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Modeling of mineral composition effects on ice nucleation due to dust in Dust Regional Atmospheric Model (DREAM)

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Mineral dust comprises a significant part of global aerosol burden. There is a large uncertainty in estimating role of dust in the Earth's climate system, partly due to its effects on radiation and cloud formation. Research showed that mineral dust was found in the samples of residual particles from cloud ice crystals collected by aircraft measurements. These results indicated that dust particles dominate over other known ice nuclei such as soot and biological particles even in regions distant from desert sources. Most recently, due to recognition of the dominant role of dust as ice nuclei, parameterizations for immersion and deposition icing specifically due to dust have been developed. The icing process is strongly influenced by dust mineral composition. A breakthrough in understanding the role of different minerals was made by Atkinson et al. [Nature, 498, 355–358 (2013)], showing that feldspars are at least by an order of magnitude more efficient nucleating catalysts than other dust minerals. This contrasts with the prevailing view that clay minerals are the most important component of atmospheric mineral dust for ice nucleation. The calculation of the number of ice nuclei in the operational DREAM model is based on atmospheric parameters and on dust concentration. The immersion and deposition ice nucleation parameterizations due to dust have been implemented in the model not taking into consideration the mineral composition of dust.
In this study, we use DREAM model with incorporated particle mineral composition to calculate ice nuclei number concentrations. Our study is focused to explore if the Atkinson's parameterization could further improve ice nucleation representation in the model. We compare the model results with relevant observations from remote sensing instruments. Synergistic sun-photometer and lidar measurements and cloud radar observations are used to explore the model capability to represent vertical features of the cloud and aerosol vertical profiles. In addition, MSG/SEVIRI ice water path satellite observations (Meteosat Second Generation the Spinning Enhanced Visible and InfraRed Imager) will be used to evaluate horizontal distribution of modeled IN.
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