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Neural-network-augmented Gaussian moment method for the statistics of cavitating bubble populations[1] SPENCER BRYNGELSON, California Institute of Technology, ALEXIS CHARALAMPOPOULOS, THEMISTOKLIS SAPSIS, Massachusetts Institute of Technology, TIM COLONIUS, California Institute of Technology — Phase-averaged bubbly flow models are forced by moments of the bubble population dynamics. Computation of such moments requires a representation of the bubble population statistics. This has traditionally been accomplished via a classes method that evolves bins of discrete bubble sizes and computes the required moments via quadrature. We instead propose a method based upon explicit evolution of low-order moments of the bubble population and Gaussian closures. This circumvents the additional expense associated with the evolution of classes in lieu of a numerical evaluation of the associated closure integrals, which is particularly advantageous when the bubble population distributions are broad. This approach is exact for linear bubble dynamics, though has larger errors for bubble populations undergoing increasingly strong nonlinear dynamics. This problem is associated with the generation of higher-order moments, which we treat via recurrent neural networks. They are trained with Monte Carlo surrogate-truth data and augment our evolution of the low-order moments and evaluation of higher-order moments. The neural networks markedly improve model predictions, even for out-of-sample testing data.

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