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Development and Assessment of Proper Orthogonal Decomposition for Analysis of Turbulent Flow in Piston Engines[1] K. LIU, D.C. HAWORTH, The Pennsylvania State University — High-resolution optical diagnostics (e.g., particle-image velocimetry – PIV) and high-resolution numerical models (e.g., large-eddy simulation – LES) are increasingly being used to develop advanced combustion systems for next-generation piston engines. To date, quantitative comparisons between PIV and LES for engines have been limited mainly to ensemble-(phase-) averaged mean quantities. Proper orthogonal decomposition (POD) has been proposed as an approach for analyzing the dynamics of complex in-cylinder processes, and as a basis for making objective quantitative comparisons between PIV and LES. Here three-dimensional, time-dependent datasets generated by performing multiple-cycle LES of motored flows for simple engine configurations are used to develop and assess the use of POD as a basis for the analysis of turbulent flow in piston engines. We explore POD variants that are required for analysis of statistically nonstationary flows in time-varying domains. We explore sensitivities of mode structure and convergence rate to spatial and temporal resolution, and perform comparisons of two-dimensional and three-dimensional POD analyses. And we explore the use of POD to identify and quantify cycle-to-cycle variations.

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