Test cases of Third Aerodynamics Prediction Challenge (APC-III)

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APC committee

Issues of APC-I and APC-II

• The variation of CFD is large for high angles of attack
  → **Test case 1:** Investigation of grids and turbulence models for high angle-of-attack flows
  → The committee recommends turbulence models other than SA

• The slight difference remains between CFD and experiment
  → **Test case 2:** Discussion on the difference based on follow-up computations under arbitrary conditions

• Improvement of buffet prediction accuracy
  → **Test case 3:** Comparison with unsteady pressure frequency spectra, unsteady PSP
  → Unsteady pressure data and flow field data are submitted.
Test Case 1: Alpha-sweep

- Model: NASA-CRM($i_H=0\text{deg}$) without support device
- Grid: Medium($\sim 10\text{M}$)
- Conditions: $M = 0.847$, $R_e = 2.26 \times 10^6$, $T_{ref} = 284\text{K}$
- Angles: $-1.79\text{deg}$, $-0.62\text{deg}$, $0.32\text{deg}$, $1.39\text{deg}$, $2.47\text{deg}$, $2.94\text{deg}$, $3.55\text{deg}$, $4.65\text{deg}$, $5.72\text{deg}$
- Data to be submitted:
  - Aerodynamic coefficients($C_D, C_L, C_m$)
    - Decompose them into pressure and friction
    - Decompose them into parts (main wing, fuselage, tail)
  - Surface $C_p$ distributions
    - Main wing
- Recommendations:
  - Usage of turbulence models other than SA
  - Discussion on high-angle-of-attack flows

Test case 2: Follow-up discussion

- Model: NASA-CRM (arbitrary configurations)
- Grid: arbitrary grids
- Conditions: arbitrary conditions
- Angles: arbitrary angles
- Data to be submitted: None
- Recommendations:
  - Discussion on the difference observed in APC-I and APC-II
  - Aeroelasticity
  - Wall interference
  - Transition
  - No tails
  - High Re
  - Subsonic
Test case 3: Buffet

- Model: NASA-CRM($i_H=0\text{deg}$) with deformation
- Grid: Arbitrary grids
- Conditions: $M = 0.85$, $Re_c = 1.5 \times 10^6$, $T_{ref} = 282K$
- Angles: 4.87deg, 5.92deg
- Data to be submitted:
  - Aerodynamic coefficients($C_D, C_L, C_m$)
  - Surface $C_p$ distributions
    - Average, RMS
  - Frequency spectra
  - Flow field contours
    - (Pressure, Mach number, eddy viscosity)

Cp measurement

Steady
Sections A-I

Unsteady
Sections E, F

CH19: $x/c=0.3097$

CH4: $x/c=0.3480$
APC Website

- NASA-CRM geometry (STL, IGES)
  - Original and deformed shapes are available
- Grid (HexaGrid, MEGG3D, UPACS)
  - Original and deformed shapes are available
- Wind tunnel data (steady/unsteady)
  - Force, moment, Cp, oil-flow
- Please see the APC website for more information
  - [https://cfdws.chofu.jaxa.jp/apc/](https://cfdws.chofu.jaxa.jp/apc/)