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Simulated dust transport in the convective boundary layer

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Soil dusts are an important source of aerosol in agricultural regions and can affect the Earth's radiation budget through the modification of cloud properties, and in particular, through their ability to act as ice nucleating particles. In order to impact cloud properties, agricultural soil dusts need to be transported from the point of emission to cloud-relevant altitudes. Vertical transport within the planetary boundary layer is strongly controlled by turbulence and is challenging to represent accurately in regional and global models. Large-eddy simulations (LES) are run at resolutions capable of resolving most of the turbulent energy directly and can thus better simulate vertical transport. In this study, we leverage the LES ARM Symbiotic Simulation and Observation (LASSO) large-eddy simulations to simulate vertical transport of agricultural dust within the turbulent boundary layer using a modified version of the stochastic dispersion model FLEXPART-WRF. We find that the modified model is better capable of simulating particle transport due to turbulence, and that particle size was the greatest factor in determining particle lifetime. Individual meteorology and particle density had intermediate effects upon particle transport, while release height had little effect upon simulation results. Finally, we utilize a quasi-single column model (QSCM) approach to determine how our results compare to a parameterized treatment of turbulence. The QSCM simulations led to greater tracer transport out of the boundary layer, with ramifications for any studies utilizing a Lagrangian stochastic model to understand tracer dispersion. These results highlight the importance of accurately simulating turbulence for understanding particle transport.