EGU21-5914, updated on 05 Dec 2022
https://doi.org/10.5194/egusphere-egu21-5914
EGU General Assembly 2021

The ice nucleating ability of macromolecules in immersion freezing decreases in the presence of salts: Implications for freezing point depression calculations

Jon F. Went[1], Jeanette D. Wheeler[2], François J. Peaudecerf[2], and Nadine Borduas-Dedekind[1,3]
[1]ETH Zürich, Environmental Systems Science, Switzerland (jwent@ethz.ch)
[2]ETH Zürich, Institute of Environmental Engineering, Switzerland
[3]University of British Columbia, Department of Chemistry, Canada

Cloud formation represents a large uncertainty in current climate predictions. In particular, ice in mixed-phase clouds requires the presence of ice nucleating particles (INPs) or ice nucleating macromolecules (INMs). An influential population of INPs has been proposed to be organic sea spray aerosols in otherwise pristine ocean air. However, the interactions between INMs present in sea water and their freezing behavior under atmospheric immersion freezing conditions warrants further research to constrain the role of sea spray aerosols on cloud formation. Indeed, salt is known to lower the freezing temperature of water, through a process called freezing point depression (FPD). Yet, current FPD corrections are solely based on the salt content and assume that the INMs' ice nucleation abilities are identical with and without salt. Thus, we measured the effect of salt content on the ice nucleating ability of INMs, known to be associated with marine phytoplankton, in immersion freezing experiments in the Freezing Ice Nuclei Counter (FINC) (Miller et al., AMTD, 2020). We measured eight INMs, namely taurine, isethionate, xylose, mannitol, dextran, laminarin, and xanthan as INMs in pure water at temperatures relevant for mixed-phase clouds (e.g. 50% activated fraction at temperatures above –23 °C at 10 mM concentration). Subsequently, INMs were analyzed in artificial sea water containing 36 g salt L^{-1}. Most INMs, except laminarin and xanthan, showed a loss of ice activity in artificial sea water compared to pure water, even after FPD correction. Based on our results, we hypothesize sea salt has an inhibitory effect on the ice activity of INMs. This effect influences our understanding of how INMs nucleate ice as well as challenges our use of FPD correction and subsequent extrapolation to ice activity under mixed-phase cloud conditions.