

INVESTIGATING AEROSOL-CLOUD INTERACTION AND AEROSOL TRANSPORT WITHIN THE COBRA AND ATTOSAT FRAMEWORK

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The transatlantic transport of dust and biomass-burning aerosols from Africa to South America is a persistent, year-round phenomenon that profoundly influences atmospheric chemistry, nutrient cycling, and ecosystem dynamics in the Amazon rainforest. This long-range transport delivers essential macro and micronutrients, particularly phosphorus, which is the most limiting element in Amazonian soils, alongside calcium, potassium, and magnesium—replenishing nutrients lost through intense weathering and leaching. During the wet season, when background atmospheric conditions are exceptionally clean, black carbon (BC) from Africa can dominate the total aerosol mass concentration and exhibits strong diurnal variability, significantly affecting radiative forcing and cloud microphysics. These aerosols also serve as cloud condensation nuclei (CCN), modulating cloud formation, precipitation patterns, and the hydrological cycle across the Amazon Basin. The Amazon Tall Tower Observatory (ATTO), operational since 2012, has provided unprecedented, high-resolution data on the physical, chemical, and biological interactions between the forest and atmosphere, enabling transformative insights into boundary layer dynamics, biogenic emissions, and aerosol–cloud–precipitation feedbacks. To extend ATTO’s scientific reach beyond the local scale, a new initiative is underway to deploy ATTOsat, a CubeSat mission designed to extrapolate key atmospheric processes observed at ATTO to the broader tropical belt. With a low-inclination orbit, ATTOsat will not be limited to the Amazon but will monitor tropical regions globally, including the African rainforest systems and the intense oceanic convection zones of Polynesia, regions that are highly sensitive to El Niño–Southern Oscillation (ENSO) variability. The satellite will carry a hyperspectral, multi-angle polarimeter instrument, conceptually similar to the HARP (Hyper-Angular Rainbow Polarimeter) suite, enabling high-resolution observations of aerosol properties, cloud microphysics, and their interactions across tropical ecosystems. This data will support the development of improved climate models and enhance our understanding of how long-range transport influences regional climate and ecosystem resilience. Complementing this satellite effort, the COBRA (Amazon Region Balloon Operations Center)—a new stratospheric balloon facility located in Palmas, Tocantins State, has been established in collaboration with CNES (French Space Agency). COBRA will host multiple balloon campaigns in the coming years, with the first mission, DEEPCONVECT, scheduled for March 2028. This campaign will launch four zero-pressure balloons to probe the upper troposphere and lower stratosphere. We propose to test the ATTOsat payload on one of these balloon flights to evaluate its capability to measure long-range transport of mineral dust and black carbon, as well as their interactions with clouds and precipitation. This in-situ validation will be critical for ensuring the accuracy and scientific utility of the CubeSat’s observations.