
The use of inorganic nitrogen by bacteria in the atmospheric system

Frédéric Mathonat*¹, François Enault², Muriel Joly¹, Mariline Théveniot¹, Raphaëlle Péguilhan¹, Jean-Luc Baray³, Guillaume Voyard¹, Ervens Barbara¹, and Pierre Amato¹

¹Institut de Chimie de Clermont-Ferrand – Institut de Chimie - CNRS Chimie, Centre National de la Recherche Scientifique, Université Clermont Auvergne, Institut national polytechnique Clermont Auvergne – France

²Laboratoire Microorganismes : Génome et Environnement – Centre National de la Recherche Scientifique, Université Clermont Auvergne – France

³Laboratoire de Météorologie Physique – Institut National des Sciences de l'Univers, Centre National de la Recherche Scientifique, Université Clermont Auvergne – France

Résumé

The atmosphere carries diverse living and metabolically active microorganisms (Amato et al., 2023). Alike in other environments, their nutritive requirements include the uptake of C, N, P and other elements from dissolved or gaseous inorganic and organic compounds, with potential impacts on biogeochemical cycles. However, such interactions are still very poorly studied in the atmospheric environment.

Numerous bioavailable chemical compounds potentially used as nutrients by microbial cells occur in the air and atmospheric waters (clouds, precipitation). So far, the investigations focused in particular on the uptake of organic carbon by microorganisms in clouds and the related biogeochemical impacts (Ervens and Amato, 2020).

One of the other elements essential to the biosphere and present in large quantities in the atmosphere is nitrogen in its various inorganic forms, including, for example, dinitrogen (N₂), which accounts for 78% of the composition of air, but also ammonium (NH₄⁺), nitrate (NO₃⁻), ammonia (NH₃), nitrite (NO₂⁻) and nitrogen oxides (NO_x), which can be found both in the gas phase and in the aqueous phase of the atmosphere (cloud) originating from anthropogenic or natural activities.

The interactions between living organisms and the various sources of nitrogen for microorganisms in the atmospheric system have not been characterized yet. Here we could quantify ammonium biodegradation rates in precipitation (2.34x10⁻⁷ to 2.30x10⁻¹⁰ μmol/L/h-1) and associate these with structural and functional biodiversity analyses (taxonomy based on ribosomes and quantification of *amoA* genes) collected at Theix near Clermont-Ferrand using an automated pluviometer. Additionally, the reanalysis of atmospheric metagenomes and metatranscriptomes from the free atmosphere and clouds for key inorganic nitrogen processing genes indicate many active nitrogen-uptake related functions in bacteria. These vary with atmospheric conditions (air/cloud), which demonstrates some level of functional organization and determinism in the heterogeneity of the aeromicrobiome. This study provides

*Intervenant

new information regarding the ecology of microorganisms in the atmospheric system and their relation to essential chemical elements of the biosphere.

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