Detection of wildfire emissions in Montevideo that occur hundreds of kilometers away.

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Introduction

Biomass burning events release large quantities of aerosols and chemical species into the atmosphere. Ground-based observations are essential for analyzing these events, as they provide continuous measurements of aerosols, trace gases, and other atmospheric parameters.

Here we show and example of detection of wildfire emissions. On November 24, 2020, the transport of the plume from one of these events was detected over Montevideo, Uruguay, through the analysis of aerosol optical depth (AOD) and Angstrom Exponent (AE). AOD exceeded the monthly mean by more than an order of magnitude. Additionally, high levels of formaldehyde were detected in the atmosphere using a DOAS instrument located next to the AERONET solar photometer.

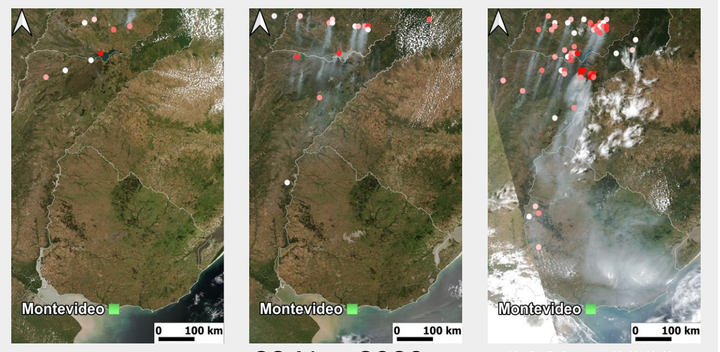
Montevideo FING site

The observation site is located at the Faculty of Engineering in Uruguay. A solar photometer CIMEL CE-318T from AERONET measures atmospheric aerosol properties.

In the same site, Differential optical absorption spectroscopy (DOAS) measurements are performed using dedicated instruments. A thermo-controlled spectrometer, with spectral range 301-463 nm and spectral resolution of ~0.6 nm, acquires diffuse solar radiation at different elevation angles.

Biomass burning in South America

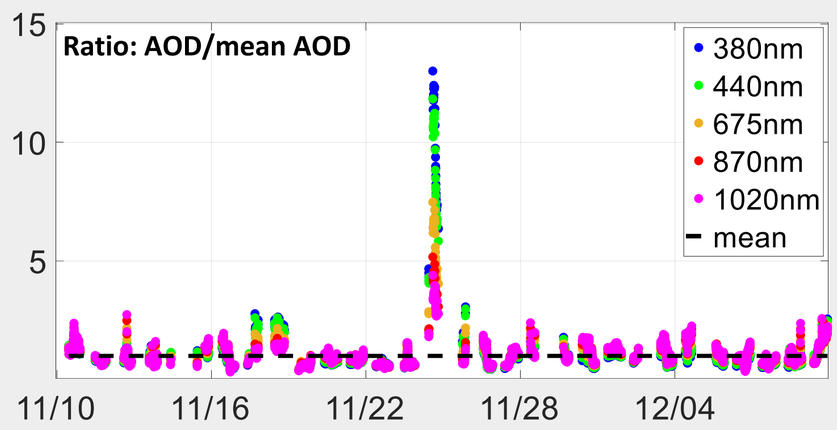
On November 24, 2020, RGB satellite images identified a significant plume transported from the Paraguay-Argentina border through central and eastern Uruguay



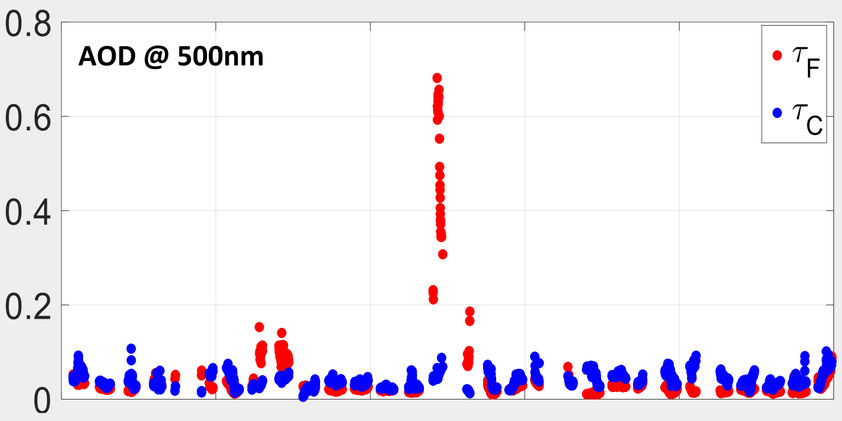
22 Nov 2020 | 23 Nov 2020 | 24 Nov 2020

RGB images and FRP data product from VIIRS/NOAA-20.

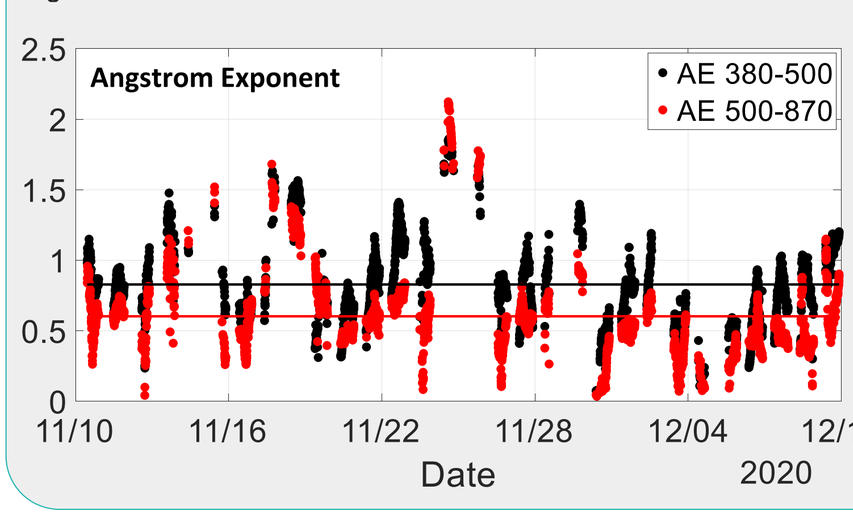
Aerosol Optical properties



AOD values around the event for different spectral bands. The plot shows the ratio of AOD to the mean. On November 24, the AOD values show a significant increase. AOD at 380nm was over 12 times higher at and AOD at 1020nm was more than 3 times.



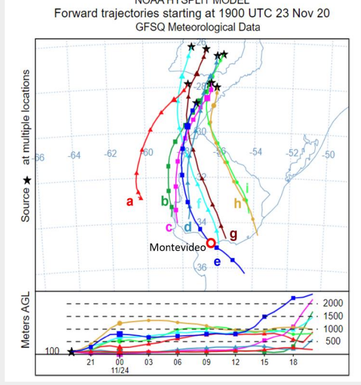
AOD at 500 nm (SDA algorithm) shows a significant increase due to the presence of fine particles (0.46 vs. 0.03) on the day of the event compared to 30-day windows. The AOD from coarse particles remained almost constant (0.06 vs. 0.04).
This observation support the idea that the increase in AOD is due to the presence of fine particles originating from biomass burning.



When comparing Angstrom Exponents, the $AE_{500-870}$ showed greater variation than the $AE_{380-500}$. This suggests that AE at longer wavelengths is a better indicator for smoke from biomass burning, as the increase in AE reflects the dominance of fine particles.

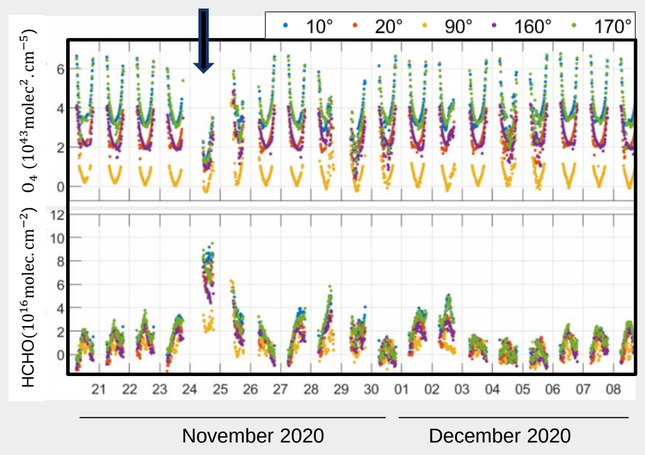
Additional analysis

1. HYSPLIT TRAYECTORIES MODEL



Several trajectories are passing near Montevideo around the time of the measurements near the event.

2. DOAS ANALYSIS



The measured O4 slant column density was affected by the presence of aerosols. There was a simultaneous increase in the slant column density of HCHO compared to the rest of the period.

Conclusions

The analysis indicates that the cause of the observed increase was the passage of a plume emitted by a distant biomass burning event. Through analysis of RGB satellite and verification of the trajectories using the transport model HYSPLIT, a large fire located 800 km north of Montevideo was confirmed. Simultaneously, analysis of solar spectra showed an increase in atmospheric constituents associated with biomass burning like formaldehyde. The AERONET data reveals a significant increase in AOD during the event, with this increase being particularly pronounced in the lower spectral bands. The O'Neill algorithm indicates that this rise is primarily driven by fine particles. Additionally, the Angstrom Exponent, especially in the higher wavelength range, further supports the increase in fine particles on that day.

REFERENCES:
O'Neill, N. T., Eck, T. F., Smirnov, A., Holben, B. N., & Thulasiraman, S. (2003). Spectral discrimination of coarse and fine mode optical depth. *Journal of Geophysical Research: Atmospheres*. https://doi.org/10.1029/2002jd002975
Osorio, M., Agesta, A., Bösch, T., Casaballe, N., Richter, A., Alvarado, L. M. A., & Frins, E. (2024). Measurement report: Combined use of MAX-DOAS and AERONET ground-based measurements in Montevideo, Uruguay, for the detection of distant biomass burning. Atmospheric Chemistry and Physics, 24(12), 7447–7465. https://doi.org/10.5194/acp-24-7447-2024

Acknowledgments