Abstract Submitted
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Hairpin vortices in the transitional and developed turbulence of a flat-plate boundary layer[1] GEORGE ILHWAN PARK, Stanford Univ., JAMES WALLACE, Univ. of Maryland, XIAOHUA WU, Royal Military College of Canada, PARVIZ MOIN, Stanford Univ. — Using Vortex lines to reveal vortical structures in turbulent flows has been in disfavor for some time. They are field lines that can be drawn wherever the flow is rotational, regardless of whether a true vortex exists there or not. However, their virtues are that the vortices they can reveal do not depend on setting a detection threshold, unlike all the vortex identifiers based on the velocity gradient tensor or based on a low pressure criterion, and they can isolate individual vortices. Such individual hairpin vortices have been identified in the transition region near $Re_\theta = 500$ of a recent flat-plate boundary layer and in the developed turbulence near $Re_\theta = 1950$. The vortices in these two regions emerge out of sheets of unorganized vorticity in the viscous sublayer and have quite similar characteristics. An octant analysis based on the combinations of signs of the velocity and temperature fluctuations, u, v and θ, shows that the momentum and heat fluxes in both the transitional and developed regions are predominantly of the mean gradient type. The fluxes appear to be closely associated with wall layer vortices that transport momentum and heat toward and away from the wall.

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