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Recent Developments for the eddy Solver

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As part of an effort within the NASA Aeronautics Transformational Tools and Technologies Project to improve the efficiency and accuracy of computational predictions of separated flows, at NASA Ames Research center we have been developing a space-time discontinuous-Galerkin (DG) spectral-element solver [1-3]. This development is specifically tailored for unsteady flows with complex physics, *e.g.* separation, shock/boundary-layer interaction, transition, *etc.* Recent work has extended this effort to a general monolithic multi-physics solver targeted at applications such as parachute fluid-structure interaction (Fig. 1), atmospheric-entry aft-body heating and jet interaction, transonic buffet of launch vehicles, *etc.*

The proposed presentation and paper will review recent developments, including demonstrations of the multi-physics capability, unsteady and shadowing adjoints for turbulent flows, LES wall-modeling for separated flows, simulations of transition and wall-roughness effects for turbine blades (Fig. 2), and high-order unstructured metric-based mesh generation.

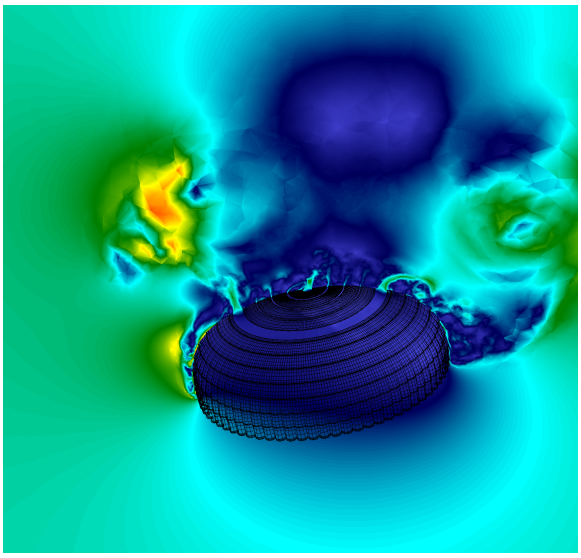

Figure 1: Computed instantaneous velocity magnitude contours for the Apollo parachute at Ma=0.5.

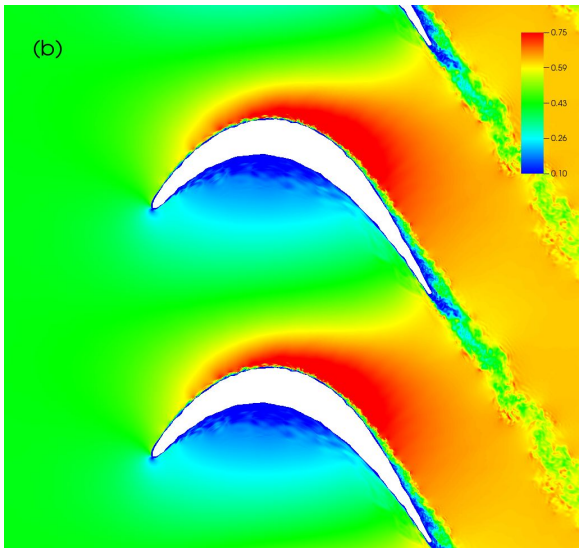

Figure 2: Computed Mach number contours in a spanwise slice along the Pack109 low-pressure turbine cascade with a roughened surface.

REFERENCES

[1] Diosady, L.T. and Murman, S.M., Higher-Order Methods for Compressible Turbulent Flows Using Entropy Variables, AIAA Paper 2015-0294.

[2] Murman, S.M., Diosady, L.T., Garai, A., and Ceze, M., A Space-Time Discontinuous-Galerkin Approach for Separated Flows, AIAA Paper 2016-1059.

[3] Garai, A., Diosady, L.T., Murman, S.M., and Madavan, N., Scale-resolving Simulations of Bypass Transition in a High-pressure Turbine Cascade Using a Spectral-element Discontinuous-Galerkin Method, Journal of Turbomachinery, Vol. 140 No. 3, 2017.