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Multi-Scale Proper Orthogonal Decomposition: Identifying Small Scale Structures based on a Large Scale Structure AKHILESHWAR BORRA, THERESA SAXTON-FOX, University of Illinois at Urbana-Champaign — Proper Orthogonal Decomposition (POD) is a technique to extract modes from a scalar or vector field by optimizing the mean square of the variable being examined. Outputs of POD are a set of orthogonal modes Φ_j with their associated temporal coefficients $a_j(t)$ and energy levels λ_j (Berkooz et Al., 1993, Taira et Al., 2017). Using multi-resolution dynamic mode decomposition (MR-DMD) (Kutz et Al., 2015) and conditional POD (Berkooz et Al., 1993) as inspiration, multi-scale POD (MS-POD) can identify the small scale structures based on the sign and strength of a large scale structure. Due to the non-linear interaction between large and small scale structures in fluids, energy of the small scale structures are influenced by the large scale structures in a phenomenon known as amplitude modulation (Mathis et Al., 2009). Filters such as Gaussian, top-hat and spectral filters have been used to understand small scale structures (Mathis et Al., 2009, Saxton-Fox et Al.,2019), however, all of these filters have various shortcomings. In this talk, the MS-POD algorithm will be presented along with results from two sample data sets. Finally, the promising outlook of MS-POD will be discussed in relation to large and small scale coherent structure interaction in turbulence.

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