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One-shot methods for nonlinear optimization of turbulent flows with heat transfer SALEH NABI, Mitsubishi Electric Research Labs, PIYUSH GROVER, Mechanical and Materials Engineering, University of Nebraska-Lincoln, C. P. CAULFIELD, BPI & DAMTP, University of Cambridge — We consider the optimization of buoyancy-driven flows governed by Boussinesq equations using i) Direct-Adjoint-Looping (DAL), and ii) one-shot methods. Various optimization scenarios are considered: first we solve a series of inverse-design problems for which the global optimal solution is known. We demonstrate that each optimization method is able to retrieve the optimal solution in a fully turbulent regime. Next, we consider the problem of maintaining a desired temperature field with specified input energy budget. The role of an approximate Hessian as a preconditioner as well as tuned step-size for the one-shot method iterations are highlighted. It is shown, by employing an efficient optimization algorithm, the one-shot method can solve the PDE-constrained optimization problem with a cost comparable (about fourfold) to that of the simulation problem alone, and substantially cheaper than using DAL, which requires $\mathcal{O}$ (10) direct-adjoint loops to converge. The optimization results arising from the one-shot method can be used for optimal sensor/actuator placement tasks, or to provide a reference trajectory to be used for online feedback control applications.

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