

Local Sources, Global Implications: The Unique Behaviors and Drivers of Atmospheric Bioaerosols

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Bioaerosols are airborne particles of biological origin. Recent research has highlighted their significance in cloud formation, emphasizing their relevance to climate change studies. However, tracking bioaerosol variations remains challenging due to their diverse sources and the technical limitations of high-altitude monitoring.

To address these challenges and provide high-resolution analysis of bioaerosol fluctuations in local air environments, our research team launched a comprehensive study in 2023. This ongoing project integrates five key components: 1). Continuous real-time bioaerosol monitoring with meteorological data, 2). Weekly analysis of (micro)biological community using continuous aerosol collection filters, 3). High-altitude aerosol sampling via light aircraft, 4). Multi-level aerosol monitoring and sampling using a 123-meter tower, 5). Sample collection in areas prone to sea of clouds formation (in planning)

Our real-time monitoring revealed intriguing temporal dynamics of aerosol and bioaerosol particles. While total aerosol particle counts (TC) showed no clear diurnal variations, bioaerosol particle counts (BC) exhibited distinct daily fluctuations. These diurnal patterns were observed only from August to October, with no significant daily variations detected from November to March. Comparative analysis across monitoring sites demonstrated that while TC variations were relatively consistent, BC diurnal patterns differed significantly between locations. This spatial heterogeneity in bioaerosol dynamics underscores the complex nature of their distribution and the potential influence of local environmental factors. Analysis of bioaerosol community structure comparisons using high-volume samplers suggest that under typical conditions, bioaerosols primarily originate from the aerosolization of local microorganisms rather than long-range transport.

Further investigation is necessary to elucidate the mechanisms underlying these observed patterns and to explore their implications for atmospheric processes, ecosystem interactions, and potential health impacts. Moreover, continued monitoring across diverse geographical and climatic conditions will be crucial for developing a comprehensive understanding of bioaerosol dynamics on both local and global scales.

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