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On Local Vortex Identification

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It is widely accepted that coherent vortical structures play a key role in determining the dynamics of complex turbulent flows. Identification of vortical structures from three-dimensional velocity fields is a crucial problem and various vortex identification schemes are proposed to achieve this purpose. We investigate popular vortex identification criteria based on point-wise analysis of the velocity gradient tensor. A new measure of spatial coherence in vortices is introduced. A new local vortex identification criterion and requirements for a vortex core are proposed. The inter-relationships between the different criteria are explored analytically using both zero and non-zero thresholds. Canonical flow examples are studied and it is observed that all the criteria, given the proposed usage of threshold, result in remarkably similar looking vortical structures. An explanation based on local flow kinematics is offered for the flows where the differences in the different criteria result in conflicting identification of vortices.

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