



AD/AG-47:

Coupling of CFD with Flight Mechanics Model

Action Group Chairman: Dr Bimo Prananta, NLR (Bimo.Prananta@nlr.nl)

Background

Flight mechanics cases influenced by non-linear aerodynamics:

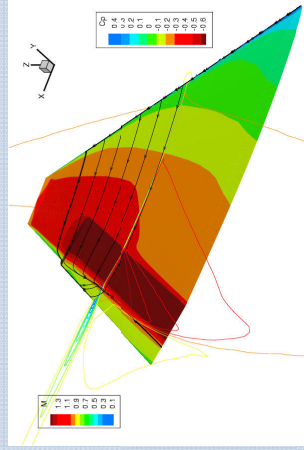
unusual flight attitude, loads at extreme of flight envelope, departure recovery

Increasing readiness of unsteady CFD:

adequate accuracy, quick turn around, safe to deploy compared to flight test

Challenge:

reliable coupling method between CFD and flight mechanics model, best practices



Previous activity: successfully completed AG/AD-38 on unsteady CFD methods

State of the art: unsteady aerodynamics for prescribed rigid motion

Conclusions: CFD can simulate complex unsteady flows due to rigid body motions

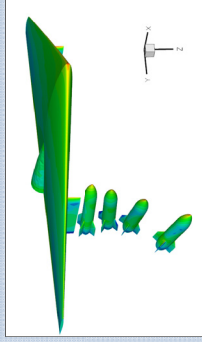
Programme/Objectives

Main objectives of AD/AG-47: (1) to provide a platform to communicate and validate the development and applications of CFD coupling to flight mechanics models; (2) to gain knowledge on non-commanded flight mechanics motion caused by non-linear aerodynamic phenomena; (3) to define a suitable test set up, by means of numerical studies, for validating the algorithms and gaining further knowledge on non-commanded flight mechanics motion.

Partners: industries, research establishments and university

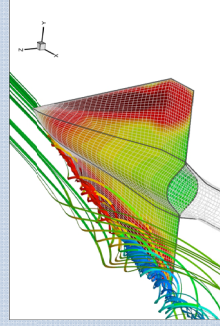
AIRBUS-MILITARY, ALENIA, CASSIDIAN, DLR, FOI, NLR, ONERA, University of Liverpool

Activities: Numerical simulations of aerodynamics coupled to flight mechanics and validations using wind-tunnel data



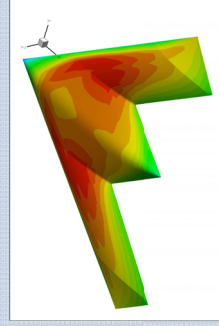
Case 1 AGARD store release

- availability of test data
- needs complex grid handling



Case 2 rolling motion of wings

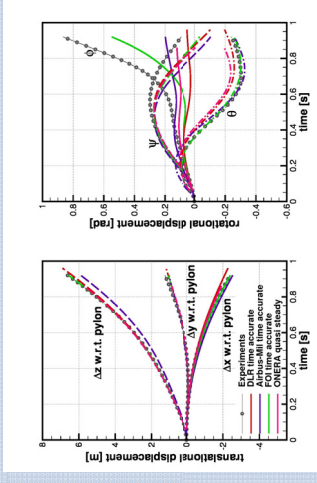
- non-linear aerodynamics
- vortex breakdown
- transonic abrupt stall



Case 3 longitudinal motion of UCAV

- realistic configuration

Results



- various strategies of solving six-DOF EOM implemented and verified
- various implicit CFD-FM coupling methods developed, quasi-steady and time-accurate
- grid strategies successfully applied:
 - grid deformation+regridding, chimera overset
 - store release test case
 - wing-interference effects are important
 - comparable accuracy of quasi-steady with assumed aerodynamic damping and time accurate
 - experimental data reproduced
 - nonlinear response due to vortex breakdown is fully captured
- exploratory study to obtain abrupt wing stall using SIS wing results in a too-weak roll moment, more studies underway
- results of longitudinal motion of UCAV
 - results in linear region obtained, typical short period+phugoid mode observed

Conclusion:

- improved readiness of coupled CFD-FM method for simulation of nonlinear flight mechanics problems