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Identification of Lagrangian Coherent Structures in a Turbulent Boundary Layer ZACHARY WILSON, Portland State University (PSU), MURAT TUTKUN, Norwegian Defence Research Establishment, RAUL BAYOAN CAL, PSU — In this study, we identify Lagrangian coherent structures (LCS) in a flat plate turbulent boundary layer at Re_θ 0f 19 100. To detect the LCS, we compute direct Lyapunov exponents (DLE) (Haller, G., Physica D, vol 149, pp 248-277, 2001). Specifically we use the velocity field obtained from stereo PIV measurements to compute trajectories, $\mathbf{x(t,t_0,x_0)}$, from initial positions, $\mathbf{x_0}$, at time t_0. For fixed integration times, $|t-t_0|$, we numerically differentiate the flow map, given by $F^t_{t_0}(\mathbf{x_0}) = \mathbf{x(t,t_0,x_0)}$, and then compute the deformation gradient tensor field $\Delta^t_{t_0}(\mathbf{x_0}) = \left[\nabla \mathbf{F^t_{t_0}}(\mathbf{x_0})\right]^{\mathbf{T}} \left[\nabla \mathbf{F^t_{t_0}}(\mathbf{x_0})\right]$. The DLE field is then found as $\mathrm{DLE^t_{t_0}}(\mathbf{x_0}) = \ln\left(\lambda_{\max}\left(\mathbf{\Delta^t_{t_0}}(\mathbf{x_0})\right)\right) / \left(\mathbf{2}\,|\mathbf{t}-\mathbf{t_0}|\right)$. Two dimensional gradient climbing is then used to find points on the locally maximizing, LCS surfaces of the field, $\mathrm{DLE^t_{t_0}}(\mathbf{x_0})$. To determine whether these surfaces truly repel (attract) near by fluid particles, the *hyperbolicity criterion* is applied (Mathur et al., Phys. Rev. Lett., vol 98, pp 144502, 2007). In particular we compute normal strain rates, $\langle \mathbf{n}, \mathbf{Sn} \rangle$, to locate repelling surfaces ($t >> t_0$ and $\langle \mathbf{n}, \mathbf{Sn} \rangle > \mathbf{0}$) and attracting surfaces ($t << t_0$ and $\langle \mathbf{n}, \mathbf{Sn} \rangle < \mathbf{0}$) within the boundary layer.

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