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First evidence of bio-degradation of organic substances in natural clouds from puy de Dôme

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Clouds are one of the most important entities controlling the atmospheric chemical cycles as many reactions involving key atmospheric species are much faster in the liquid phase as respect to the gas phase. The role of clouds in atmospheric chemistry has been recognized by several important papers in the past. However, so far, the role of biological processes has never been investigated despite the fact that biodegradation of important organic species is clearly identified and significant in other environment like lakes or rivers.

Atmospheric water represents, in some respects, an extreme environment characterized by low temperatures, relatively low pH and complex mixtures of organic and inorganic compounds. However, bacteria, fungi, yeast and protozoa can survive in such media and therefore can be metabolically active. In this context, micro-organisms can be considered as biocatalysts able to transform organic and inorganic compounds in cloud water.

In this study, about 100 bacterial strains were isolated in atmospheric water samples from clouds at the puy de Dôme (alt 1465 m, Massif Central, France) and their metabolic potential was investigated. We have also shown, using in situ 1H Nuclear Magnetic Resonance, that most of the isolated bacteria were able to degrade various organic substrates such as formate, acetate, lactate and succinate which represent the major organic acids present in cloud water. This is a very important information since these processes are competing with chemical and photochemical reaction mechanisms

but have never been considered in the past.

These results were obtained under laboratory experiments with pure strains and pure compounds, at 17˚C and 27˚C (Amato et al. Atmosph. Environ. 2005, 39, 4143-4153). Some strains were shown to be psychrophilic and our first results show that they remain active on these organic compounds at 5˚C. In the future, experimental conditions will be modified to be closer and closer to cloud water content. Kinetic constants of biodegradation will be integrated in an atmopheric chemistry model and will be compared to constants issued from chemical and photochemical reactions to evaluate the effective role of bacteria in cloud chemistry.