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Hyper-realistic lung model for quantitative CT and CFD-based lung assessment of personalized exposure to air pollution JIWOONG CHOI, University of Kansas Medical Center, IN KYU LEE, University of Kansas, WON-CHEOL CHUNG, KYOUNG NAM KIM, CHANG-HOON LEE, Seoul National University Hospital, PRATHISH RAJARAMAN, CHING-LONG LIN, University of Iowa, CHANG HYUN LEE, Seoul National University College of Medicine —
We propose a hyper-realistic lung model for personalized assessment of lung exposure to air pollution, based on inspiratory and expiratory computed tomography (CT) images, computational fluid dynamics (CFD) simulations, and individual exposure measurement. We collected inspiratory and expiratory chest CTs, pulmonary function test (PFT) data, and personal air pollution exposure measurements from 200 subjects, to date, with healthy, asthma, chronic obstructive pulmonary disease (COPD), and interstitial pulmonary fibrosis (IPF) lungs. We first apply exposure amount of particulate matters (PMs) to an individual, by five standard size ranges, PM1, PM2.5, PM4, PM10, and total suspended particles (TSP). Then, a PFT-based personalized tidal breathing pattern at the mouth and regional ventilation based on inspiration-expiration CT image matching with the compliance lung model provides realistic prediction of cumulative inhalation of PMs at different size ranges. Large eddy simulations (LES) and particle transport simulations resolve regional lung distribution of PMs throughout the entire conducting airways. The proposed model associates regional particle deposition hot spots with disease-specific structural and functional alteration associated with particulate air pollutions.

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