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Parameterization of cloud glaciation by atmospheric dust

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The exponential growth of research interest on ice nucleation (IN) is motivated, inter alias, by needs to improve generally unsatisfactory representation of cold cloud formation in atmospheric models, and therefore to increase the accuracy of weather and climate predictions, including better forecasting of precipitation. Research shows that mineral dust significantly contributes to cloud ice nucleation. Samples of residual particles in cloud ice crystals collected by aircraft measurements performed in the upper tropopause of regions distant from desert sources indicate that dust particles dominate over other known ice nuclei such as soot and biological particles. In the nucleation process, dust chemical aging had minor effects. The observational evidence on IN processes has substantially improved over the last decade and clearly shows that there is a significant correlation between IN concentrations and the concentrations of coarser aerosol at a given temperature and moisture.

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. Based on these achievements, we have developed a real-time forecasting coupled atmosphere-dust modelling system capable to operationally predict occurrence of cold clouds generated by dust. We have been thoroughly validated model simulations against available remote sensing observations. We have used the CNR-IMAA Potenza lidar and cloud radar observations to explore the model capability to represent vertical features of the cloud and aerosol vertical profiles. We also utilized the MSG-SEVIRI and MODIS satellite data to examine the accuracy of the simulated horizontal distribution of cold clouds. Based on the obtained encouraging verification scores, operational experimental prediction of ice clouds nucleated by dust has been introduced in the Serbian Hydrometeorological Service as a public available product.