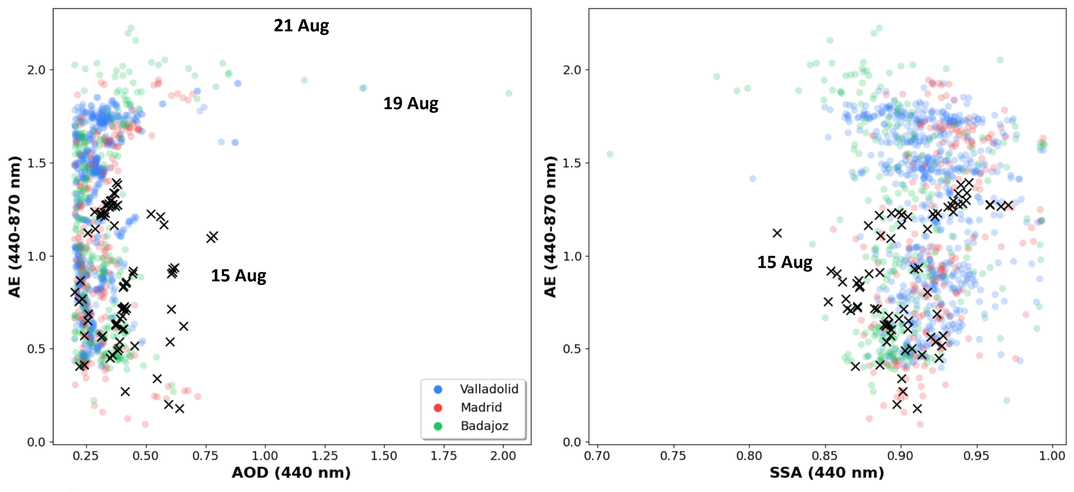
Night-time monitoring at Valladolid



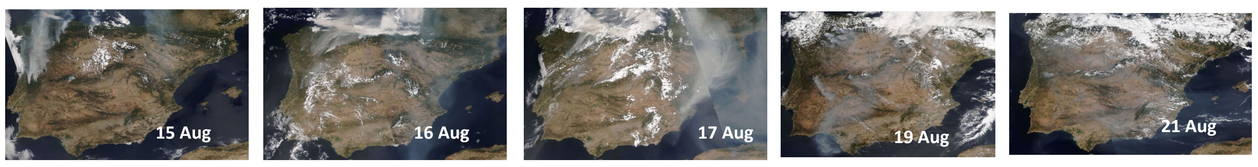
AOD from all-sky camera measurements compared with Sun–Moon photometer

Instrumentation: OMEA-3C-TF by *Alcor System* and *Cimel* CE318-T.
Tri-band filter: reduces the spectral bandwidth of the RGB channels. Multi-exposure raw images every 2 minutes.
Camera's cloud screened and calibrated AOD retrieval at **472, 537.5, 614.4, and 548 nm** (*Román et al.*, 2025). AOD from photometer interpolated to the camera wavelengths. Continuity between daytime and nighttime measurements is ensured despite moon presence.

Optical properties

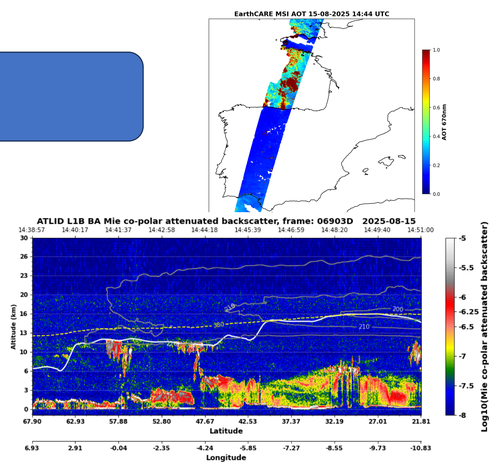


AOD, Ångstrom Exponent (AE), and Single Scattering Albedo (SSA) values for August 2025. High turbidity (AOD>0.25) was observed throughout the month. The highest AOD values are associated with fine-mode particles (AE > 1.5), typical of biomass burning smoke. Also, some days show AE values with high SSA indicate coarse-mode biomass burning particles (ash), consistent with the retrieved inversions.



EarthCare Overpass

The 15 August overpass captured smoke plumes over the Iberian Peninsula and the Bay of Biscay. MSI AOD retrievals were optimized by refining the cloud mask to prevent intense biomass burning plumes from being misclassified as clouds.



Conclusions & Outlooks

Persistently high **AOD** values were recorded due to numerous wildfire outbreaks, particularly in the northwest of the Iberian Peninsula. The extreme intensity of these fires facilitated the transport of **coarse ash particles** at low altitudes, significantly degrading visibility and air quality across the entire region. The strategic distribution of monitoring stations across the Peninsula enables the characterization of particle types and transport heights. Furthermore, **all-sky cameras** prove highly effective for continuous monitoring, providing essential data during nighttime periods.

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