1^{st} AIAA Transition Modeling and Prediction Workshop

Description of Test Cases

Rev 1.2 – 13 February 2020

Please check https://transitionmodeling.larc.nasa.gov/aiaa-cfd-transition-modeling-dg/ periodically for updates

Case 0 – Fully Turbulent 3D Bump-in-Channel Verification Case - REQUESTED

CFD-based transition modeling approaches are generally coupled with a RANS turbulence model that activates once transition occurs. Experience with the Drag Prediction and High-Lift Prediction Workshop series has shown that verified implementations of turbulence models is a necessary (but not sufficient) condition for accurate predictions. Accordingly, participants of the Transition Modeling and Prediction Workshop are requested to complete the 3D Bump-in-Channel verification case from the NASA Turbulence Modeling Resource (https://turbmodels.larc.nasa.gov/bump3d.html). All simulations for this case should be run fully turbulent.

Case 1 – Zero-Pressure-Gradient Flat Plate (2D)

- **REQUESTED:** Grid resolution study for T3A conditions (Case 1A)
- **REQUESTED:** Grid resolution study for T3B conditions (Case 1B)
- **OPTIONAL:** Fully turbulent grid resolution study for T3B conditions (Case 1C)

Mach number	0.2
Angle of attack	0°
Reynolds number	200,000 per grid unit
Reference temperature	540 R
Inlet turbulence conditions	Case 1A (T3A): • Inlet turb. intensity = 5.855% • μ_T/μ = 11.9 Case 1B (T3B) • Inlet turb. intensity = 7.216% • μ_T/μ = 99
Comments	Grid resolution studies to be performed using all members of the common grid family for both the T3A and T3B inlet turbulence conditions. Inlet turbulence quantities for participant grids may vary. Participants should report whether or not they use free-stream sustaining terms with the underlying turbulence model.

Case 2 – NLF(1)-0416 Airfoil (2D)

- **REQUESTED:** Grid resolution study using at least three grid levels (coarse, medium, and fine) for two fixed angles of attack (Case 2A)
- **REQUESTED:** Alpha sweep using medium-resolution grid (Case 2B)
- **OPTIONAL:** Alpha sweep using fine-resolution grid (Case 2C)

Mach number	0.1
Angle of attack	Case 2A: 0° and 5° Case 2B and 2C: [-4°,8°] in 2° increments
Reynolds number	4 million (based on chord length)
Reference temperature	540 R
Freestream turb. Intensity	0.15% (or N_{crit} = 7.2)
Gridding guidelines	Recommended medium-grid spacings: LE spacing: 0.0010 chords TE spacing: 0.0005 chords $\Delta y = 3.5 \times 10^{-6}$ chords Growth rates < 1.2 normal to wall Far-field boundaries at least 1000 chords from surface
Comments	Quantities of interest include section lift, drag, and pitching-moment coefficients, surface pressure distributions, surface skin-friction distributions, and transition locations (if predicted). Structured C-type grids to be made available, though participants are encouraged to generate their own. Free-stream eddy-viscosity ratio may vary depending on modeling approach and best practices More information on the geometry and reference experimental data may be found in NASA Technical Paper 1861

Case 3 – 6:1 Prolate Spheroid (3D)

- **REQUESTED:** Alpha sweep using medium-resolution grid
- **OPTIONAL:** Grid-resolution study for 10° angle of attack

Mach number	0.13
Angle of attack	5°, 10°, and 15°
Reynolds number	6.5 million (based on spheroid length)
Reference temperature	540 R
Freestream turb. Intensity	0.15% (or, critical Tollmien-Schlichting and crossflow amplification factors calibrated based on wind-tunnel data)
Gridding guidelines	Recommended spacings: LE/TE spacing: 0.1% of spheroid length $\Delta y = 2.3 \times 10^{-6}$ spheroid lengths Growth rates < 1.2 normal to wall Far-field boundaries at least 100 chords from surface
Comments	Quantities of interest include surface skin friction distributions, surface pressure distributions, and transition locations (if predicted). Structured-overset and unstructured grid systems to be made available, though participants are encouraged to generate their own. Free-stream eddy-viscosity ratio may vary depending on modeling approach and best practices

Case 4 – Natural-Laminar-Flow Common Research Model (CRM-NLF)

- **REQUESTED:** Grid-resolution study using at least three grid levels for fixed angle of attack of 1.98031° (Case 4A)
- **REQUESTED:** Angle-of-attack sensitivity study (alpha sweep) using medium-resolution grid (Case 4B)
- **OPTIONAL:** Fully turbulent grid-resolution study using at least three grid levels for fixed angle of attack of 1.98031° (Case 4C)

While this case features nominal conditions of M = 0.86 and a Re = 15e6 (based on mean-aerodynamic chord), participants should use the best-available knowledge of the true run conditions as summarized in the table below.

Alpha	**Mach**	**Total Temp (°F)**	**Total Pressure (psi)**	**Re (1/ft)**
1.44848	0.856489	39.12449	38.56152	12.52710e6
1.98031	0.856491	39.74462	38.55972	12.50530e6
2.46141	0.856051	40.56726	38.55962	12.47449e6
2.93787	0.855801	41.89012	38.55696	12.42762e6

Freestream turb. Intensity	0.24% (or, critical Tollmien-Schlichting and crossflow amplification factors calibrated based on wind-tunnel data)
Gridding guidelines	See Gridding Guidelines document
Comments	Quantities of interest include surface skin friction distributions, surface pressure distributions, and transition locations (if predicted). Structured-overset and unstructured grid systems to be made available by committee, though participants are encouraged to generate their own. Free-stream eddy-viscosity ratio may vary depending on modeling approach and best practices