DPW-8 & AePW-4

Static Deformation Working Group

January 17, 2025

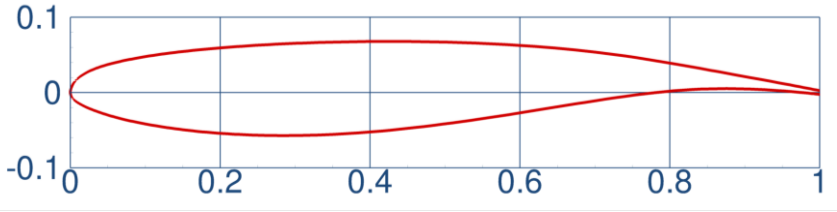
dpwaiaa@gmail.com
(working group specific email TBD

AIAA
SHAPING THE FUTURE OF AEROSPACE

Administrative Information

- **Meeting schedule**
  - Third Friday of the month; 10:00 Eastern Time (will adjust with US Daylight Saving Time)
- **For questions about the working group, please email** dpwaiaa@gmail.com
- **Websites**
  - Static Deformation Working Group website
    https://aiaa-dpw.larc.nasa.gov/WorkingGroups/Group2/group2.html
  - Geometry/Grid websites
    https://aiaa-dpw.larc.nasa.gov/geometry.html
    https://aiaa-dpw.larc.nasa.gov/grids.html
  - Postprocessing website (including ONERA OAT15A experimental results)
    https://aiaa-dpw.larc.nasa.gov/postprocessing.html
  - Large File Upload
    https://nasagov.app.box.com/f/fd164563283b4e85857d1a0975b0b363

Test Case 1a: Workshop-Wide Validation



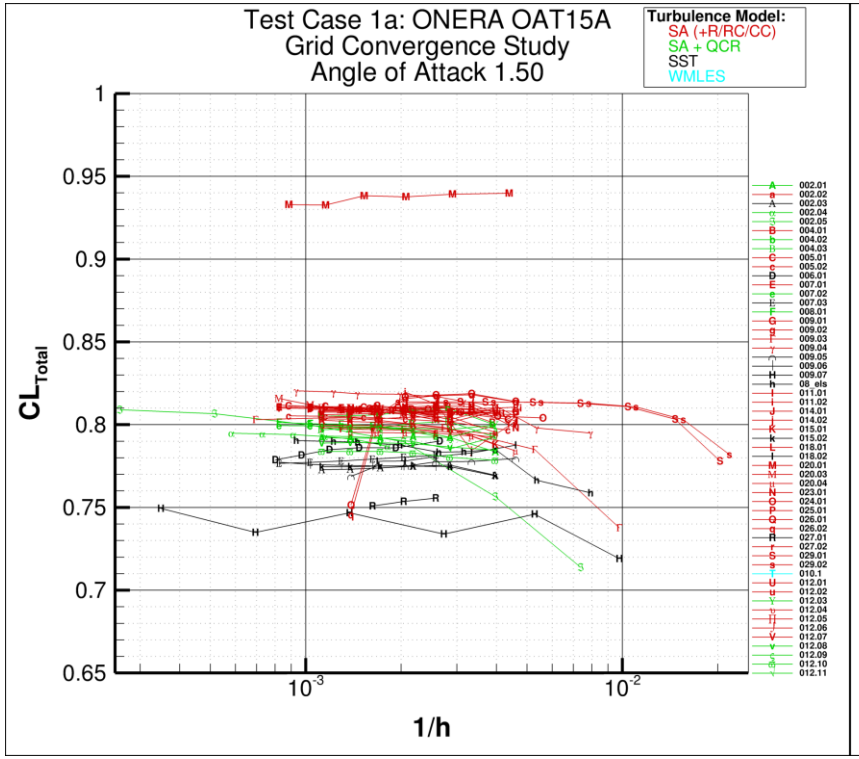
ONERA OAT15A Transonic Airfoil

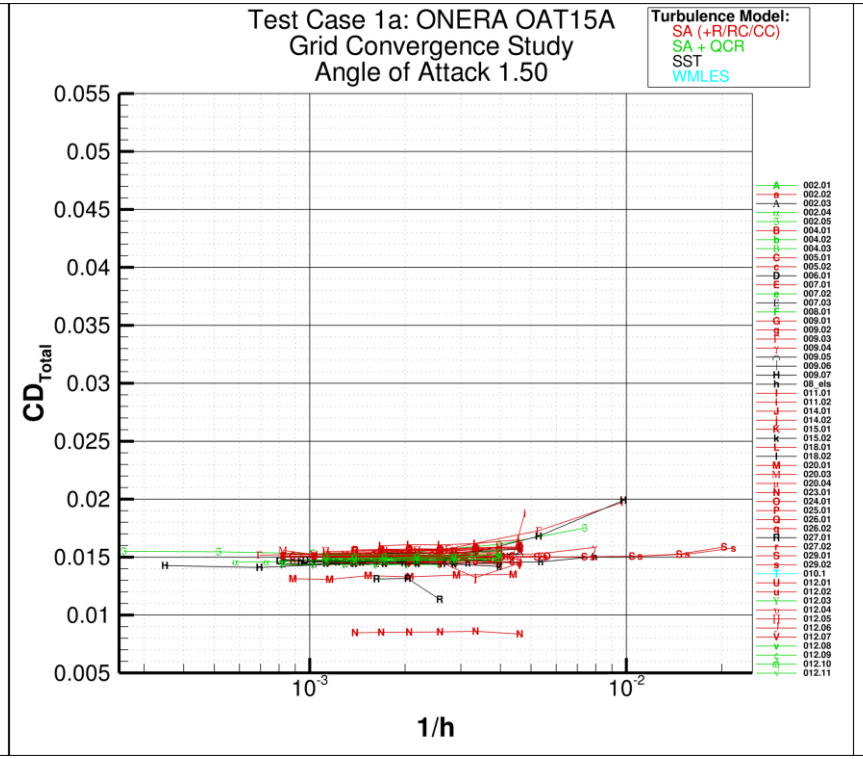
- **Validation of steady CFD analysis, required**
- **Users are encouraged to employ best practices**
- **Settings**
  - Steady CFD (e.g., RANS)
  - Prefer some version of SA, multiple turbulence models can be submitted
  - Purely 2D simulations (one cell wide)
- **Grids**
  - Six-member RANS grid family; four are required, six are desirable
  - Encourage use of committee-supplied grids; user-generated grids are acceptable
  - Committee-supplied grid is one cell wide with a 230mm chord (same as experiment) and follows RANS best practices
- **Conditions**
  - Mach 0.73, Re_c=3m (based on chord length), T_{static}= 271 K (487.8 R)
  - Alpha: 1.36, 1.50, 2.50, 3.00, 3.10

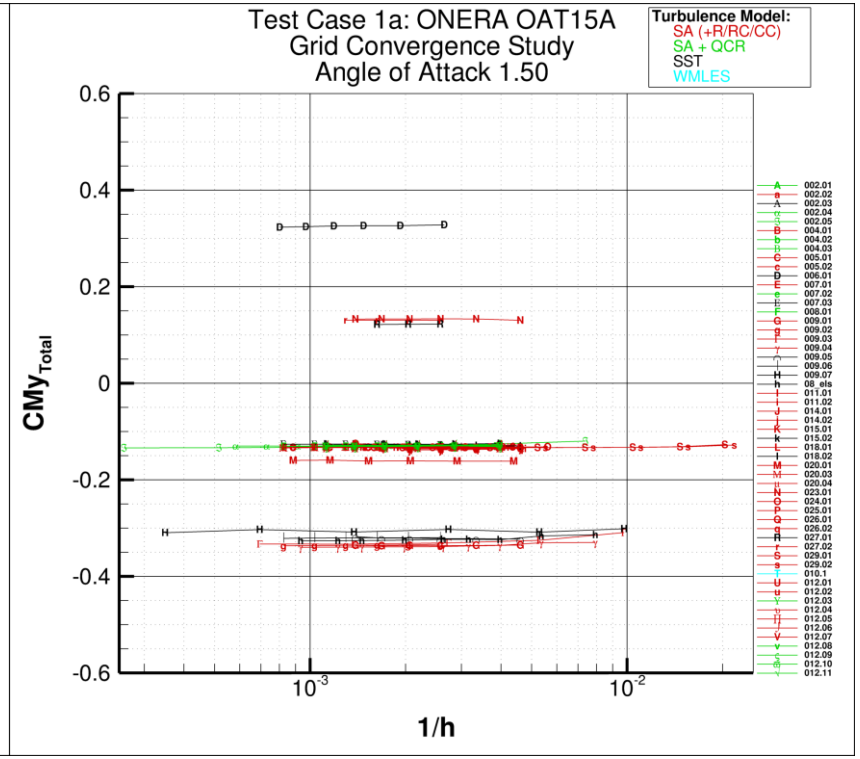
Jaquin, et al. "Experimental Study of Shock Oscillation over a Transonic Supercritical Profiles." AIAA Journal, Vol. 47, No. 9, 2009. Pages 1985-1994.

Test Case 1a: Results

- **Grid Convergence Study**
  - Alpha = 1.50°

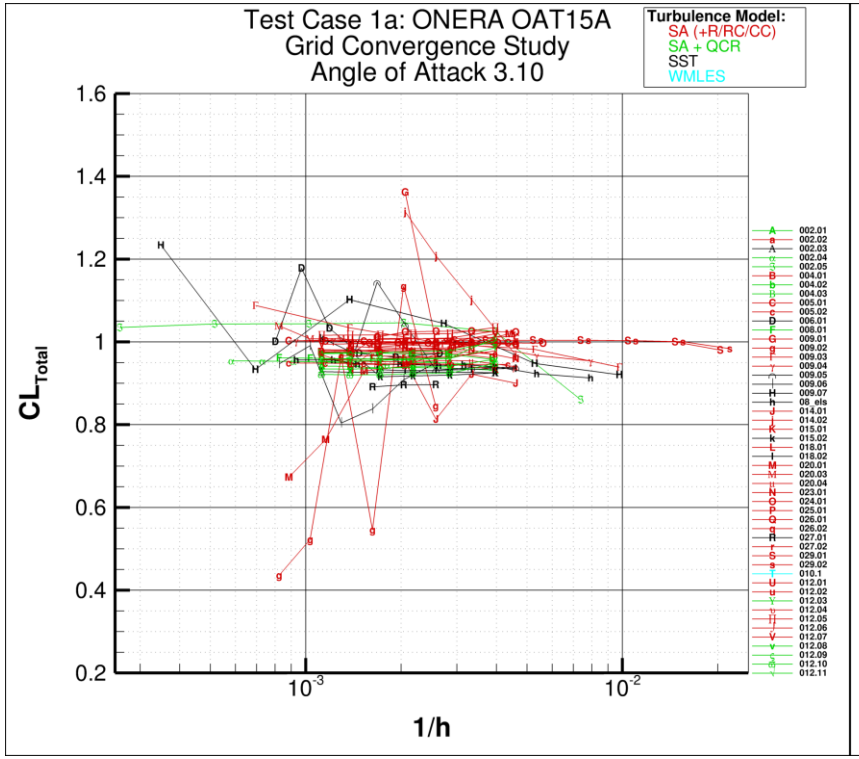


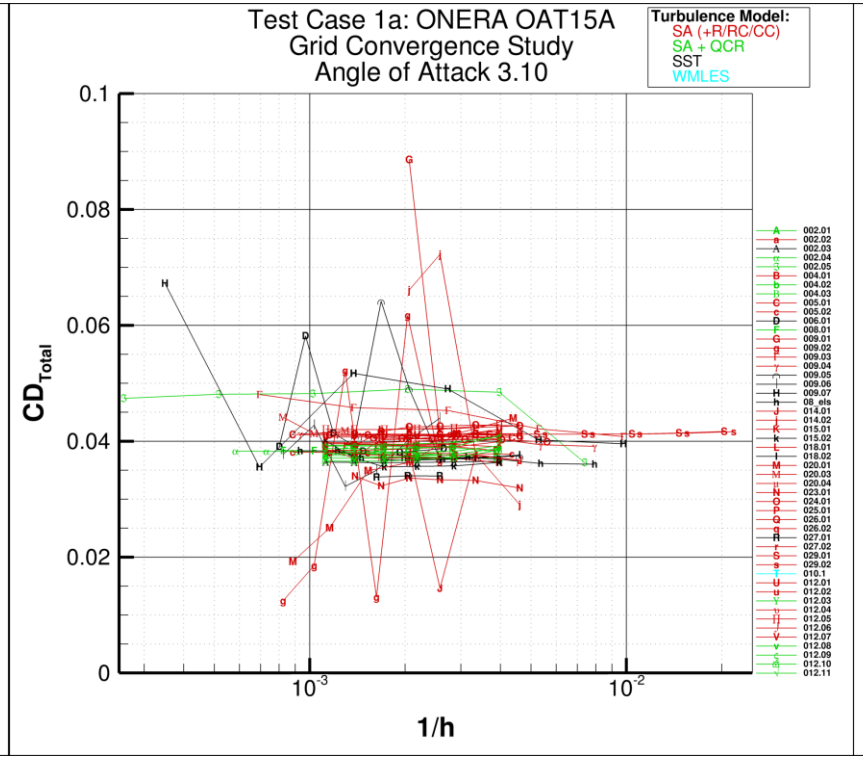


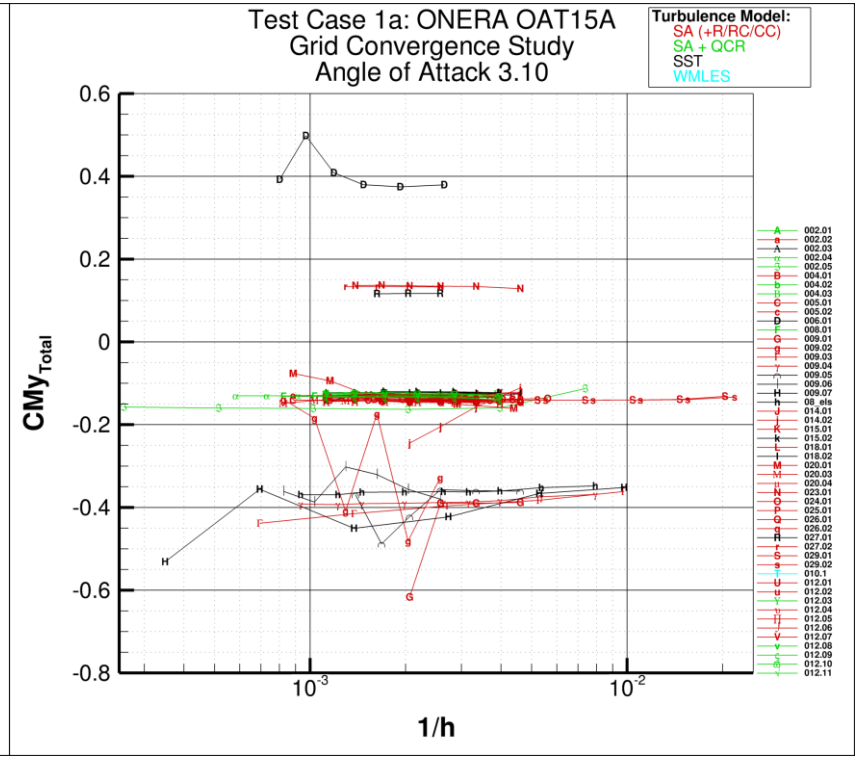


Test Case 1a: Results

- **Grid Convergence Study**
  - Alpha = 3.10°







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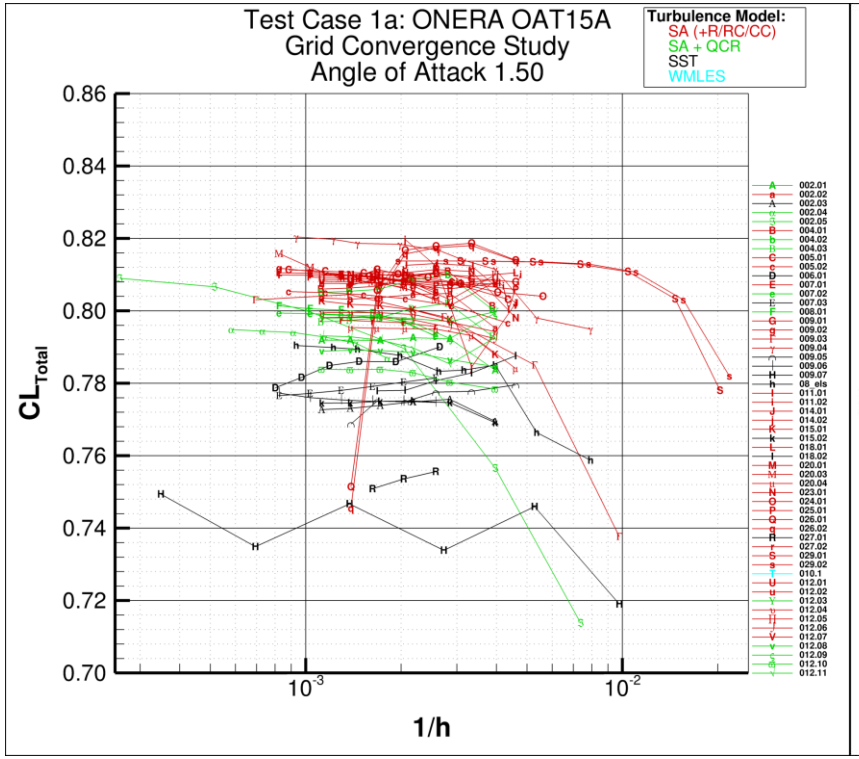

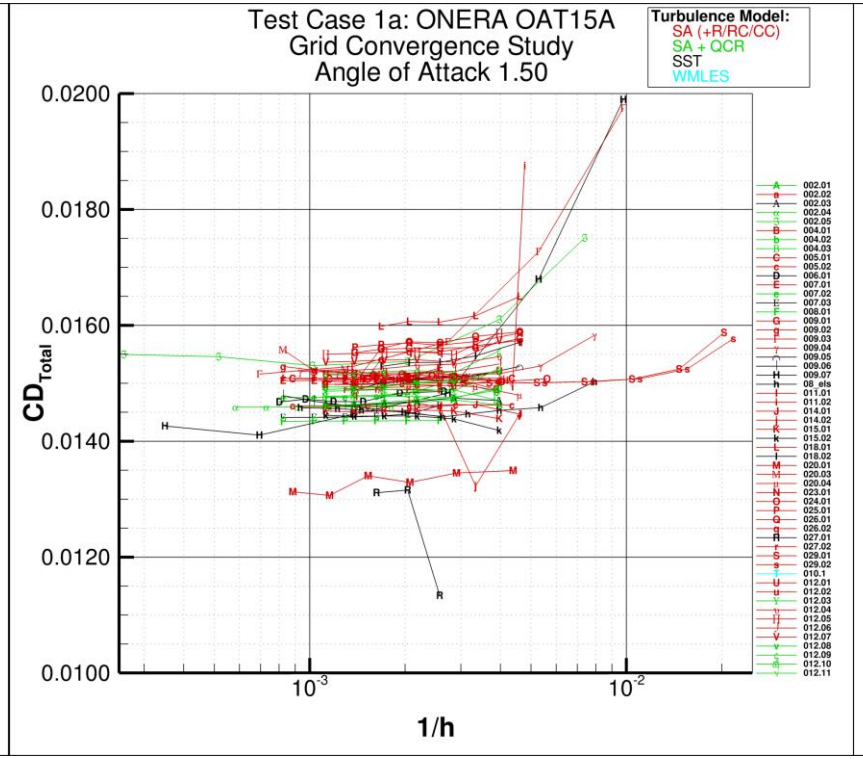

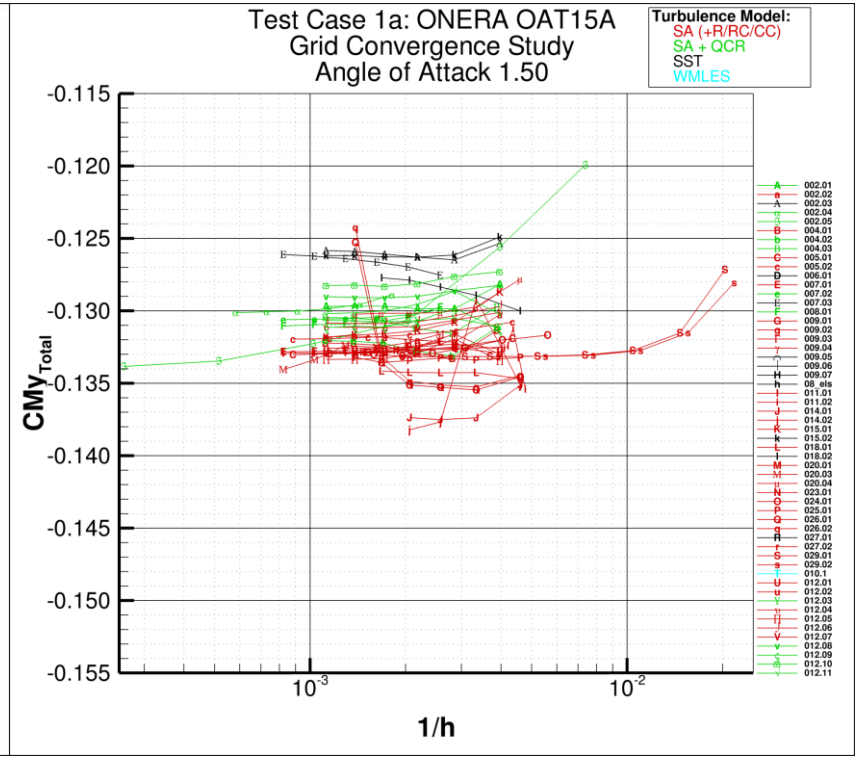

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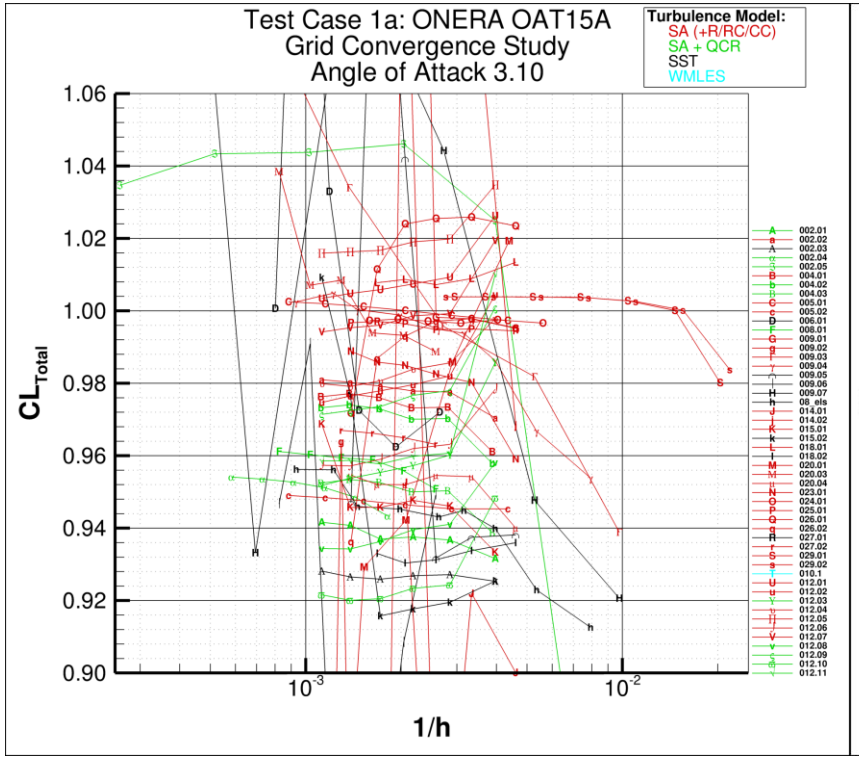
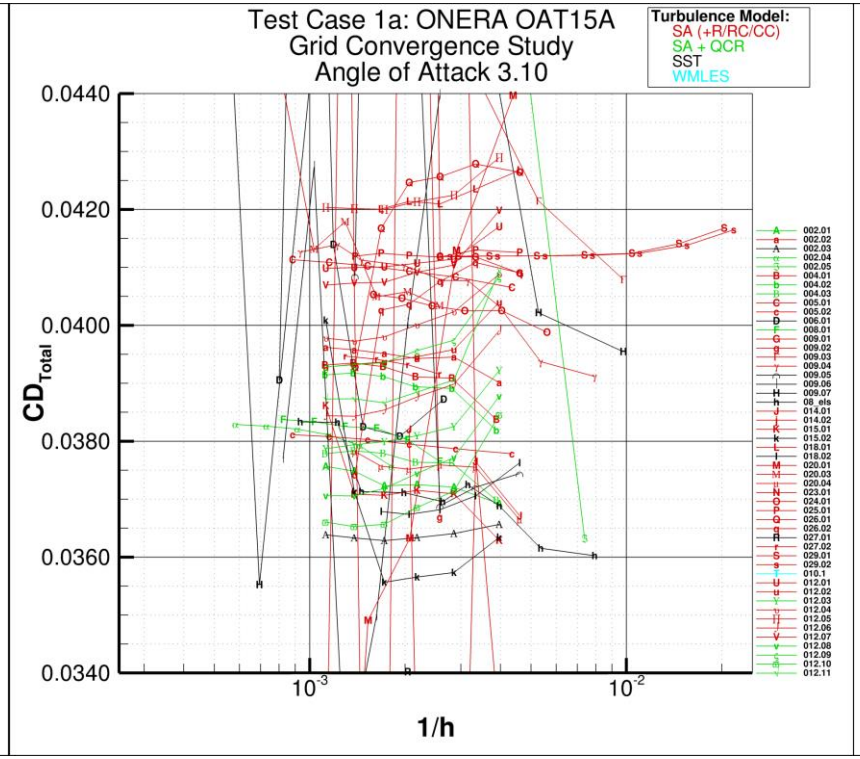
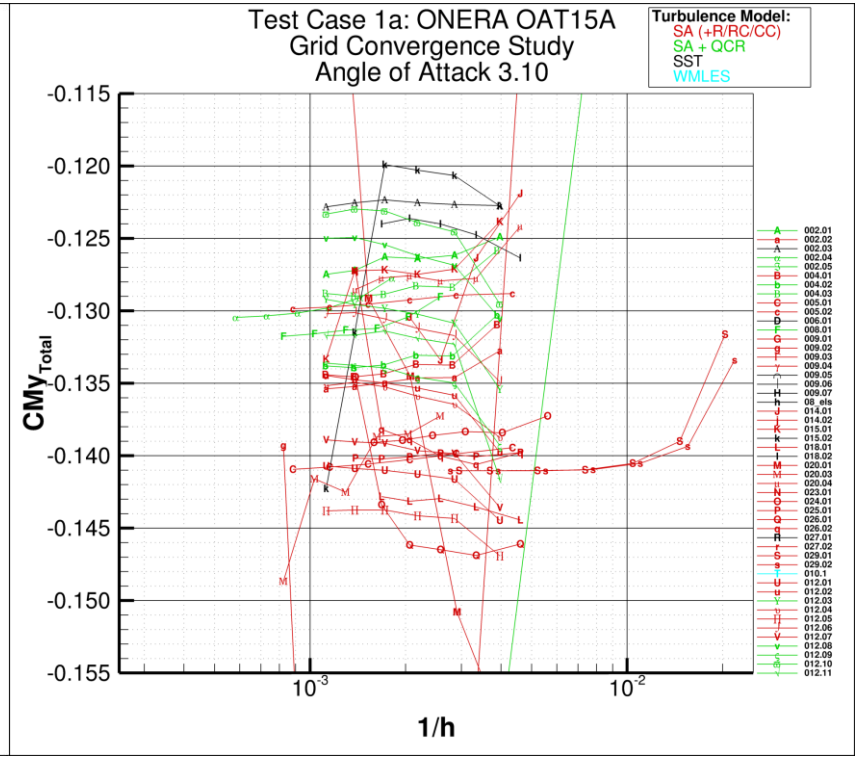
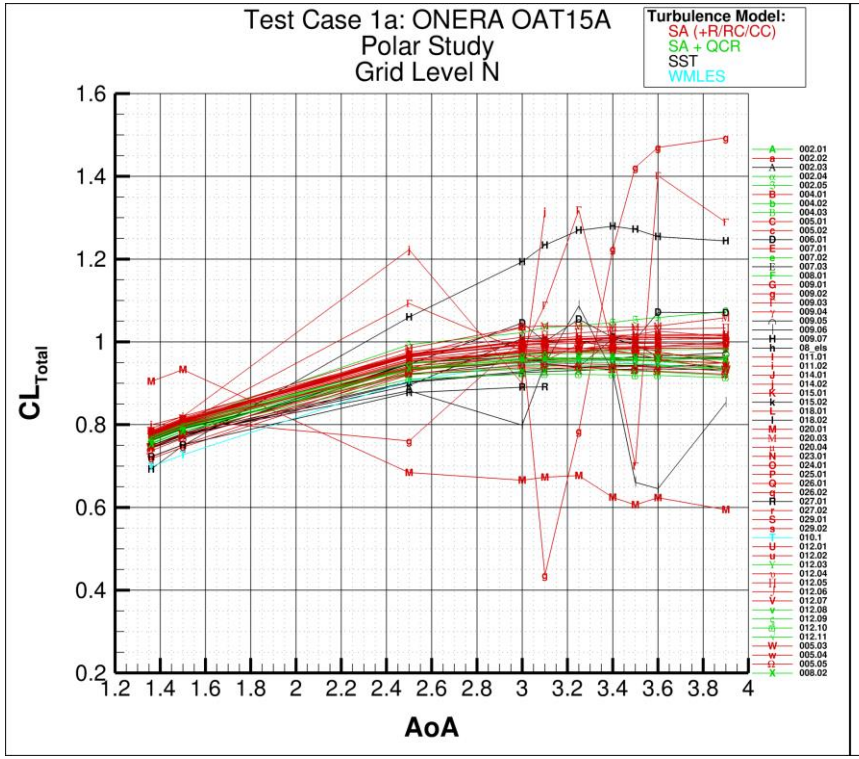


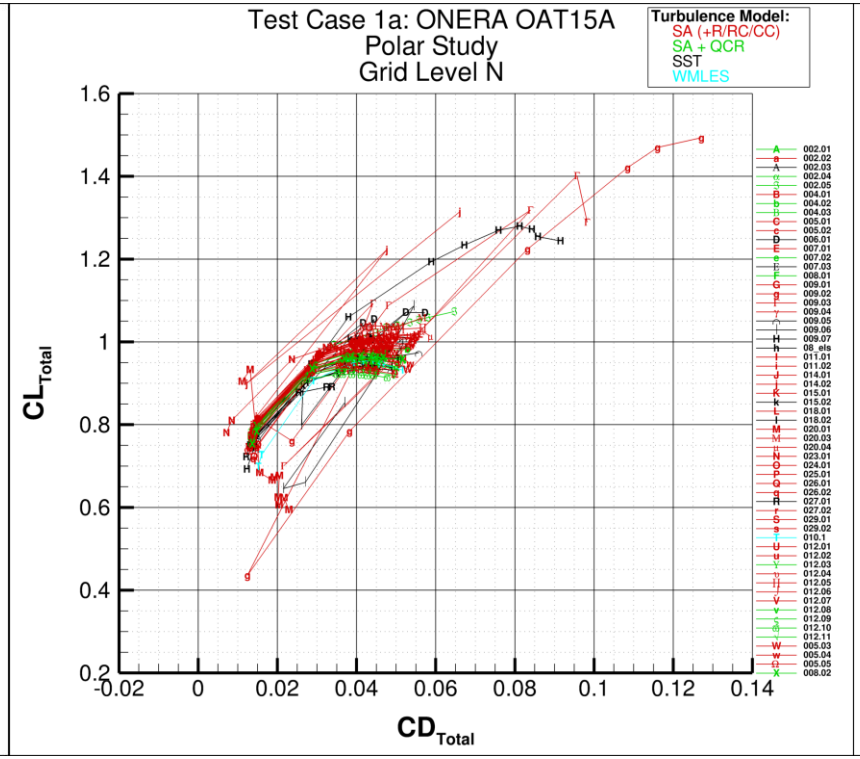


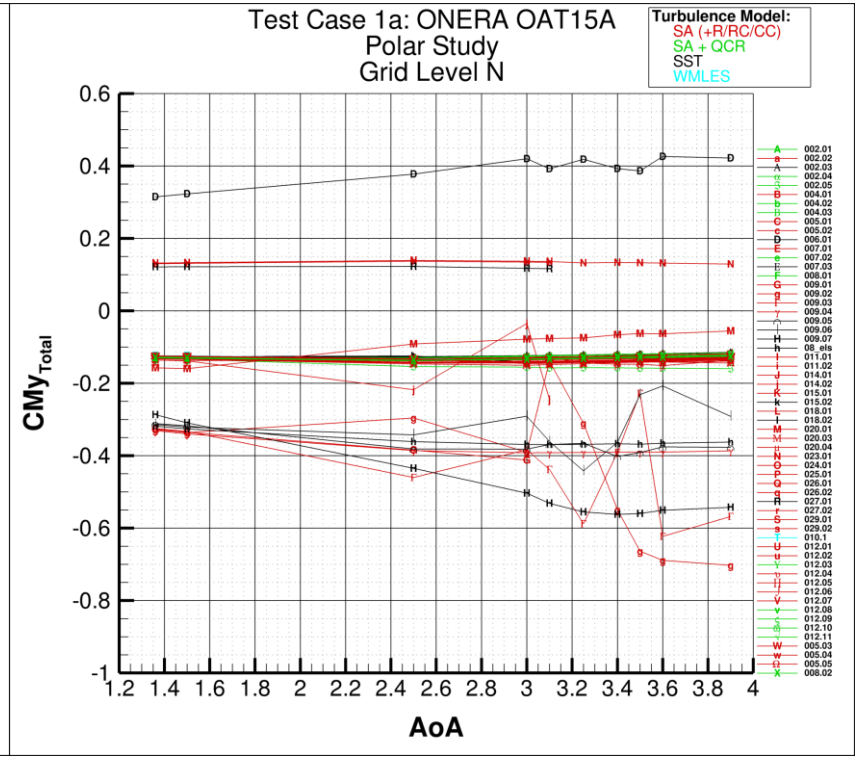


Test Case 1a: Results

- **Lift, Drag, Pitching Moment Polars**
  - Finest Submitted Grid Level







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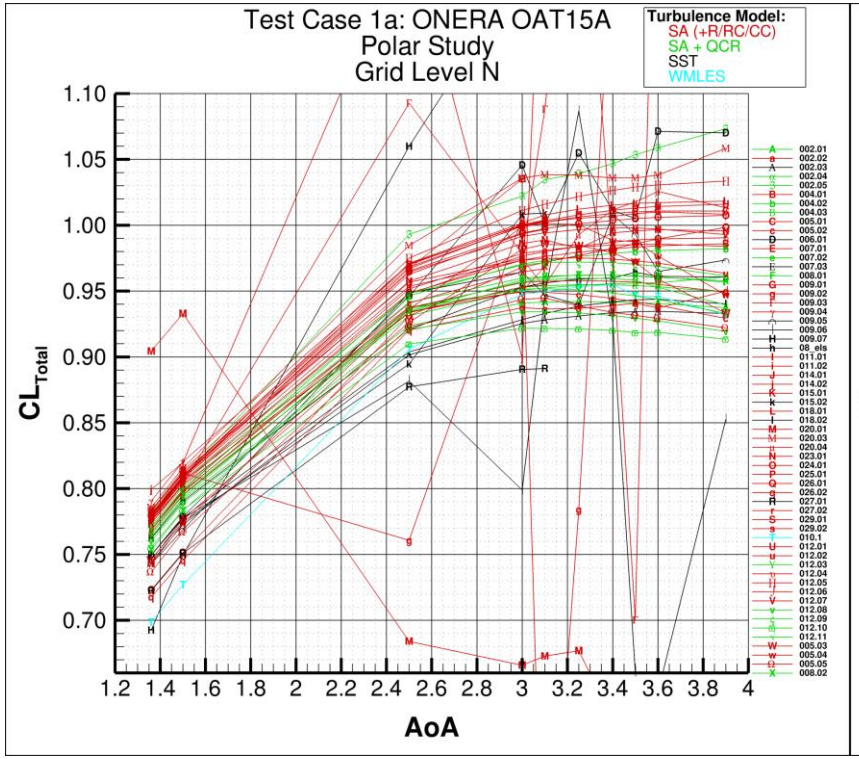
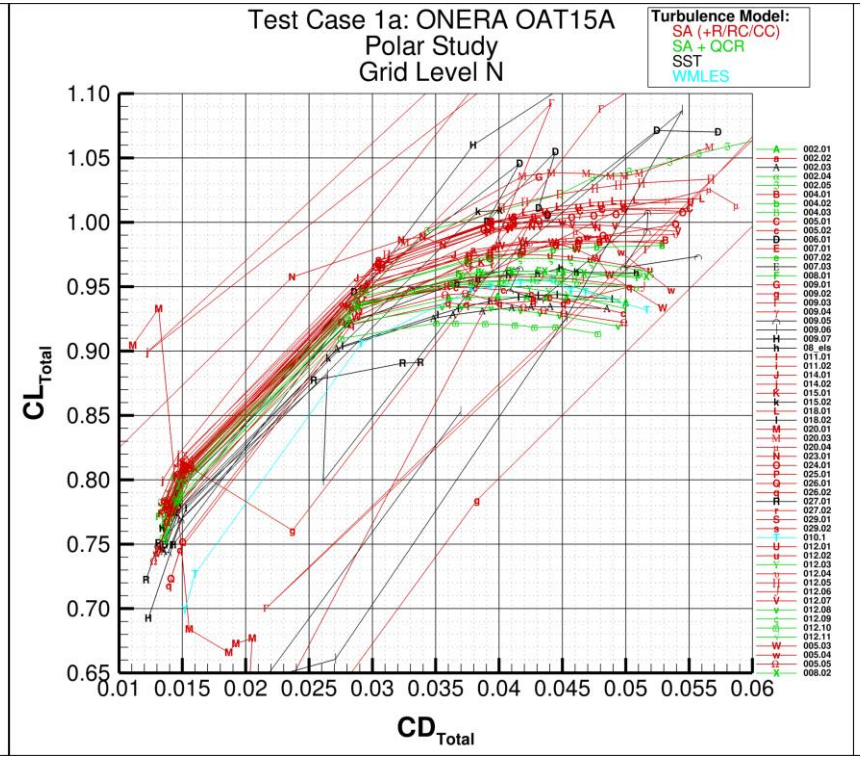
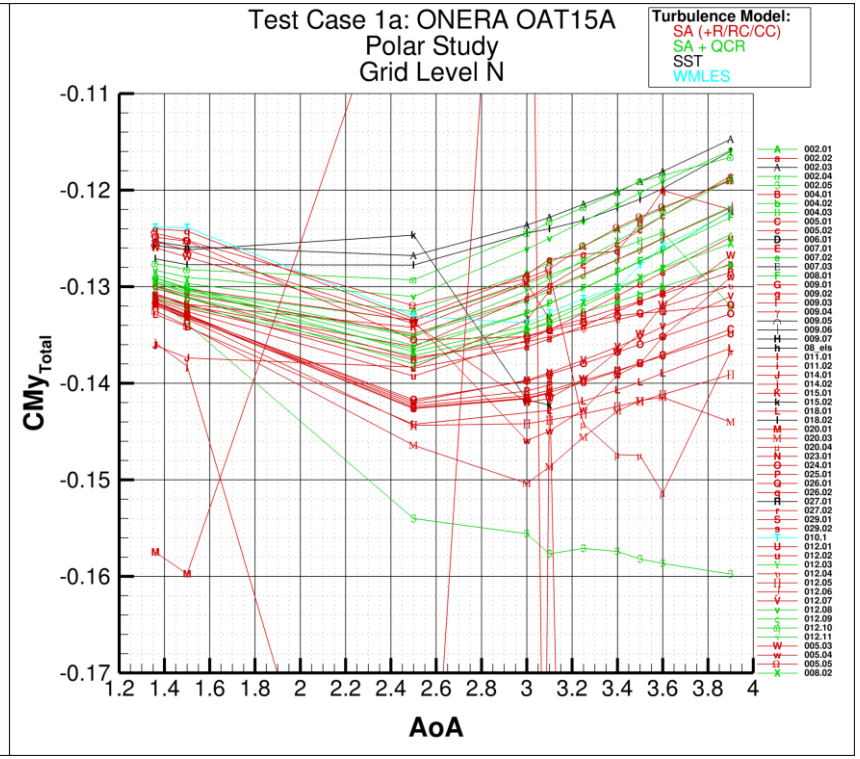
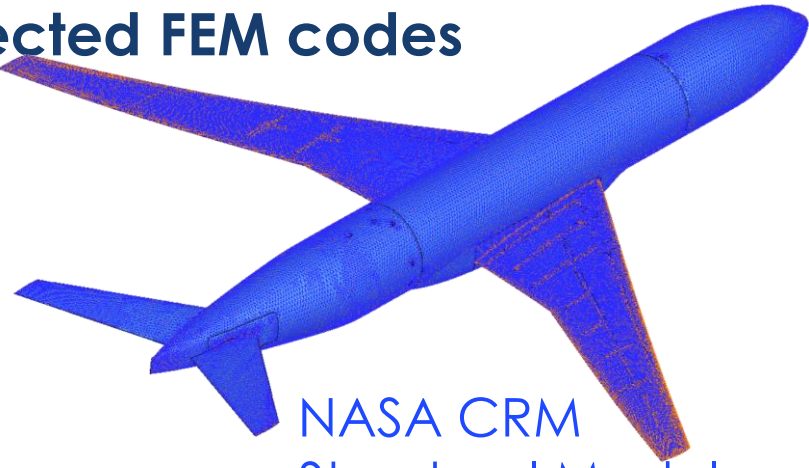






Test Case 1b: FEM Validation

- **Validation of Structural Model for NASA CRM**
  - Tap Test planned for comparison to normal mode solutions of FEM models
  - Static Loads Tests will be conducted to compare deflection measurements (and maybe twist) to Linear Static FEM solutions
- **Users are encouraged to employ best practices for selected FEM codes**
- **Settings**
  - Linear Eigenvalue Analysis (e.g. NASTRAN® SOL103)
- **Conditions**
  - Rigid suspension at sting
- **Grid**
  - MSC NASTRAN® solid 4-node tetrahedral finite-element structural model
  - Model consists of $6.8 \cdot 10^6$ elements, $4.1 \cdot 10^6$ degrees-of-freedom
  - Supplied by NASA Langley's Configuration Aerodynamics Branch
  - Wind tunnel sting will be added as beam model



NASA CRM
Structural Model

Test Case 2a: Wing/Body Deformation

- **CFD/FEM start from unloaded (wind-off) geometry/grid**
- **CRM Wing/Body**
  - Reynolds numbers: 5M (LoQ) [Available: 5M(LoQ),20M(LoQ),20M(HiQ),30M(HiQ)]
  - Mach Number: 0.85 [Available: 0.70, 0.85, 0.87]
  - Angle of Attack: 3.00 deg [Available: -3.0 – 12.0 deg]
- **Committee-supplied**
  - NASA CRM geometry in jig/unloaded condition
    - Trip location, if tested (optional to use)
  - MSC NASTRAN® finite-element model of the NASA CRM
  - Grid Family (L1:**T**iny/L2:**C**oarse/L3:**M**edium/L4:**F**ine/L5:e**X**tra-fine/L6:**U**ltra-fine)
- **Comparison metrics**
  - Forces / Moments
  - Sectional Twist / Deformation
  - Sectional C_P distribution

Test Case 2b: Wing/Body Deformation (polar)

- **CFD/FEM start from unloaded (wind-off) geometry/grid**
- **CRM Wing/Body**
  - Available Reynolds numbers: 5M (LoQ), 20M (LoQ), 20M (HiQ), 30M (HiQ)
  - Range of Mach numbers: 0.70, 0.85, 0.87 (Mcruise = 0.85)
  - Range of Angles of attack: -3.0 – 12.0 deg (AOAcruise ~ 2.75-3.00 deg)
- **Committee-supplied**
  - NASA CRM geometry in jig/unloaded condition
    - Trip location, if tested (optional to use)
  - MSC NASTRAN® finite-element model of the NASA CRM
  - Grid Family (L1:**T**iny/L2:**C**oarse/L3:**M**edium/L4:**F**ine/L5:e**X**tra-fine/L6:**U**ltra-fine)
- **Comparison metrics**
  - Forces / Moments
  - Sectional Twist / Deformation
  - Sectional C_P distribution

Test Case 3: Wing/Body/Nacelle/Pylon

- **CFD/FEM start from unloaded (wind-off) geometry/grid**
- **CRM Wing/Body/Nacelle /Pylon**
  - Available Reynolds numbers: 5M (LoQ)
  - Range of Mach numbers: 0.70, 0.85, 0.87 (Mcruise = 0.85)
  - Range of Angles of attack: -3.0 – 12.0 deg (AOAcruise ~ 2.75-3.00 deg)
- **Committee-supplied**
  - NASA CRM geometry in jig/unloaded condition
    - Trip location, if tested (optional to use)
  - MSC NASTRAN® finite-element model of the NASA CRM
  - Grid Family (L1:**T**iny/L2:**C**oarse/L3:**M**edium/L4:**F**ine/L5:e**X**tra-fine/L6:**U**ltra-fine)
- **Comparison metrics**
  - Forces / Moments
  - Sectional Twist / Deformation
  - Sectional C_P distribution

Key Questions: Static Deformation Working Group

- **What level of accuracy can transonic wing deformations be calculated?**
- **What is the uncertainty in configuration force/moments due to aeroelastic deformation uncertainty?**
- **What are the most efficient/accurate methods for coupling the aero/structural computations?**
  - What are the computational time/accuracy savings between using a full fidelity vs reduced beam structural model?
  - Do modal solutions compare well to direct fluid-structure mapping solutions?
  - Does a full vs symmetry plane solution result in different solutions?
- **What accuracy is lost by using a "lower fidelity" aerodynamic?**

Nominal Schedule

- **June, 2024**
  - First Working Group Meeting ✔
  - ONERA OAT15A geometry release ✔
- **July, 2024**
  - ONERA OAT15A grids released ✔
  - AVIATION in-person meeting ✔
- **November, 2024**
  - All workshop virtual meeting (11/8) ✔
- **January, 2025**
  - SciTech Forum: Mini Workshop 1 ✔
  - CRM Grids Available
- **March, 2025**
  - FEM Validation Data released
- **July, 2025**
  - AVIATION in-person meeting
  - (Special Session: ONERA OAT15a?)
- **Summer/Fall, 2025 (?)**
  - Mini Workshop 2
- **January, 2026**
  - SciTech in-person meeting
- **February, 2026**
  - Delivery of final data set (perhaps alternate submissions prior to this date)
- **June, 2026**
  - Workshop in San Diego, CA

Working Group Meeting Cadence

- **Currently set up for 10:00 Eastern time on third Friday of each month**
  - A suitable meeting time is very difficult for global participants
  - Recurring meeting invite sent

- **Next meeting: Friday, February 21st**
  - Please contact ben.j.rider2@boeing.com if you are interested to present grids or solutions

dpwaiaa@gmail.com