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# ZDES and URANS simulations of 3D transonic buffet over infinite swept wings

**Frédéric Plante[1,2], Julien Dandois[2] and Éric Laurendeau[1]**

**[1]Polytechnique Montréal, Montréal, Québec, H3T1J4, Canada.**
**[2]ONERA, Université Paris Saclay, Meudon, 92100, France.**

## Abstract

This paper presents a study of transonic buffet over three-dimensional infinite swept wings. These configurations consist of the extrusion of an ONERA OALT25 airfoil with periodic boundary condition in span. Unsteady Reynolds Averaged Navier-Stokes (URANS) simulations are performed to assess the effect of the sweep angle. Spanwise flow structures are observed on these essentially 2D configurations, forming what has been named buffet cells. The 3D buffet frequency is correlated with the wavelength of these cells and the sweep angle. A Zonal Detached Eddy Simulation (ZDES) has also been carried out to provide numerical validation of the URANS simulations. This simulation will also be used to assess the capacity of hybrid RANS/LES simulations to model the 3D effects involved in transonic buffet. At last, these simulations will provide insight into the complex physics involved in transonic buffet.

### Preliminary results

URANS simulations have been carried out for 3D infinite swept wings based on the OALT25 airfoil with sweep angles of 10°, 20° and 30°. Figure 1 shows the pressure distribution on the suction side of those wings. We observe a regular 3D flow pattern along the span. The number of buffet cells increases with the sweep angle. One should note that a constant span of 6 chords between the two parallel planes closing the domain is imposed and the periodic boundary conditions impose an integer number of cells. Figure 2 shows the spectrum of the local lift coefficients extracted at a chosen spanwise section. We observe a near constant peak at around 64 Hz for all sweep angles. This frequency corresponds to the usual 2D buffet frequency at St = 0.06-0.07. The 3D buffet phenomenon is characterized by the peaks at 41 Hz, 109 Hz and 232 Hz for sweep angles of 10°, 20° and 30° respectively. These frequencies are associated with the convection of buffet cells towards the wing tip. Hence, the 3D buffet frequency increase is correlated with the increase of the transverse speed due to the sweep angle and decrease of the wave length of the buffet cells.

So, there is a superposition of two phenomena : the 2D buffet phenomenon at St = 0.06-0.07, which is independent of the sweep angle and the 3D phenomenon for which the frequency increases with the sweep angle. Based on the literature, URANS simulations can produce accurate solutions of transonic buffet, but are sensitive to turbulence model and numerical parameters [1,2]. This has motivated many studies using hybrid RANS/LES simulations for 2D [1] and 3D [3,4] configurations. However, to the author's knowledge, the 3D studies of transonic buffet in the literature have been carried out on half-wing body configurations. This motivates this study on simplified configurations in order to get more insight into the phenomenological differences between 2D and 3D buffet. Figure 3 shows an isosurface of Q criterion of a currently running ZDES simulation for a 3D wing at a sweep angle of 30°. A POD and a DMD will be performed to separate the 2D and 3D buffet phenomena.

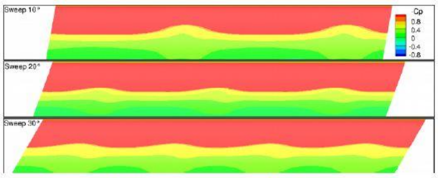

Figure 1: Pressure coefficients over infinite swept wings in buffet conditions

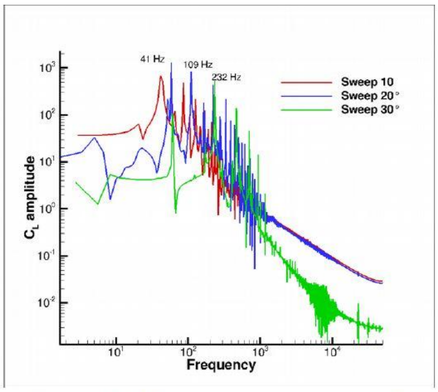


Figure 2: Lift coefficients spectrum for several swept wings in buffet conditions

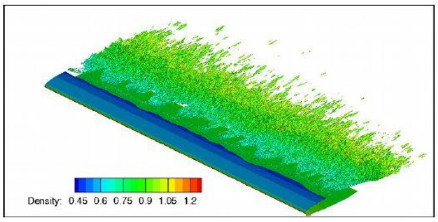


Figure 3: Q criterion isosurface colored by density

## References

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