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Evaluation of radiation forcing from snow pollution by black carbon emissions from forest fires using the SNICAR radiation model and data from the INMCM5 climate model

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In this study, we consider the effect on climate of one of the atmospheric aerosols - black carbon. Estimates are obtained for changes in the surface albedo and additional radiation forcing associated with account for BC emissions from forest fires. For this, we used the data of a historical experiment with the climate model INMCM5 [1] developed at the INM RAS, as well as the one-dimensional SNICAR (SNow-ICe-AErosole radiation model) [2] model of radiation transfer in the snow layer. In the historical experiment with the climate model INMCM, carried out as part of the CMIP6 project [3], the climate of the Earth system was simulated from 1850 to 2014. In this case, the external forcing on the Earth system was set as close as possible to the observed one.

Based on the monthly average model data on the height of the snow cover, as well as the flux of black carbon from the atmosphere, assuming uniform mixing of the precipitation of BC in the snow, the concentration of BC in each cell of the model grid was calculated. Then, using the obtained concentrations, radiation forcing caused by BC emission from forest fires was calculated using the SNICAR model.

Since anthropogenic emissions of black carbon far exceed emissions resulting from the burning of biomass, two seasons that differ in the intensity of forest fires were chosen to study the role of forest fires in the radiation balance. Based on the GFED (Global Fire Emission Database) [4], 1998 (corresponding to large emissions of black carbon at mid-latitudes into the atmosphere caused by biomass burning) and 2001 (corresponding to small emissions) were selected as such seasons. Moreover, it is known that the anthropogenic source for the specified period changed slightly. Additional forcing amounted to 2-3 W/m^2 locally with a relative estimation error of the order of 10-15%. The results of calculations of the average annual radiation forcing for the mainland are in good agreement with [2], [5].

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