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Full Domain Flow Information Recognition Around Buildings With Sparse Near-Wall Data Through A Physics-Informed Data-Driven Approach

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In the aspect of building wind engineering, sparse data in the near-wall region are easier to access by means of wind tunnel tests or field measurements. However, they are far from enough to reconstruct the whole wind fields which are also worthy of attention. To make full use of both conventional computational fluid dynamics (CFD) method and field measurement data, we propose a physics-informed data-driven approach for reconstructing wind fields around buildings with sparse near-wall data in this paper. Specifically, the flow field around a building is achieved by combining a physics-informed neural network (PINN), which has been demonstrated to be a reliable machine-learning solver for Reynolds-averaged Navier-Stokes (RANS) equation, with a small number of discrete data points in the near-wall region. Firstly, we close the RANS equation by using a zero-equation model and incorporate the residuals of the physical governing functions in the loss function of the neural network. Secondly, a small sampling of known data points of wind velocity and pressure are embedded into the loss function, serving as a training dataset for supervised learning. The predicted velocity and pressure of the flow field are then compared with CFD results or wind test results to illustrate the accuracy of proposed scheme. The low discrepancy indicates that the proposed method is a potential auxiliary means to predict spatial flow field in the wind tunnel test and practice.