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Unsteady 3D flow simulations in cranial arterial tree LEOPOLD GRINBERG, Brown University, TOMER ANOR, JOSEPH MADSEN, Childrens Hospital, GEORGE KARNIADAKIS, Brown University — High resolution unsteady 3D flow simulations in major cranial arteries have been performed. Two cases were considered: 1) a healthy volunteer with a complete Circle of Willis (CoW); and 2) a patient with hydrocephalus and an incomplete CoW. Computation was performed on 3344 processors of the new half petaflop supercomputer in TACC. Two new numerical approaches were developed and implemented: 1) a new two-level domain decomposition method, which couples continuous and discontinuous Galerkin discretization of the computational domain; and 2) a new type of outflow boundary conditions, which imposes, in an accurate and computationally efficient manner, clinically measured flow rates. In the first simulation, a geometric model of 65 cranial arteries was reconstructed. Our simulation reveals a high degree of asymmetry in the flow at the left and right parts of the CoW and the presence of swirling flow in most of the CoW arteries. In the second simulation, one of the main findings was a high pressure drop at the right anterior communicating artery (PCA). Due to the incompleteness of the CoW and the pressure drop at the PCA, the right internal carotid artery supplies blood to most regions of the brain.

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