Ice Nucleating Particles in the Atmosphere: An Overview

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Abstract

Cloud radiative and microphysical properties are changed by the formation of ice particles in tropospheric clouds. Inside the troposphere, ice nucleates through homogeneous freezing at temperatures below - 38℃ with relative humidity above 140% in regards to ice. In the absence of such ideal conditions, ice nucleation can occur through heterogeneous nucleation triggered by aerosols particles known as ice-nucleating particles (INPs) nucleating ice at a temperature higher than homogeneous ice nucleation. This study overviews the recent advancements in understanding heterogeneous ice nucleation with special reference to ice-nucleating particles (INPs). New improvements in distinguishing the heterogeneous freezing systems, air pertinence, vulnerabilities, and questions about INPs are portrayed in this review. Key aspects covered include the diverse mechanisms of heterogeneous ice nucleation, factors influencing this phenomenon, and the various sources of atmospheric INPs such as dust, sea sprays, volcanic ash, and bioaerosols. Additionally, recent research on INP measurement techniques, with a special emphasis on immersion freezing, is highlighted. This review also discusses the implications of INPs on climate change and cloud formation, emphasizing their crucial role in influencing precipitation patterns and overall atmospheric dynamics. Furthermore, it delves into the potential applications of INPs in various fields such as agriculture, medicine, and materials science. The study underscores the significance of bridging the gaps in our understanding of INPs and emphasizes the necessity for further investigations into the particle properties facilitating ice nucleation.

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