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Modeling of heat and mass transfer during gas adsorption by aerosol particles in air pollution plumes

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ABSTRACT Although it is commonly accepted that air pollution is dominated by local emissions many studies report that plumes of harmful pollutants can be transported by wind across oceans and continents and warn about the growing danger of air quality degradation. Adsorption of trace atmospheric gases by aerosol particles contributes to the evolution of concentration distribution of the trace constituents and can effect on subsequent chemical reactions in the atmosphere. In the present study we suggest a two dimensional model of adsorption of trace atmospheric constituents by aerosol particles in air pollution plume emitted from industrial source. The model is based on an application of theory of turbulent diffusion in atmospheric boundary layer in conjunction with plume dispersion model. The wind velocity profiles used in the simulations were fitted from data obtained in field measurements conducted in the Northern Negev (Israel) using the experimental wind mast. The developed model allows analyzing spatial and temporal evolution of adsorbate concentration in the gaseous phase as well as in the particulate matter. The adsorbate concentration distributions are calculated for the particulate matter $PM_{2.5\text{-}10}$, which is typical for industrial emissions. Numerical calculations are performed for the different meteorological conditions including vertical temperature distribution in ABL and atmospheric stability classes. It is shown that the concentration of the gases adsorbing by aerosol plume strongly depends on level of atmospheric turbulence. The results of the present study can be useful in an analysis of different atmospheric pollution models including gas adsorption by aerosol plumes emitted from industrial sources.

REFERENCES

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