Development of an Efficient Radiobiokinetic Calculation Method Using Matrices and Vectors

Joy, David (School: Oak Ridge High School)

Since the discovery of radiation, scientists have endeavored to predict and understand the effects of radioactive materials in humans, which can cause serious ailments. The International Commission on Radiological Protection (ICRP) has developed models to predict the effects of many different radioactive isotopes and methods of intake. These models represent the human body as a collection of compartments between which radioactive material is transferred. Existing solvers for these models, such as the Dose and Risk Calculation Software (DCAL) typically use a small timestep for initial calculations, but increase the timestep later in the calculation, sacrificing accuracy in order to deliver results quickly. In this project, a method called Matrix-Based Efficient Radiobiokinetic Calculation (MERC) was developed that solely uses matrix-vector multiplication, aided by matrix diagonalization. MERC delivers results in computational time similar to DCAL, but uses a small constant timestep throughout the calculations. MERC was tested on six ICRP models (C-14, H-3, I-131 Pb-210, Sr-90, and Y-90) and two non-radioactive chemical models (Mn and Pb) using an intravenous injection intake mode and was found to have consistently lower error than DCAL beyond 0.01 days as well as computational time independent of the timestep length. In the future, MERC will be expanded to model other types of radioactive intake and isotopes and will be used to expand existing models by adding compartments.

Awards Won: