Abstract Submitted
for the DFD20 Meeting of
The American Physical Society

On the enhancement of boundary layer skin friction by turbulence: a moment-of-momentum approach[1] PERRY JOHNSON, University of California, Irvine, AHMED ELNAHHAS, Center for Turbulence Research, Stanford University — Turbulence enhances the skin friction coefficient of a boundary layer by augmenting momentum transport, which increases the drag of streamlined bodies. Turbulence also increases the streamwise growth of the boundary layer, however, indirectly opposing the skin friction enhancement. Other phenomena such as freestream pressure gradients also influence the skin friction. In this presentation, a moment-of-momentum integral equation is introduced to quantify these effects, decomposing the skin friction coefficient into that of a baseline laminar zero pressure gradient (ZPG) boundary layer plus augmentations due to turbulence, freestream pressure gradient, and changes to the streamwise development of the boundary layer. While similar to the relations of Fukagata, Iwamoto, and Kasagi (FIK) as well as Renard and Deck (RD), our approach is unique in that it truly isolates the skin friction of a laminar ZPG boundary layer in a single term so that other terms may be fairly interpreted as augmentations relative to that baseline case. In the process, a clearer interpretation of the original FIK approach emerges. The moment-of-momentum approach is demonstrated for laminar boundary layers with non-zero pressure gradients, as well as transitional and turbulent boundary layers.

[1]Supported by U.S. DoE and NASA

Perry Johnson
University of California, Irvine

Date submitted: 31 Jul 2020 Electronic form version 1.4