

Aerosol effects on central Amazon evapotranspiration

Marco A. Franco^{a*}, Gustavo F. Teixeira^a, Paulo Artaxo^c, Cléo Q. Dias-Júnior^b, Mariano A. B. da Rocha^b

^a*Institute of Astronomy, Geophysics and Atmospheric Sciences of the University of São Paulo, Rua do Matão, 1226, São Paulo-SP, Brazil*

^b*Institute of Physics of the University of São Paulo, Rua do Matão, 1371, São Paulo - SP, Brazil*

^c*National Institute of Amazonian Research, Av. André Araújo, 2936, Manaus - AM, Brazil*

**Presenting author (marco.franco@usp.br)*

The Amazon rainforest is increasingly affected by climate change, deforestation, ENSO variability, and extreme climatic events, all of which alter evapotranspiration (ET) patterns across the biome [1]. The central Amazon provides a unique setting to assess aerosol–ET interactions, with relatively pristine wet-season conditions and enhanced absorbing aerosol loads during the dry season due to biomass burning and long-range transport from Africa [2, 3]. This study investigates relationships between aerosol microphysical and radiative properties and ET at the Amazon Tall Tower Observatory (ATTO) site from 2016 to 2025. Aerosol properties were obtained from a CIMEL CE318-T AERONET sun photometer, while ET was estimated from latent heat flux measured by a CSAT3B/LI-7200RS eddy-covariance system. The investigation of aerosol effects was conducted by dividing the wet (Feb - May) and dry (Aug - Nov) seasons into periods with higher (75th percentile) and lower (25th percentile) aerosol optical depth (AOD) in 500 nm, hereafter referred to as clean and polluted periods, respectively. The results show that ET is higher during the dry season ($AOD_{dry,avg} \sim 0.29$, $ET_{median} = 3.50$ mm/day) than during the wet season ($AOD_{dry,avg} \sim 0.09$, $ET_{median} = 3.20$ mm/day), indicating a greater relevance of diffuse radiation produced by high aerosol loads in evapotranspiration processes. However, during the dry season, evapotranspiration showed an inverse relationship with AOD, with statistical significance (p -value < 0.01). Higher evapotranspiration rates were observed under cleaner atmospheric conditions ($AOD_{clean} = 0.15$; $ET = 3.58$ mm/day) than under more polluted conditions ($AOD_{polluted} = 0.58$; $ET = 2.94$ mm/day). This represents a $\sim 18\%$ reduction in evapotranspiration under high aerosol loading conditions. During the wet season, significant differences in ET were observed only under a stricter contrast between clean and polluted conditions, with $AOD_{clean} \leq 0.10$ and $AOD_{polluted} > 0.10$. In this case, ET increased from 3.14 mm/day under cleaner conditions to 3.55 mm/day under higher aerosol loading. These results reveal a seasonally dependent aerosol–evapotranspiration relationship in the central Amazon. In the wet season, low aerosol variability and near-pristine conditions limit aerosol impacts on ET. In contrast, during the dry season, biomass-burning aerosols strongly modify the surface radiation balance, reducing direct and diffuse radiation reaching the canopy and constraining photosynthesis, transpiration, and ecosystem-scale ET. Thus, aerosols may act as an additional stressor on Amazonian land–atmosphere coupling during dry periods, although different other processes might contribute to the differences in ET observed. Additional aerosol properties, including scattering albedo, Ångström coefficients, size distribution, asymmetry factors, and radiative forcing, will be discussed in detail in the presentation.

References

- [1] Franco, Marco A., et al. "How climate change and deforestation interact in the transformation of the Amazon rainforest." *Nature Communications* 16.1 (2025): 7944.
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- [3] Machado, Luiz AT, et al. "Hemispheric synoptic patterns control rainfall and long-range aerosol transport in the Amazon." *Geophysical Research Letters* 53.5 (2026): e2025GL117732.

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