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Global stability analysis of a transonic flow over OAT15A airfoil
FULVIO SARTOR, CLEMENT METTOT, DENIS SIPP, ONERA, DAFE TEAM
— A transonic interaction between a shock wave and a turbulent boundary layer on a supercritical profile is numerically and theoretically investigated. If the angle of attack is small, RANS simulations converge towards a steady solution; beyond a critical value, the shock exhibits self-sustained oscillations, and the flow can be related to the so-called transonic buffet. Linear stability analysis indicates that for low angle of attack the flow is stable in a global framework. In this case, the noise amplifier behavior of the flow is investigated through a singular value decomposition of the global Resolvent, which highlights the frequency selection process typical of shock-wave/boundary-layer interactions. It will be shown that the shock behaves as a low-pass filter, and Kelvin-Helmholtz type instability are related to high-frequency unsteadiness. When increasing the angle of attack, an unstable eigenvalue appears and the unsteady behavior can be correctly represented by the unstable global mode, as shown by Crouch et al. JFM 2009. The mechanism that is responsible for buffet onset will be discussed, and comparisons between adjoint/direct global modes and optimal forcing/response will be performed.

Fulvio Sartor
ONERA

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