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Examination of Machine Learning for the Modeling of Hypersonic Boundary Layers ABHINAND AYYASWAMY, HAIFENG WANG, School of Aeronautics and Astronautics, Purdue University — There is a great need for accurate, applicable, and grid-flexible wall models for hypersonic flows. This work examines the use of machine learning for constructing wall models that are targeted to produce a minimum loss of accuracy on coarse-grid simulations when compared to fine-grid calculations. Specifically, we use machine learning to reconstruct the velocity gradient on the wall in the wall-normal direction by introducing a velocity gradient correction factor. This compensates for the loss of accuracy when using finite volume discretization to find the velocity gradient in the highly non-linear region for coarse grids. The examination of machine learning is done in the Reynolds-averaged Navier-Stokes simulations (RANS) of hypersonic boundary layers. Fine-grid RANS simulations are conducted to generate training data for machine learning. The Random forest bagged algorithm is used to model the velocity gradient correction factor. Different choices of input parameters are examined. A priori assessment of the model is compared against fine-grid RANS results. It is found that with the machine learning model, the modeled velocity gradient correction factor can reproduce the velocity gradient on the wall improving the relative error from 50% to within six percent.

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