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Second-order adjoint-based sensitivity for hydrodynamic stability and control EDOUARD BOUJO, Ecole Polytechnique Federale de Lausanne — Adjoint-based sensitivity analysis is routinely used today to assess efficiently the effect of flow control on the linear stability properties of globally unstable flows. Sensitivity maps identify regions where small-amplitude control is the most effective, i.e. yields the largest first-order (linear) eigenvalue variation. In this study an adjoint method is proposed for computing a second-order (quadratic) sensitivity operator. The method is applied to the flow past a circular cylinder, controlled with a steady body force or with a model of passive control device. Maps of second-order eigenvalue variations are obtained, without computing controlled base flows and eigenmodes. For finite control amplitudes, the second-order analysis improves the accuracy of the first-order prediction, informs about its range of validity, and about whether it under/overestimates the actual eigenvalue variation. The second-order variation can be decomposed into two mechanisms: second-order base flow modification, and interaction between first-order base flow and eigenmode modifications. Finally, the optimal control for second-order stabilization is computed via a quadratic eigenvalue problem.

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