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Use of 222Rn for estimation of greenhouse gases emissions at Russian territory

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It is well known that 222Rn is widely used as a tracer for studying different atmospheric processes including estimations of greenhouse gases emissions. Calculation of 222Rn fluxes from the soil into the atmosphere allows quantitative estimation of greenhouse gases emissions having the soil origin or sources of which are located near the surface. For accurate estimation of 222Rn fluxes detailed investigations of spatial and temporal variations of its concentrations are necessary.

222Rn concentrations data in the atmospheric surface layer over continental Russia from Moscow to Vladivostok obtained during the six TROICA (Transcontinental Observations Into the Chemistry of the Atmosphere) expeditions of the mobile laboratory along the Trans-Siberian railroad are analyzed. Spatial distribution, diurnal and seasonal variations of surface 222Rn concentrations along the Trans-Siberian railroad are investigated. According to the obtained data surface 222Rn concentration values above continental Russia vary from 0.5 to 75 Bq/m3 depending on meteorological conditions and geological features of the territory with the average value being 8.42 $\pm$ 0.10 Bq/m3. The average 222Rn concentration is maximum in the autumn expedition and minimum in the spring one.

The factors mostly influencing 222Rn concentration variations are studied: surface temperature inversions, geological features of the territory, precipitations. 222Rn accumulation features in the atmospheric surface layer during night temperature inversions are analyzed. It was noted that during night temperature inversions the surface 222Rn concentration is 7 - 8 times more than the one during the nights without temperature inversions. Since atmospheric stratification determines accumulation and diurnal variations of many atmospheric pollutants as well as greenhouse gases its features are analyzed in detail. Surface temperature inversions were mainly observed from 18:00-19:00 to 06:00-07:00 in the warm season and from 16:00 to 08:00-09:00 in the cold season. During this time 222Rn accumulated in the surface atmospheric layer with its maximum concentration values being observed near sunrise.

222Rn fluxes from the soil into the atmosphere from Moscow to Vladivostok during surface temperature inversions are estimated taking into account geological factors. 222Rn accumulation layer depth in the lower atmosphere is calculated.

Using the data of CO2, CH4 and 222Rn concentrations obtained in the expeditions we analyzed correlations between the greenhouse gases and 222Rn. There are significant positive correlations between CO2, CH4 and 222Rn concentrations during night temperature inversions especially in summer and in autumn. It indicates similar accumulation both 222Rn and the greenhouse gases in the surface layer during atmospheric stability. On the basis of the regressions between 222Rn, CO2 and CH4 concentrations the greenhouse gases night time fluxes in the surface layer from Moscow to Vladivostok are estimated using the calculated values of 222Rn fluxes.

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