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A new airborne aerosol sampling system: development, validation, and application in vertical measurement of black carbon mixing state

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Vertical measurements of aerosol physical-chemical properties have important significance for better addressing the environment and climate effects of atmospheric aerosol. Traditional in-situ vertical observations of those properties are mainly based on aircraft platforms which are costly and restrictive, and not applicable for near-ground (<500 m) measurements. Within the boundary layer, tethered balloon and unmanned aerial vehicle (UAV) are ideal observation platforms but cannot carry heavy online aerosol instruments due to payload limitations. In this study, a new lightweight airborne aerosol sampling system is developed for tethered balloon and UAV platform. The system can collect airborne aerosol samples at up to 12 heights with conductive bags, and the samples can be analyzed later by online instruments such as aerosol mass spectrometer and single particle soot photometer (SP2). During an intensive field campaign conducted in Lhasa in summer of 2020, the new developed system was applied together with a SP2 to determine the vertical profile of refractory black carbon (rBC) mixing state. Preliminary results show that most rBC containing particles are external mixture and the proportion of internally mixed rBC increases with height. The vertical profiles of rBC mixing state are affected by surface emissions, the development of atmospheric boundary layer and meteorological conditions.