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A Direct-Forcing Immersed Boundary Method with Dynamic Velocity Interpolation RANDALL MCDERMOTT, NIST — In a direct-forcing immersed boundary method, first introduced by Fadlun et al. (2000), the momentum equation is supplemented by a force term which drives the local velocity to a specified value. The method has gained popularity due to its ease of implementation in Cartesian, structured flow solvers and several variants on the basic theme have been proposed (see, e.g., Balaras (2004), Choi and Edwards (2008), Roman et al. (2009)). Generally, the first off-wall velocity point is forced to obey a simple interpolation, usually a linear, power-law, or log-law profile. These methods have been shown to work well for incompressible, statistically stationary flows. In the method proposed here, the velocity is obtained through dynamic evaluation of the boundary layer equations. The advantage of this approach is that, in principle, it is possible to better control the flow divergence (important for variable-density flows like fire–the primary application of our solver) and to account for the effects of local fluctuations in the flow field. The boundary layer equations are discretized with a second-order spatial scheme and time-step restrictions are avoided by formulating the streamwise momentum equation as an ordinary differential equation in time with a simple analytical solution. The method is tested on wavy-channel and cylinder/sphere wake flows across a broad range of Reynolds numbers.

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