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Impact of particle composition on ice formation and cloud radiative effect

Sara Bacer (1), Andrea Pozzer (1), Vlassis Karydis (1), Alexandra Tsimpidi (1), Holger Tost (2), Sylvia Sullivan (3), Donifan Barahona (4), Athanasios Nenes (3,5,6), Jos Lelieveld (1,7)

(1) Max Planck Institute for Chemistry, Mainz, Germany (sara.bacer@mpic.de), (2) Johannes Gutenberg University Mainz, Mainz, Germany, (3) Georgia Institute of Technology, Atlanta, USA, (4) NASA Goddard Space Flight Center, Greenbelt, USA, (5) Foundation for Research and Technology, Hellas, Greece, (6) National Observatory of Athens, Athens, Greece, (7) The Cyprus Institute, Nicosia, Cyprus

Clouds play a fundamental role in the atmosphere by influencing the global radiative energy budget, and their representation in numerical models is one of the main sources of uncertainties in climate predictions. In particular, the ice crystal formation process is very challenging, as multiple mechanisms occur for the ice nucleation depending on aerosol characteristics and environmental conditions. We have implemented the ice crystal formation parameterization of Barahona and Nenes (2009) into the ECHAM5/MESSy Atmospheric Chemistry (EMAC) general circulation model in order to improve the representation of ice and mixed-phase clouds. The parameterization considers the contribution from various precursor aerosols acting as ice nucleating particles and accounts for the competition between homogeneous and heterogeneous nucleation and the presence of pre-existing ice crystals. Here, we show that the use of this parameterization improves the representation of the ice crystal number concentrations with respect to the standard EMAC configuration. Through sensitivity tests performed by applying the newly implemented parameterization, we investigate the influence of mineral dust, black carbon, and particulate organic matter on ice crystal production and cloud radiative effects.