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Buoyancy-Induced Columnar Vortices[1] MARK SIMPSON, ARI GLEZER, Georgia Institute of Technology — Naturally-occurring, buoyancy-driven columnar vortices ("dust devils") that are driven by an instability of the thermally stratified, ground-heated air layer and are sustained by entrainment of the ground-heated air, occur spontaneously in the natural environment with core diameters of 1-50 m and heights up to one km. These vortices convert low-grade waste heat in the air layer overlying the warm surface into a flow with significant kinetic energy that may be exploited for power generation by coupling the vortex to a vertical-axis turbine. The considerable kinetic energy of the vortex column cannot be explained by buoyancy alone, and the fundamental mechanisms associated with the formation, evolution, and dynamics of an anchored, buoyancy-driven columnar vortex are investigated in a laboratory facility using a heated ground plane and an azimuthal array of flow vanes. The present investigation focuses on the vortex formation, structure, and the dependence of its scaling and strength on the thermal resources and the characteristic scales of the anchoring flow vanes using stereo-PIV with specific emphasis on the production, advection, and tilting of vorticity within the entrained boundary layer. Approaches for the manipulation of these mechanisms for increasing the available kinetic energy and therefore the generated power are also investigated.

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