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Lagrangian coherent structures and turbulence characteristics downstream of prosthetic aortic valves MARCO D. DE TULLIO, Politecnico di Bari — The flowfield through prosthetic heart valves is investigated by means of direct numerical simulations, considering the fully coupled fluid-structure interaction problem. Two different aortic valve models are modeled: a bileaflet mechanical and a biological one. In order to reveal fluid flow structures and to better understand the transport mechanics, Lagrangian coherent structures (LCS) are used. LCS are distinguished material surfaces that can be identified as boundaries to regions with dynamically distinct behavior, and are revealed as hypersurfaces that locally maximize the finite-time Lyapunov exponent (FTLE) fields. Post-processing the flow simulation data, first FTLE fields are calculated integrating dense meshes of Lagrangian particles backward in time, and then attracting LCS are extracted. A three-jet configuration is distinctive of bi-leaflet mechanical valves, with higher turbulent shear stresses immediately distal to the valve leaflets, while a jet-like flow emerges from the central orifice of bio-prosthetic valves, with high turbulent shear stresses occurring at the edge of the jet. Details of the numerical methodology along with a thorough analysis of the different flow structures developing during the cardiac cycle for the two configurations will be provided.

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