Time-dependent modes associated with finite time instabilities in unstable fluid flows[1] HESSAM BABAEE, THEMISTOKLIS SAPSIS, MIT — We apply a recently developed variational formulation for the determination of a finite-dimensional, time-dependent, orthonormal basis that captures the directions associated with finite-time instabilities. We demonstrate the capability of the method for two problems: the Orr-Sommerfeld/Squire operator and the vertical jet in crossflow. In the first problem we demonstrate that the time-dependent subspace captures the strongly transient non-normal energy growth (in the short time regime), while for longer times the modes capture the expected asymptotic behavior of the dynamics. We also consider the vertical jet in crossflow at the jet Reynolds number of $Re_j = 900$. We demonstrate that the subspace instantaneously captures the most unstable directions of the time-dependent flow. We explore the connection between the shear flow, non-normal growth and persistent instabilities.

Themistoklis Sapsis
MIT

Date submitted: 30 Jul 2015   Electronic form version 1.4