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Simultaneous measurement of aero-optical distortion and turbulent structure in a heated boundary layer[1] THERESA SAXTON-FOX, BEVERLEY MCKEON, Caltech, ADAM SMITH, STANISLAV GORDEYEV, University of Notre Dame — This study examines the relationship between turbulent structures and the aero-optical distortion of a laser beam passing through a turbulent boundary layer. Previous studies by Smith et al (AIAA, 2014 - 2491) have found a bulk convection velocity of $0.8U_\infty$ for aero-optical distortion in turbulent boundary layers, motivating a comparison of the distortion with the outer boundary layer. In this study, a turbulent boundary layer is developed over a flat plate with a moderately-heated section of length 25δ. Density variation in the thermal boundary layer leads to aero-optical distortion, which is measured with a Malley probe (Smith et al, AIAA, 2013 - 3133). Simultaneously, 2D PIV measurements are recorded in a wall-normal, streamwise plane centered on the Malley probe location. Experiments are run at $Re_\theta = 2100$ and at a Mach number of 0.03, with the heated wall 10 to 20°C above the free stream temperature. Correlations and conditional averages are carried out between Malley probe distortion angles and flow features in the PIV vector fields. Aero-optical distortion in this study will be compared to distortion in higher Mach number flows studied by Gordeyev et al (J Fluid Mech, 2014), with the aim of extending conclusions into compressible flows.

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