Abstract Submitted
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Multi-Scale Human Respiratory System Simulations to Study Health Effects of Aging, Disease, and Inhaled Substances[1] ROBERT KUNZ, DANIEL HAWORTH, GULKIZ DOGAN, The Pennsylvania State University, ANDRES KRIETE, Drexel University — Three-dimensional, unsteady simulations of multiphase flow, gas exchange, and particle/aerosol deposition in the human lung are reported. Surface data for human tracheo-bronchial trees are derived from CT scans, and are used to generate three- dimensional CFD meshes for the first several generations of branching. One-dimensional meshes for the remaining generations down to the respiratory units are generated using branching algorithms based on those that have been proposed in the literature, and a zero-dimensional respiratory unit (pulmonary acinus) model is attached at the end of each terminal bronchiole. The process is automated to facilitate rapid model generation. The model is exercised through multiple breathing cycles to compute the spatial and temporal variations in flow, gas exchange, and particle/aerosol deposition. The depth of the 3D/1D transition (at branching generation n) is a key parameter, and can be varied. High-fidelity models (large n) are run on massively parallel distributed-memory clusters, and are used to generate physical insight and to calibrate/validate the 1D and 0D models. Suitably validated lower-order models (small n) can be run on single-processor PCs with run times that allow model-based clinical intervention for individual patients.

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