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K-Means Clustering for Data Visualization and Flow Interpretation: Inclined Jet in Crossflow Example JULIA LING, JULIEN BODART, FILIPPO COLETTI, JOHN EATON, Stanford University — The k-means clustering algorithm is a versatile data processing technique that has not yet been extensively applied to fluids data sets. The clustering algorithm can operate in high dimensional spaces to extract structure from large data sets. In the context of fluid dynamics, k-means clustering can be used to cluster the output of experimental or computational results based on mean velocity gradients or other single-point statistics. This technique has been applied to three dimensional mean velocity fields for an inclined jet in crossflow that were acquired using MRI-based 3D velocimetry, a Reynolds Averaged Navier Stokes (RANS) simulation, and a Large Eddy Simulation (LES). In each case, the clusters were based on the mean velocity gradient tensor. The optimal number of clusters was determined using an external validation technique in which a linear regression was performed within each LES cluster to predict the Reynolds stresses based on the mean velocity gradient. These linear regressions were subsequently evaluated on a validation subset of the LES data, and it was shown that eight clusters gave the lowest validation error. These eight clusters were used to explore the differences in flow structure between experiment, LES, and RANS and to determine which characteristics were associated with higher error in the RANS simulation. It was shown that the RANS Reynolds stresses were least accurate in regions of high strain or high streamwise vorticity.

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