Effective large-scale fluid equations
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A general procedure for deriving effective large-scale fluid equations is presented. It is applicable to a large class of non-linear systems. Starting from the original dynamical equations, the formalism determines closed equations governing the large-scale component of the fields. In this way, complex flows can be numerically simulated with moderate computational resources. The procedure is applied to the two-dimensional Navier-Stokes equation for incompressible flow and to a decaying one dimensional Burgers flow. The resulting systems are numerically solved on a coarse grid. The solutions are compared to direct numerical simulations of the Navier-Stokes equation and of Burgers equation, which require a much finer grid. The characteristic features of the flow at all stages of its evolution are well reproduced, including a correct energy exchange between large and small scales.