

## Exploring the effects of mineral dust acidification on oxidative potential and limiting nutrient solubility

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Mineral dust aerosol particles are ubiquitous in the atmosphere; they contribute to more than half of the total atmospheric aerosol burden and have far-reaching impacts on biogeochemical cycles, air quality and Earth's radiative budget (Kok et al., 2023). Much of the impact of dust is linked to its mild alkalinity and metal content, which directly influence atmospheric reactivity. However, metals and other trace nutrients (TN), such as phosphorous, are largely insoluble in freshly emitted dust and exhibit limited bioavailability for ecosystems upon deposition. The same metals can induce considerable oxidative stress upon inhalation, but mostly if in soluble form (Fang et al., 2017). Previous studies have found that atmospheric processing and, in particular, acidification of dust (occurring via condensation of sulfate, nitrate and organic acids) can substantially increase TN solubility (Baker et al., 2021), increasing the adverse health effects of population exposure to dust (Fang et al., 2017). Atmospheric processing also influences dust hygroscopicity and cloud forming ability, directly affecting Earth's radiative budget and deposition patterns (Tang et al., 2016).

Previous experiments investigating the effect of atmospheric processing on mineral dust properties were mainly conducted in bulk materials/samples. The dissolution kinetics of metals and TN remains poorly constrained under real atmospheric conditions. To address this issue, we have developed an atmospheric simulation chamber facility where mineral dust particles from a wide range of soils can be generated and be aged by any mechanisms relevant for the atmosphere (e.g., acidification through photooxidation and/or nocturnal chemistry). Dust particles are generated from different soil samples using a soft saltation system and introduced inside an 8 m<sup>3</sup> Teflon chamber. Blacklights around the chamber can be used to irradiate the inside with UV light and simulate daytime photochemical processes in the atmosphere. Gas-phase species and aerosols can be injected from external sources or produced inside the chamber by direct photolysis or oxidation of precursor gases. Figure 1 shows an example of an experimental sequence with mineral dust being introduced inside the chamber and aged using nitrous acid and ozone to produce nitric acid. The particle size distribution inside the chamber is monitored in real-time using a

combination of different sizing instruments (i.e., a scanning mobility particle sizer, two optical particle counters and an aerodynamic aerosol classifier). The concentration of precursor gases is measured with gas monitors and a proton-transfer reaction mass spectrometer. Dust samples before and after aging are also collected for further analysis.

With this contribution, we will present a detailed characterization of the chamber facility and an initial exploration of the effects of acidification on mineral dust properties. Specifically, we will show how different aerosol pH levels impact the solubility of TN and the oxidative potential (measured with a DTT assay) of mineral dust particles under real atmospheric conditions.

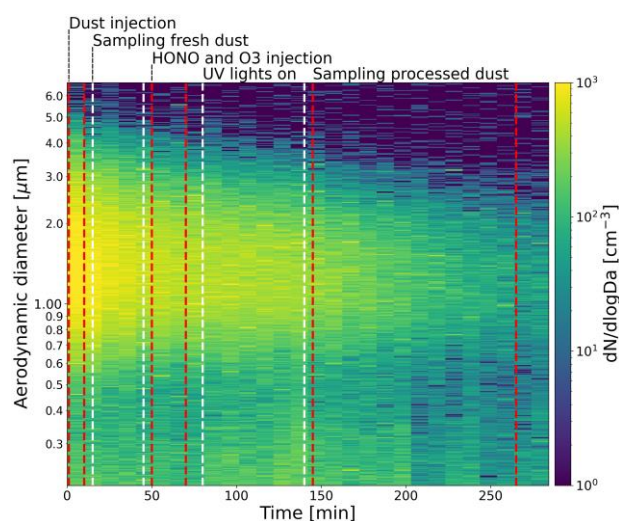


Figure 1. A typical chamber experiment illustrating the evolution of mineral dust size distribution and the various experimental phases. Dust is injected in the chamber, and after 30-60min, the size distribution shape and concentration become atmospherically relevant ( $\sim 100\text{-}250 \mu\text{g m}^{-3}$ ). Aging then commences and samples are collected after some time.

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