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Impacts of a Saharan dust event on weather over Eastern Mediterranean simulated by the WRF-Chem model

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Dust storms represent a significant source of aerosols in the atmosphere, impacting atmospheric composition and air quality. Moreover, the pollution caused by dust storms can exert a radiative effect, influencing short-term weather patterns and climate. In our research, we employed the Weather Research and Forecasting model coupled with Chemistry (WRF-Chem) to investigate how dust storms affect aerosol pollution levels and their related short-term meteorological consequences, using the Eastern Mediterranean as a case study. We focused on the severe dust outbreak of March 2018, a period marked by intense dust transport in the Easten Mediterranean and especially Greece caused mainly by strong southwesterly winds. We conducted model experiments, comparing scenarios with and without dust emissions to quantify the influence of these emissions on dust concentration, aerosol optical depth (AOD), shortwave radiation, and meteorological variables such as temperature, water vapor and cloud cover. Our results indicate that high concentrations of dust in the atmosphere can reduce the amount of radiation reaching the surface due to scattering and absorption by the dust particles. Additionally, it was found that the reemitted longwave radiation can increase the temperature near the surface. Regions in central Greece, as well as Crete and western Turkey, show an increase in temperature when dust emissions are considered in simulations, since they were more affected by the dust. Finally, a decrease in water vapor concentration was noted, primarily attributed to the hygroscopic nature of the dust particles and also to the change in atmospheric circulation induced by increased temperatures. Our research underscores that aerosols generated by dust storms can significantly alter weather conditions, emphasizing the importance of incorporating such feedbacks for more accurate weather forecasting.