

A new description of heterogeneous freezing within the NASA GEOS-5 modelDonifan Barahona[†];[†] NASA GSFC and I.M. Systems Inc., USALeading author: donifan.o.barahona@nasa.gov

This work presents the development and implementation of a new formulation of heterogeneous ice nucleation within the NASA Global Earth Observing System Model version 5 (GEOS-5). It is shown that by defining the appropriate nucleation coefficient, the ice nucleation spectrum (hence the aerosol freezing fraction) and the aerosol surface area distribution are simply related by Laplace transformation. The heterogeneous freezing fraction of dust, soot, organics and biological material are described in this manner for the immersion, deposition, and deliquescence-freezing modes. Effects of the aerosol size, contact angle and soluble coatings on the aerosol freezing fraction are accounted for. The new formulation is implemented within the recently updated cloud microphysics scheme of GEOS-5. The updated scheme is completely prognostic and links cloud number and mixing ratio as well as precipitation rates to ambient conditions and aerosol size distributions using state-of-the-art cloud formation parameterizations. Cloud droplet activation, and ice nucleation by homogeneous and heterogeneous freezing are described accounting for sub-grid variability in vertical velocity and supersaturation. The comparison between an empirical treatment of heterogeneous ice nucleation and the comprehensive treatment presented here is analyzed in terms of the global distribution of cloud ice and liquid and precipitation rates.