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Aero-Optical Distortions by a Turbulent Wake[1] ALI MANI, MENG WANG, PARVIZ MOIN, Stanford University — The aero-optical distortions caused by the turbulent wake behind a circular cylinder at $Re_D = 3900$ and $M = 0.4$ are investigated numerically. Large-eddy simulation is employed to compute the spatial and temporal variations of the index-of-refraction field, and a combination of ray tracing and Fourier optics is used to track the optical propagation and its far-field intensity patterns. Instantaneous and statistical descriptions of the optical aberrations are obtained for different flow resolution, optical wavelengths, and distances of propagation. An analytical description based on statistical solutions of the paraxial wave equation is provided to support the computed statistical behavior of beam propagation. Our results confirm that the effective range of an optical beam can be severely compromised by turbulence. In the parameter range considered, small scales of the flow are found to be optically active and must therefore be computationally resolved or modeled. It is found that the root-mean-square of the gradient of a distorted wave front plays a key role in causing beam spread as it propagates to the far field.

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