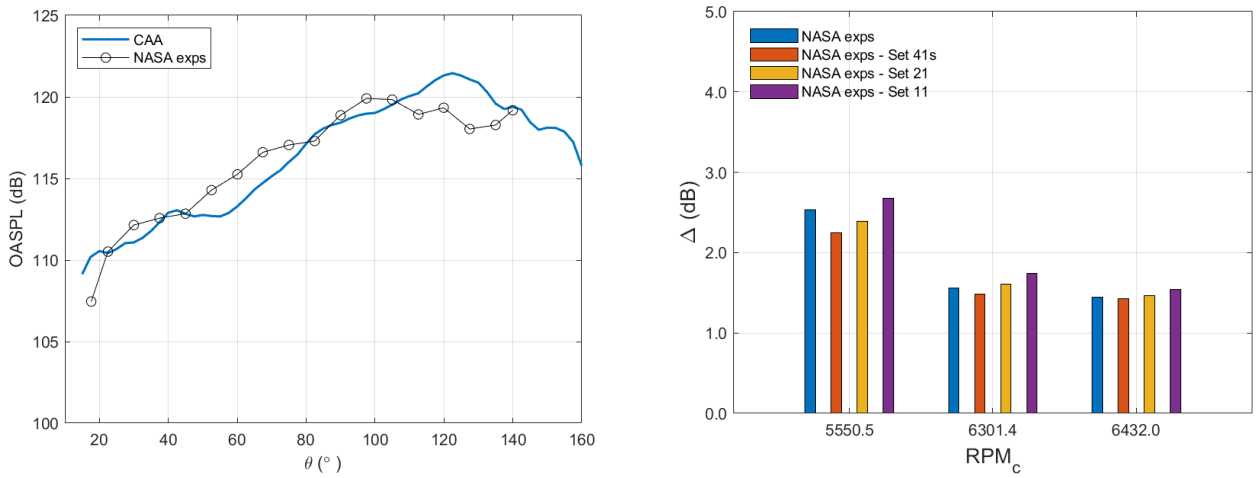

Figure 7. OASPL directivity at 6,432 RPMc (left) and discrepancy (right). CAA: computational aeroacoustics.

Acoustic energy generated by the open fan configuration is calculated from the OPWL. This quantity is calculated by integrating the source power level spectrum for frequencies from 0.5 to 50 kHz. The power level spectrum is obtained by assuming axisymmetry with respect to the propulsor axis, $\psi \in [0, 2\pi]$, and is calculated by using only the same receiver locations used in the experiments. The sideline acoustics data are mapped onto a constant radius, equal to the sideline distance *d*, by assuming spherical spreading (Stephens, 2014). Comparisons of OPWL calculated from simulations and that of experiments are shown in Figure 8. The OPWL trends with corrected rotor speed are in qualitative agreement with the experimental trends, as shown on the left. Closer agreement is found above 6,000 RPMc, whereas the agreement decreases at lower speeds. Numerical predictions are closer to the experimental values at the two highest rotor speeds, with an average discrepancy of less than 1 dB, whereas larger values of 2.5 dB are found at the lowest rotor speed, as shown on the right.

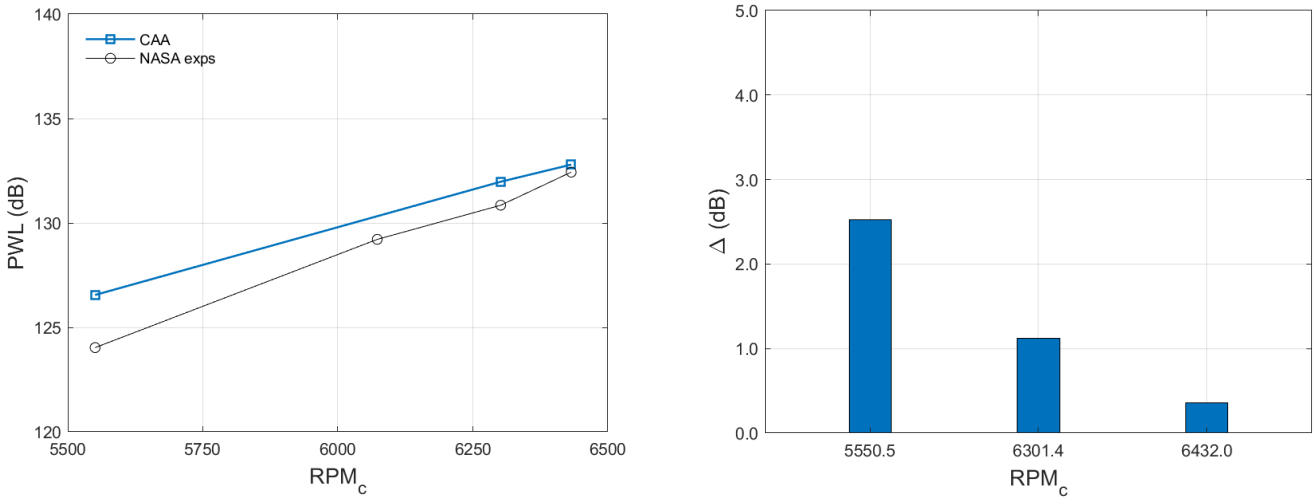

Figure 8. Overall power level (PWL) for calibrated cases. CAA: computational aeroacoustics.

Considerations

The results reported in this document should be viewed in light of the following considerations:

1. Lack of knowledge regarding actual geometry

- Variability in installation of the F31/A31 wind tunnel model, such as blade pitch variation, could lead to angular variations of up to 0.1° from blade to blade.
- Blade deformation may arise from rotation, as blades deform differently at each rotor speed.

2. Simulation aspects
   - The FW-H solver with impermeable surfaces does not account for convection effects (Cerizza, 2022).
   - Impermeable surfaces may not account for very near effects in the flow-field.

Note that each of the above considerations can influence the simulation predictions and hence may result in discrepancies, although the magnitude of these discrepancies is unknown. Installation variability has been argued to result in discrepancies in both aerodynamics and acoustics (Nark, 2016; Envia, 2012). Moreover, neglecting deformations due to operating conditions has also been found to result in aerodynamic and acoustic discrepancies (Falissard, 2018).

Aspects related to simulations are currently being addressed by the authors and will be reported in future work. However, aspects related to a lack of knowledge in geometry are intrinsic to experiments and thus unavoidable in simulations unless provided as part of the outcome from experiments.

Milestones
None.

Major Accomplishments
Extended validation has been completed for all cases at a zero angle of attack.

Publications
"Aerodynamic Calibration for Aeroacoustics Validation of an Open Fan Configuration," to appear on AIAA SciTech 2023.

Outreach Efforts
None.

Awards
None.

Student Involvement
For this task, Brenton Willier (continuing PhD student) and Grant Stevenson (continuing MS student) worked on geometry preparation for numerical analysis and acoustic data analysis.

Plans for Next Period
Future work will focus on completing the remaining validation cases. These remaining cases include a case with a non-zero angle of attack and a case with the nominal pitch setting.

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