Geophysical Research Abstracts
Vol. 16, EGU2014-6267, 2014
EGU General Assembly 2014

On the usage of classical nucleation theory in predicting the impact of bacteria on weather and climate

Maher Sahyoun (1,2), Niels Woetmann Nielsen (1), Jens Havskov Sørensen (1), Kai Finster (2), Ulrich Bay Gosewinkel Karlson (3), Tina Šantl-Temkiv (4), and Ulrik Smith Korsholm (1)

(1) Department of Research and Development, Danish Meteorological Institute, Copenhagen, Denmark. (msa@dmi.dk), (2) Department of Bioscience, Aarhus University, Aarhus, Denmark. , (3) Department of Environmental Science, Aarhus University, Roskilde, Denmark, (4) Department of Physics and Astronomy, Aarhus University, Aarhus, Denmark

Bacteria, e.g. Pseudomonas syringae, have previously been found efficient in nucleating ice heterogeneously at temperatures close to -2°C in laboratory tests. Therefore, ice nucleation active (INA) bacteria may be involved in the formation of precipitation in mixed phase clouds, and could potentially influence weather and climate. Investigations into the impact of INA bacteria on climate have shown that emissions were too low to significantly impact the climate (Hoose et al., 2010).
The goal of this study is to clarify the reason for finding the marginal impact on climate when INA bacteria were considered, by investigating the usability of ice nucleation rate parameterization based on classical nucleation theory (CNT).
For this purpose, two parameterizations of heterogeneous ice nucleation were compared. Both parameterizations were implemented and tested in a 1-d version of the operational weather model (HIRLAM) (Lynch et al., 2000; Unden et al., 2002) in two different meteorological cases. The first parameterization is based on CNT and denoted CH08 (Chen et al., 2008). This parameterization is a function of temperature and the size of the IN. The second parameterization, denoted HAR13, was derived from nucleation measurements of SnomaxTM (Hartmann et al., 2013). It is a function of temperature and the number of protein complexes on the outer membranes of the cell. The fraction of cloud droplets containing each type of IN as percentage in the cloud droplets population were used and the sensitivity of cloud ice production in each parameterization was compared.
In this study, HAR13 produces more cloud ice and precipitation than CH08 when the bacteria fraction increases. In CH08, the increase of the bacteria fraction leads to decreasing the cloud ice mixing ratio. The ice production using HAR13 was found to be more sensitive to the change of the bacterial fraction than CH08 which did not show a similar sensitivity. As a result, this may explain the marginal impact of IN bacteria in climate models when CH08 was used. The number of cell fragments containing proteins appears to be a more important parameter to consider than the size of the cell when parameterizing the heterogeneous freezing of bacteria.