GARTEUR

GROUP FOR AERONAUTICAL RESEARCH AND TECHNOLOGY IN EUROPE

FRANCE GERMANY ITALY THE NETHERLANDS SPAIN SWEDEN UNITED KINGDOM

AD/AG-47:
Coupling of CFD with Flight Mechanics Model

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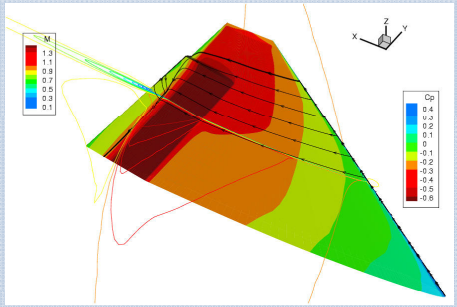
Background

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

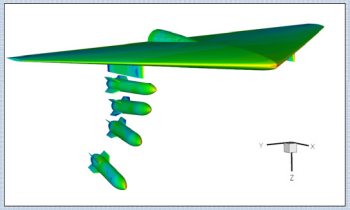
Programme/Objectives

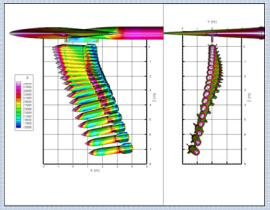
Main objectives of AD/AG-47: (1) to provide a platform to communicate and validate the development and applications of CFD coupling to flight mechanics models; (2) to gain knowledge on non-commanded flight mechanics motion caused by non-linear aerodynamic phenomena; (3) to define a suitable test set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

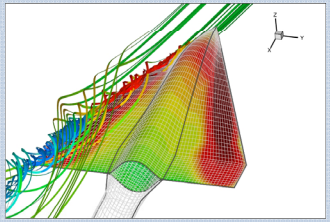
Activities: Numerical simulations of aerodynamics coupled to flight mechanics and validations using wind-tunnel data

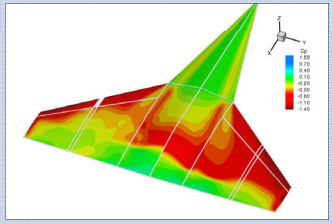
Case 1 AGARD store release
- availability of test data
- needs complex grid handling



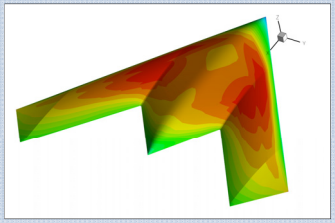


Case 2 rolling motion of wings
- non-linear aerodynamics
- vortex breakdown
- transonic abrupt stall





Case 3 longitudinal motion of UCAV
- realistic configuration

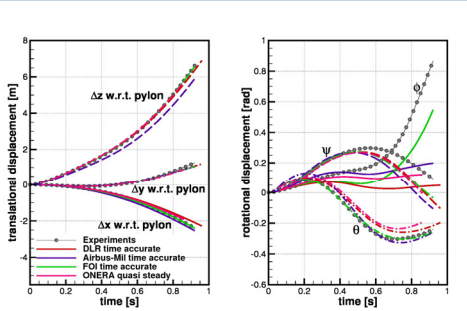


AIRBUS MILITARY CASSIDIAN AN EADS COMPANY

AleniaAeronautica A Finmeccanica Company

DLR NLR FOI ONERA UNIVERSITY OF LIVERPOOL

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
- results of rolling motion of wings
  - 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+phuigoid mode observed

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