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Precipitation Scavenging of Gaseous Pollutants with Arbitrary Solubility in Inhomogeneous Atmosphere

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We suggest a one-dimensional model of precipitation scavenging of gaseous pollutants with arbitrary solubility by rain that is valid for nonuniform initial vertical distributions of soluble trace gases and temperature in the atmosphere. We investigate effect of a nonstationary inhomogeneous temperature distribution in the atmosphere on the rate of gas scavenging by precipitation. It is showed that when gradients of temperature and soluble trace gases concentration in the atmosphere are small, evolutions of altitudinal temperature and concentration distributions under the influence of rain are governed by linear wave equations that describe propagation of temperature and scavenging wave fronts. Scavenging coefficient and the rates of precipitation scavenging are calculated for wet removal of methanol using measured initial distribution of methanol and temperature in the atmosphere. In the case of the exponential initial distribution of soluble trace gases and linear temperature distribution in the atmosphere, scavenging coefficient in the region between the ground and the scavenging front is proportional to the rainfall rate, solubility parameter in the undercloud region adjacent to the cloud bottom and to the growth constant in the formula for the initial distribution of the soluble trace gas concentration in the atmosphere. Theoretical predictions of the value of the scavenging coefficient for sulphur dioxide washout by rain and of the dependence of the magnitude of the scavenging coefficient on rain intensity are in good agreements with the available atmospheric measurements.

Key words: Inhomogeneous atmosphere, gas absorption, precipitation scavenging, scavenging coefficient, rain droplets, inhomogeneous temperature

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