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Turbulence in the trachea and its effect on micro-particle deposition TAYLOR GEISLER, ERIC SHAQFEH, GIANLUCA IACCARINO, Stanford University — The health effects of inhaled aerosols are often predicted by extrapolating experimental data taken using nonhuman primate animal studies to humans. While the existence of a laminar-to-turbulent flow transition in the human larynx is widely reported in the literature, it was previously unknown, to our knowledge, whether a similar flow behavior exists in the airways of rhesus monkeys. By using Large Eddy Simulation (LES) in the CT-based airway models of rhesus monkeys we demonstrate the existence of such a flow transition at elevated inspiratory flow rates. The geometries comprise the nasal cavity, larynx, and trachea. We observe turbulence intensity values that peak after the larynx and decay throughout the trachea similar to that of humans. Deposition of inhaled micro-particles is also computed and validated using experiments in 3D-printed model airways with excellent agreement. Deposition in the turbulent regions of the airway (larynx and trachea) is shown to be substantial at elevated flow rates and to depend on the flow unsteadiness. These results provide insight into the fate of inhaled particles in rhesus monkey animal experiments and their connection to human inhalation.

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