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Effect of endogenous microbiota on the molecular composition of cloud water: a study by Fourier-transform ion cyclotron resonance mass spectrometry (FT-ICR MS)

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Cloud droplets contain dynamic and complex pools of highly heterogeneous organic matter, resulting from the dissolution of both water soluble organic carbon in atmospheric aerosol particles and gas-phase soluble species, and are constantly impacted by chemical, photochemical and biological transformations. Recently, the presence of microorganisms, as bacteria, fungi and yeasts, was highlighted in clouds: they are alive and metabolically active [1]. In this work, we report the results of molecular characterisation of a cloud water sample collected at the puy de Dôme observatory, incubated with endogenous microbiota at two different temperatures (5 and 15°C). Microbial metabolism is able to transform the dissolved organic matter and it changes the molecular composition of cloud water, as evidenced by Fourier-transform ion cyclotron resonance mass spectrometry (FT-ICR MS).
Microorganisms were metabolically active and strongly modified the dissolved organic matter since they were able to form and consume many compounds. At 15°C, microorganisms were able to consume 58% of the compounds initially present and produce 266 new compounds. For this cloud sample, the impact of dark chemistry was negligible. Decreasing the temperature to 5°C led to the more efficient degradation of organic compounds (1716 compounds vs 1094 at 15°C) but with the less important production of new ones (173). The influence of endogenous microbiota was evaluated on oxygen to carbon and hydrogen to carbon ratios and other parameters. Using Venn diagrams, four fractions of compounds were identified: (1) compounds consumed by microbial activity; (2) compounds not transformed during incubation; (3) compounds resulting from dark chemistry (i.e. hydrolysis and Fenton reactions) and, finally, (4) compounds resulting from microbial metabolic activity.
These transformations were analysed using a division into classes based on the O/C and H/C ratios: lipid-like compounds, aliphatic/peptide-like compounds, carboxylic-rich alicyclic molecule (CRAM)-like structures, carbohydrate-like compounds, unsaturated hydrocarbons, aromatic structures and highly oxygenated compounds (HOCs) [2]. Lipid-like and aliphatic/peptide-like compounds were the most impacted since they were consumed to maintain the microbial metabolism. On the contrary, the relative percentages of CRAMs and carbohydrates increased after incubation.
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References

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