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A Businger Mechanism for Intermittent Bursting in the Stable Boundary Layer

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In this seminar, I will talk about research that started during the final part of my PhD-project at Delft University of Technology, Netherlands, and continues in Cologne. I hope to show you that the combination of turbulence-resolving simulations and observations of the (extremely) polar stable boundary layers reveal interesting phenomena occuring within those SBLs:

High-resolution large-eddy simulations of the Antarctic very stable boundary layer reveal a mechanism for systematic and periodic intermittent bursting. A nonbursting 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 time scale 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, with one key difference. Whereas Businger proposes that the flow acceleration in the upper layer results from downward turbulent transfer of high-momentum flow, the current results indicate no turbulent activity in the upper layer, hence requiring another source of momentum. 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.