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Direct numerical simulation from laminar to fully-developed turbulence in spatially evolving pipe flow and flat plate boundary layer XIAOHUA WU, Royal Military College of Canada, PARVIZ MOIN, Center for Turbulence Research, Stanford University, RONALD J. ADRIAN, JON R. BALTZER, Arizona State University, JEAN-PIERRE HICKEY, Center for Turbulence Research, Stanford University — Direct numerical simulations of spatially evolving pipe flow and boundary layer have been performed. The pipe is 250R long, the flow Reynolds number is 6000 and 8000, and the calculation used up to 1.7 billion grid points. Pipe inlet disturbance is from a very-thin wire ring placed at different radial locations. It is found that energy norm in the flow downstream of such disturbance can grow exponentially with axial distance. The boundary layer's momentum thickness Reynolds number develops from 80 to 3000 with a free-stream turbulence intensity decaying from 3 percent to 0.8 percent. Its mesh has 4 billion grid points. Good quantitative agreement with experimental data is obtained. In both the pipe flow and the boundary layer, under these inlet disturbances, Lambda vortex, hairpin packet, infant turbulent spot, mature turbulent spot, and hairpin forest occur naturally and sequentially. Passive scalar was also introduced in the simulation in a manner analogous to the color band experiment of Osborne Reynolds.

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