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Super-resolution reconstruction of turbulence using unsupervised deep learning HYOJIN KIM, JUNHYUK KIM, SUNGJIN WON, CHANGHOON LEE, Yonsei University — We propose an unsupervised learning model that adopts a cycle-consistent generative adversarial network (CycleGAN) for super-resolution reconstruction of turbulence. In most practical problems, turbulence data is unpaired. A representative example is large-eddy simulation (LES) and the corresponding direct numerical simulation (DNS) data, for which a supervised learning is impossible. We trained our model using unpaired LES and DNS data in turbulent channel flows. As a result, the model can successfully reconstruct the high-resolution flow field with statistically DNS-quality from the LES one. In addition, the model showed excellent performance for another input data obtained by different LES model that was not used in the training process, and produced highly accurate statistics for temporal behavior despite not considering the temporal information. Through the unsupervised learning, a super-resolution reconstruction of turbulent flows would be extended to more practical applications such as LES modeling, removal of experimental noise, and synchronization of different experiments.

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