Near-Field Analysis with CFD++

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Flow Solver & Computing Platform

- CFD++ V12.1.1
  - 2nd Order, node-based, TVD with continuous limiter
  - Implicit Runge-Kutta with multigrid
  - Realizable K-epsilon (RKE) turbulence model
- IBM Cluster
  - 8 nodes 16 processors/node
  - Limited computing availability due to other program usage

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Cases Run

- **Ran Only Workshop Provided Grids**

- **Axie**
  - **Inviscid, mixed grid, scales 1.00, 1.28, 1.60, 2.00**
- **JWB**
  - **Inviscid, tetrahedral grid, scales 0.70, 0.83, 1.00**
- **C25D Flow-Through**
  - **Viscous (RKE), mixed grid, scales 1.00, 1.28, 1.60, 2.00**
- **C25D Powered**
  - **Viscous (RKE), mixed grid, scales 1.28, 1.60, 2.00**

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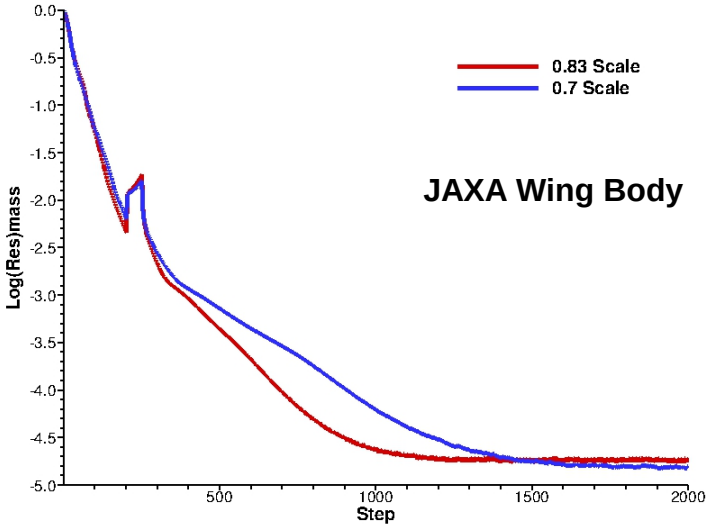
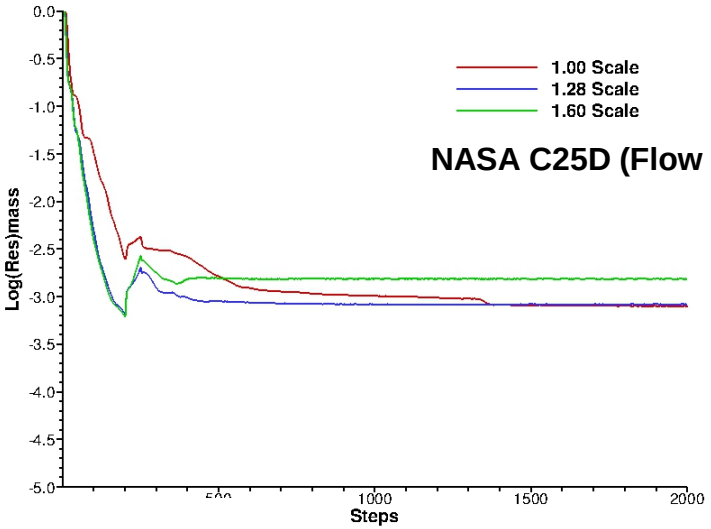
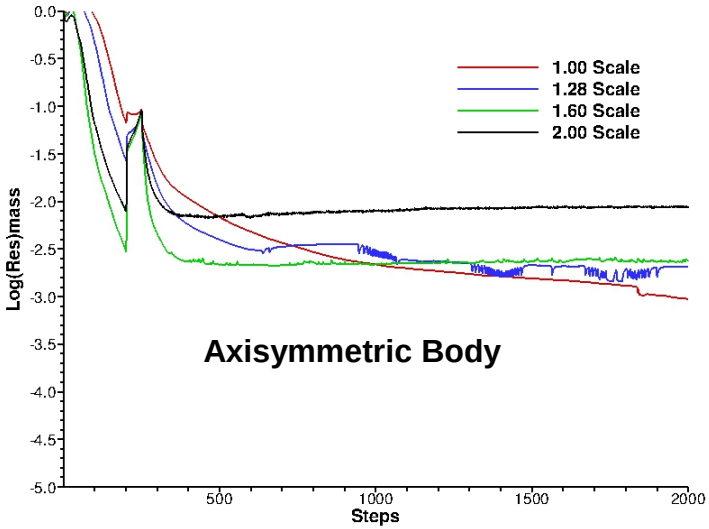
Flow Solver Convergence



JAXA Wing Body



NASA C25D (Flow Through)



Axisymmetric Body

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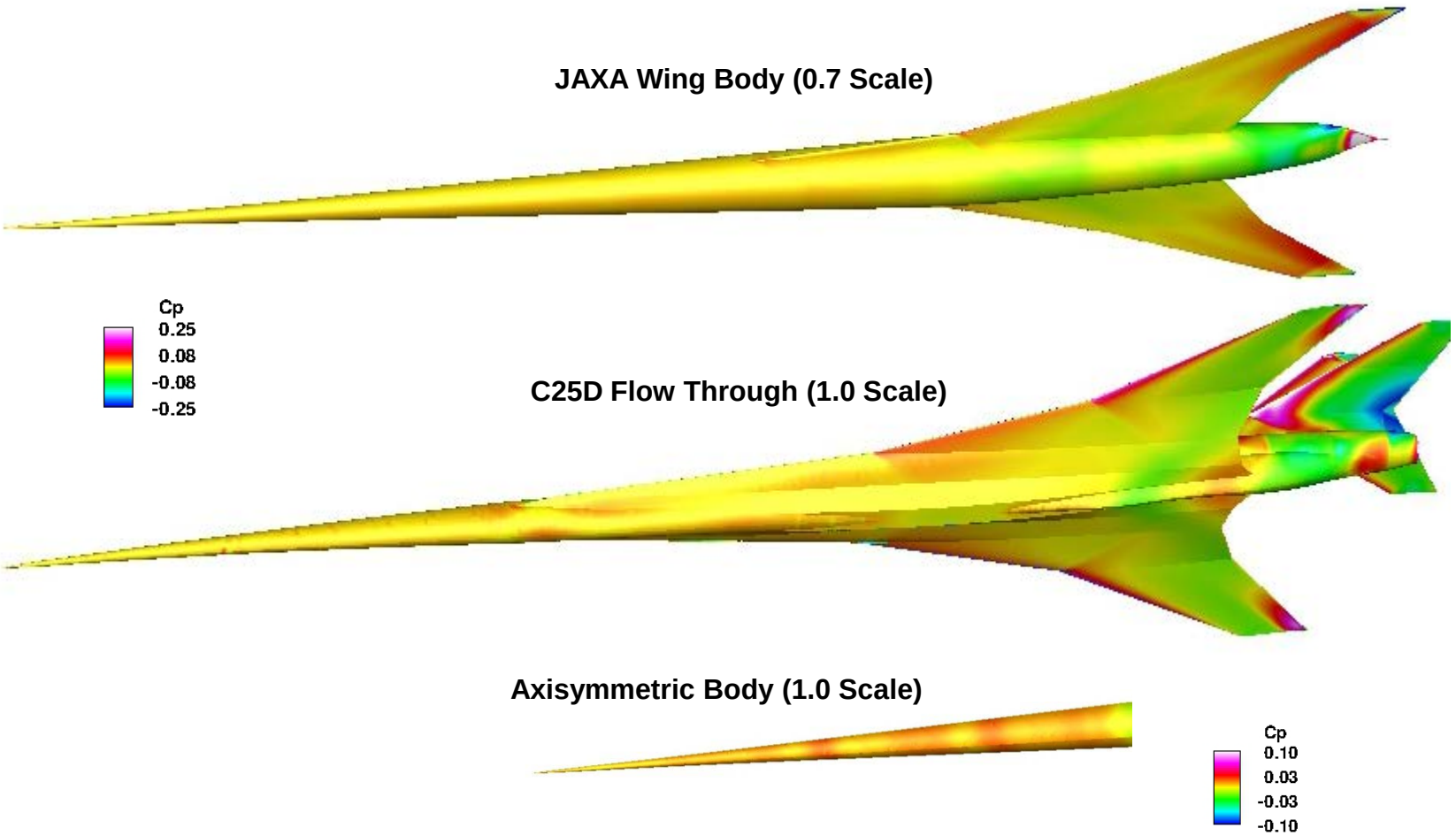
Solution Illustrations (Surface Pressure)

- **Oscillations due to grid quality structured vs unstructured**



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Solution Quality

- **Running finer grids until grid convergence improves confidence**
  - **But what if the solution is "wrong" (for example BCs database corruption, typo [00023769 vs 0.0023769], etc.)**
  - **Other solution properties and trends can be checked, some examples are:**
    - **Convert Dp/p into AEQ and examine its behavior**
    - **Compare Far-Field and Near-Field Dp/p and AEQ**
    - **Check solution Dp/p magnitude behavior vs square-root of distance (in the far-field: like from the forebody or from far-field corrected Dp/p)**

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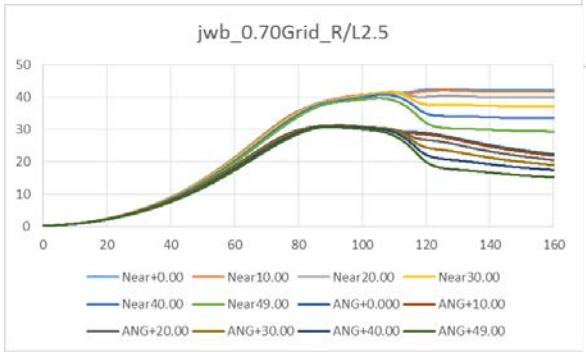
Solution Quality Checks

- **Examine AEQ behavior: shape, near-far-field, with distance**

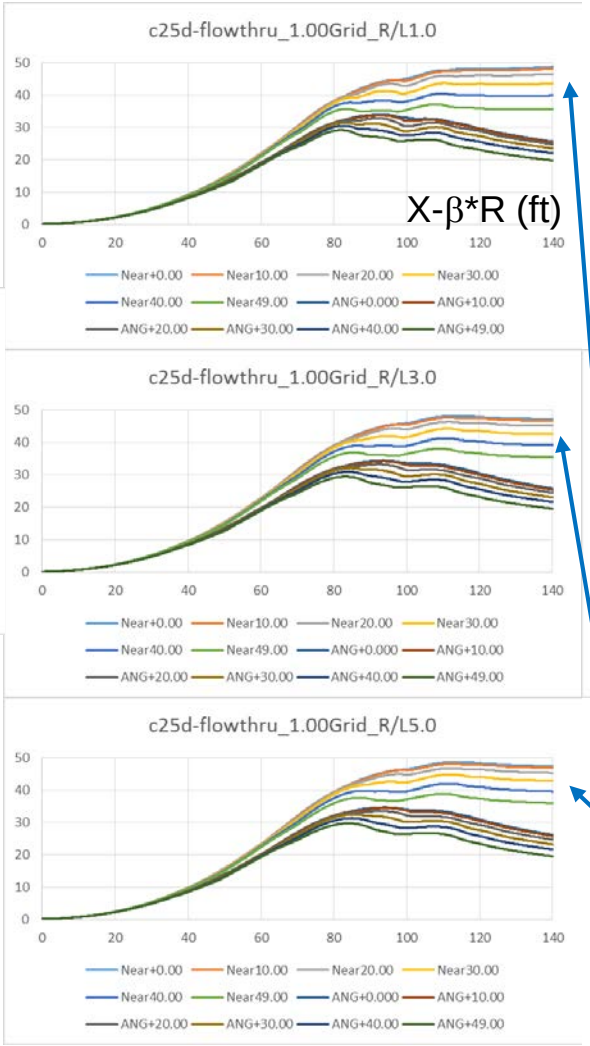
Note: Near-to-far-field corrections calculated from Phi 0-50 data with (cosine) extrapolation of 60-180 data, so increments are approx-imate, particularly at higher Phi.



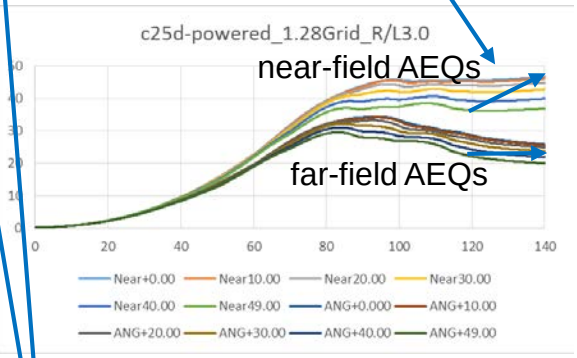
Symmetrical jwb solution until 110 – 120 ft

AEQ (sq ft)

X-β*R (ft)



Increasing near-field and level far-field is expected behind the vehicle



Total AEQs are slightly higher at the closest distance R/L = 1.0 (vs 3.0 and 5.0)

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