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Transient wake and trajectory of free falling cones with various apex angles YAQING JIN, ALI M. HAMED, LEONARDO P. CHAMORRO, Mechanical Science and Engineering, University of Illinois at Urbana-Champaign — The early free-fall stages of cones with a density ratio 1.18 and apex angles of 30°, 45°, 60°, and 90° were studied using a wireless 3-axis gyroscope and accelerometer to describe the cone 3D motions, while the induced flow in the near wake was captured using particle image velocimetry. The Reynolds number based on the cone diameter and the velocity at which the cone reaches the first local velocity maximum is found to set the limit between two distinctive states. Before this Re is reached the departure from the vertical path and cone rotations are insignificant, while relatively rapid growth is observed after this Re. Sequences of vertical velocity, swirling strength, LES-decomposed velocity, and pressure fields shows the formation and growth of a large and initially symmetric recirculation bubble at the cone base and highlights the presence of a symmetric 3D vortex rollup dominating the near-wake in the early stages of the fall. Later, the shear layer at the edge of the wake manifests in the shedding of Kelvin-Helmholtz vortices that, due to the nature of the recirculation bubble, reorganize to constitute a part of the rollup. Later in the fall, the wake loses its symmetry and shows a high population of vortical structures leading to turbulence. The asymmetric wake leads to strong interactions between the flow field and the cone creating complex feedback loops.

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