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Sensitivity Analysis of Spiral Vortex Breakdown UBAID QADRI, DHIREN MISTRY, MATTHEW JUNIPER, University of Cambridge — Vortex breakdown occurs in some swirling flows, such as those in gas turbine combustion chambers. Previous studies have established that the initial breakdown is steady and axisymmetric but that an unsteady spiralling breakdown mode develops on top of this, due to a region of absolute instability. We investigate the linear stability of steady axisymmetric vortex breakdown in a semi-infinite domain for an incompressible fluid at Re = 200. We relate the global behaviour of the flow to its local stability properties. We use direct numerical simulation (DNS) of the linearized direct and adjoint Navier–Stokes equations to obtain the linear direct and adjoint global modes. We use these to map the regions of the flow that are most sensitive to external forcing and internal feedback. This enables us to identify the wavemaker region, which causes spiral vortex breakdown. We find that, for low swirls, the wavemaker of the linear global mode lies in the axisymmetric breakdown bubble. Previous studies of the same flow indicate that the wavemaker of the nonlinear global mode lies in the wake of the axisymmetric breakdown bubble. We explain this apparent contradiction by analogy with two coupled Van der Pol oscillators.

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