Abstract Submitted
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Distinguishing chaotic structures from background turbulence using Benford's law[1] HUIXUAN WU, XINGTIAN TAO, University of Kansas — Unsteady turbulent flow is featured by multi-scale structures. Some of the large-scale structures are caused by periodic boundary motion, unsteady flow separation, or vortex shedding. They are usually deterministic, but their chaotic nature makes them almost undistinguishable from the background turbulence. We attempt to identify the deterministic structures in an unsteady turbulent field and to examine them through the lens of Benford's law. Chaotic signals usually disobey the Benford's law, which claims that the first significant digits of a stochastic sequence follow the probability distribution: P (d) = log (1+1/d) and d = 1, 2, ... 9. We decomposed a turbulent wake field downstream a cylinder into large-scale motions and sub-grid-scale fluctuations. In the near wake where the Karman vortex dominated the flow dynamics, the large-scale velocity signal disobeyed the Benford's law; While far downstream the cylinder, the large-scale signal gradually shifted to the Benford distribution. The sub-grid fluctuations in both near and far wakes followed the Benford's law. These results suggested that large energy-containing structures could be isolated from the background turbulence and modeled using lower dimensions.

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