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Hairpin vortices in the transitional and developed turbulence of a flat-plate boundary layer* J. WALLACE, Univ. of Maryland, X. WU, Royal Military College of Canada, I. PARK, P. MOIN, Stanford Univ. — The use of vortex lines to reveal vortical structures in turbulent shear flows has been in disfavor for some time, in spite of their successful use by Kim and Moin (1986, JFM 162) and Rogers and Moin (1987, JFM 176). This is because they are field lines that can be drawn wherever the flow is rotational, regardless of whether a true vortex exists in a part of the field or not. For this reason, it would be better to call them vorticity lines rather than vortex lines. A virtue that such lines have, however, is that the vortical structures 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. Furthermore, vorticity lines can be used to isolate a single vortical structure. We will show that individual hairpin vortices can be identified using vorticity lines in the transition region at $Re_\theta = 500$, where turbulent spots merge, and in the developed turbulence at $Re_\theta = 1850$ within a recent DNS of a flat-plate boundary layer, and that the vortices so identified have quite similar characteristics. These vortices emerge out of sheets of unorganized vorticity in the viscous sublayer. An attempt will be made to follow the temporal and spatial evolution of these vortical structures using simulation files closely separated in time.
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