

Simulation of the Airflow in the Upper Airways with Applications to Aerosols

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Abstract. Transitional fluid flow and micro-particle transport-deposition analysis is performed on a realistic airway model. A realistic extrathoracic airway geometry is obtained from CT imaging study in five healthy never-smoker adult male subjects. The realistic model is highly irregular resulting in very complex flow patterns with flow separations and skewed velocity profiles. Detailed analysis of these flows is presented for typical inhalation modes. In order to account for intersubject variability in deposition patterns and make patient-specific simulations possible, a Lagrangian particle tracking module with efficient particle search method is developed for unstructured hexahedral meshes to simulate the dispersed phase. Insight into regional deposition is presented for three different flow rates with particle diameters ranging between 2 and 20 μm . The crucial differences between our fluid as well as particle results are compared with those obtained on 'average' models to highlight the importance of considering realistic geometries.

Key words: *Realistic extrathoracic airway model, Unstructured grids, Transitional airflow, Lagrangian stochastic trajectory method.*

1. Introduction

Inhaled medications have been available for many years for the treatment of lung diseases and are widely accepted as the optimal route of administration for the first-line therapy for asthma and chronic obstructive pulmonary diseases. The advantage of pulmonary drug delivery through inhalation has recently led to the development of a series of new aerosol medication. For some medications, this kind of drug administration is chosen as it offers topical treatment of a specific lung condition while limiting the whole-body effects. To be effective, the alveolar zone of the respiratory tract has to be reached. Although the lungs are the final targets, a certain part of the dose will deposit on the walls of the extra thoracic (mouth-throat) region. This passage is highly irregular and with several obstructions like the mouth, the 90-degree bend and the vocal cords

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