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Challenge of visualising large airway flows and particle transport

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Post-processing large data-sets of complex flows is a challenging task. The extraction of concise and meaningful data is particularly difficult when investigating novel problems. Here a subject-specific model of the upper human airways is investigated. The computational domain was reconstructed from Computed Tomography images, and extends from the face to the third branch generation in the lungs. A sniff (peak at 30 l/min) is simulated, based on experimental data.
The complex anatomy and impulsive flow conditions result in a turbulent flow, with different characteristics in the various airway partitions. Spatial and temporal discretization are at the direct numerical simulations scales. This simulation is unique thanks to the fine resolutions achieved in analysing the upper human airways. This massive simulation is investigated with respect to turbulence power spectra, transport phenomena and particle deposition, coherent structures and other measures of physiological significance. The complex anatomy and flow field are seen to perform efficient conditioning of the inspired air.

Keywords: human upper airway, computational fluid dynamic, visualization, turbulence