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The use of global modes to understand transition and perform flow control

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The stability of highly non-parallel flows are considered using superposition of global modes. When purturbed by the worst case initial condition these flows often exhibits a large transient growth associated with the development of wavepackets. The global modes of the systems also provides a good starting point for the design of reduced order models used to control the growing disturbances. As the main example, the control of a globally unstable boundary-layer flow along a cavity is considered. The disturbance development is associtated with the development of a wavepacket along the cavity shear layer followed by a global cycle related to the two unstable global modes. Direct numerical simulations of this flow are coupled to a measurement feedback controller, which senses the wall shear stress at the downstream lip of the cavity and provides the actuation at the upstream lip. A reduced order model for the control is obtained by a projection on the least stable global eigenmodes. The LQG controller is run in parallel to the Navier-Stokes time integration and it is shown to damp out the global oscillations.