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The Transport and Processing of Dust by Tropical Cyclones

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Convective storms play a fundamental role in transporting dust from the boundary layer to the mid- and upper troposphere. This vertical redistribution of dust has important implications for upper tropospheric heating, cirrus cloud formation, long-range transport, CCN and IN sources, and ocean fertilization. However, the efficiency of this transport process, defined as the ratio of aerosols returned to the mid- and/or upper troposphere to those ingested by the storm, is still not well understood. Dust transport processes may be particularly important in those regions where tropical storms interact with the Saharan Air Layer (SAL). Cloud resolving model simulations using the Regional Atmospheric Modeling System (RAMS) have been conducted of Tropical Storm (TS) Debby (2006) in order to evaluate how efficiently these storms transport dust from the SAL to the mid- and upper troposphere. RAMS has a prognostic aerosol scheme in which dust is activated based on the environmental conditions, tracked within different hydrometeor species, and returned to the atmosphere following sublimation and evaporation. The microphysical processes impacting the dust transport have been tracked to determine which processes have the greatest impact on dust transport efficiency, and a dust budget of those processes impacting dust redistribution at the middle and upper levels has been constructed. This budget has also been compared with CloudSat and Calipso data obtained along A-Train transects of TS Debby, as well as those before and after the passage of this tropical storm. The results demonstrate that the mass of dust transported by TS Debby to the upper troposphere is about two orders of magnitude smaller than that deposited on the surface in association with wet and dry deposition processes, whereas the dust mass transported to mid-levels is similar to that deposited on the surface. The microphysical and dynamical processes determining this vertical redistribution of dust will be discussed.