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Quantifying the Discrepancy in RANS Modeling of Reynolds Stress Eigenvectors System JINLONG WU, Virginia Tech, RONEY THOMPSON, Federal University of Rio de Janeiro, JIANXUN WANG, Virginia Tech, LUIZ SAMPAIO, Stanford University, HENG XIAO, Virginia Tech — Reynolds-Averaged Navier-Stokes (RANS) equations are the dominant tool for engineering design and analysis applications involving wall bounded turbulent flows. However, the modeled Reynolds stress tensor is known to be a main source of uncertainty, comparing to other sources like geometry, boundary conditions, etc. Recently, several works have been conducted with the aim to quantify the uncertainty of RANS simulation by studying the discrepancy of anisotropy and turbulence kinetic energy of the Reynolds stress tensor with respect to a reference database obtained from DNS. On the other hand, the eigenvectors system of Reynolds stress tensor is less investigated. In this work, a general metric is proposed to visualize the discrepancy between two eigenvectors systems. More detailed metrics based on the Euler angle and the direction cosine are also proposed to quantify the discrepancy of eigenvectors systems. The results show that even a small discrepancy of the eigenvectors of the Reynolds stress can lead to a drastically different mean velocity field, demonstrating the importance of quantifying this kind of uncertainty/error. Furthermore, the Euler angle and the direction cosine are compared for the purpose of uncertainty quantification and machine learning, respectively.

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