High Lift Workshop 6
Test Case 1 – Transient Simulations

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RANS TFG Meeting – September 23, 2026

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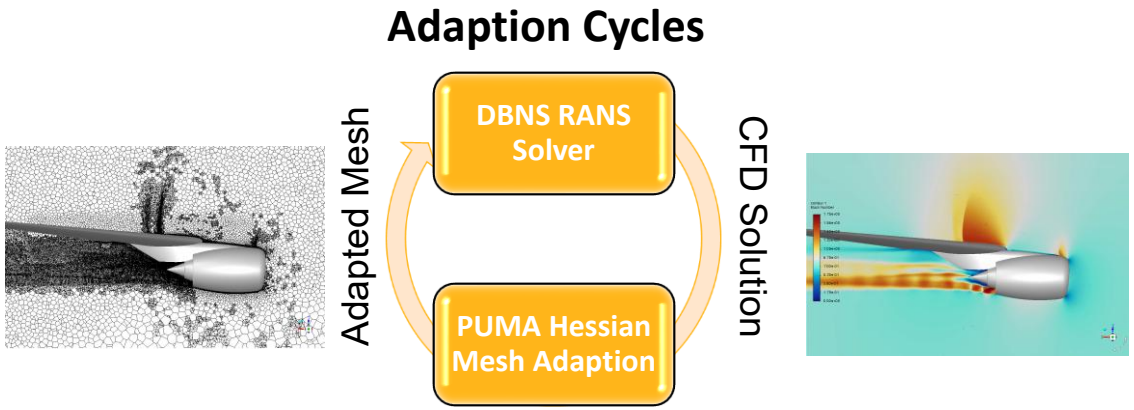
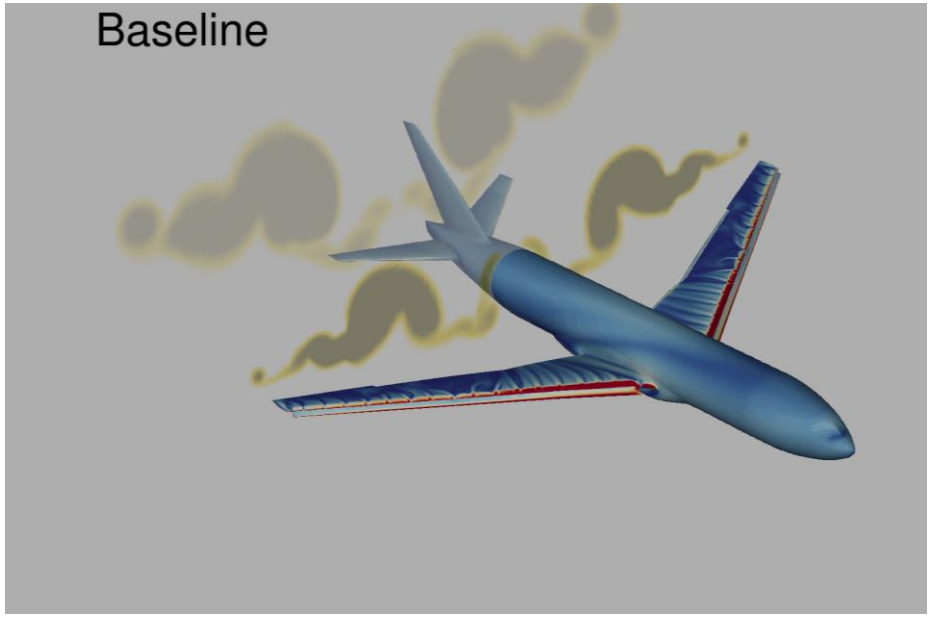
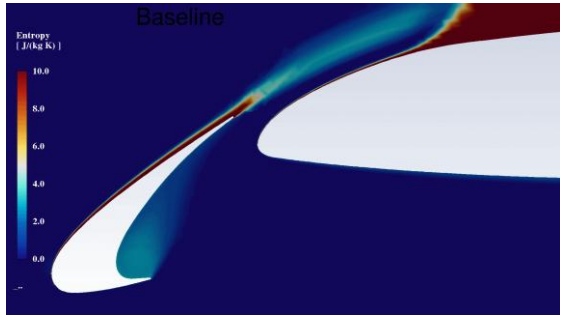
CFD Methodology – RANS (Fixed-grid & Adapted)

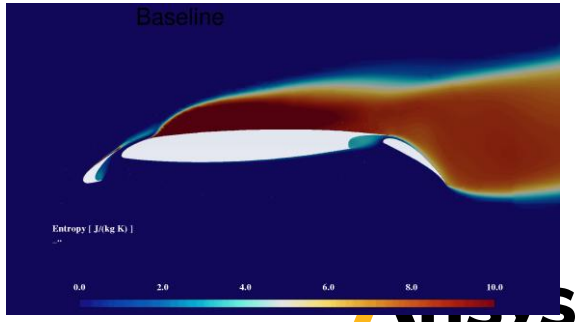
- **Solver Settings & Models**
  - Similar approach to what has been used during HLPW5
  - **RANS**
    - DBNS (Density Based Solver): Coupled Roe-FDS
    - Spatial discretization: 2nd Order Upwind
    - Iteration method: Implicit Euler, local time-stepping (steering to reach max CFL)
    - Initialization method: Full Multi Grid (FMG), cold start
    - Turbulence model – **SA**
    - Air as Ideal Gas with temperature dependent properties
    - Workshop provided meshes: Pointwise – HexVol (F1) – Quad dominant
  - **Mesh Adaption**
    - PUMA – Polyhedral Unstructured Mesh Adaption
    - Isotropically refines or coarsens cells
    - Used Combined Hessian Indicator - Entropy
      - Primitive of RANS (Density, Pressure, Velocity & Temperature)
      - Entropy
    - Solution interpolated between each adaption cycle
    - Number of Iterations per each adaption cycle - 2000
    - Wall surfaces and adjacent cells are not refined



HLPW5: Case 2.3 – AoA = 20.7°







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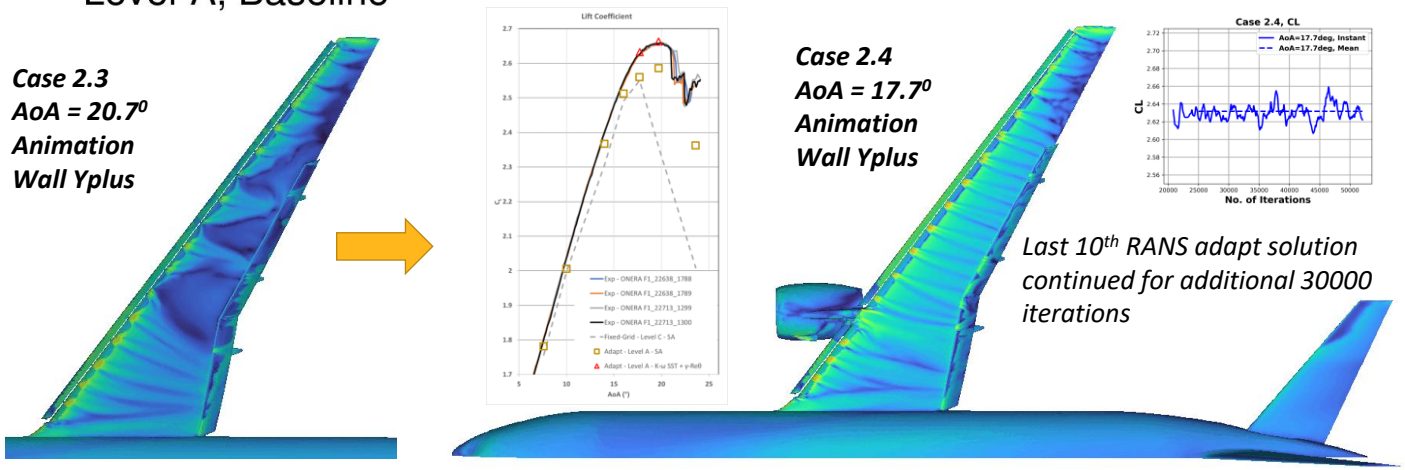
CFD Methodology – URANS & SBES (on Adapted RANS)

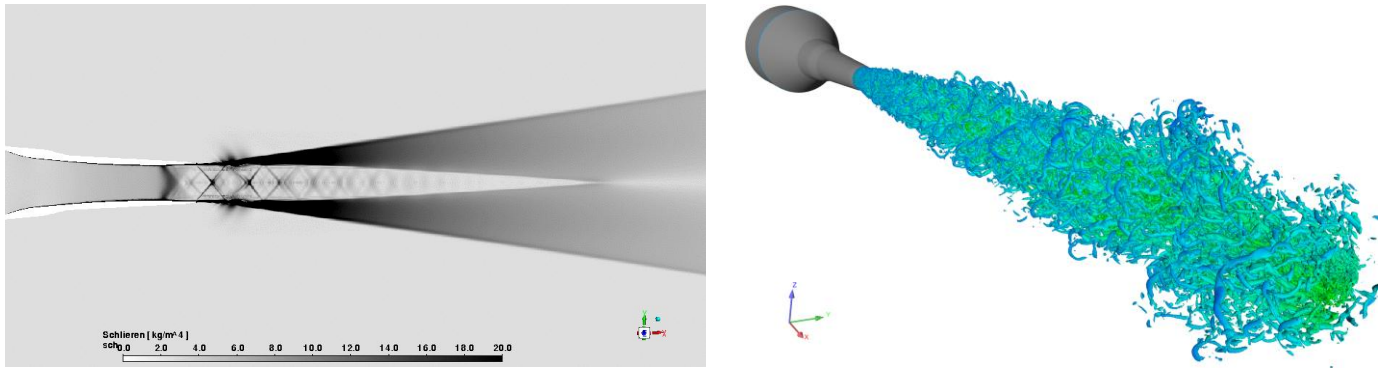
- **Solver Settings & Models**
  - **URANS**
    - Implicit DBNS (Density Based Solver): Roe-FDS
    - Spatial discretization: 2nd Order Upwind
    - Transient Formulation: Second Order Implicit with dual time stepping
    - Time step = 2.5e-5 sec; 15 iterations per time step
    - Initialization method: 2nd order Adapted RANS
    - Viscous models: **SA & k-ω SST + γ transport equation**
    - Corrections: **Crossflow Transition & Curvature Correction**
    - Air as Ideal Gas with temperature dependent properties
    - Workshop provided meshes: Pointwise – HexVol (F1) – Quad dominant
  - **SBES**
    - Similar to URANS
    - Subgrid-Scale Model: WALE
    - Workshop provided meshes: ANSA – HRLES grids generated by Embraer

RANS Laminar-Turbulent Transition Prediction for High Lift Configuration Aircraft
AIAA 2026-4018 Conference Paper
5th High Lift Prediction Workshop

Level-A, Baseline



High-Fidelity SBES Simulations for Supersonic Nozzle Exhaust
AIAA 2024-0753 Conference Paper
6th Propulsion Aerodynamics Workshop; Special Session – Nozzle



SBES accurately resolved the unsteady mixing layer behind the nozzle and hence correctly represented the TKE increase seen in experiments within the potential jet core region and produced a jet core length that is more consistent with experiments than U/RANS

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Case 1 – URANS SA – DBNS
AoA = 30°

From RANS SA – DBNS – CFL 15 + Mesh Adaption

Pointwise Hex Dominant Mesh

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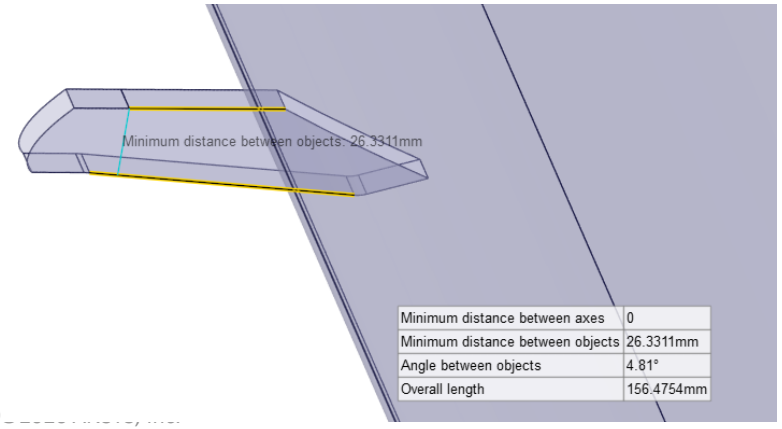
Case 1 – URANS SA in Fluent

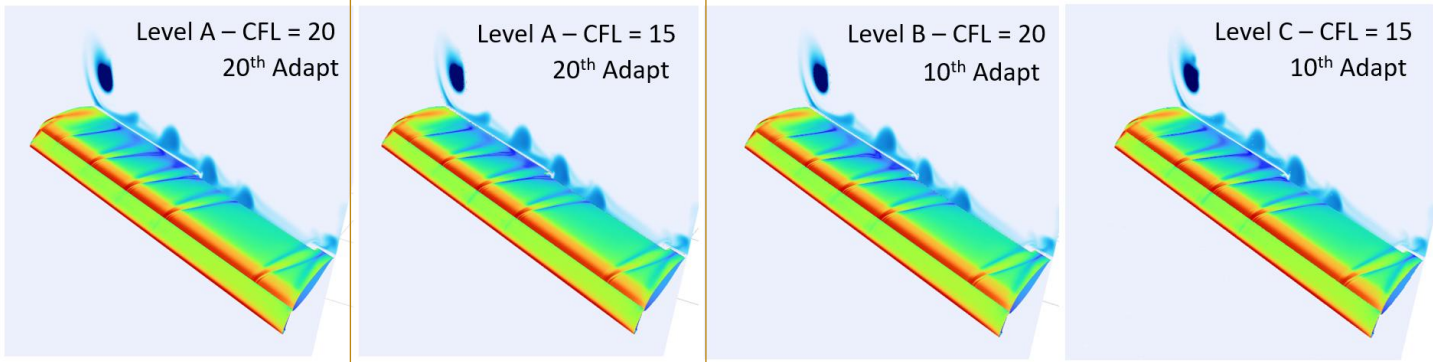
- Choose time step to capture slat bracket rolling vortices.
  - Slat brackets have the smallest characteristic length (2.6e-2m) when compared to the slat, flap and main wing.
  - Use 15 time steps to represent the characteristic time of the slat bracket ($c_{bracket}/U_\infty$)
  - $\Delta t \approx 2.5e\text{-}5sec$

Slat Bracket



May 2026 Presentation

Mesh Adaption on Level A, B & C Mesh at AoA = 30°



Level A – CFL = 20, 20th Adapt	Level A – CFL = 15, 20th Adapt	Level B – CFL = 20, 10th Adapt	Level C – CFL = 15, 10th Adapt
C_L = 2.298	C_L = 2.294	C_L = 2.301	C_L = 2.301
C_D = 0.4491	C_D = 0.4481	C_D = 0.4493	C_D = 0.4477
C_m = -0.03080	C_m = -0.02881	C_m = -0.03019	C_m = -0.02690
Cell Size = 245 M	Cell Size = 215 M	Cell Size = 184 M	Cell Size = 444 M

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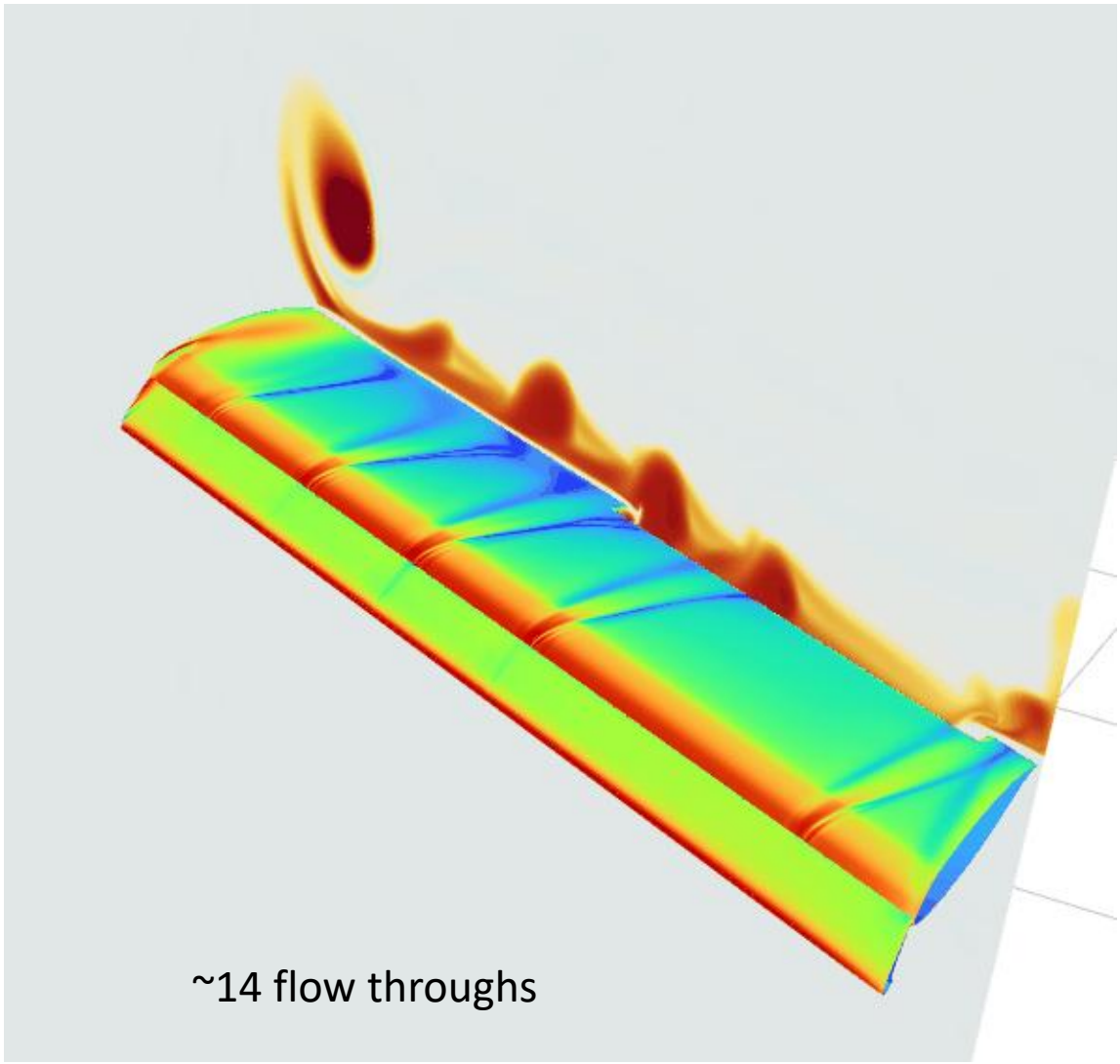
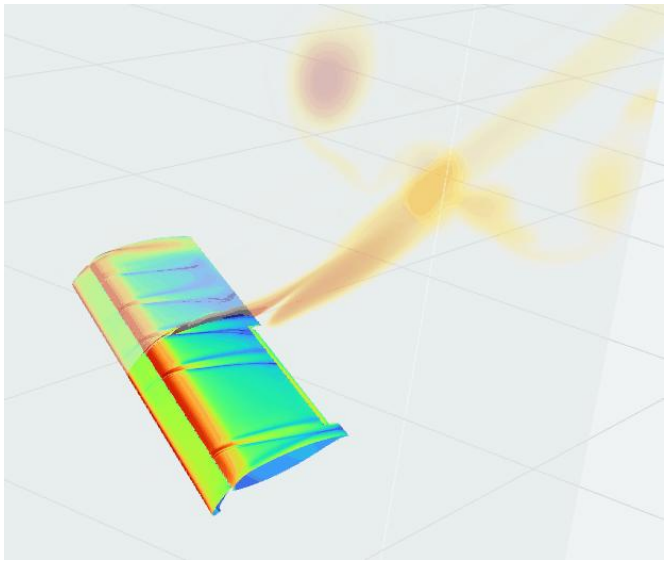
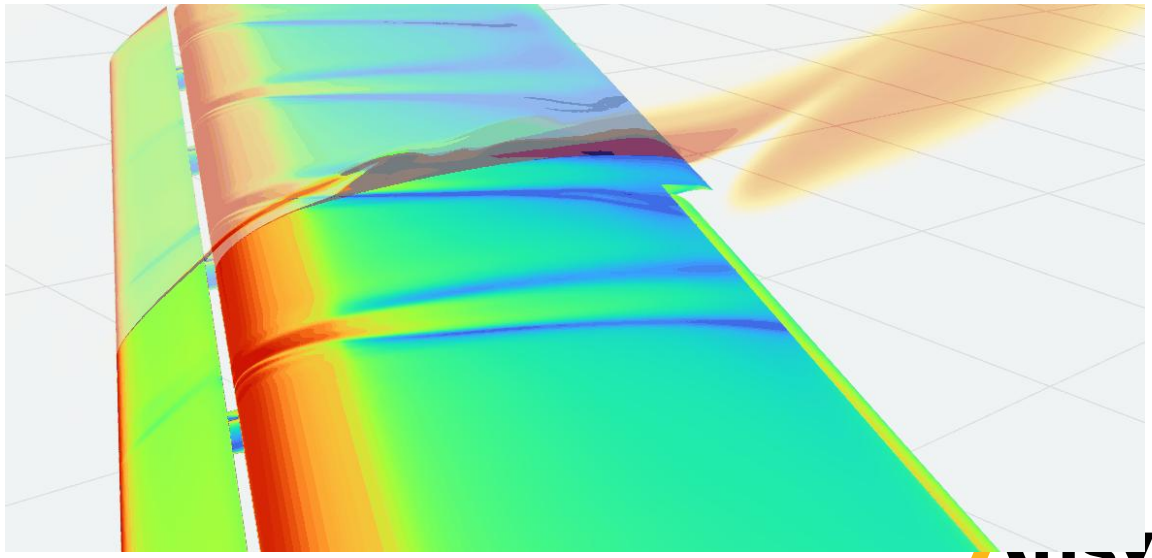
Case 1 – URANS SA on Pointwise Coarse Adapted Mesh at AoA = 30°







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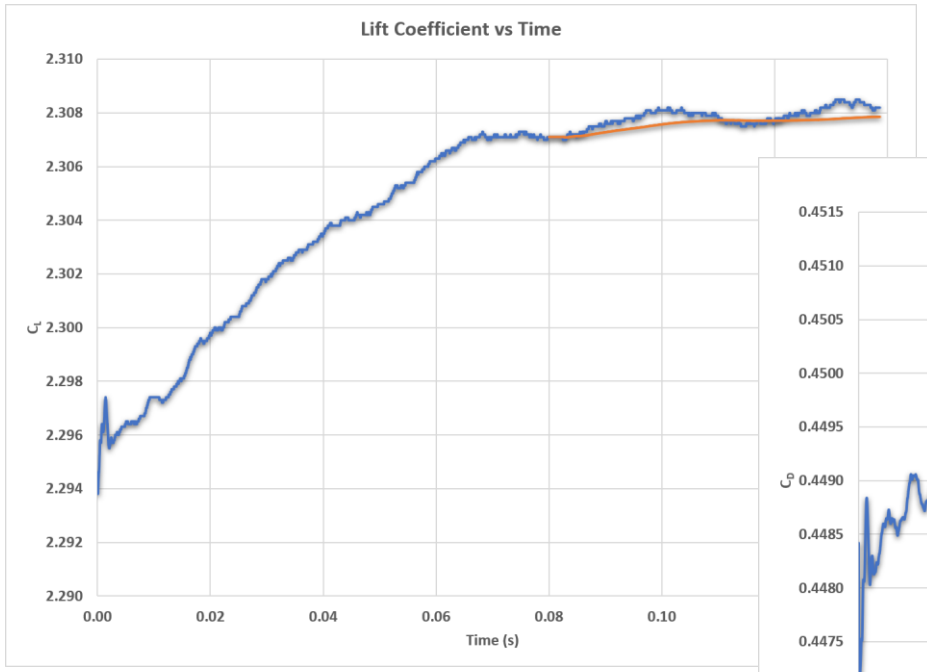
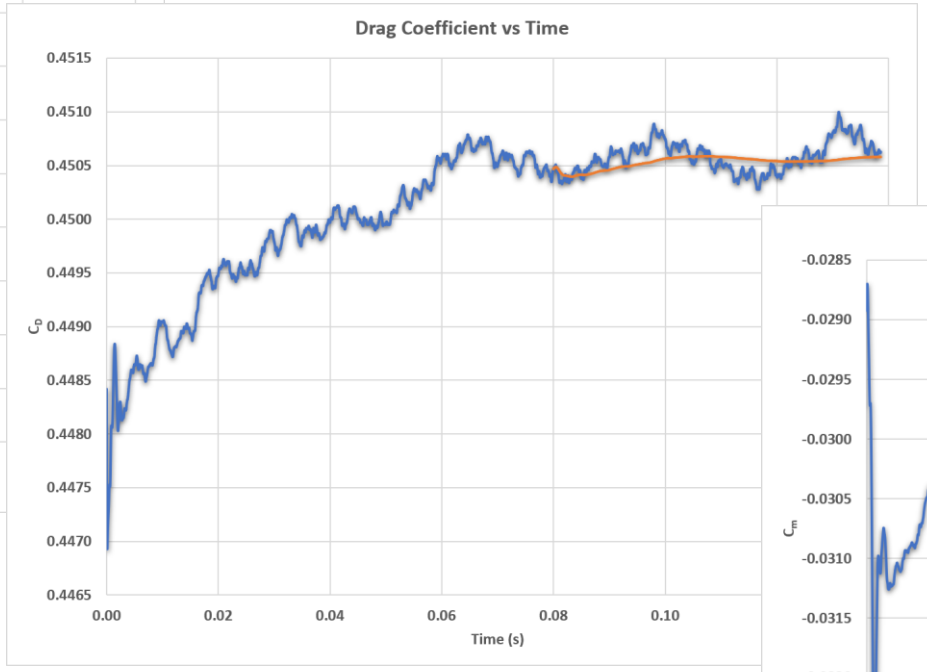
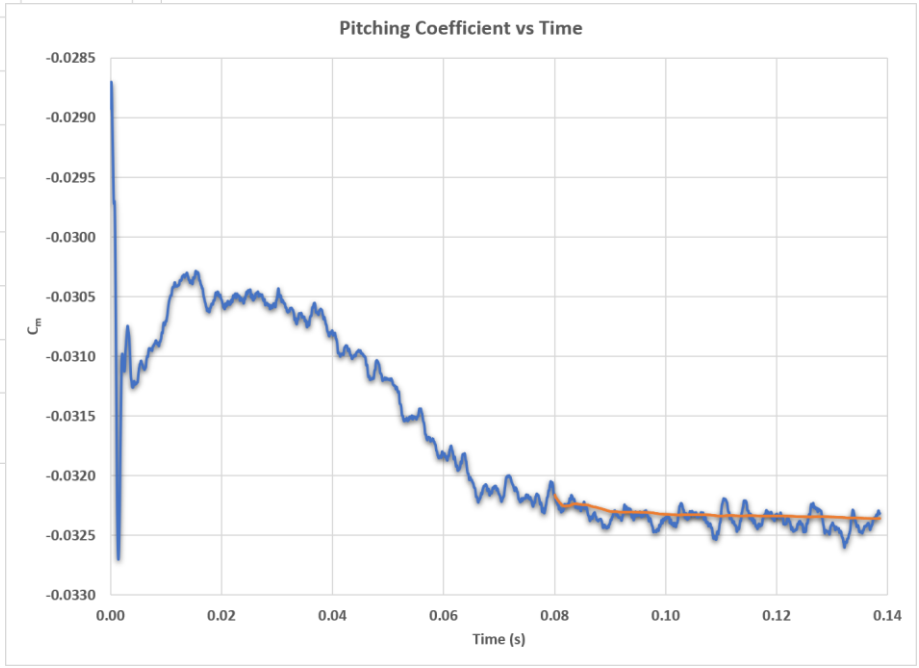
Case 1 – URANS SA on Pointwise Coarse Adapted Mesh at AoA = 30°







C_L		C_D		C_m	
Avg.	σ	Avg.	σ	Avg.	σ
2.308	3.56e-4	0.4506	1.44e-4	-0.03236	7.87e-5

Taken after 0.08 sec (~6 flows over the wing)

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Case 1 – RANS & URANS k-ω SST – DBNS Transition + Crossflow + CC AoA = 30°

Ansa Coarse Mesh

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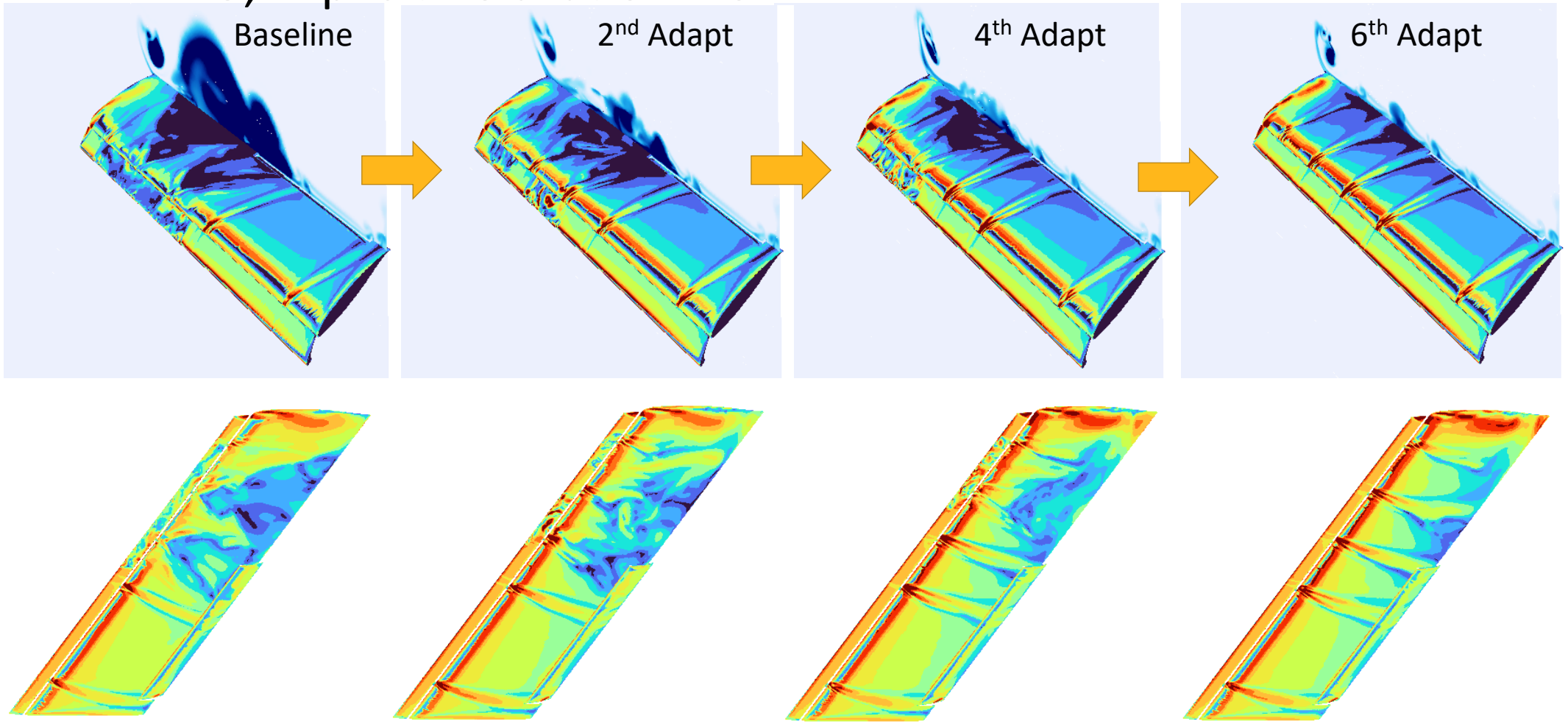
Case 1 – RANS Mesh Adaption at AoA = 30°

CFL = 15, Explicit Relaxation = 0.4



k-w SST Intermittency, Curvature Correction, Cross-Flow Transition

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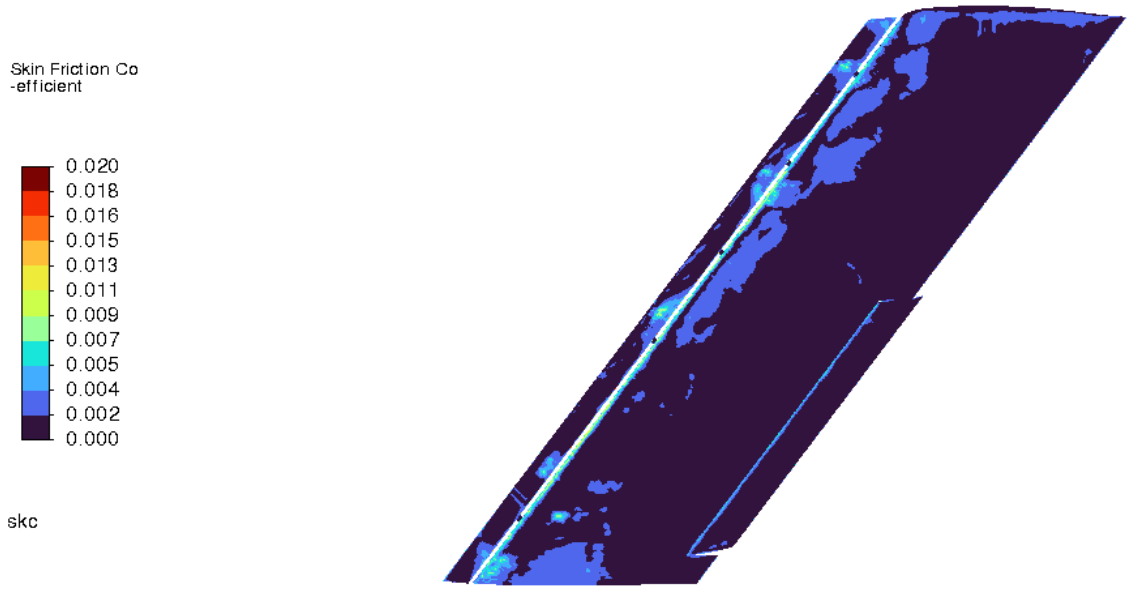
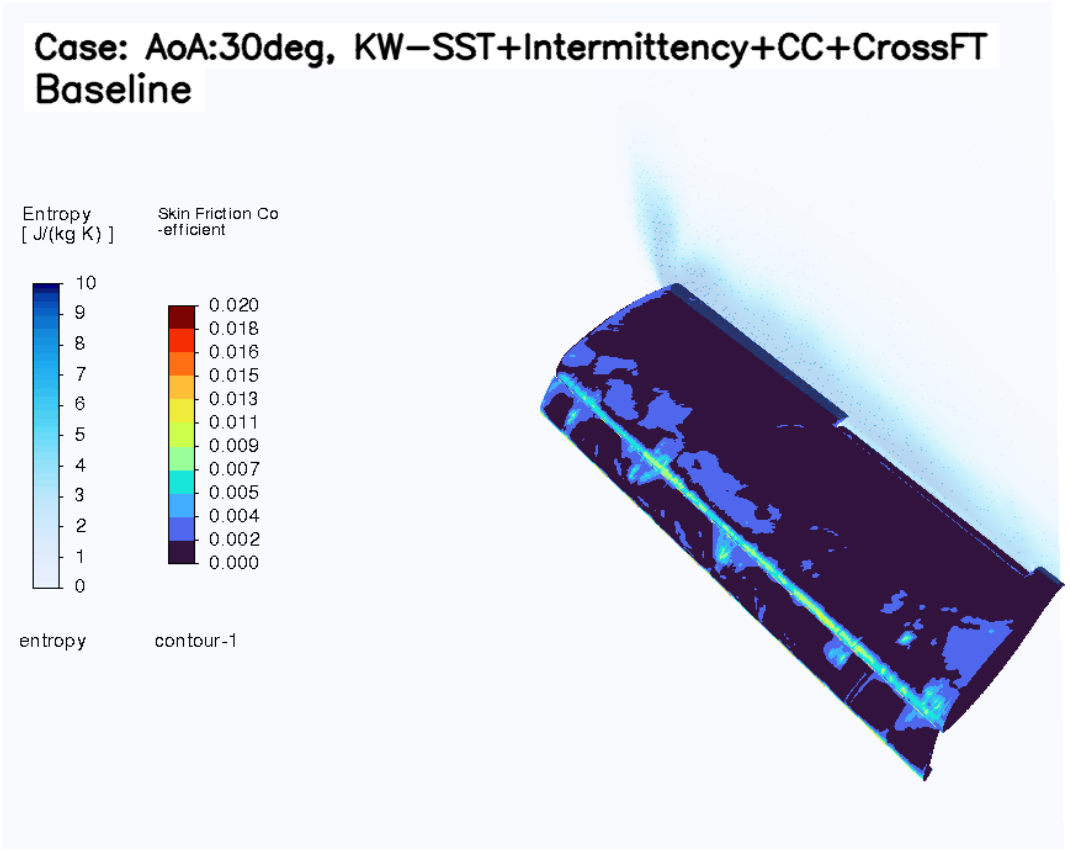
Case 1 – RANS Mesh Adaption at AoA = 30°

CFL = 15, Explicit Relaxation = 0.5





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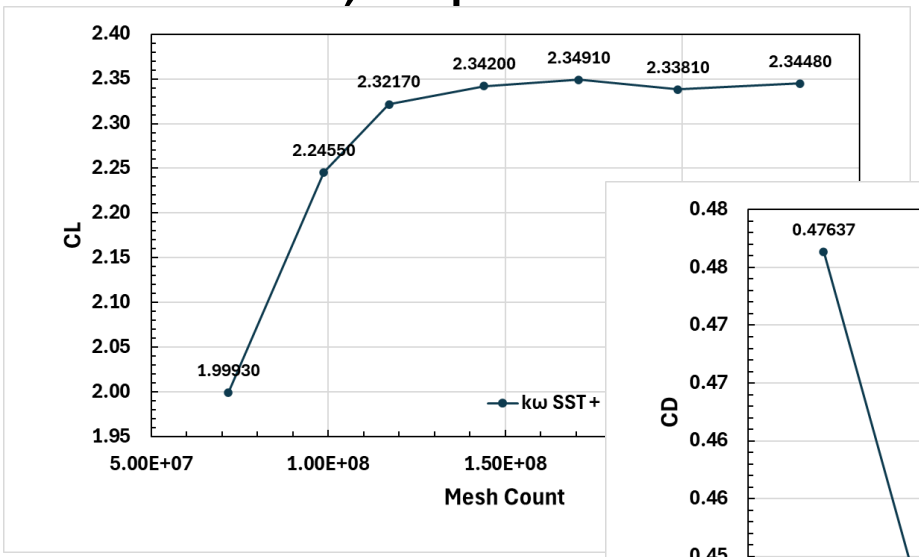
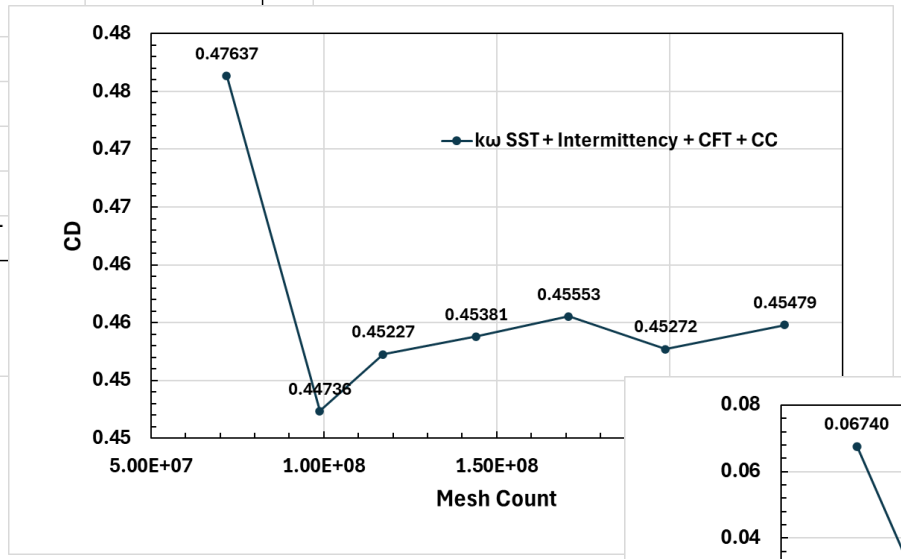
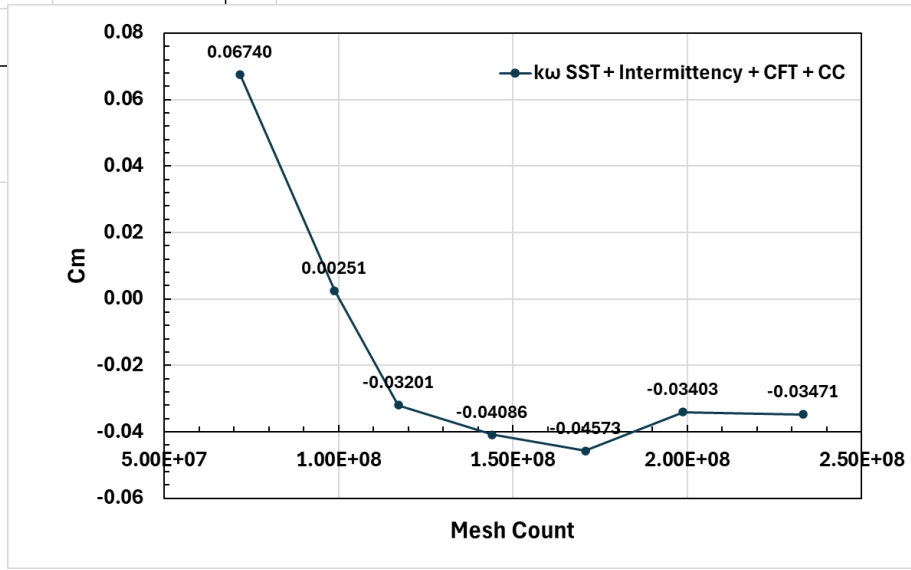
Case 1 – RANS Mesh Adaption at AoA = 30°

CFL = 15, Explicit Relaxation = 0.5







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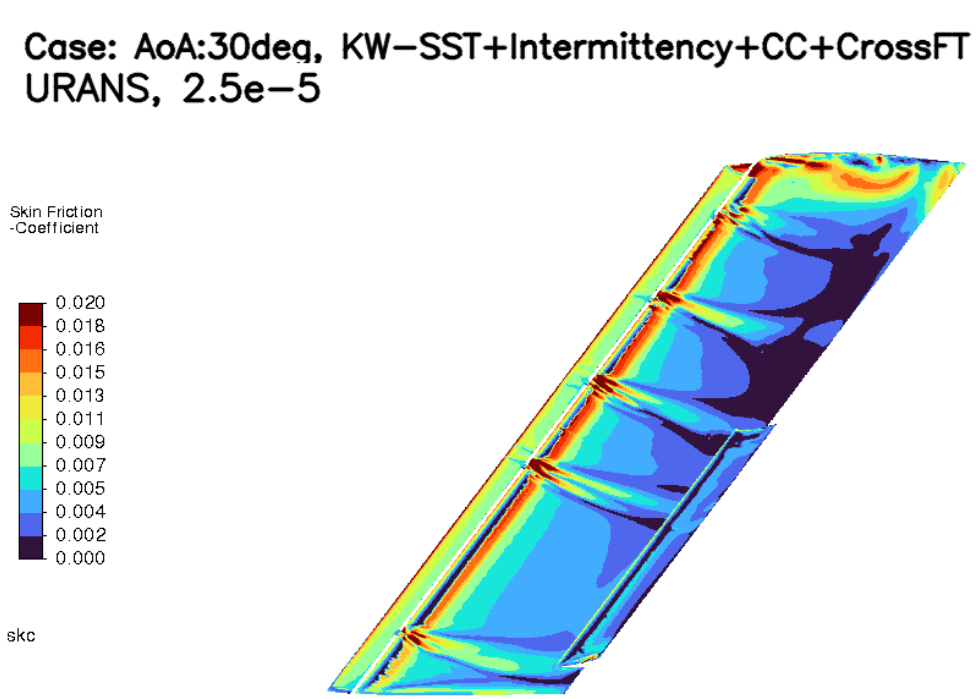
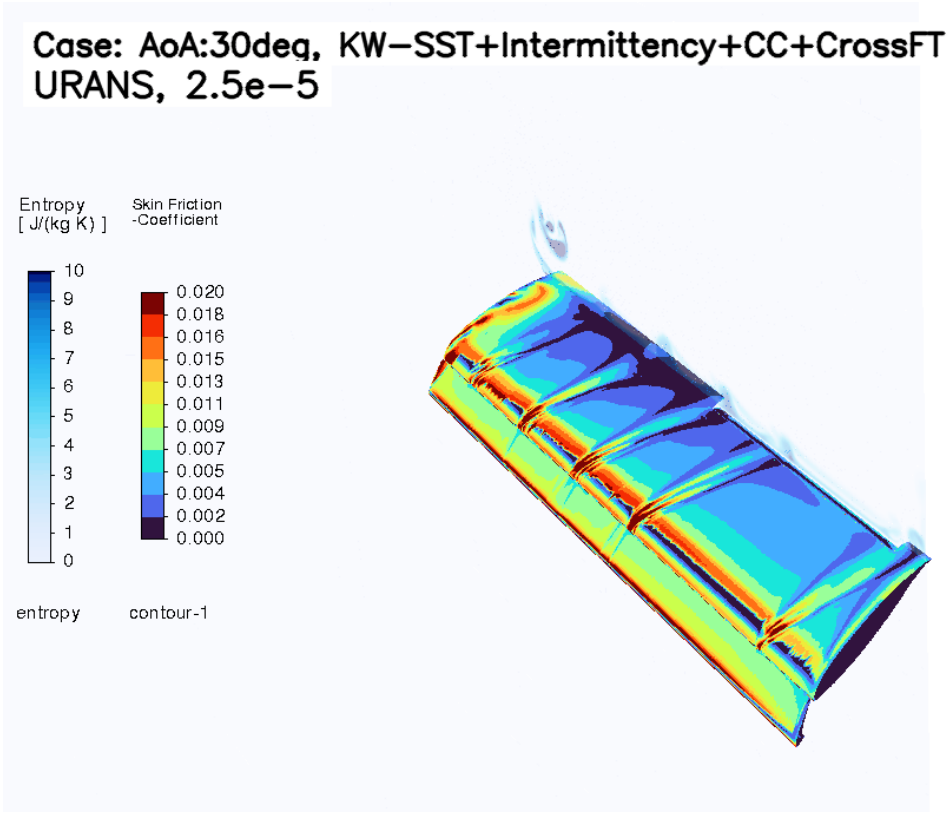
Case 1 – URANS on RANS Adapted Mesh at AoA = 30°





k-w SST Intermittency, Curvature Correction, Cross-Flow Transition

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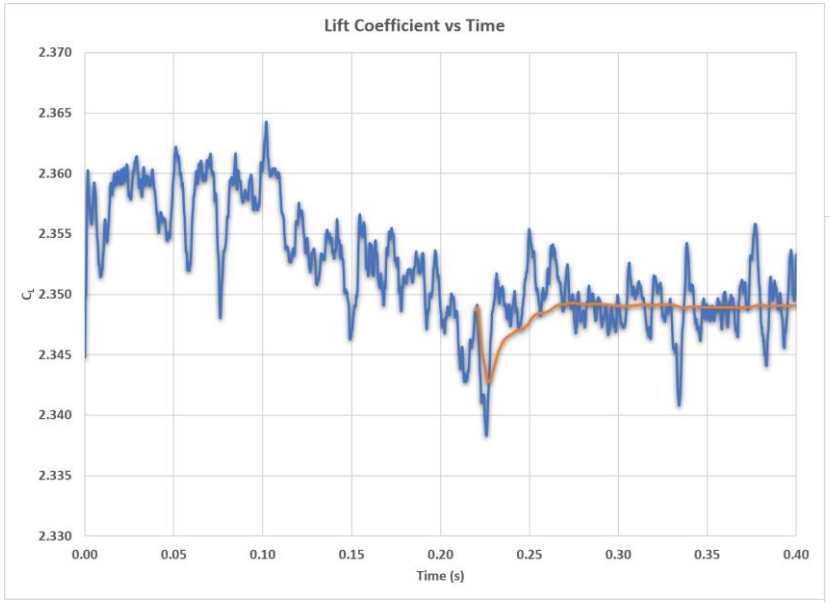
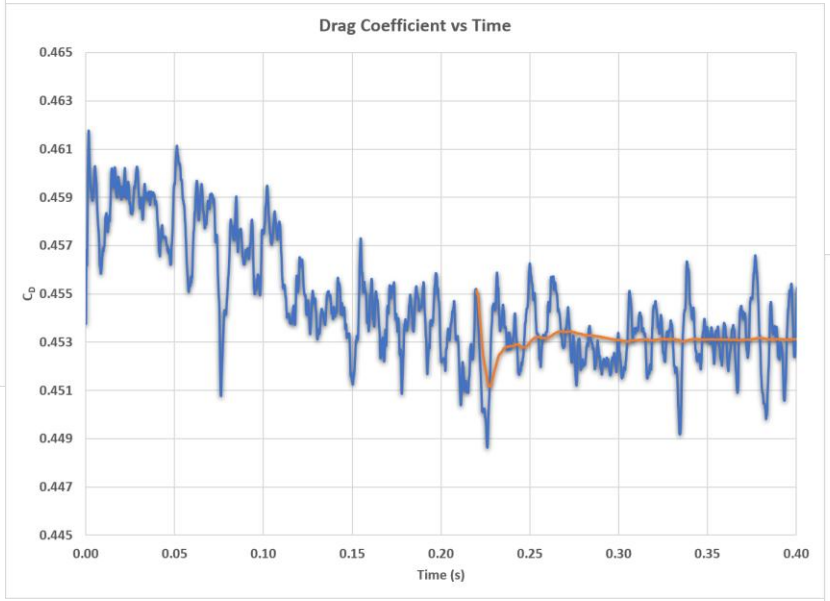
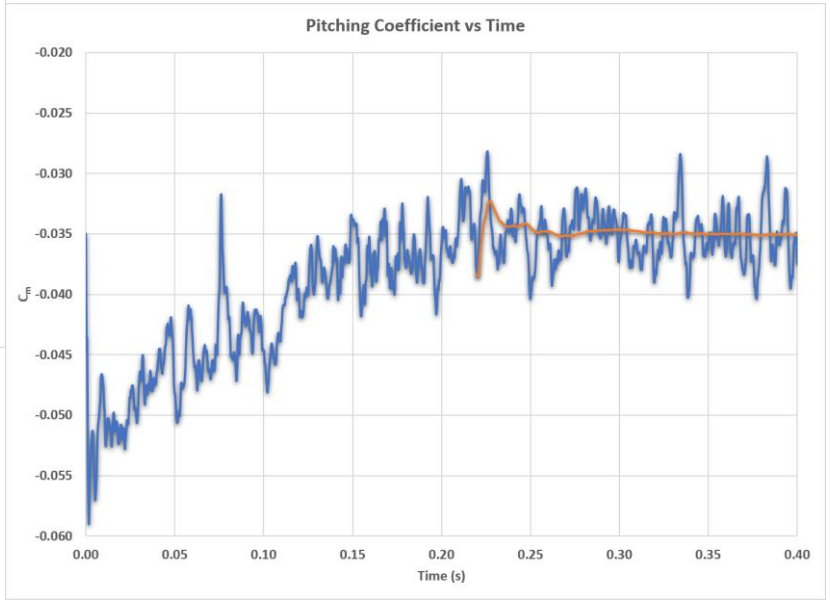
Case 1 – URANS on RANS Adapted Mesh at AoA = 30°







C_L		C_D		C_m	
Avg.	σ	Avg.	σ	Avg.	σ
2.349	2.63e-3	0.4531	1.34e-3	-0.03507	2.23e-3

Taken after 0.22 sec (~18 flows over the wing)

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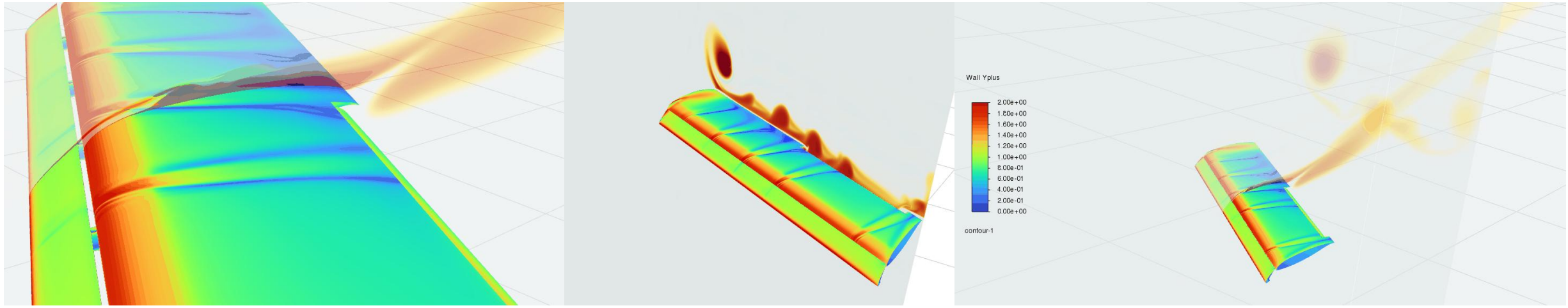
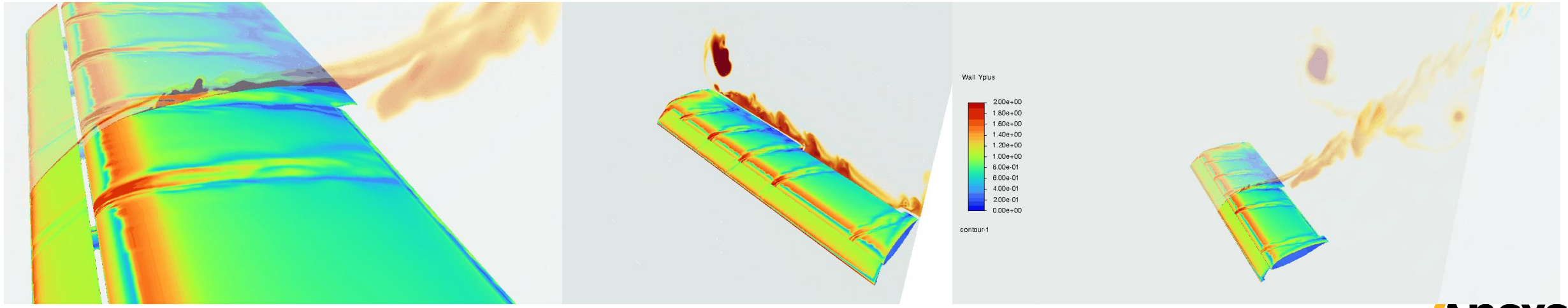
Case 1 – URANS SA vs URANS Transition k-ω SST on Pointwise Coarse Adapted Mesh at AoA = 30°

URANS - SA



URANS – k-ω SST + Transition + Curvature & Crossflow



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Case 1 – SBES
k-ω SST – DBNS Transition + Crossflow + CC
AoA = 30°

Ansa Coarse Mesh

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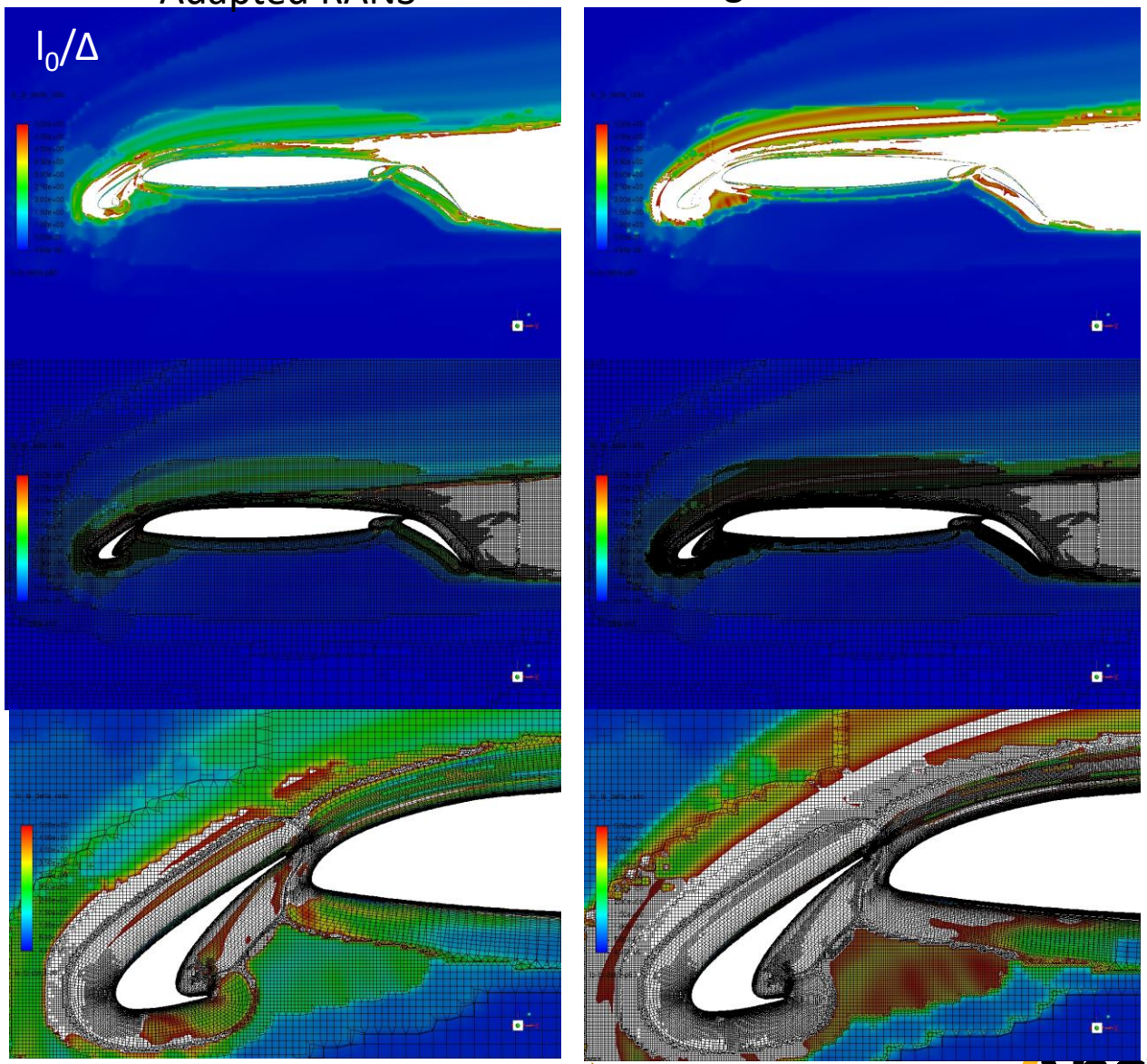
Case 1 – SBES with k-ω SST in Fluent

- Examine if adapted mesh is suitable to capture large eddies:
  - Approximate length scale of eddies using Kolmogorov's energy spectrum.
  - Try to resolve for 80% of the turbulent kinetic energy which gives 5 cells to capture the integral length scale of an eddy.
  - Use PUMA to refine cells that have an integral length scale that is 5 times lower than the characteristic length of this cell.

$$\frac{l_0}{\Delta} < 5$$



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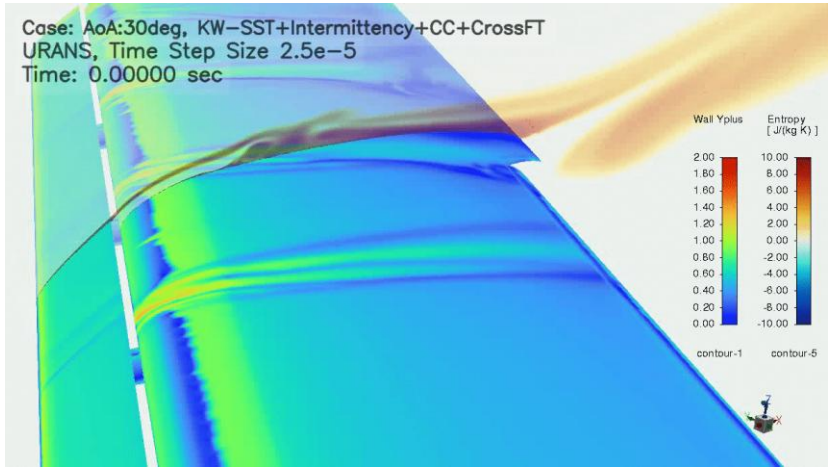
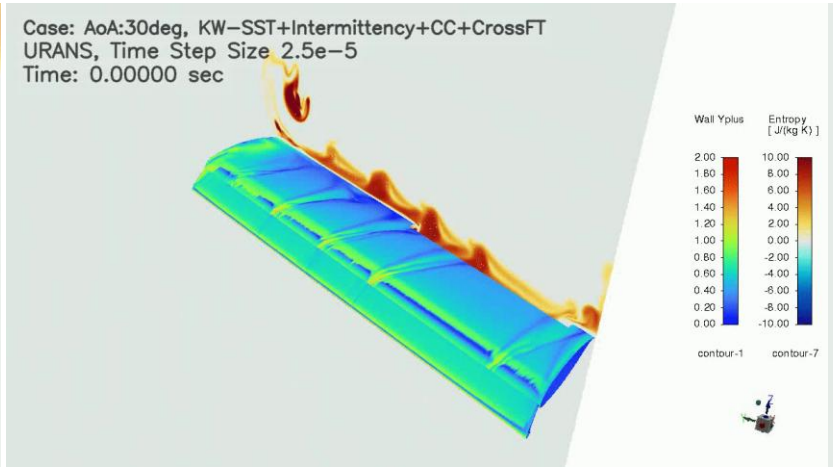
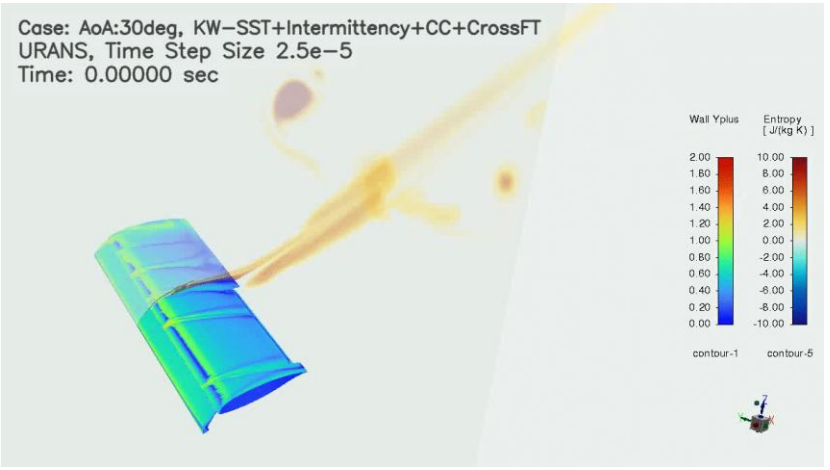
Case 1 – URANS vs SBES

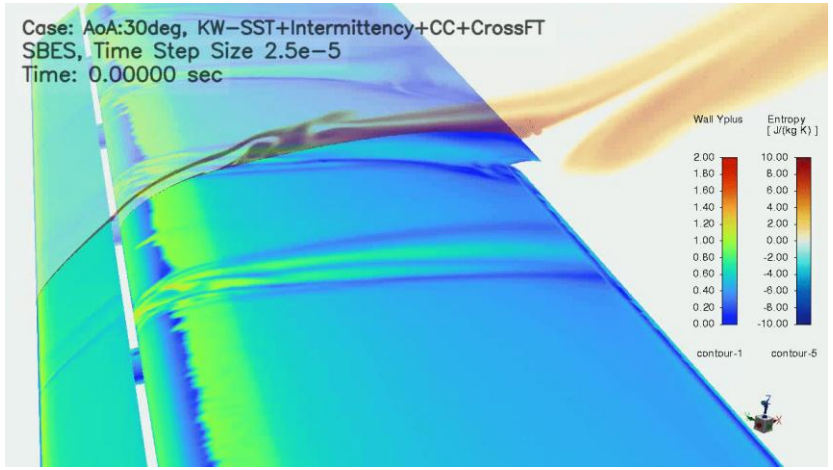
URANS

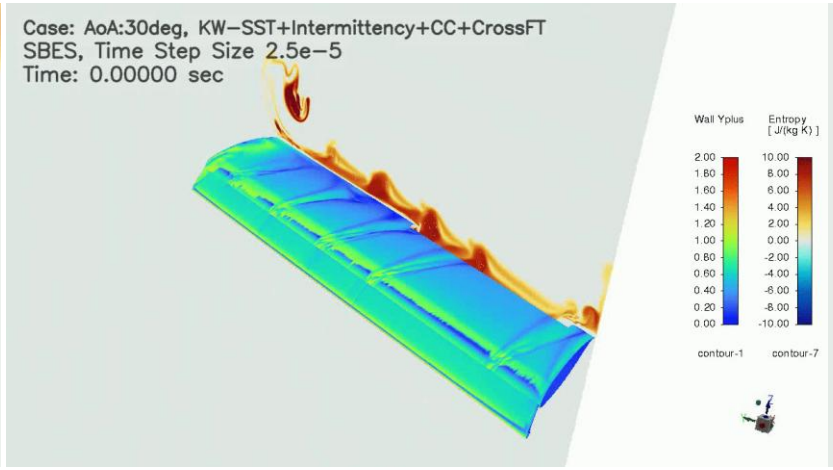


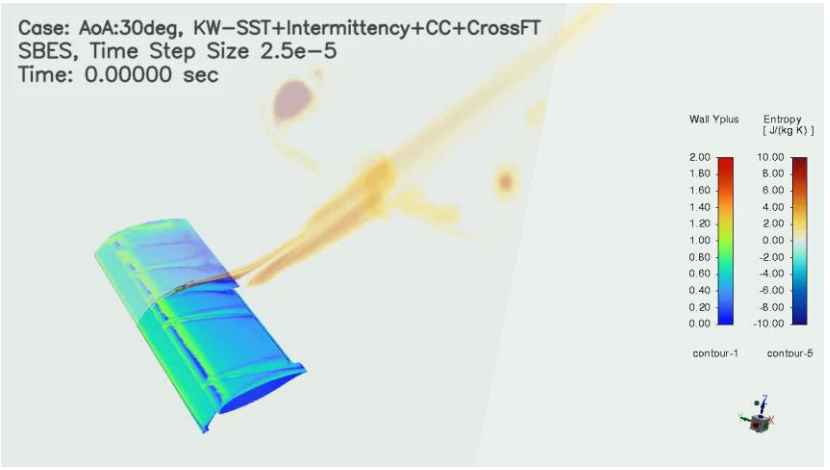




SBES







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