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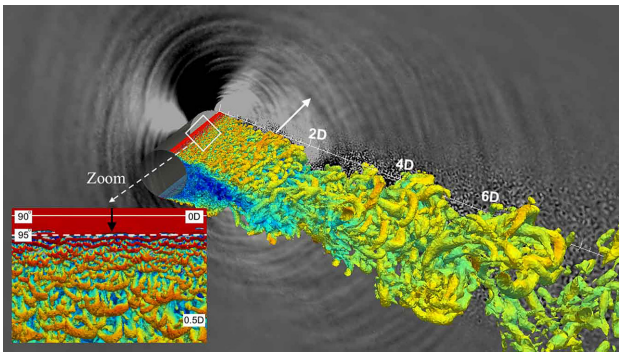
The first compressible, wall-resolved large eddy simulation of turbulent flow around a circular cylinder in the critical regime reveals flow features and noise sources.



The complex fluid dynamics of a turbulent flow around a circular cylinder are not yet fully understood, although this type of flow has many engineering applications, including train pantographs, car axles and aircraft landing gears.

This type of flow can be categorized into four regimes depending on its Reynolds number, which is the ratio of inertial forces to viscous forces in the flow. While previous experiments and simulations have investigated other regimes, Zhang et al. are the first to use a compressible, wall-resolved large eddy simulation to measure characteristics of a turbulent flow around a circular cylinder in the critical regime, which has an intermediate Reynolds number. Their simulation agrees well with existing experimental and incompressible large eddy simulation of this type of flow.

The critical regime exhibits transitional flow. It's partially laminar and partially turbulent.

By tracking the evolution of the flow's boundary and shear layers, the authors described the transition from laminar flow to turbulent flow caused by shear-layer instability near the cylinder. They are also the first to observe weak flow reattachment after separation.

Additionally, the authors were the first to qualitatively identify far-field and near-field noises and their sources in this type of flow. By analyzing maps of filtered pressure signals, they determined the dominant noise is vortex shedding, an oscillating flow whose tone is broader and shallower than previously reported for the same flow in a subcritical regime.

Author Chaofan Zhang said understanding cylinder flow more deeply in the critical regime is very challenging, and the authors are proud to provide insights that could be useful for its applications in transportation.

Source: "Turbulent flow and noise sources on a circular cylinder in the critical regime," by Chaofan Zhang, Stéphane Moreau, and Marlène Sanjosé, *AIP Advances* (2019). The article can be accessed at https://doi.org/10.1063/1.5121544.