Impacts of Forest Types and Rainfall on the Concentration and Diversity of Airborne Fungi in Central Amazonia

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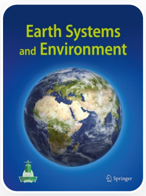

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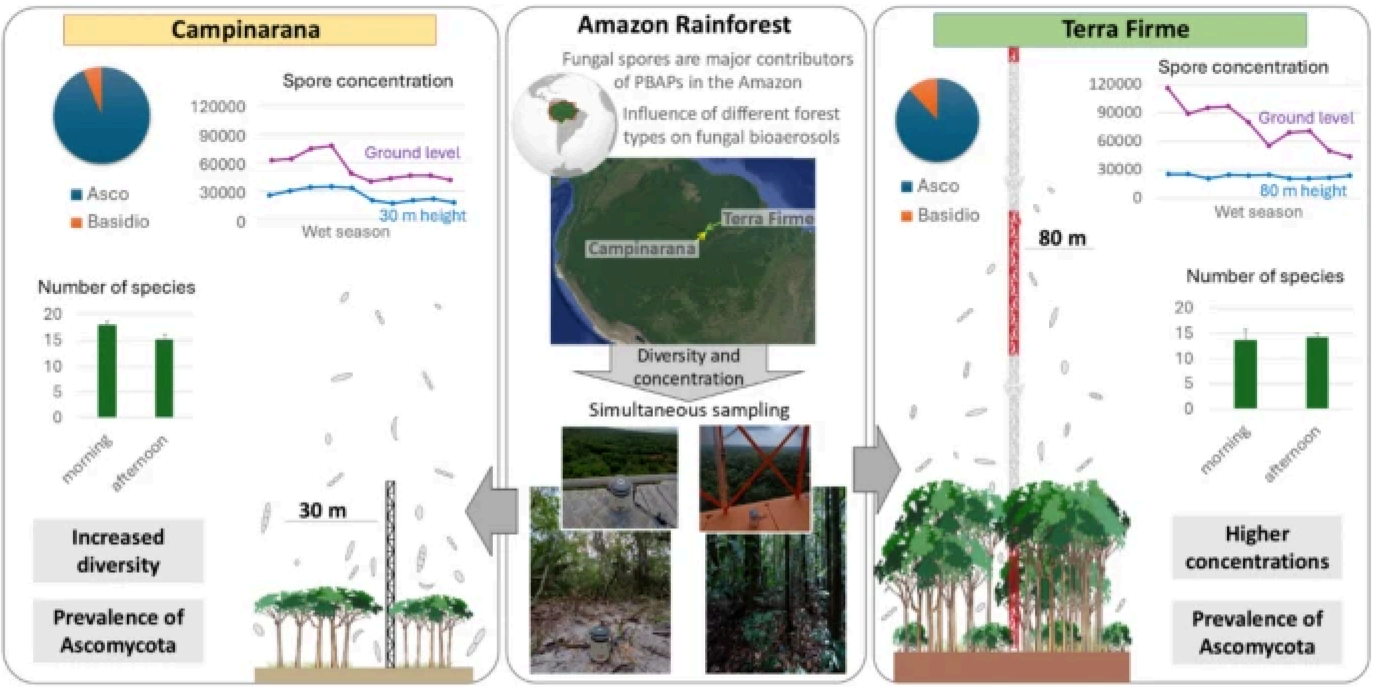
Abstract

Although fungal spores are of major importance to the Amazon Forest and exhibit a direct and indirect role in local and global climate regulation, there is still much unknown about their diversity, ecology and underpinning factors. Here, we show the impacts of two distinct forest types ("Campinarana" and "Terra Firme") on the diversity and concentrations of airborne fungal spores collected within the Amazon Tall Tower Observatory (ATTO) site during the 2024 wet season. A total of 3,176,880 spores were counted and 20 morphotype-species were identified. Whilst "Terra Firme" exhibited a 34% higher spore concentration than "Campinarana", the latter hosted a higher number of species than the former, likely due to higher habitat heterogeneity. Rainfall occurrence strongly affected fungal concentrations at the "Terra Firme" site, whereas at the "Campinarana" site, it had a larger influence on the number of species. Diel time (morning *vs*. afternoon) had no effect on the concentration, number of species and diversity of airborne fungi, however increasing sampling height from the ground reduced all these parameters. Across all sampling conditions, Ascomycota dominated the aerosol composition (90%), and the genus *Cladosporium* sp., which plays a key role in nutrient cycling, ranked in first by comprising *ca.* 40% of all spores collected. Our results underscore the impact of distinct forest types and microenvironmental conditions on airborne fungi, highlighting the role of rainfall and the importance of conserving Amazon's distinct habitats to support climate regulation within and outside the biome.

Graphical Abstract



This graphical abstract depicts the comparative dynamics of airborne fungal spores across two distinct types of forest with the Amazon biome, “Terra Firme” and “Campinarana”. The central panel shows the area of interest, with the relative position between the two sampling areas, and the sampling strategy. The left panel represents the “Campinarana” ecosystem, noted for its sandy, oligotrophic soils, lower canopy height, and sparser vegetation structure. In contrast, the right panel depicts the “Terra Firme” forest, characterised by a dense canopy, clay-dominated soil, higher plant biomass, and significant litter productivity. Over both landscapes, schematic spore icons indicate the presence of primary biological aerosol particles (PBAPs) that play crucial roles in cloud formation, ice nucleation, and overall climate regulation, with the major contribution of *Cladosporium* sp. (*ca.* 40% of the aerosol load) and the predominance of Ascomycota (*ca.* 90% of spores). Key annotations highlight that “Terra Firme” exhibits a 34% higher spore concentration, while “Campinarana” hosts a higher fungal diversity. This integrated visual summary encapsulates how forest type and rainfall interact to shape airborne fungal diversity and abundance, with implications for understanding ecosystem services and climate impacts in the Amazon region.

Highlights

We examined the impacts of rainfall and two distinct forest types on airborne fungi sampled within the Amazon biome.

"Terra Firme" forest exhibited a 34% higher concentration of fungal spores, while "Campinarana" forest hosted a higher diversity of species.

Cladosporium sp. accounted for nearly 40% of the fungal aerosol load, and Ascomycota represented approximately 90% of the spore composition.

Sampling height and rainfall notably impacted airborne spore concentration and diversity at the Central Amazon rainforest.

Our findings highlight the importance of forest conservation for a regulated climate cycle.

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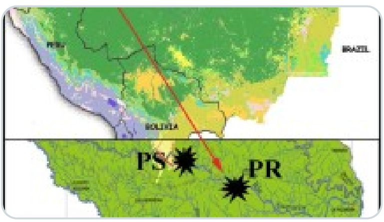

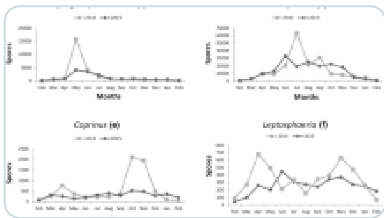

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Data Availability

Data will be made available upon request.

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MCM, ACSRC, DMCS, RIA, FLTG and FR conceived and designed the research; MCM, ACSRC, and DMCS collected fieldwork data; MCM, ACSRC, DMCS, and CGGB performed data analyses; MCM, ACSRC, DMCS, CGGB, MFA, MAFSD, PLSD, RIA, MAC, MAF, JAM, LDM, CQDJ, RHMG, LR, LATM, PA, FC, TŠ-T, BW, CP, FLTG, FR wrote and edited the manuscript; MCM, FLTG and FR led the writing of the manuscript. Critical contribution to drafts and final approval for publication was given by all authors.

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Ethics declarations

Conflict of interests

Authors declare no conflict of interest.

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