Assimilation of Satellite-derived Aerosol Optical Thickness and Online Integration of Aerosol Radiative Effects in a mesoscale model

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Abstract

To investigate the importance of aerosol radiative effect in the atmosphere, numerical simulation of a dust event during the Puerto Rico Dust Experiment (PRIDE) is presented by using the Colorado State University (CSU) Regional Atmospheric Modeling System (RAMS). Through assimilation of geostationary satellite-derived aerosol optical thickness (AOT) into the RAMS, spatial and temporal aerosol distribution is optimally characterized, facilitating accurate estimation of aerosol radiative effects. Radiative effect of dust aerosols is then estimated using different types of radiative transfer and aerosol transport schemes and comparisons against observations show that a direct on-line consideration of aerosol radiative effects produces the best results. Numerical simulations show that if the aerosol radiative effects are not properly represented, the uncertainty in the simulated AOT is 0.05 (10%), the surface energy balance is different by 40~60Wm^{-2}, and the 2m air temperature is biased by 0.5~1°C during the day and 1~2°C during the night. The results from this study demonstrate that the assimilation of satellite aerosol retrievals has the potential to significantly improve not only weather forecast but also aerosol forecasts. Our results suggest that neglecting radiative interactions in mesoscale models could result in significant uncertainties in the surface energy balance and the associated atmospheric processes.