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Introducing Spectral Proper Orthogonal Decomposition: Superior identification of coherent structures in turbulent flows MORITZ SIEBER, KILIAN OBERLEITHNER, C. OLIVER PASCHEREIT, Chair of Fluid Dynamics, Hermann-Foettinger-Institut, TU Berlin — The identification of coherent structures from experimental or numerical data is an essential task in fluid dynamics. Today's commonly used approaches employ the construction of a modal base that captures the dominant flow structures. Typically, these modes are either energy (POD) or frequency (Fourier decomposition) ranked. However, there are numerous examples where the relevant coherent structures occur at low energies or at multiple frequencies. To overcome the shortcoming of the current "rigid" approaches, we propose a new method - Spectral Proper Orthogonal Decomposition (SPOD). It is based on classical POD and it applies to spatially and temporally resolved data. The new method involves an additional temporal constraint that enables a clear separation of phenomena that occur at multiple frequencies and energies. It allows for a continuous shifting from the energy ranked POD to the frequency ranked Fourier decomposition by changing a single parameter. In this presentation we demonstrate the SPOD on experimental data of some flow cases, where the commonly used methods fail to assign the relevant coherent structures to single modes. The SPOD, however, achieves a proper separation of spatially and temporally coherent structures that might be hidden in noise or spread over a wide frequency range. In spite of all these benefits, the algorithmic complexity and computational cost of the SPOD is still comparable to the snapshot POD.

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