http://dx.doi.org/10.4172/2157-7617.C1.027

Biological ice-nucleating macromolecules in the atmosphere

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The freezing of liquid water at temperatures below 273.15 K is thermodynamically favorable, but kinetically impeded. Freezing at temperatures higher than around 235 K only occurs when catalytic impurities that support the proper arrangement of water molecules are present. ese so-called ice nucleators can be of various origins, ranging from silicate crystals to soot particles to biological macromolecules. In the atmosphere, these particles massively contribute to cloud glaciation, and therefore in uence albedo and precipitation. Some organisms among bacteria, fungi, animals, and plants are capable of producing biological ice-nucleating macromolecules (bioINMs), which are proteins or saccharides. Individual bioINMs are much smaller than other ice nucleators (down to a few nanometers), and can catalyze freezing at far higher temperatures (up to the thermodynamic freezing point). As most bioINMs are easily extracted from their host cell when in contact with water, they can distribute in soil, water, and air independently, respectively attached on other particles. Since it was believed for a long time that only insoluble micro-sized particles have the potential to nucleate ice, these bioINMs have been widely ignored, and have not been adequately taken into account in atmospheric model calculations. is becomes more urgent, since the anthropogenic in uence on landscapes, water bodies, and the atmosphere also in uence the formation and distribution of bioINMs.

Biography

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