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Understanding Dust Impacts on Tropical Storm Development During the NASA HS-3 Field Campaign

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One of the overall scientific goals of the NASA Hurricane and Severe Storm Sentinel (HS-3) field campaign is to better understand the role of the Saharan Air Layer (SAL) in tropical storm development. During the 2012 and 2013 HS-3 deployments, the Cloud Physics Lidar (CPL) observed dust within SAL air in close proximity to a developing Nadine (September 11, 2012) and Gabrielle (August 24 and 29, 2013). For both deployments, the NASA GEOS-5 modeling system supported HS-3 by providing 0.25° resolution 5-day global forecasts of aerosols, which were used to support mission planning. The aerosol module was radiatively interactive within the GEOS-5 model, but aerosols were not directly coupled to cloud and precipitation processes. In this study we revisit the aerosol forecasts with an updated version of the GEOS-5 model. To capture indirect effects related to aerosol – cloud interactions, we have added the capability to couple aerosols to cloud and precipitation processes in GEOS-5. Additionally, we extend our simulated particle size distribution to include larger particles, which will help to better capture the impact of aerosols on longwave radiation. For each Nadine and Gabrielle case study, we run multi-day climate simulations leading up to each respective Global Hawk flight without aerosol interaction, with direct aerosol radiative feedback alone, and with both direct and indirect aerosol radiative effects. For each set of simulations, we compare simulated dust mass fluxes to identify differences in SAL entrainment related to the interaction betweens dust aerosols and the atmosphere. We then identify storm track differences and quantify changes in cloud and precipitation fields, as well as wind and temperature anomalies that can be validated using Airborne Vertical Atmospheric Profiling System (AVAPS) dropsonde profiles. By performing this sensitivity analysis, we expect to better understand how both the direct and indirect impacts of dust impact cyclogenesis, particularly in the early stages of system development.