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Stream-wise statistical homogeneity in boundary layer resolvent analysis JOSEPH RUAN, GUILLAUME BLANQUART, Caltech — Resolvent analysis is the natural extension of linear stability theory to statistically stationary turbulent flows and has been used to predict the dominant mode shapes for various spatiotemporal frequencies. However, extension of the method to boundary layers often requires assuming stream-wise statistical homogeneity even though the flow is non-homogeneous in the stream-wise direction. The current study investigates the validity of this assumption by leveraging boundary layer self-similarity to rescale the boundary layer in the wall-normal direction (Ruan & Blanquart 2020). In the rescaled coordinates, the stream-wise direction is much more closely approximated as statistically homogeneous. Resolvent analysis is then applied to 1) the Cartesian (unscaled) system and 2) the rescaled system for a variety of spatiotemporal modes at Reynolds numbers of 1000, 2500 and 4000 with a constant kinetic energy norm. Both methods agree on mode shapes for inner layer spatiotemporal frequencies, but differ significantly on mode peak location and mode width for outer layer spatiotemporal frequencies. Finally, analytical expressions are provided both to explain the changes and to provide estimates of high Reynolds number behavior.

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