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# Accurate and ultrafast calculation for estimating three-dimensional gamma dose rate fields from arbitrary airborne radionuclide distributions

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The three-dimensional (3D) distribution of gamma dose rate field is a necessity for assessing the radiation effect of airborne radionuclides. Because of the complexity of air dispersion scenarios, current methods only estimate one- or two-dimensional dose rates, and trade accuracy and generality for acceptable speed. The lack of efficient 3D calculation methods prevents the 3D radiation effect assessment of airborne radionuclides. This study proposes a 3D dose rate field calculation method that accelerates the computation by several orders of magnitude without loss of accuracy or generality. This method reformulates the time-consuming 3D integral in the standard dose rate model as a convolution and uses a fast Fourier transform to accelerate its solution. The convolution form provides a new receptor-oriented insight into dose rate calculation that can flexibly describe the radiological response of biological tissues. This new method relies on no approximations or assumptions, so it is accurate and applicable to arbitrary air dispersion models and airborne radionuclide distributions. This approach is validated by both simulations and a field experiment. The results show that the proposed method is accurate and fast in both simple and highly complex air dispersion scenarios, and provides better quantitative and qualitative agreement with the experimental data than a popular tabulated method. This method may provide a more realistic dose rate field estimation for a real nuclear accident, such as the Fukushima accident.