Abstract Submitted
for the DFD19 Meeting of
The American Physical Society

Universality of uniform momentum zones in high-Reynolds-number boundary layers MICHAEL HEISEL, University of Minnesota, CHARITHA DE SILVA, University of New South Wales, NICHOLAS HUTCHINS, IVAN MARUSIC, University of Melbourne, MICHELE GUALA, University of Minnesota — Regions of coherent streamwise velocity known as uniform momentum zones (UMZs) are evaluated using eleven zero-pressure-gradient boundary layer datasets including a direct numerical simulation and atmospheric field measurements. UMZ properties are compared across a wide range of friction Reynolds number $Re_\tau \sim O(10^3 - 10^6)$ and surface conditions from hydraulically smooth to fully rough. In the logarithmic region, the UMZs exhibit universal behavior irrespective of Reynolds number and surface conditions. The velocity difference across the shear interfaces between UMZs scales with the friction velocity u_τ and the wall-normal thickness of UMZs scales with the wall-normal distance. Further, the UMZ statistics provide a direct link between the spatial organization of boundary layer turbulence and the hypothetical attached eddies used to derive velocity statistics in the logarithmic region. The observed universal behavior of the UMZs can also be used to develop and refine the representative eddies used in reduced-order models of high-Reynolds-number boundary layers.

Michael Heisel
University of Minnesota

Date submitted: 26 Jul 2019 Electronic form version 1.4