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Buoyancy-Induced Columnar Vortices[1] MARK SIMPSON, ARI GLEZER, Georgia Institute of Technology — The formation of anchored, buoyancy-driven columnar vortices that is driven by the instability of a thermally stratified air layer and is sustained by entrainment of ground-heated air is investigated in a meter-scale laboratory facility using a heated ground plane and an azimuthal array of flow vanes. Naturally-occurring, buoyancy-driven columnar vortices ("dust devils") spontaneously occur with core diameter of 1-50 m at the surface and heights up to one km, with considerable angular and axial momentum. Such vortices convert low-grade waste heat in an air layer overlying a warm surface into a flow with significant kinetic energy. The considerable kinetic energy of the vortex column cannot be explained by buoyancy alone and is a result of the production, concentration, and tilting of horizontal vorticity produced in the air layer over the heated ground plane. The present investigation focuses on the fundamental mechanisms of the formation, evolution, and dynamics of the available vorticity within the columnar vortex using stereo-PIV with specific emphasis on the scaling and distribution of the available kinetic energy flux. It is shown that the scaling and strength of these vortices can be significantly altered through adjustments of the flow vanes and the global sensible heat absorbed by the air flow.

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Mark Simpson
Georgia Institute of Technology

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