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Three-Dimensional Velocity Field De-Noising using Modal Projection[1] SARAH FRANK, SIAVASH AMELI, ANDREW SZERI, SHAWN SHADDEN, University of California, Berkeley — PCMRI and Doppler ultrasound are common modalities for imaging velocity fields inside the body (e.g. blood, air, etc) and PCMRI is increasingly being used for other fluid mechanics applications where optical imaging is difficult. This type of imaging is typically applied to internal flows, which are strongly influenced by domain geometry. While these technologies are evolving, it remains that measured data is noisy and boundary layers are poorly resolved. We have developed a boundary modal analysis method to de-noise 3D velocity fields such that the resulting field is divergence-free and satisfies no-slip/no-penetration boundary conditions. First, two sets of divergence-free modes are computed based on domain geometry. The first set accounts for flow through "truncation boundaries", and the second set of modes has no-slip/no-penetration conditions imposed on all boundaries. The modes are calculated by minimizing the velocity gradient throughout the domain while enforcing a divergence-free condition. The measured velocity field is then projected onto these modes using a least squares algorithm. This method is demonstrated on CFD simulations with artificial noise. Different degrees of noise and different numbers of modes are tested to reveal the capabilities of the approach.

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