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A Preliminary 3D AI-Driven Adaptive Mesh Technique in Adaptive Atmospheric Model Fluidity-Atmosphere

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Adaptive meshes are pivotal in numerical modeling and simulation, offering a means to efficiently, precisely, and flexibly represent intricate physical phenomena, particularly when grappling with their intricacies and varying scales. However, traditional adaptive mesh generation and optimisation algorithms tend to consume a large amount of computational cost, leading to a significant reduction in computational efficiency. Addressing this challenge effectively, we turn to the cutting-edge realm of artificial intelligence and neural networks. In our study, In our study, we harness the innovative power of a long short-term memory (LSTM) neural network as as a model for predicting the density of adaptive unstructured grids. By using the LSTM neural network to predict the mesh density of adaptive unstructured meshes in different sub-regions and obtain their position coordinates, followed by Delaunay triangulation methods are used to guide the generation of the meshes. To demonstrate the practical applicability of our approach, we seamlessly integrate the LSTM mesh density prediction model into the adaptive atmospheric model Fluidity-Atmosphere (Fluidity-Atmos), thereby enabling real-time mesh adaptation during numerical simulations. We evaluate the effectiveness of the method in terms of simulation accuracy and computational efficiency through a series of 2D experiments. The results show that the mesh generated by the LSTM mesh density prediction model is highly similar to the mesh pattern generated by the Fluidity-Atmos model. It is worth noting that the number of meshes generated by the LSTM mesh density prediction model is not fixed, and its number is dynamically adjusted in real time to meet the simulation requirements.

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