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Experimental and numerical investigations on large fuselage configurations

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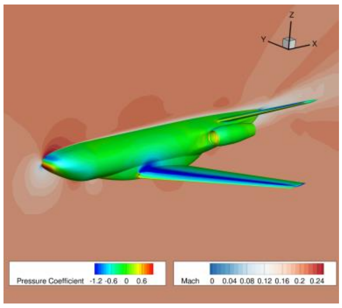
Abstract
The present paper describes the results of an experimental investigation, part of the Clean Sky 2 Airframe ITD project, aiming at measuring the impact of the fuselage width on aircraft aerodynamic performance and stability. The ONERA MYSTIC Overall Aircraft Design (OAD) tool was used to perform the preliminary design of aircraft geometries considering a multi-disciplinary optimization process based on aerodynamics, structural, propulsion and handling qualities. Four tail shapes were selected (T, V, U and Pi tails illustrated in Figure 1.a) in combination with three fuselage cross-sections (cylindrical 2.5m wide, 3.50m wide and 4.50m wide), two variants of the fuselage nose (classical and ONERA NOVA adapted geometry illustrated in Figure 1.b) and two variations of the engine positions (on the side and above the fuselage) resulting in a total of 17 different configurations to which 4 tail-less configurations were added for comparison. With the aim of minimizing the installation time, a modular strategy has been adopted for the model manufacturing. The selected configurations were tested at 1/20 scale in the ONERA Lille L1 wind tunnel with the use of the PQR device, which allows performing measurements while the model is dynamically rotated in both angle of attack and sideslip. Measurements in the wind tunnel were performed using a 6 components balance as well as pressure taps distributed in the wing and the rear part of the fuselage geometries. Particle Image Velocimetry (PIV) measurements in the wake of the aircraft were also performed to identify the modification of the wake induced by the larger fuselage shape. The measurements of the wind tunnel are compared in this paper to CFD computations performed considering a Reynolds Averaged Navier-Stokes (RANS) modelling of the flow and an analysis of the advantages and drawbacks of each configuration is presented. Finally, conclusions are drawn on the limitations of the preliminary sizing methods and suggestions are made for improving prediction accuracy for future campaigns.

a) Illustration of the tail shapes manufactured for the Wind tunnel test campaign



b) CFD Modelling of the flow around the Large Fuselage 3,50m configuration equipped with V-Tail and NOVA nose

Figure 1 – Illustration of the shapes for the Wind tunnel test campaign