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Statistical comparison of coherent structures in fully developed turbulent pipe flow with and without drag reduction FRANCESCA SOGARO, ROBERT POOLE, DAVID DENNIS, University of Liverpool — High-speed stereoscopic particle image velocimetry has been performed in fully developed turbulent pipe flow at moderate Reynolds numbers with and without a drag-reducing additive (an aqueous solution of high molecular weight polyacrylamide). Three-dimensional large and very large-scale motions (LSM and VLSM) are extracted from the flow fields by a detection algorithm and the characteristics for each case are statistically compared. The results show that the three-dimensional extent of VLSMs in drag reduced (DR) flow appears to increase significantly compared to their Newtonian counterparts. A statistical increase in azimuthal extent of DR VLSM is observed by means of two-point spatial autocorrelation of the streamwise velocity fluctuation in the radial-azimuthal plane. Furthermore, a remarkable increase in length of these structures is observed by three-dimensional two-point spatial autocorrelation. These results are accompanied by an analysis of the swirling strength in the flow field that shows a significant reduction in strength and number of the vortices for the DR flow. The findings suggest that the damping of the small scales due to polymer addition results in the undisturbed development of longer flow structures.

David Dennis
University of Liverpool

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