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Adsorption of trace atmospheric gases by dust aerosol particles emitted from arid source areas

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Abstract

We suggest a two-dimensional model of adsorption of trace atmospheric gases by mineral dust particles with origin from desert soils. The model is based on the application of theory of turbulent diffusion in the atmospheric boundary layer (ABL) in conjunction with the model of gas adsorption by porous solid particles (see Elperin et al. 2017). The numerical model is formulated using parameterizations based on aeolian (by wind) dust emission experiments (see Katra et al. 2016). The aeolian field experiments were performed at a dust source (loess soil in Northern Negev, Israel) using a portable boundary layer wind tunnel to determine the emitted particulate matter (PM) fluxes for different wind speeds and varying soil conditions. The numerical analysis is performed for the adsorption of gas-phase HNO_3 by dust particulate matter. We determined numerically concentration distributions of the atmospheric dust particulate matter, and trace gas using shear velocity and emitted dust flux from the soils employed in the experiments. Analysis was performed for the case of neutral and slightly stable stratification of ABL typical for dust storm events in the East Mediterranean. The numerical analysis showed that during dust events the slightly stable atmosphere is characterized by higher concentration of PM10 in the surface layer than the neutrally stable atmosphere. It is found that in the case of neutral stratification as well as for stable atmospheric stratification the concentration of nitric acid HNO_3 strongly depends on concentration of atmospheric dust particles. The developed model enhances our capacity of quantification of atmospheric dust effects in climate models as well as health risk assessment.

Keywords: Dust particles; Scavenging; Gas adsorption; Atmosphere; Nitric acid vapor

References

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