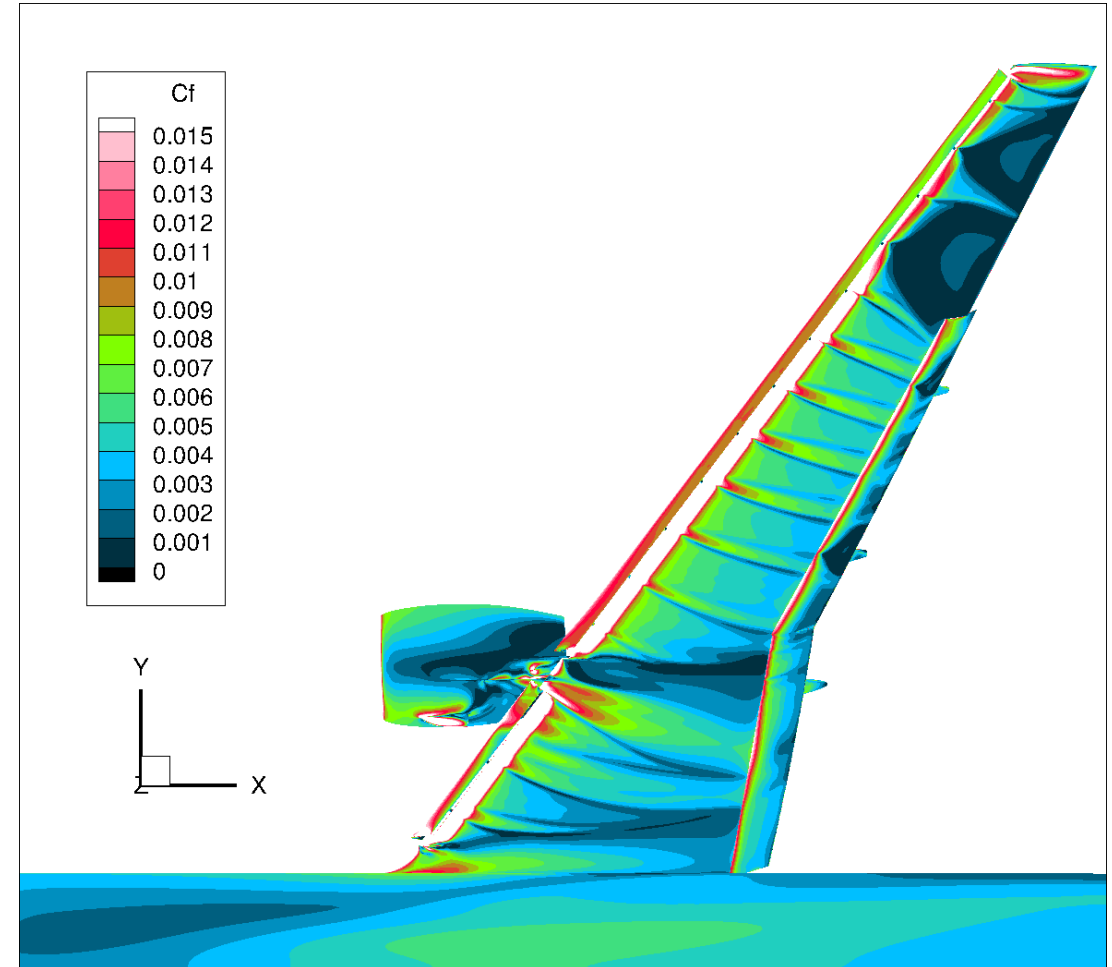# CFD Simulation Methods for High-Lift Aircraft Configurations (Part 1) – RANS modelling sensitivities

Based on the paper presented at AIAA Aviation 2022

T. Fitzgibbon, P. Spalart, J. Bungener and Q. Wang., "An Analysis of Modeling Sensitivity Effects for High Lift Predictions Using the Flow360 CFD solver", Chicago, IL, 2022, AIAA Aviation Forum and Exposition

Introduction

- Work performed as part of the AIAA High-Lift Prediction Workshop

- High-Lift predictions involve complex flow physics.

- Aim to establish RANS best-practices for High-Lift flows.

- Compare RANS results with DES predictions. (Part 2)

Skin friction contours for a RANS solution at α=19.57°

BUILT BY FLEXCOMPUTE – A SOLVER TECHNOLOGY COMPANY

Flow Conditions + Meshes

- Geometry: HL-CRM (half-body)

- Focus on the C_{Lmax} study,
  - M_∞=0.2, Re No. = 5.49 million
  - α - sweep from 2.78° to 21.47°
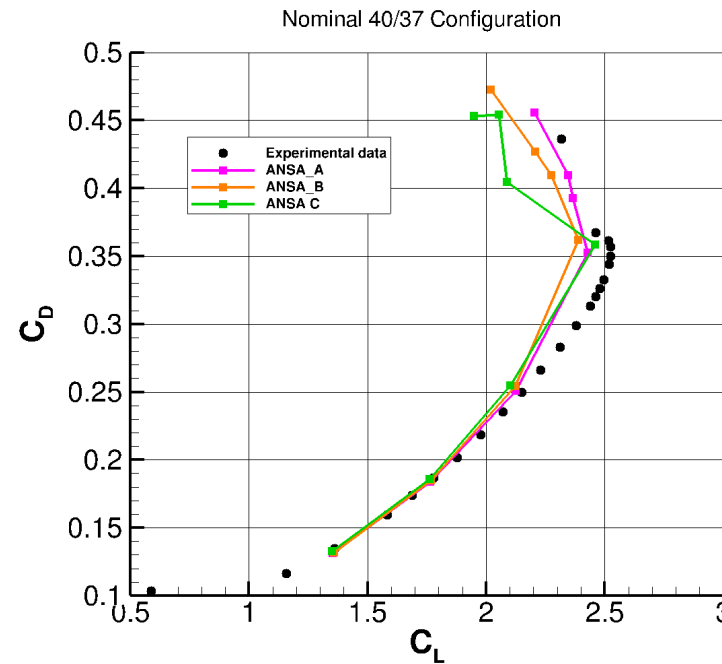- Committee and non-committee grids used

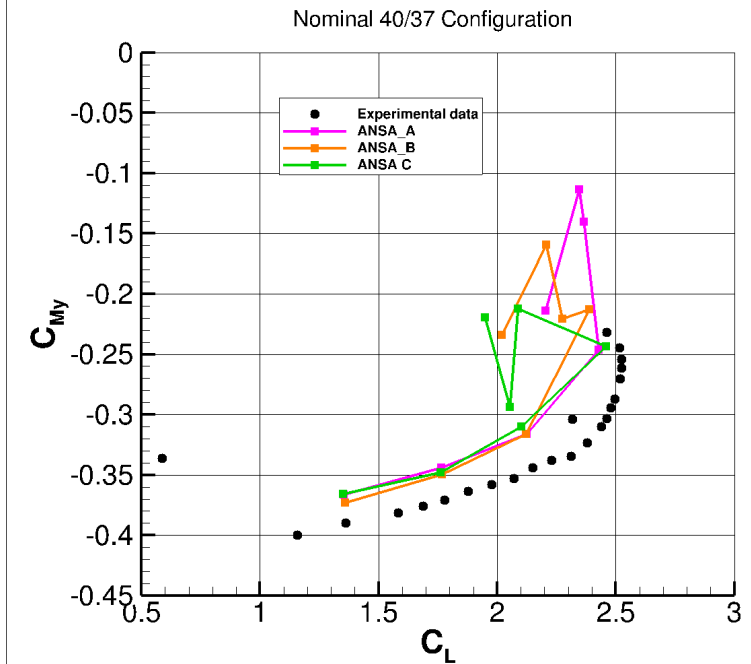|	ANSA	Pointwise
Level A	68M	12M
Level B	138M	32M
Level C	**218M**	91M
Level D		**209M**

Meshing Sensitivity
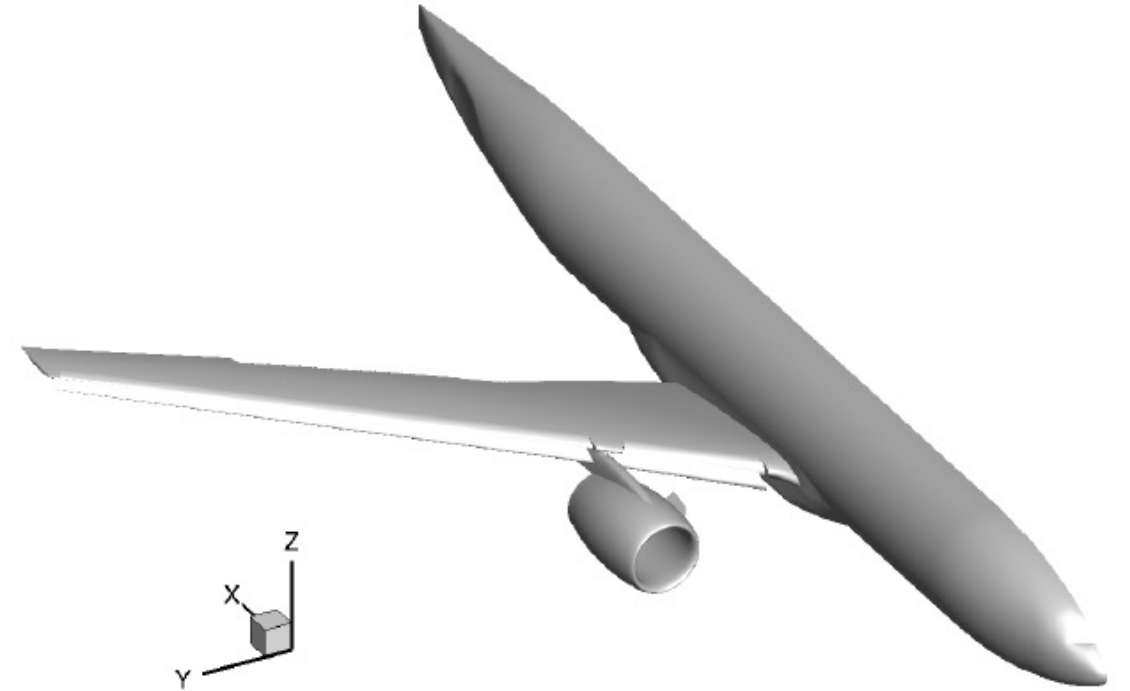
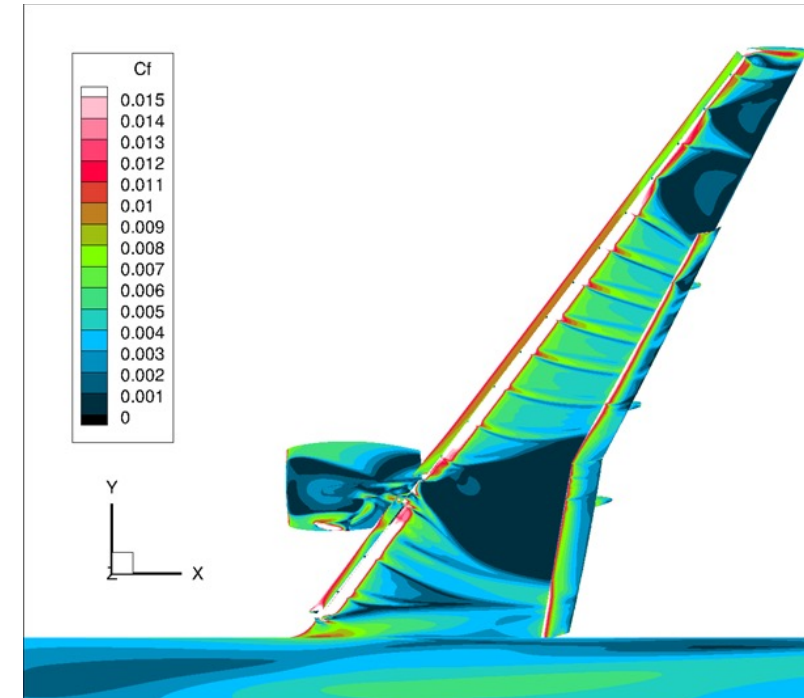- Effect of mesh refinement (ANSA grids)

C_L vs alpha
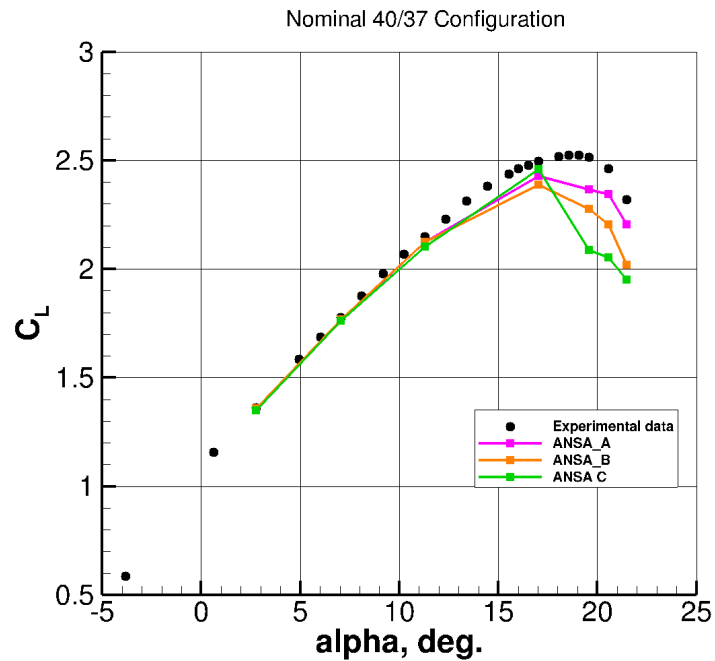
C_D vs C_L

C_M vs C_L

Meshing Sensitivity

- Effect of mesh refinement (ANSA grids) – Skin Friction contours at α =19.57°

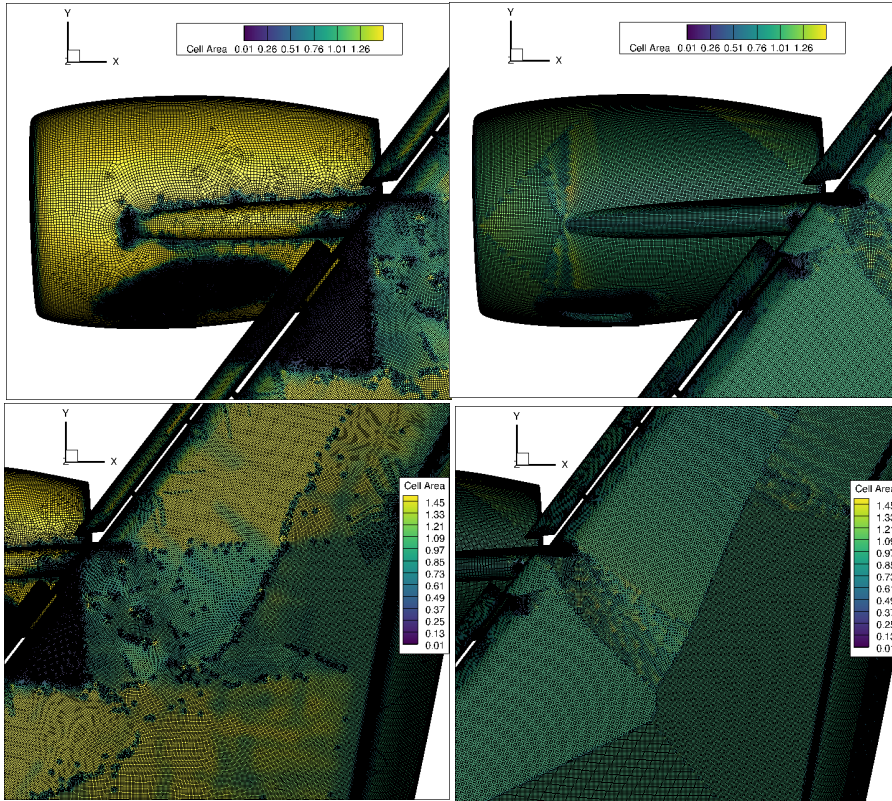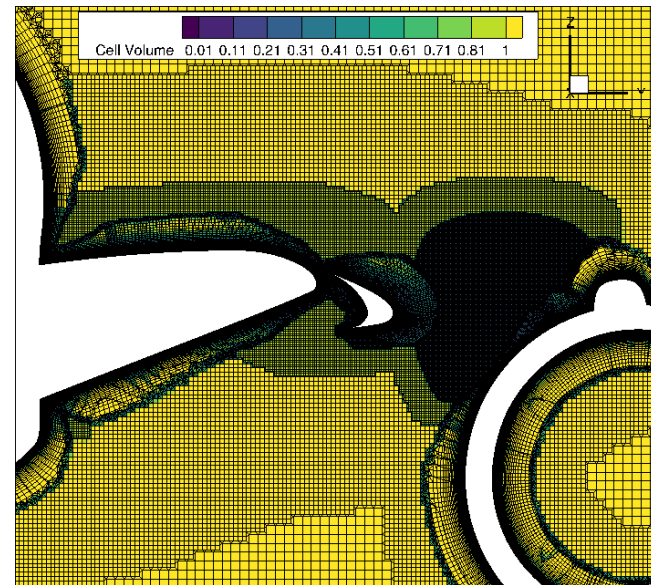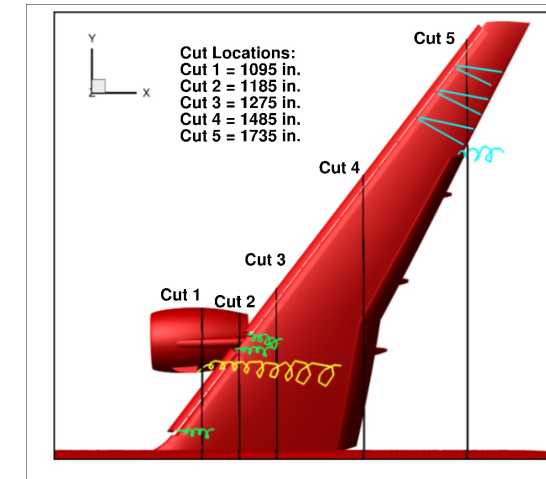**ANSA A**   **ANSA B**   **ANSA C**
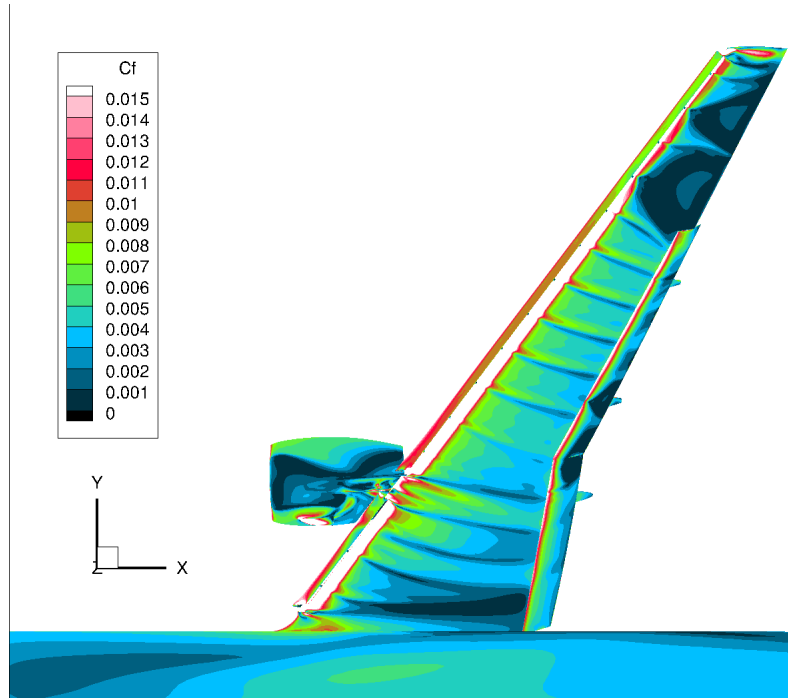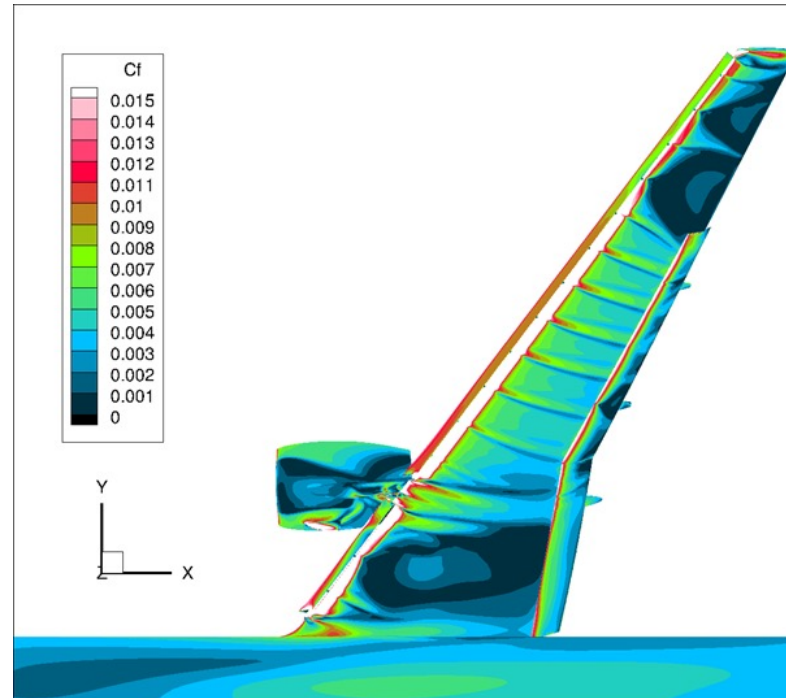
Meshing Sensitivity

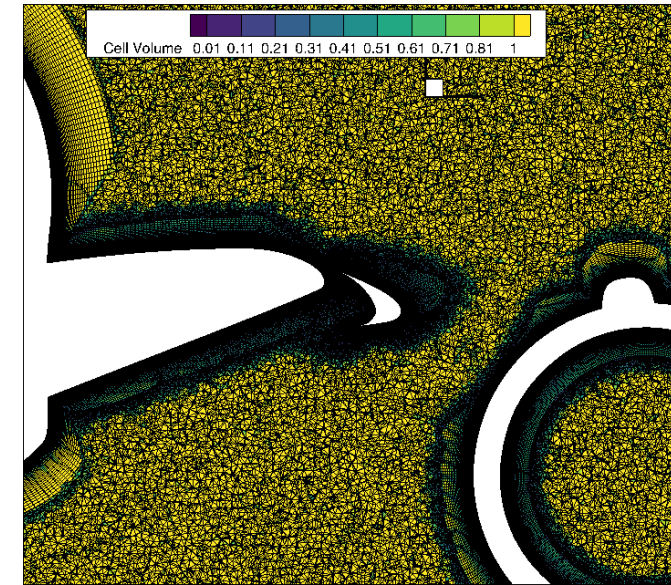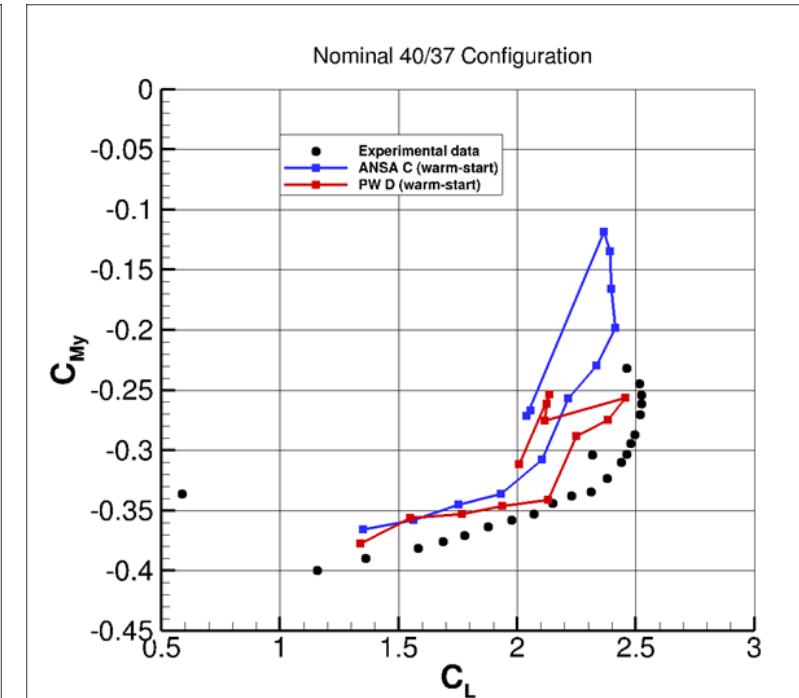- Effect of grid family – Pointwise vs ANSA grids

ANSA   Pointwise
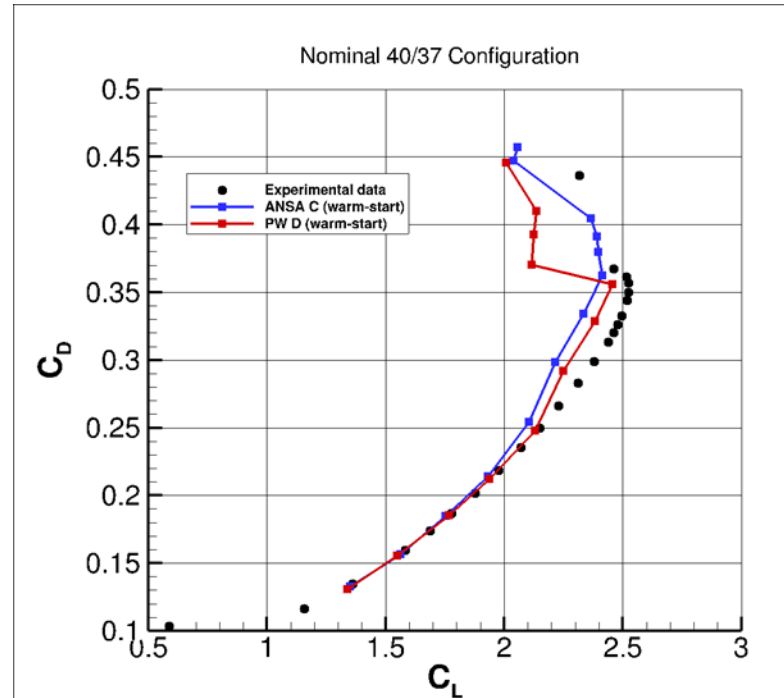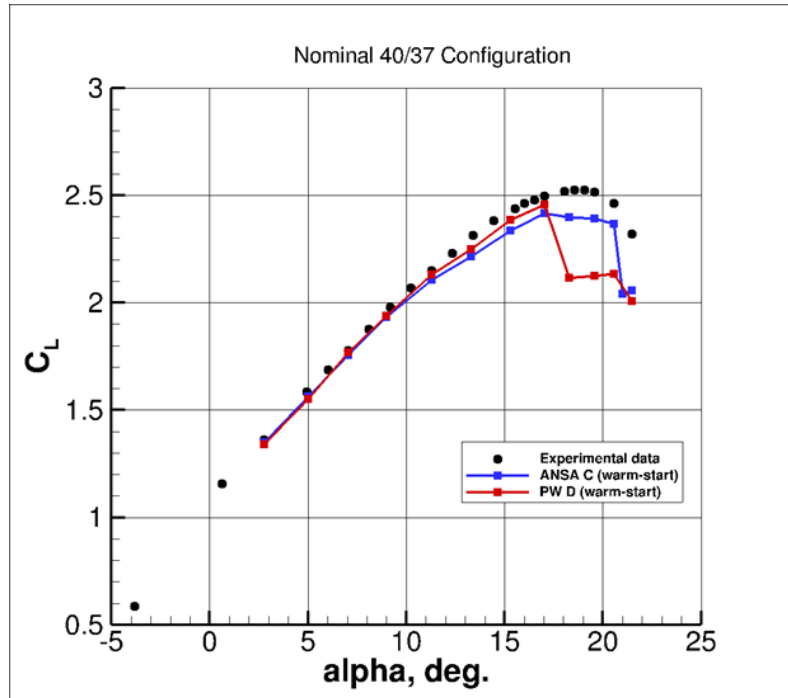

ANSA   Pointwise

Cut 1

Meshing Sensitivity

- Effect of grid family – Pointwise vs ANSA grids, SA, warm-started

C_L vs alpha

C_D vs C_L

C_M vs C_L

Meshing Sensitivity
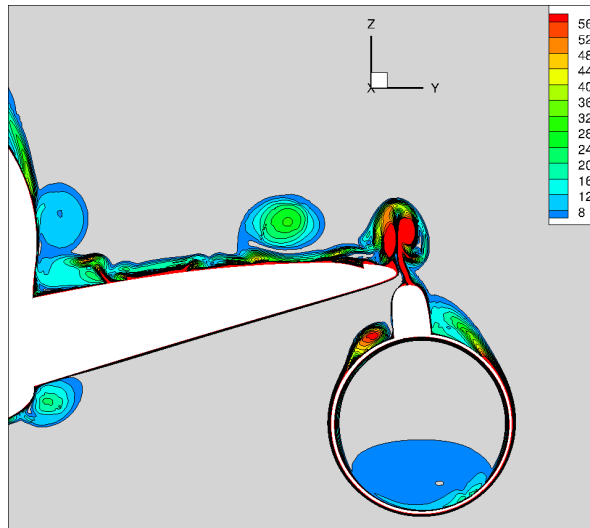
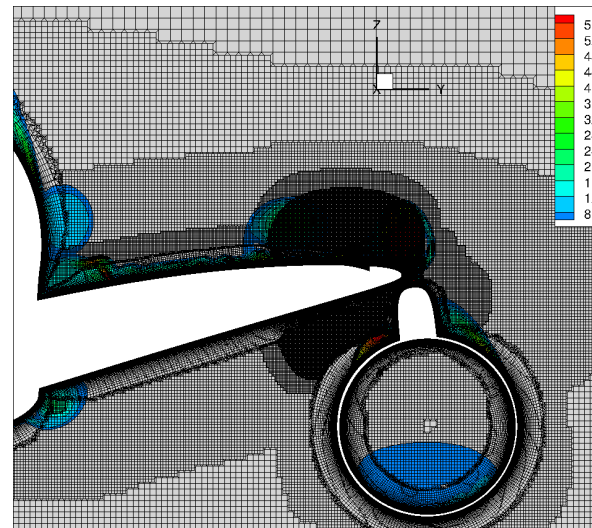- Effect of grid family - skin friction contours α =19.57°
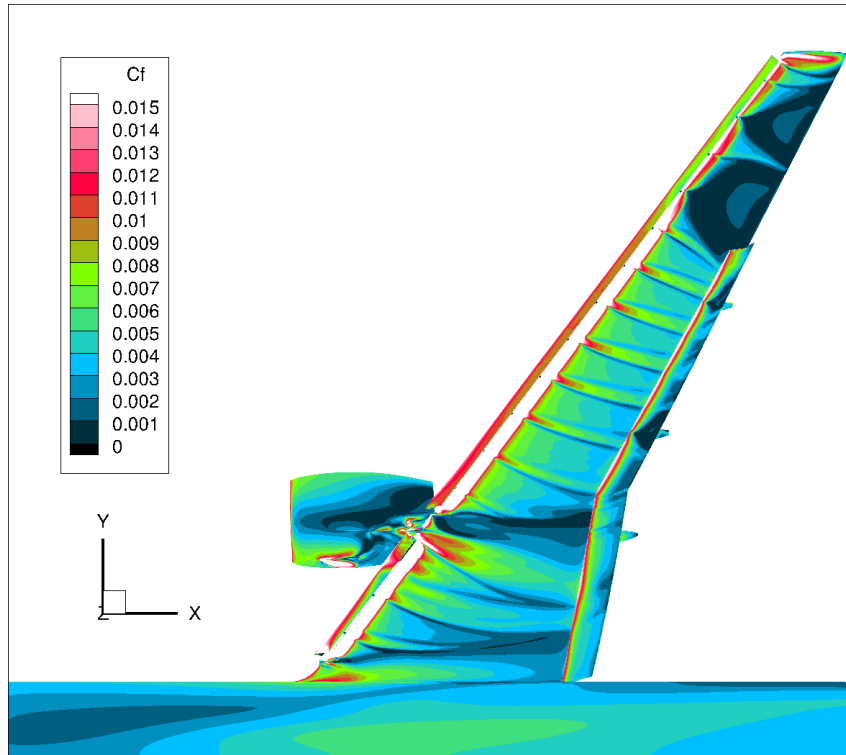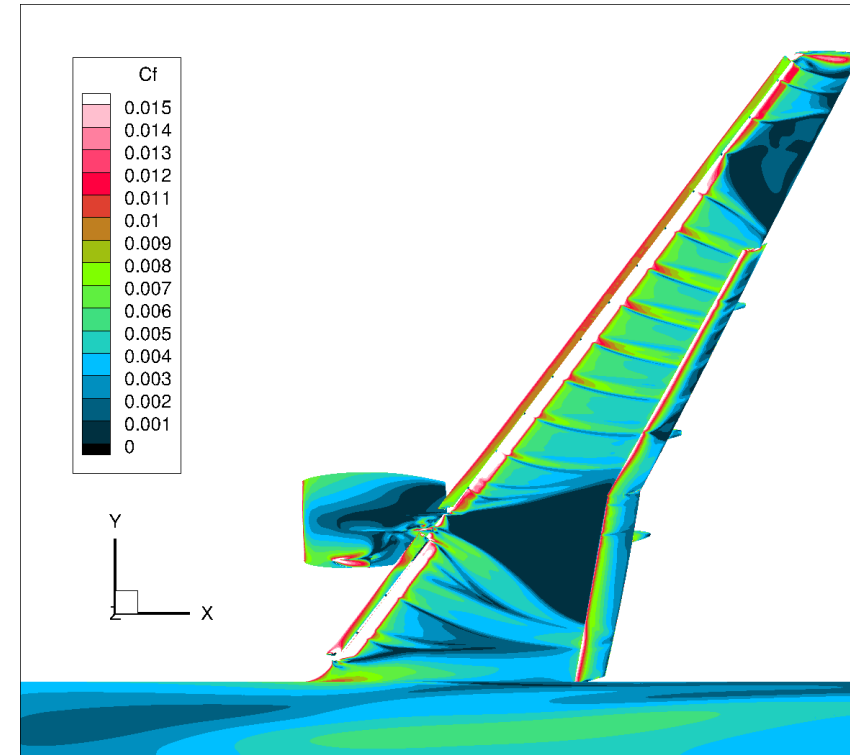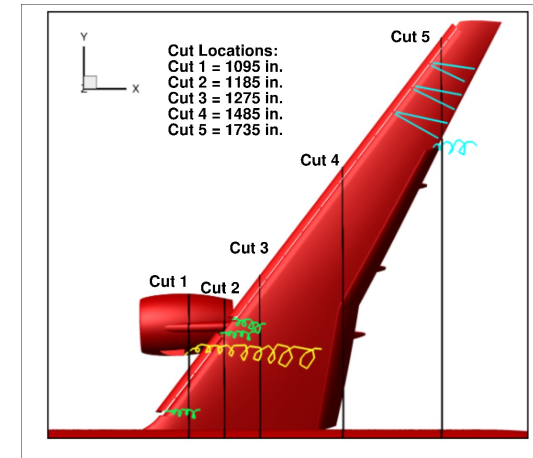

ANSA

Pointwise

Meshing Sensitivity
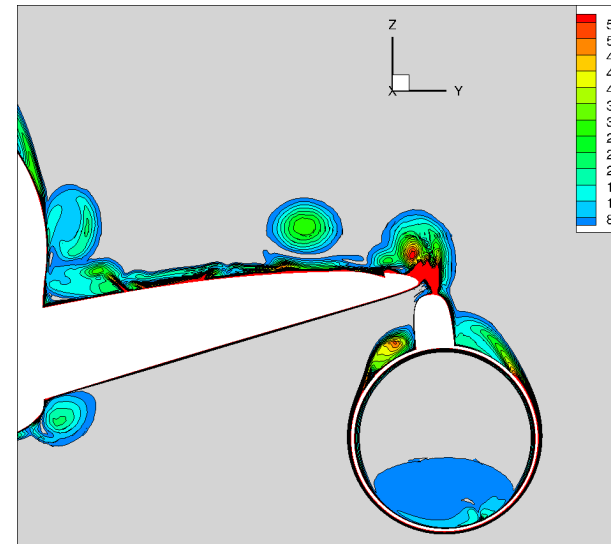
- Effect of grid family off-body vorticity contours at α =19.57° (cut 2)

ANSA

Pointwise
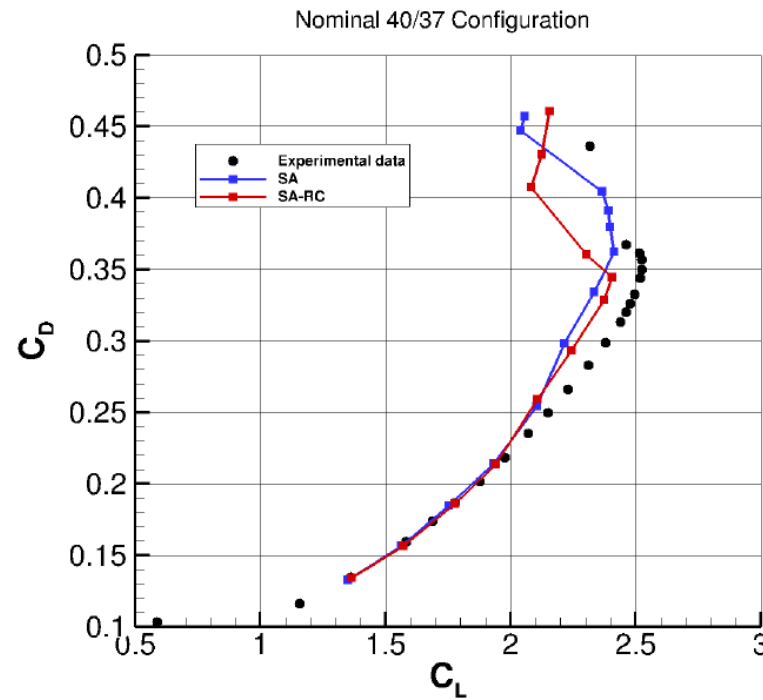
Turbulence Modelling Sensitivity
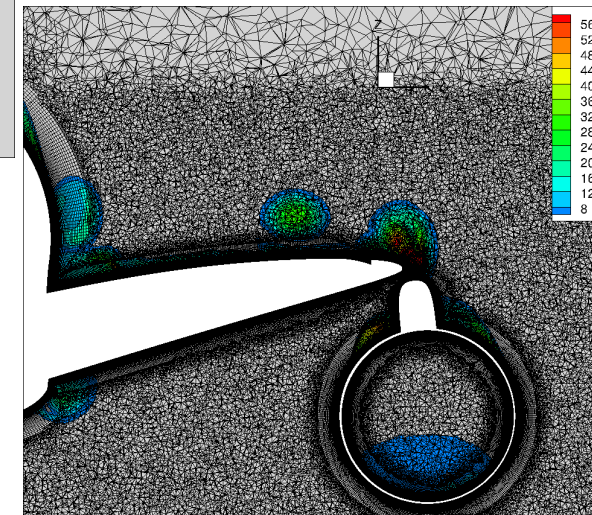
- Effect of RC correction – C level grid, warm-started

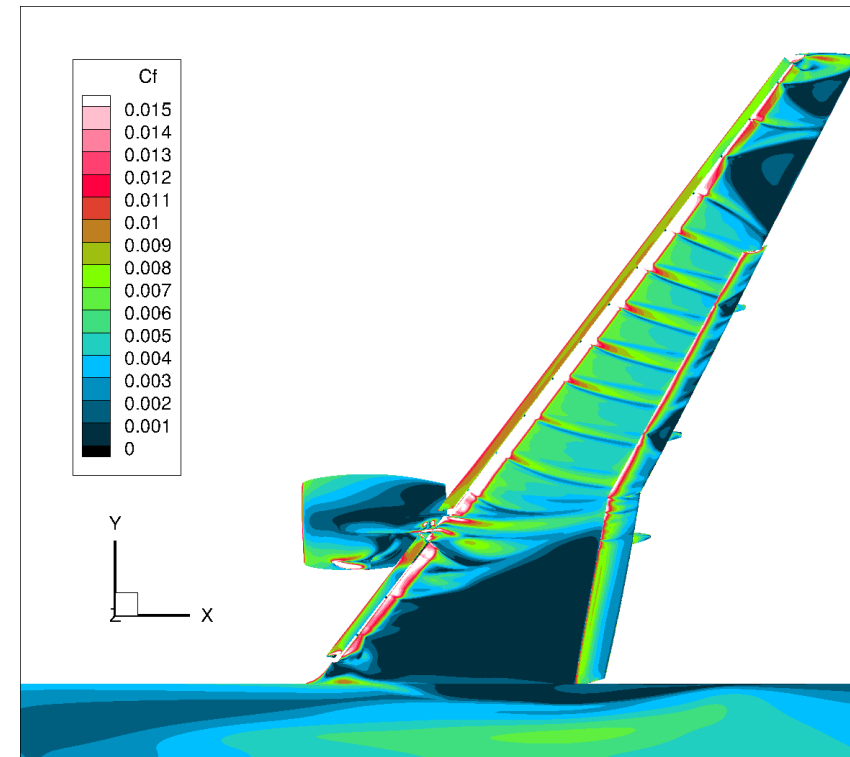C_L vs alpha C_D vs C_L C_M vs C_L

Meshing Sensitivity
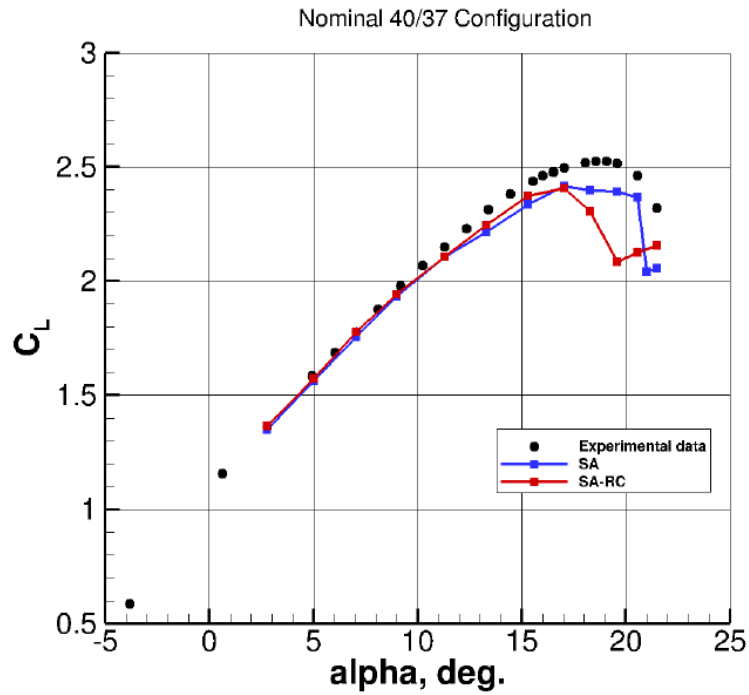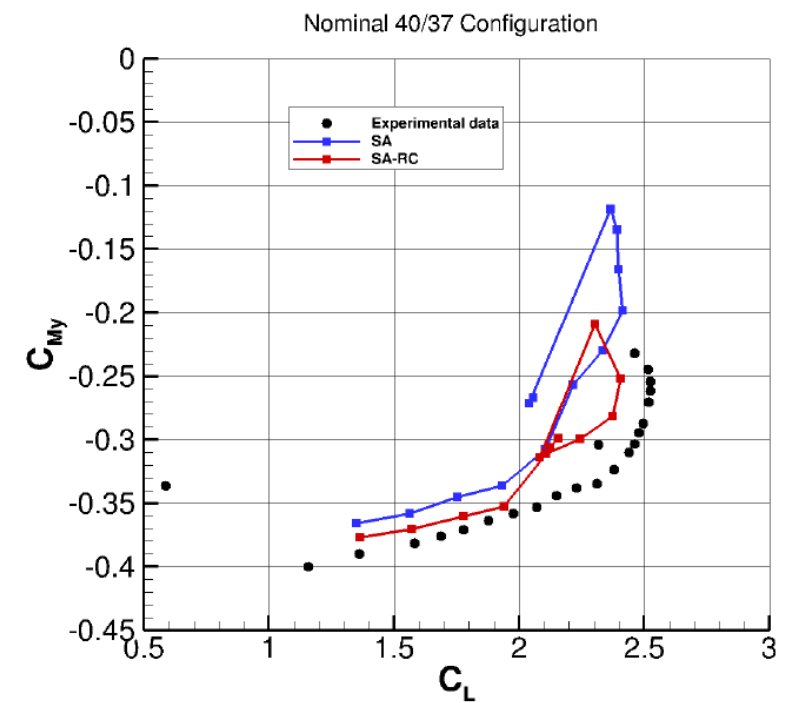
- SA vs SA-RC – Skin Friction contours at α =19.57°

SA

SA-RC

Meshing Sensitivity
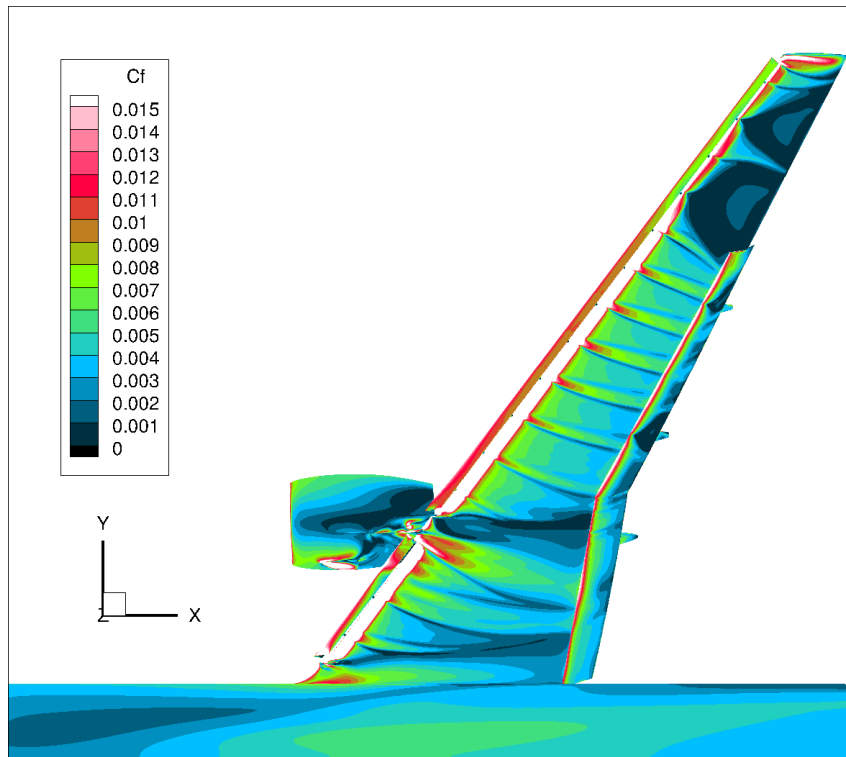
- SA vs SA-RC – Off-body vorticity α =19.57° (Cut 2)
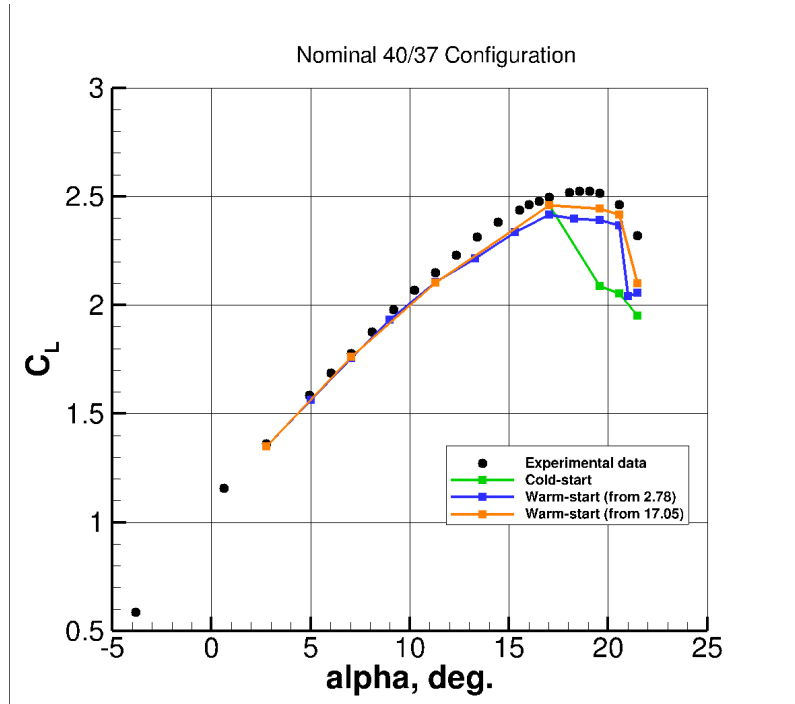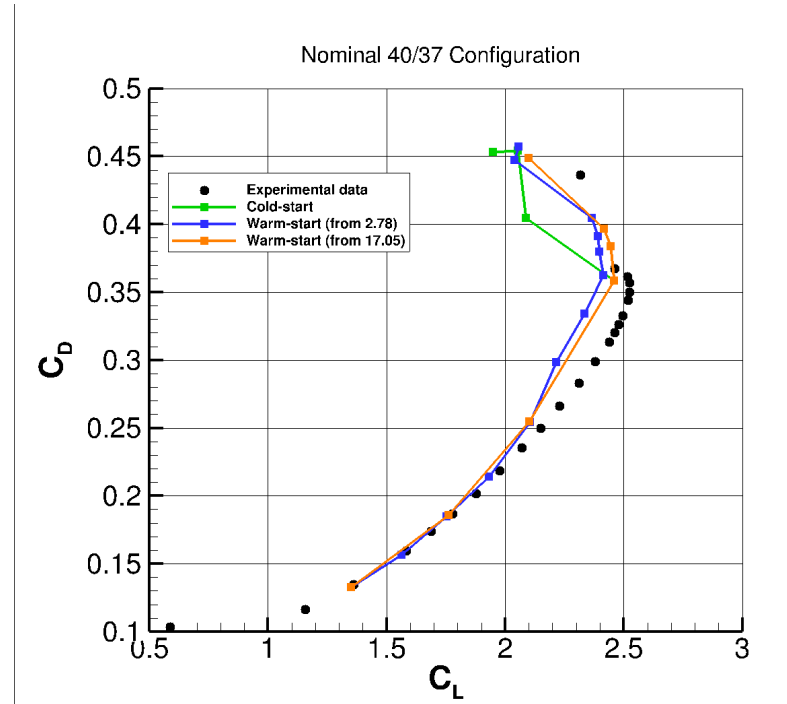

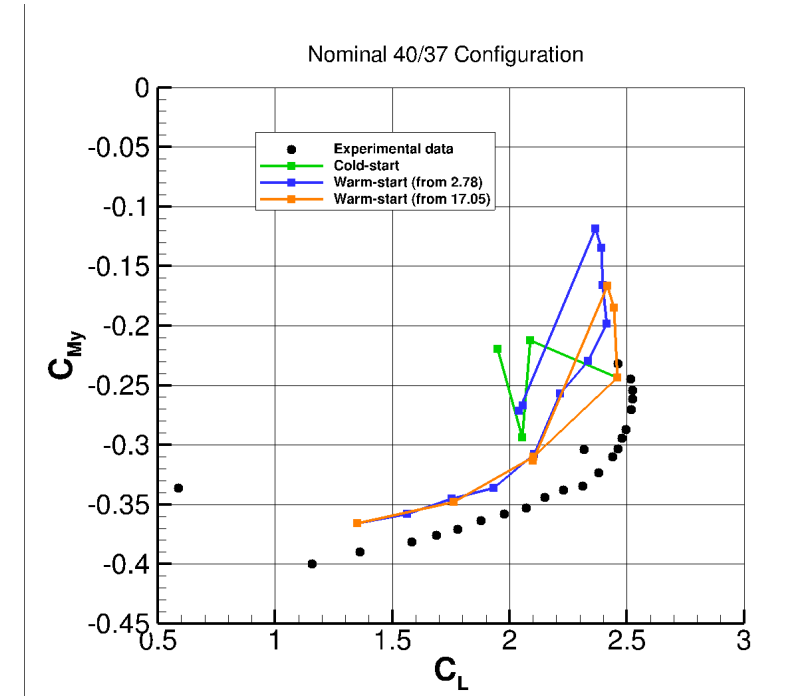**SA**

SA-RC

Solution Approach Sensitivity
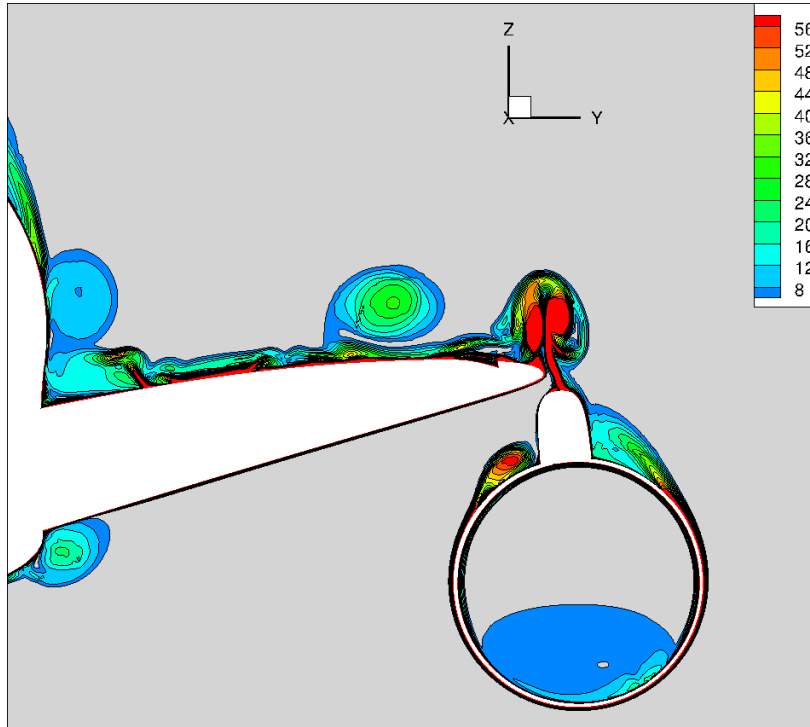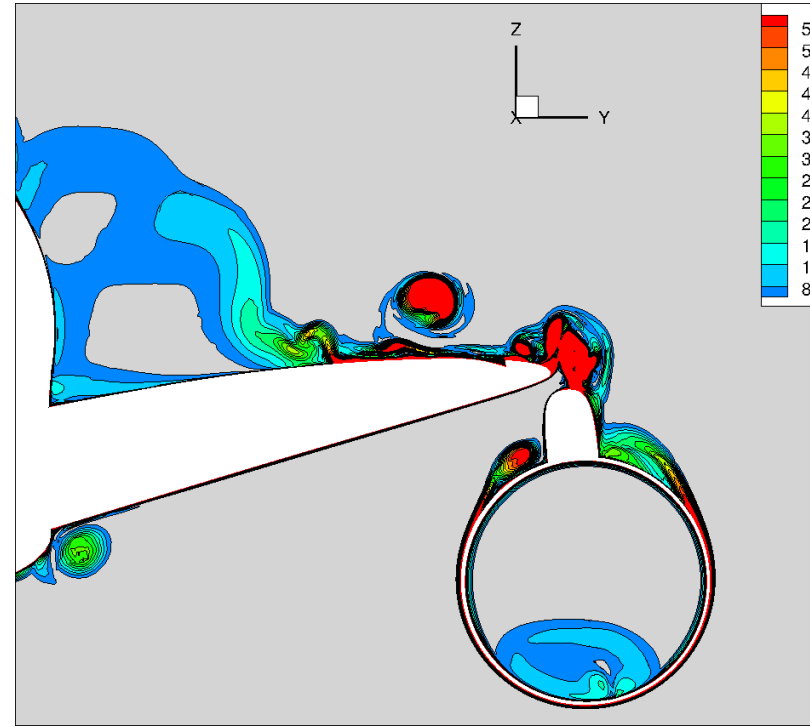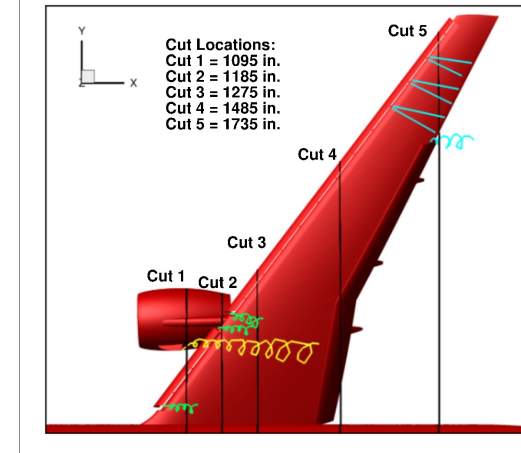
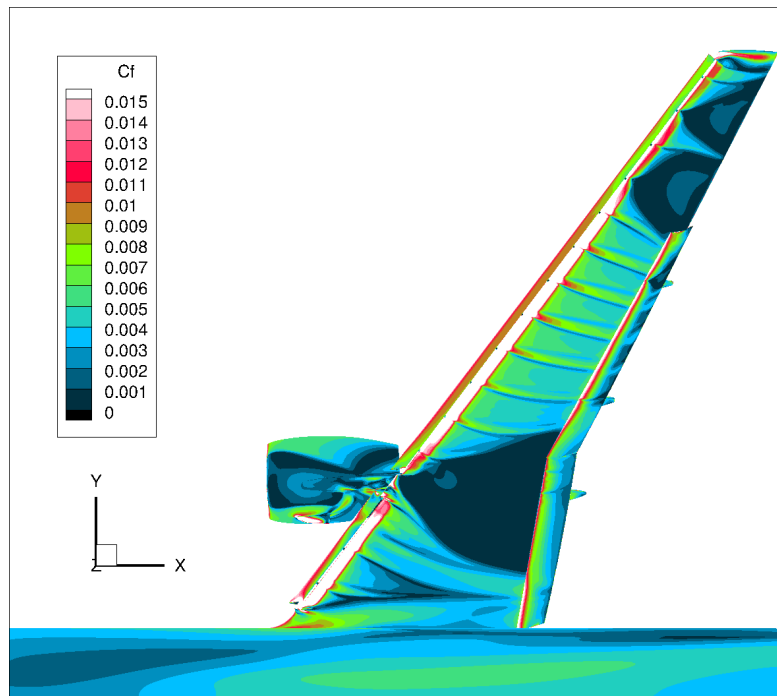- Cold-starts vs Warm-Starts, ANSA C grid with SA model
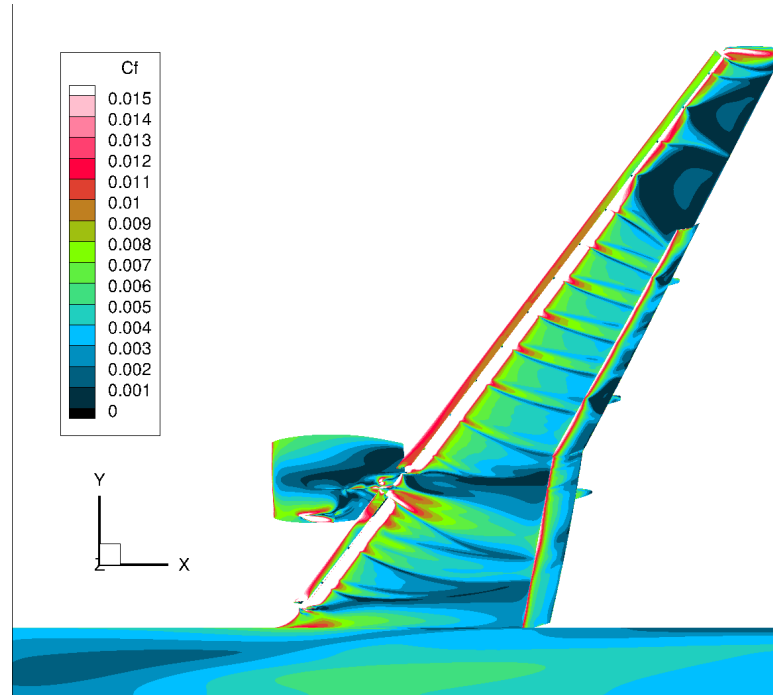

C_L vs alpha

C_D vs C_L

C_M vs C_L

Solution Approach Sensitivity
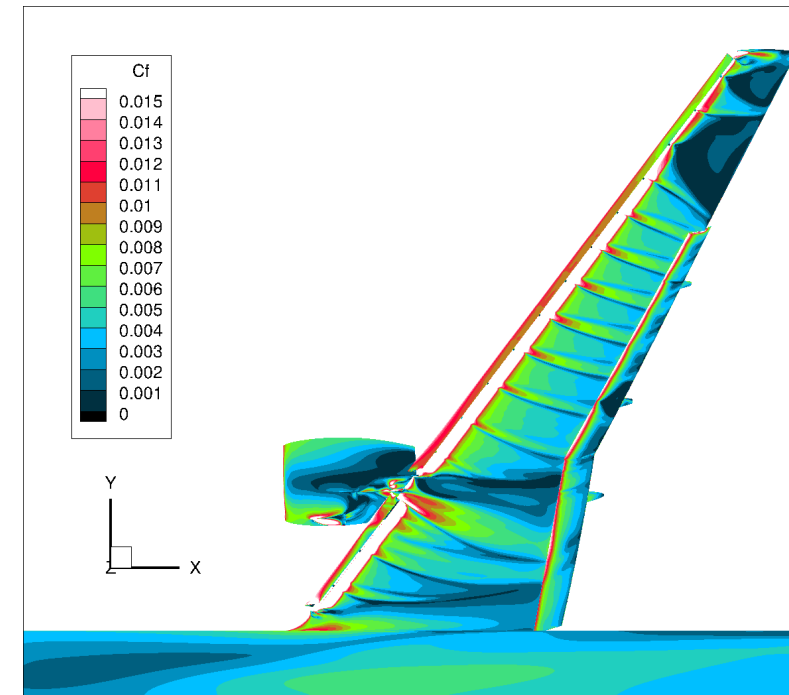
- Cold-starts vs Warm-Starts - Skin Friction contours at α =19.57°

Cold-start   **Warm-start from 2.78°**   **Warm-start from 17.05°**

RANS Sensitivities - Conclusions

- RANS solutions significant modeling sensitivities for high-lift predictions:
  - Mesh sensitivity
  - Initial condition sensitivity
  - Turbulence modeling sensitivity

  Best-practice result: ANSA C warm-started with SA model

Skin friction contours for a RANS solution at
α=19.57°