Metals in Arctic Snow and frost flowers: Impacts on ice melting-nucleation processes

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The role of Arctic in influencing global energy and moisture budgets is becoming more pronounced as the notion of pristine Arctic environment is fading away with long-range transport of pollutants and anthropogenic industrial activities in Arctic. Our goal was to explore the potential interactions between metal and metal-interacting bacteria with freezing processes in five different Arctic snow and frost flowers using techniques such as triple quad ICP-MS/MS, HR-TEM/EDS, and next generation sequencing (NGS).

Each Arctic snowpack types and frost flowers showed: i) varied distinct heavy metal content. 27 metals: (transition metals, metalloids, alkali metal/earth metal, actinides, & lanthanides) were detected with the highest concentrated elements as Iron, Mercury, and Strontium; 8 rare elements (0.002 – 1.8 μg/L). The highest and least variations were observed in fresh snow and frost flower respectively; yet both had high concentration of ^{238}U. ii) a diverse community of bacteria capable of interacting with heavy metals (resistance/tolerance): blowing snow (1239), surface hoar snow (2243), windpack (2431), frost flowers (1440), and Montreal urban snow (5498) with specific bacterial genera such as: Azospirillum (surface hoar snow), Paenibacillus (blowing snow), and Cycloclasticus, (frost flower); bacteria with confirmed or associated ice nucleation activity: Pseudomonas genera, Flavobacterium, Corynebacterium, and Pseudoxanthomonas. iv) distinct ice nucleation temperature that was partly associated with its microbial population; type and concentrations of its nano size metals. Interestingly the highest ice nucleation activity was recorded for Arctic fresh snow (-9.5 ± 1°C). This study provides a base line for future studies.