A Businger Mechanism for Intermittent Bursting in the Stable Boundary Layer

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High-resolution large-eddy simulations of the Antarctic very stable boundary layer reveal a mechanism for systematic and periodic intermittent bursting. A non-bursting state with a boundary-layer height of just 3 m is alternated by a bursting state with a height of ≈5 m. The bursts result from unstable wave growth triggered by a shear-generated Kelvin-Helmholtz instability, as confirmed by linear stability analysis. The shear at the top of the boundary layer is built up by two processes. The upper, quasi-laminar layer accelerates due to the combined effect of the pressure force and rotation by the Coriolis force, while the lower layer decelerates by turbulent friction. During the burst, this shear is eroded and the initial cause of the instability is removed. Subsequently, the interfacial shear builds up again, causing the entire sequence to repeat itself with a timescale of 10 min. Despite the clear intermittent bursting, the overall change of the mean wind profile is remarkably small during the cycle. This enables such a fast erosion and recovery of the shear. This mechanism for cyclic bursting is remarkably similar to the mechanism hypothesized by Businger in 1973. In his proposed mechanism, the momentum in the upper layer is increased by the downward turbulent transport of high-momentum flow. From the results, it appears that such transfer is not possible as the turbulent activity above the base flow is negligible. Finally, it would be interesting to construct a climatology of shear-generated intermittency in relation to large-scale conditions to assess the generality of this Businger mechanism.