Onset of turbulent mean dynamics in boundary layer flow CURTIS 
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Stanford University — Statistical properties of turbulence in low Reynolds num-
ber boundary layers are compared. Certain properties are shown to approach an 
asymptotic state resembling higher Reynolds number flow much earlier during tran-
sition than previously thought. This incipient turbulence is less stochastic and more 
organized than developed turbulence farther downstream, but the mean dynamics 
and production mechanisms are remarkably similar. The onset of turbulence in 
our recent simulations is also similar to that observed in the bypass transition of 
Wu & Moin where continuous freestream turbulence, rather than small-amplitude 
linear waves, triggers transition. For these inflow disturbances, self-sustaining tur-
bulence occurs rapidly after laminar flow breakdown without requiring a signif-
ciaent development length nor significant randomization. Slight disagreements with 
FST-induced bypass transition are observed that correlate with the extra strain a 
turbulent freestream would impose upon the near-wall dynamics. Nevertheless, the 
turbulence statistics are similar shortly after the skin-friction overshoot independent 
of upstream receptivity. This early onset of deterministic turbulence provides sup-
port for reduced-order modeling of turbulent boundary layers based on non-linear 
estability mechanisms.

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