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Effective Free Surfaces RAMESH YAPALPARVI, BARTOSZ PROTAS, Department of Mathematics and Statistics, McMaster University, Hamilton — In this investigation we introduce the concept of an "effective free surface" arising as a solution of time–averaged equations in the presence of free boundaries. This work is motivated by applications of optimization theory to problems involving free surfaces, such as droplets impinging on the weld pool surface in welding processes. In such problems the time–dependent governing equations lead to technical difficulties, many of which are alleviated when methods of optimization are applied to a steady problem with effective free surfaces. The corresponding equations are obtained by performing the Reynolds decomposition and averaging of the time–dependent free–boundary equations based on the volume–of–fluid (VoF) formalism. We identify the terms representing the average effect of fluctuating free boundaries which, in analogy with the Reynolds stresses in classical turbulence models, need to be modelled and propose some simple algebraic closures for these terms. We argue that effective free boundaries can be computed using methods of shape optimization and present some results.

Ramesh Yapalparvi
Dept of Mathematics and Statistics, McMaster University, Hamilton

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