



Recent and Upcoming Improvements to the OVERFLOW CFD Code

Joseph M. Derlaga

Charles W. Jackson

Michael V. Donello

Pieter G. Buning

NASA Langley Research Center

March 19/20th, 2024

Outline

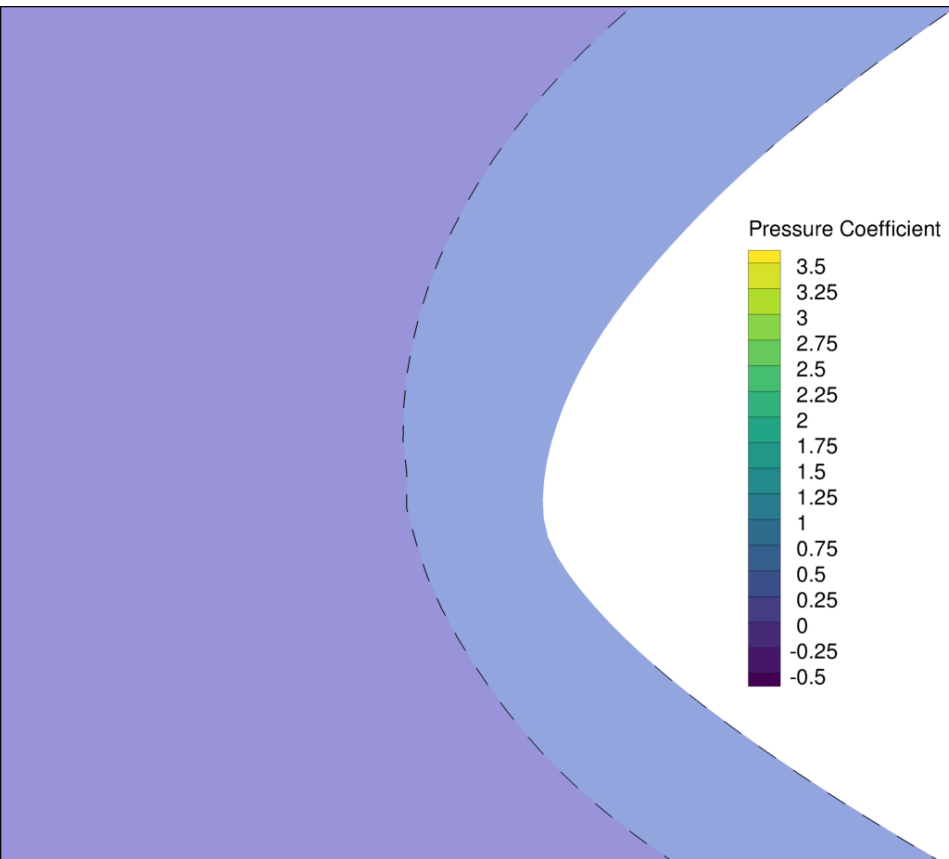
- Algorithmic improvements
- HPC improvements
- Community requests
- Future work

Algorithmic Improvements

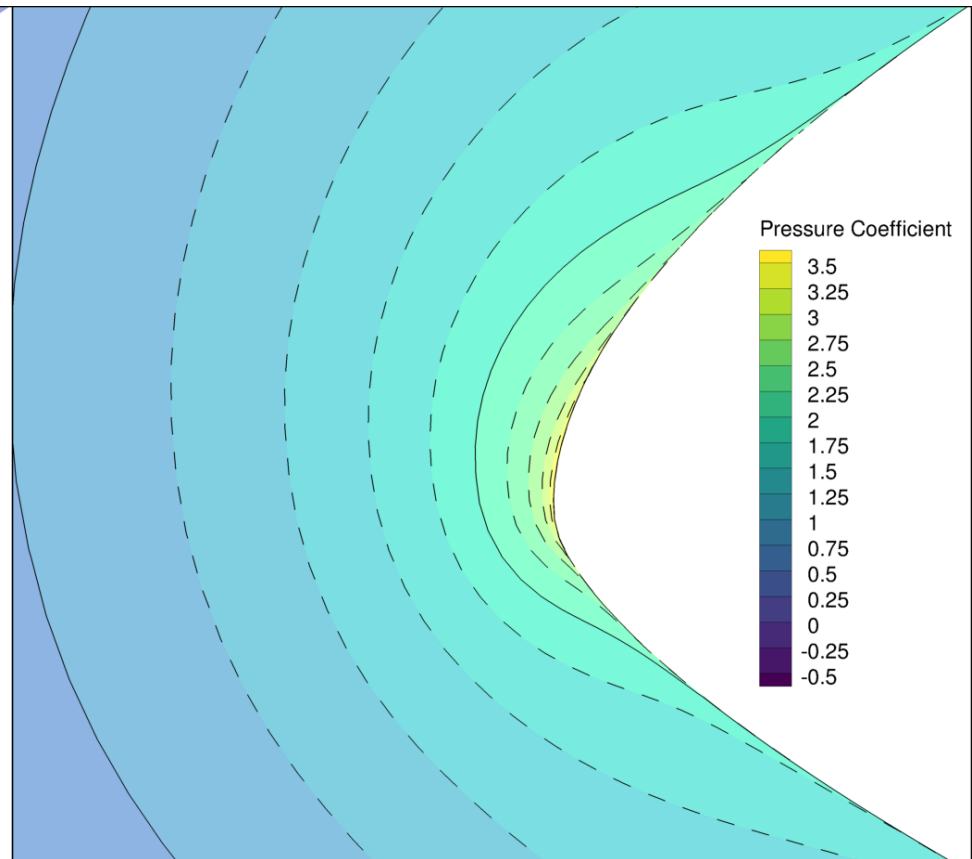
- Addition of implicit physical and overset boundaries
 - Quicker setup of flow field near bodies
 - Improved force/moment convergence
 - Better residual convergence and reduction in 'echo chamber' behavior inside of overset blocks
 - Please refer to AIAA 2020-1045 and 2021-2747 for more details

Implicit Physical BCs

Original SSOR, 1 processor



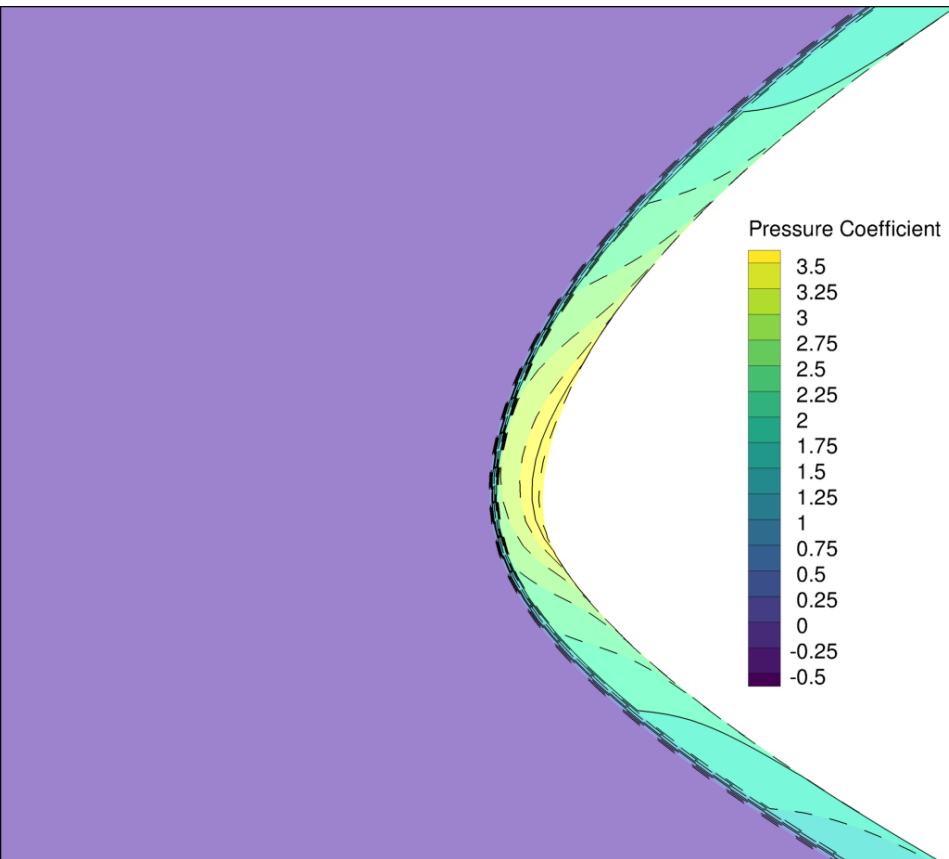
Improved SSOR, 1 processor



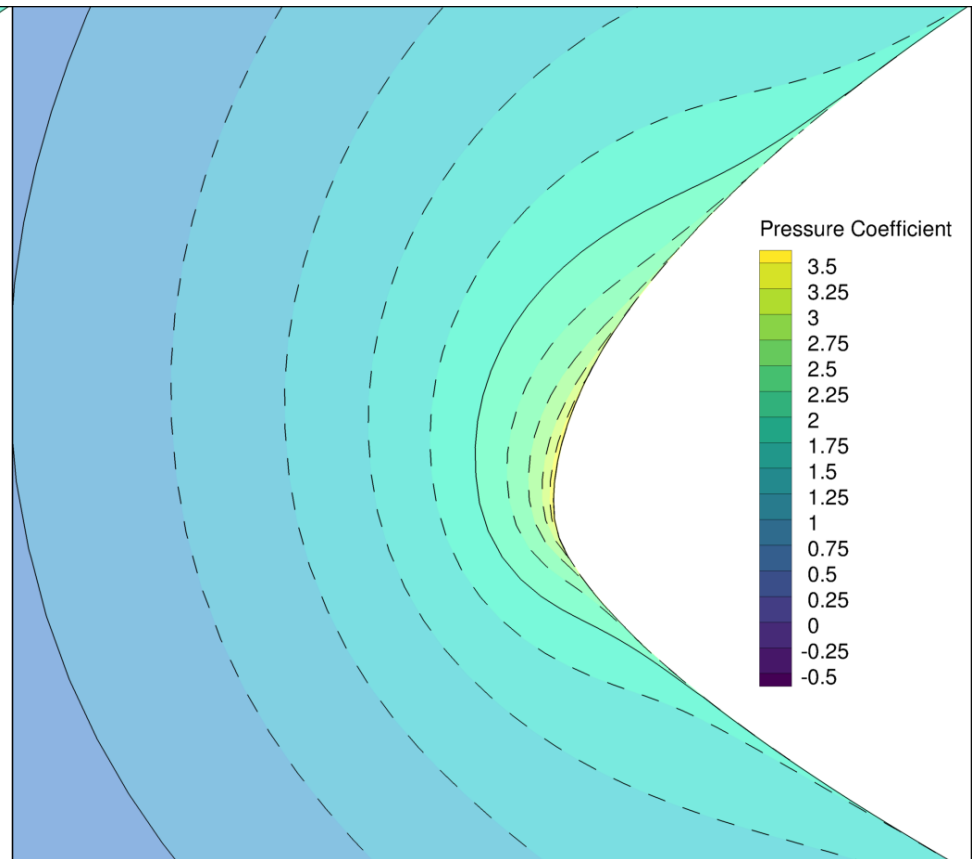
Impulsive start, one nonlinear step

Implicit Physical BCs

Improved SSOR, 8 processors



Improved SSOR, 1 processor

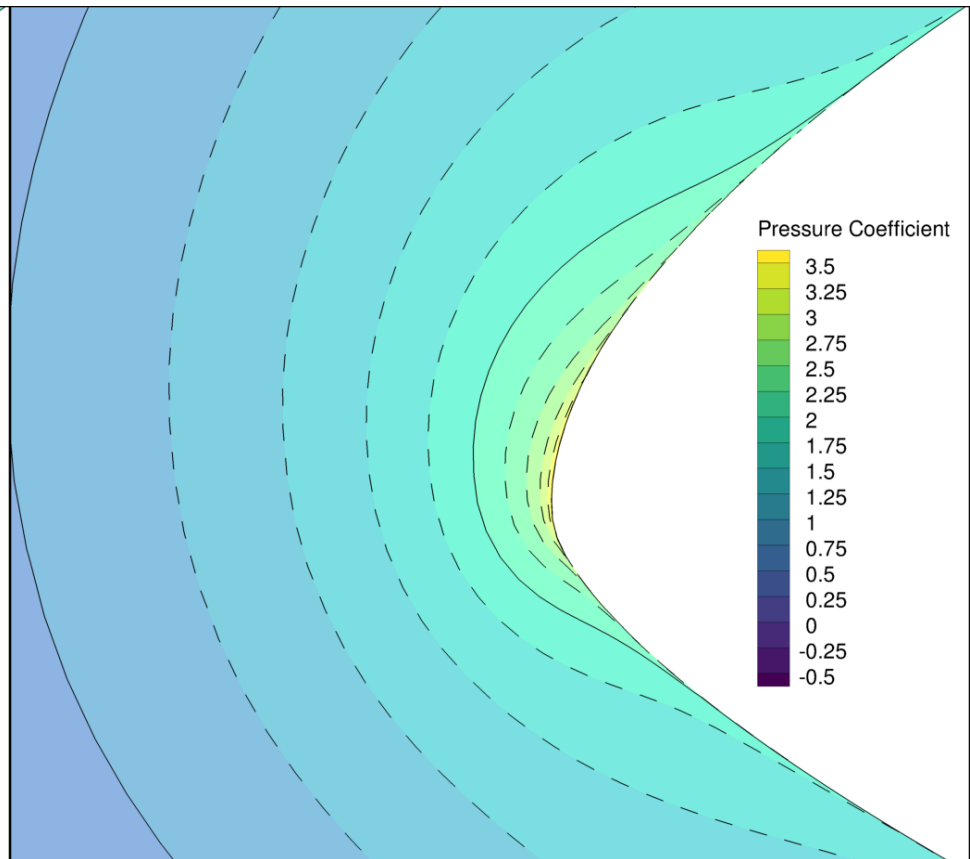
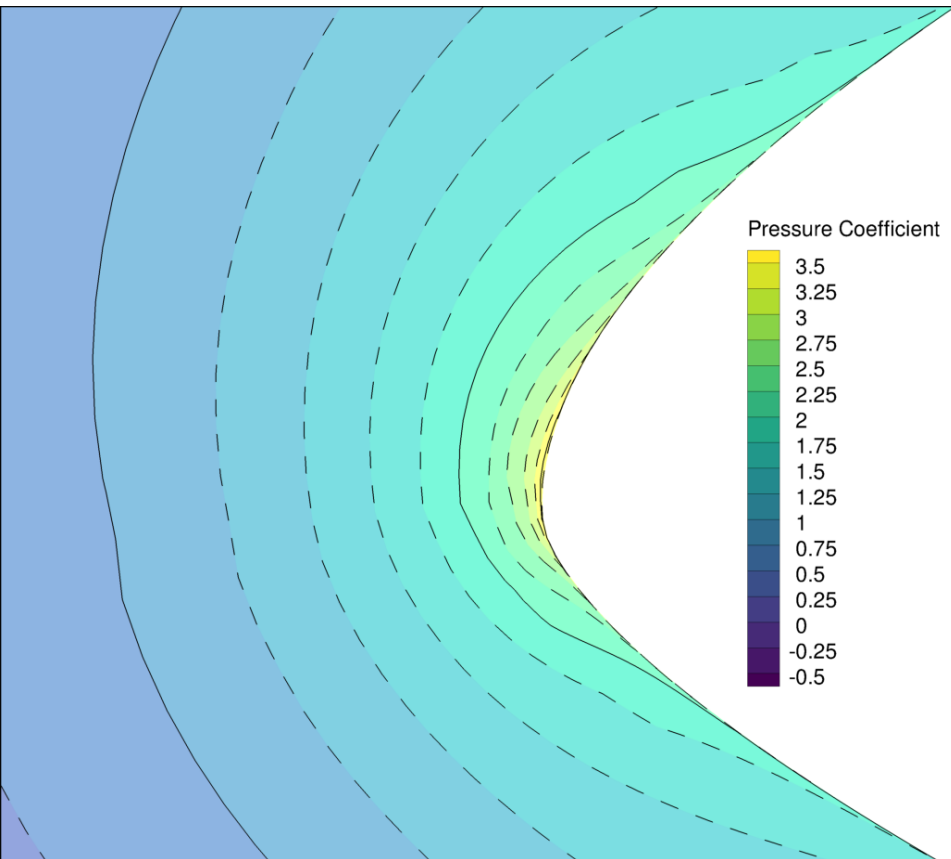


Impulsive start, one nonlinear step

Implicit Overset BCs

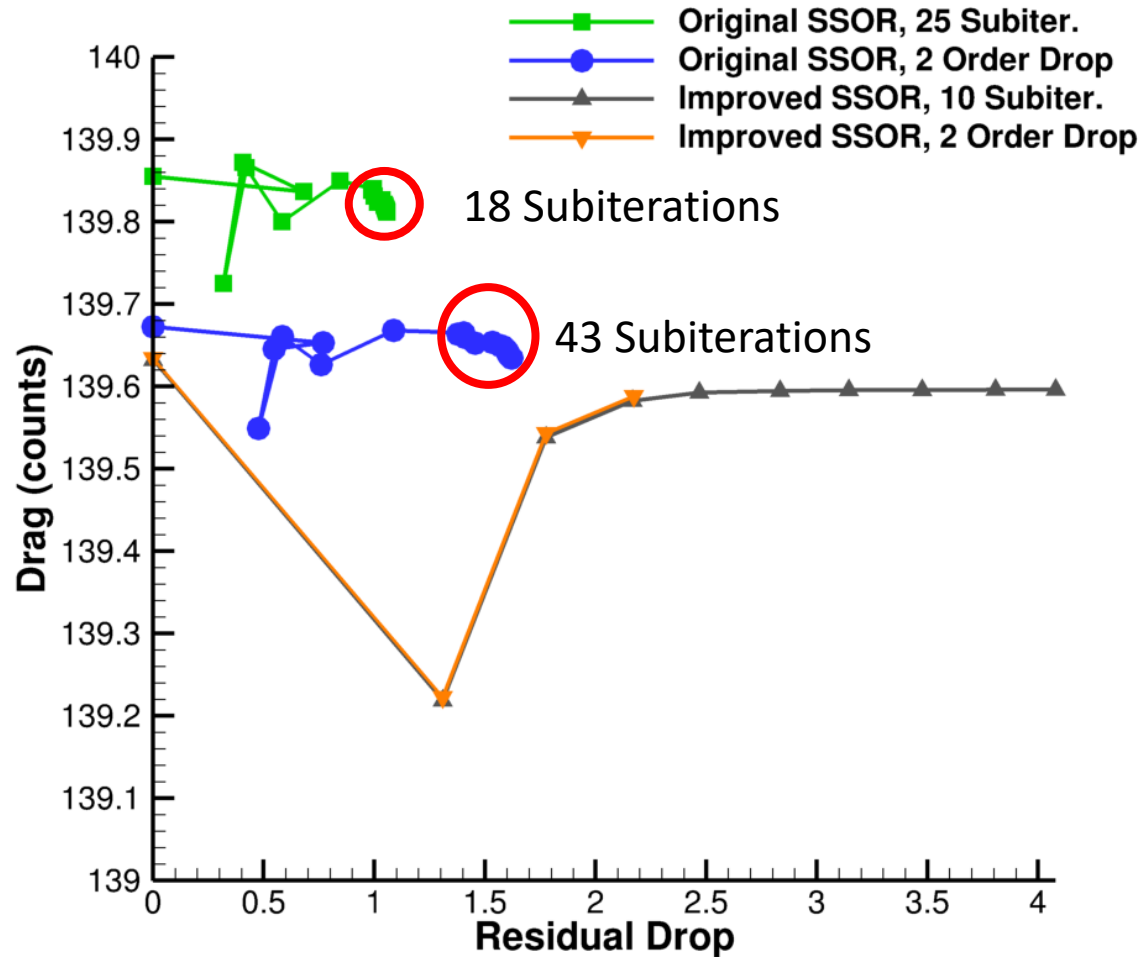
Parallel SSOR, 8 processors

Improved SSOR, 1 processor



Impulsive start, one nonlinear step

Integrated Forces



Generic Quadcopter Rotor

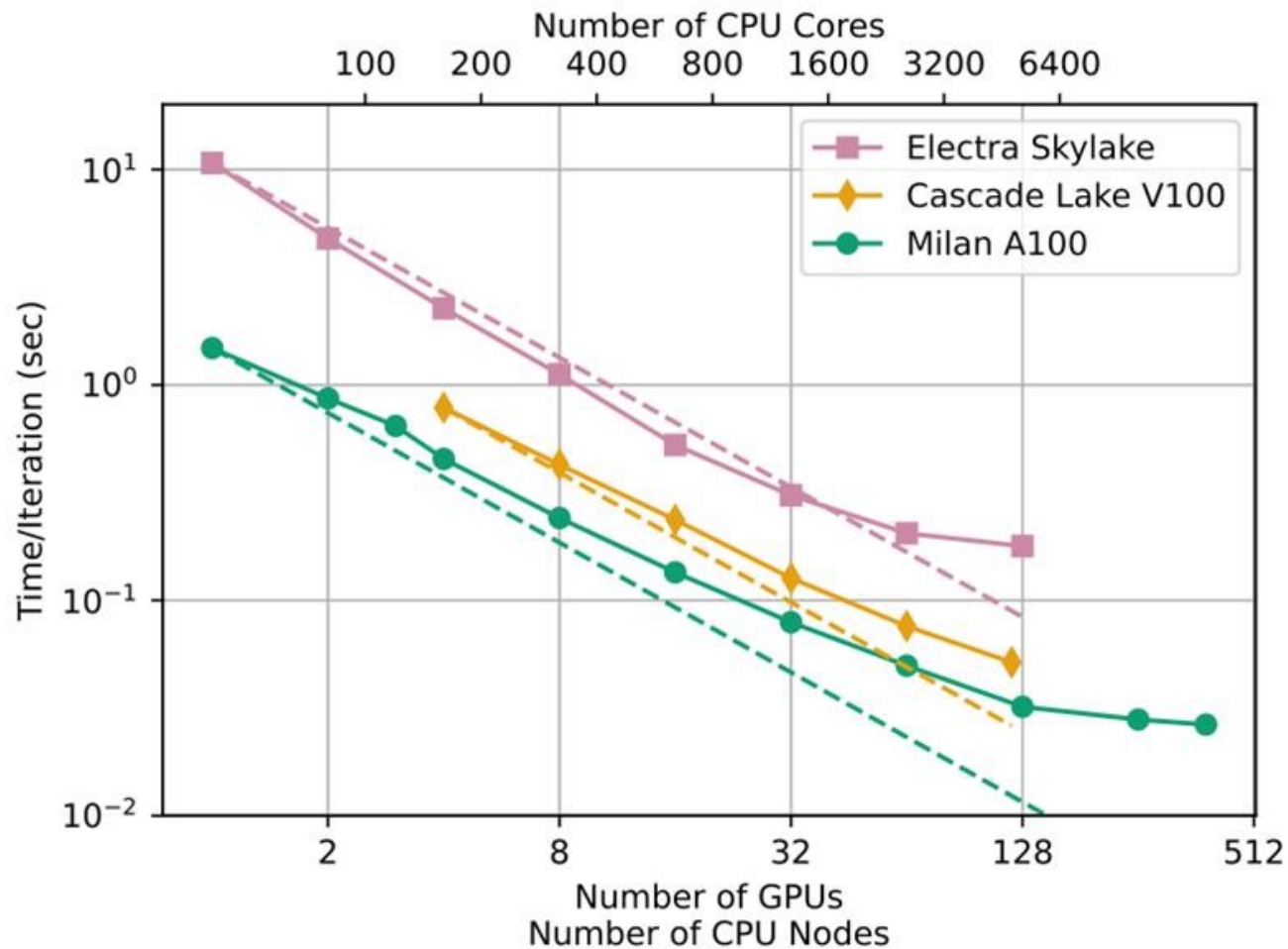
- Two-bladed rotor in hover with time steps based on a $1/4$ degree rotation
 - Speedup from a week to a weekend
 - And faster time to a better converged solution, too!

Residual Convergence, per Rev	Time for 2 Order Drop, Hours	Time for 3 Order Drop, Hours
Old SSOR	14	> 36
Improved SSOR	5	9
Speedup	2.8x	> 4x

HPC Improvements

- GPUs!
 - Central schemes, SA, RBM, Newton/Dual subiterations have all been ported
 - Multi-GPU capable
 - Run on grids with > 4 billion points
 - Please refer to AIAA 2024-0042 for more details
- Will be porting the upwind schemes next(ish)

HPC Improvements



Community Requests

- Standard triq and double precision triq output
 - Workaround for ANOPP2 not fully supporting PLOT3D
- Split restart capability
 - Avoids residual blips that can take a significant amount of time to damp out
- Vreman SGS model
 - User exploration of LES
- Improved documentation through a rewritten/new user manual

Ongoing/Future(?) Work

- Continue GPU porting/rewriting
 - SSOR schemes not yet available, but will be
- Jacobian Free Newton-Krylov (in progress)
 - Provides a path to deeper convergence
- Tricubic overset interpolation
 - Improves the accuracy of interpolated solution values
- On-the-fly data reduction
 - Acoustic simulations have large I/O costs
- Switch to conservative/non-overset off-body solver
 - Avoid donor/receiver injection altogether

Questions?

- In recent years, OVERFLOW has been primarily funded by the Revolutionary Vertical Lift Technology project of the Advanced Air Vehicles Program
- Special thanks to Brian Allan and Doug Boyd (LaRC) for testing during the development of OVERFLOW 2.3 and 2.4