Abstract Submitted
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Numerical simulation of aero-optical distortions by turbulent boundary layers[1] KAN WANG, MENG WANG, University of Notre Dame — Compressible large-eddy simulations are carried out to study the aero-optical distortions caused by flat-plate turbulent boundary layers at $Re_\theta = 1400$ and 2800 and $M = 0.5$. The fluctuating index-of-refraction field is calculated from the density field, and ray tracing is employed to compute the optical path differences (OPD). It is found that optical wavefront distortions are predominantly caused by the logarithmic layer and wake region. Consistent with previous experimental findings, the distortion magnitude is dependent on the direction of propagation due to anisotropy of the boundary-layer vortical structures. An optical beam is distorted more severely when it is tilted toward downstream than upstream. This is explained by a correlation analysis of the fluctuating density field, which shows that the correlation length is larger along downstream-tilted optical paths than upstream-tilted ones. The predicted OPD magnitude and structure at both Reynolds numbers are compared to clarify the Reynolds number dependence and effect of small flow scales.

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