Geophysical Research Abstracts
Vol. 19, EGU2017-18583, 2017
EGU General Assembly 2017

Deposition ice nucleation on black carbon aerosols predicted using FHH adsorption parameters

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Deposition ice nucleation (DIN) occurs when water vapor is nucleated directly to ice on insoluble aerosol particles at low temperatures. The traditional way to represent DIN theoretically is using the classical heterogeneous nucleation theory (CHNT), which describes the interaction between the ice nucleus and the underlying aerosol surface using a single parameter, the contact angle. Unfortunately, CHNT is not able to correctly predict the critical supersaturations at which DIN is initiated when reasonable contact angle values corresponding to measurements are used (the situation is similar with heterogeneous liquid drop nucleation, where critical supersaturations are drastically over-predicted if measured contact angles are used). Therefore, if CHNT is used e.g. in a climate model, one needs to apply contact angle values that are adjusted so that the theory matches laboratory measurements of DIN. In a recent theoretical development, we have postulated that adsorption and nucleation of water vapor on hydrophobic surfaces can be described within a unified framework, and that experimental adsorption FHH (Frenkel-Halsey-Hill) parameters can be used to predict the critical supersaturation at which nucleation of water vapor occurs on a given surface. Remarkably, the new theory does not need any adjustable parameters. In this presentation, the new theory is applied to both liquid drop nucleation and DIN occurring on black carbon aerosols, and it is shown that in both cases, the predictions correspond well to experimental results.