Multiblock Navier-Stokes Solver for SST Wing-Fuselage Configuration

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ABSTRACT

An implicit multiblock Navier-Stokes solver, which contains the LU-SGS subiteration method and the HLLEW scheme, has been developed for numerical simulations on complex and realistic aerodynamic configurations. One-level halo cells are used to communicate data between abutting blocks. The resulting method is applied to the NAL supersonic transport (SST) model.

Key Words: Navier-Stokes Equations, Numerical Simulation, Multiblock Grid

1. Introduction

Numerical methods for the Navier-Stokes equations have advanced to the state where the flow analysis is performed on complex geometries with a multiblock structured grid [1].

The present multiblock solver is developed based on the finite difference code for a singe-block grid, which solves the thin-layer Navier-Stokes equations with the LU-SGS subiteration algorithm [2] and the Harten-Lax-van Leer Einfeldt-Wada (HLLEW) scheme [3]. To calculate the convective and viscous fluxes in the block boundary, data communication is performed through one-level halo cells.

The method is used for the flow simulation on the Supersonic Transport (SST) wing-body model designed by National Aerospace Laboratory (NAL) at the supersonic cruise Mach number.

2. Results and Discussions

The steady flows are simulated for the SST wing-fuselage model designed by NAL of Japan. The fuselage length is 11.5m, the moment reference point x = 5.254, the mean aerodynamic chord 2.754m and the reference area $S = 10.12 m^2$. The multiblock grid of 30 blocks is generated for SST configuration without the tail wing based on the model geometry provided by NAL. All of the results presented are for a Reynolds number (based on fuselage length) of 27.5×10^6, Mach numbers of 2.0 and angles of attack from -2° to 6° .

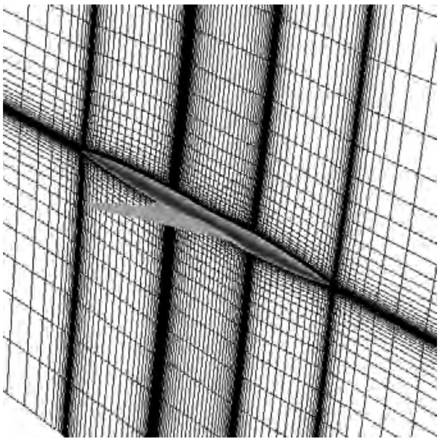

Fig. 1 SST wing-fuselage model

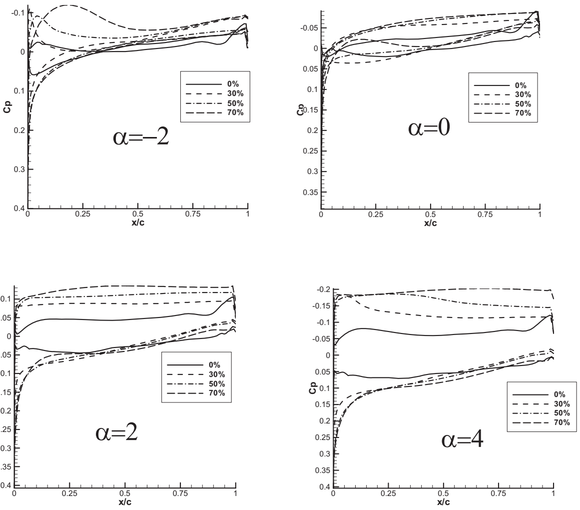

Fig. 2 Surface pressure distributions of SST wing-fuselage model

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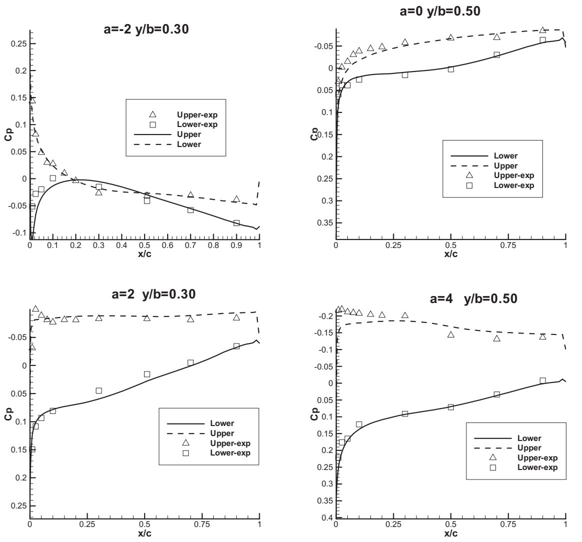

Fig. 3 Comparison of pressure distributions between experiment and calculation

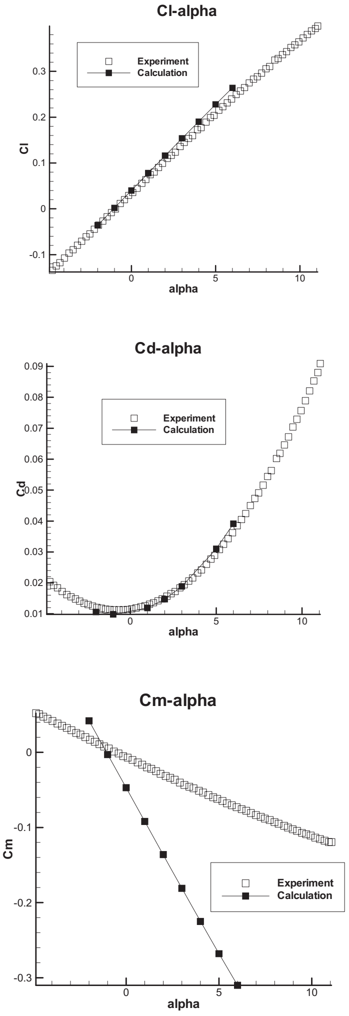

Fig.4 Comparison of aerodynamic coefficients for SST model

SST wing-fuselage configuration without the tail wing is shown in Fig. 1. Surface pressure distributions are shown in Fig. 2. Figure 3 shows the comparison of pressure distributions between experiment and calculation. Figure 4 shows the comparison of aerodynamic forces between experiment and calculation. Calculation results agree well with experiment except for the moment. Computations for the full configuration (SST model including the tail wing) will be presented at the workshop, using the multiblock grid provided by NAL.

3. Concluding Remarks

A multiblock Navier-Stokes solver, which contains the LU-SGS time-marching method and the HLLEW spatial discretization scheme, has been developed for flow simulations on complex configurations. The SST model (without tail wing) is simulated with the present solver. This computed results agree well with experimental data except for the moment.

References

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