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Fluid exchange dynamics during respiratory-type flows ERIN CONNOR, AARON TRUE, MELANIE HOLLAND, JOHN CRIMALDI, University of Colorado, Boulder — Respiratory-type flows occur across a large range of scales in natural and engineered environments. These flows, characterized by the cyclic inhale and exhale of a fixed fluid volume through an orifice, result in dynamic spatiotemporal flow interactions even in quiescent surroundings. We use numerical and experimental approaches to investigate simple respiratory-type flows at scales relevant to biological sensory and metabolic processes. Organisms successfully gain access to scalars in the flow when the amount of exhaled fluid that is subsequently re-inhaled (exchange ratio, r_E) is small. This study focuses on this exchange of fluid, whereas studies of other similar flows with 'net-zero mass flux' (e.g. synthetic jets) often emphasize the transport of momentum. Using time-resolved flow fields to map the Lagrangian histories of inhale and exhale cycles, we demonstrate that r_E is sensitive to small changes in Reynolds number (Re). We show that this sensitivity is due to asymmetries in the inhale and exhale flow structures; these asymmetries vanish only in the limit as Re approaches zero. We also demonstrate that r_E is sensitive to the I:E ratio, defined as the ratio of inhalation time to exhalation time. Our results suggest that organisms could optimize the exchange of fluids with their environment by modulating Re or I:E ratio.

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