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Energy Cascade Analysis: from Subscale Eddies to Mean Flow[1]
MOHAMAD IBRAHIM CHEIKH, LOUIS WONNELL, JAMES CHEN, Kansas State Univ — Understanding the energy transfer between eddies and mean flow can provide insights into the energy cascade process. Much work has been done to investigate the energy cascade at the level of the smallest eddies using different numerical techniques derived from the Navier-Stokes equations. These methodologies, however, prove to be computationally inefficient when producing energy spectra for a wide range of length scales. In this regard, Morphing Continuum Theory (MCT) resolves the length-scales issues by assuming the fluid continuum to be composed of inner structures that play the role of subscale eddies. The current study show- cases the capabilities of MCT in capturing the dynamics of energy cascade at the level of subscale eddies, through a supersonic turbulent flow of Mach 2.93 over an 8 compression ramp. Analysis of the results using statisti- cal averaging procedure shows the existence of a statistical coupling of the internal and translational kinetic energy fluctuations with the corresponding rotational kinetic energy of the subscale eddies, indicating a multiscale transfer of energy. The results show that MCT gives a new characteri- zation of the energy cascade within compressible turbulence without the use of excessive computational resources.

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