Abstract Submitted
for the DFD11 Meeting of
The American Physical Society

Numerical simulation of transitional flow in a human upper airway segment in the presence of uncertainty OLAF MARXEN, von Karman Institute for Fluid Dynamics — The flow in human airways may be laminar, transitional, or turbulent in different airway segments. Specifically, laminar-turbulent transition is believed to occur in the larynx or in the trachea. Present approaches to simulate such flows typically employ numerical methods solving the steady Reynolds-averaged Navier-Stokes equations. However, natural airway deformations or pathological obstructions such as tumors may generate recirculation zones and lead to highly unsteady flow features that are not well captured by these numerical methods. We perform direct numerical simulations of transitional flow through a pipe-like canonical geometry representative of an airway segment. The incompressible Navier-Stokes equations in conjunction with an immersed boundary method are solved to simulate the unsteady flow. In order to model perturbations present in the incoming flow, small-amplitude disturbances are forced to explicitly trigger flow instabilities. Time-dependent inflow profiles are applied to model the change in flow velocity during the breathing process. In order to account for natural variability during breathing, the inflow profile is treated as an uncertain function. Resulting uncertainty in the flow field is quantified using stochastic collocation.

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Date submitted: 05 Aug 2011 Electronic form version 1.4