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Why do large and small scales couple in a turbulent boundary layer? PROMODE R. BANDYOPADHYAY, Naval Undersea Warfare Center, Newport, RI — Correlation measurement, which is not definitive, suggests that large and small scales in a turbulent boundary layer (TBL) couple. A TBL is modeled as a jungle of interacting nonlinear oscillators to explore the origin of the coupling. These oscillators have the inherent property of self-sustainability, disturbance rejection, and of self-referential phase reset whereby several oscillators can phase align (or have constant phase difference between them) when an "external" impulse is applied. Consequently, these properties of a TBL are accounted for: self-sustainability, return of the wake component after a disturbance is removed, and the formation of the 18o large structures, which are composed of a sequential train of hairpin vortices. The nonlinear ordinary differential equations of the oscillators are solved using an analog circuit for rapid solution. The post-bifurcation limit cycles are determined. A small scale and a large scale are akin to two different oscillators. The state variables from the two disparate interacting oscillators are shown to couple and the small scales appear at certain regions of the phase of the large scale. The coupling is a consequence of the nonlinear oscillatory behavior. Although state planes exist where the disparate scales appear de-superposed, all scales in a TBL are in fact coupled and they cannot be monochromatically isolated.

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