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A parallel direct numerical simulation of dust particles in a turbulent flow

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Due to their effects on radiation transport, aerosols play an important role in the global climate. Mineral dust aerosol is a predominant natural aerosol in the desert and semi-desert regions of the Middle East and North Africa (MENA). The Arabian Peninsula is one of the three predominant source regions on the planet "exporting" dust to almost the entire world. Mineral dust aerosols make up about 50% of the tropospheric aerosol mass and therefore produces a significant impact on the Earth's climate and the atmospheric environment, especially in the MENA region that is characterized by frequent dust storms and large aerosol generation. Understanding the mechanisms of dust emission, transport and deposition is therefore essential for correctly representing dust in numerical climate prediction. In this study we present results of numerical simulations of dust particles in a turbulent flow to study the interaction between dust and the atmosphere. Homogenous and passive dust particles in the boundary layers are entrained and advected under the influence of a turbulent flow. Currently no interactions between particles are included. Turbulence is resolved through direct numerical simulation using a parallel incompressible Navier-Stokes flow solver. Model output provides information on particle trajectories, turbulent transport of dust and effects of gravity on dust motion, which will be used to compare with the wind tunnel experiments at University of Texas at Austin. Results of testing of parallel efficiency and scalability is provided. Future versions of the model will include air-particle momentum exchanges, varying particle sizes and saltation effect. The results will be used for interpreting wind tunnel and field experiments and for improvement of dust generation parameterizations in meteorological models.