



ONERA

THE FRENCH AEROSPACE LAB



THALES



Trajectory “Greening”

Alberto CHIESA, Alenia Aermacchi

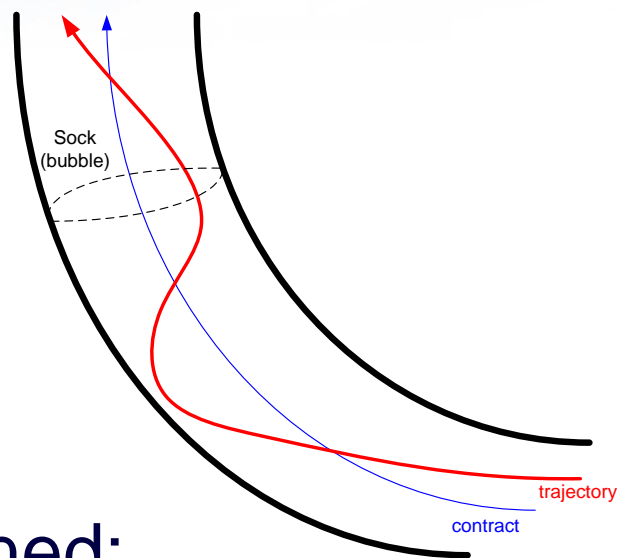
Second Demonstration Workshop

Braunschweig, Germany

June 25th, 2013

Wind exploitation - Objectives

To obtain emission reduction with an optimization of trajectory inside of given contract using the knowledge of local wind scenario

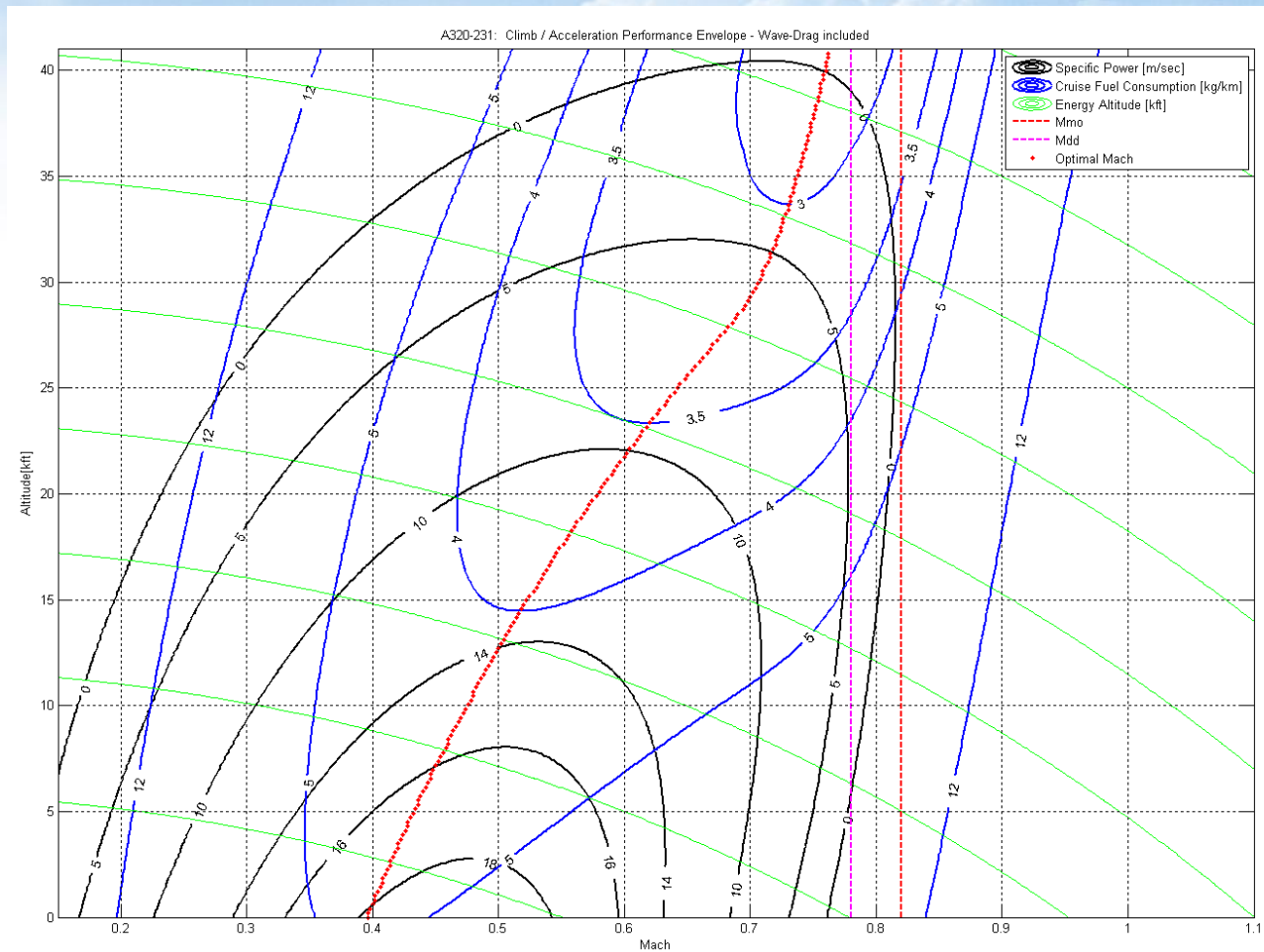


Optimization obtained:

- with the knowledge of A/C aerodynamic characteristics
- Tracking “tail wind zones”

Online optimization - Concept

A320-231 airliner
with its nominal
weight (70 ton)
Altitude 30,000[ft] ,
optimal Mach
0.71



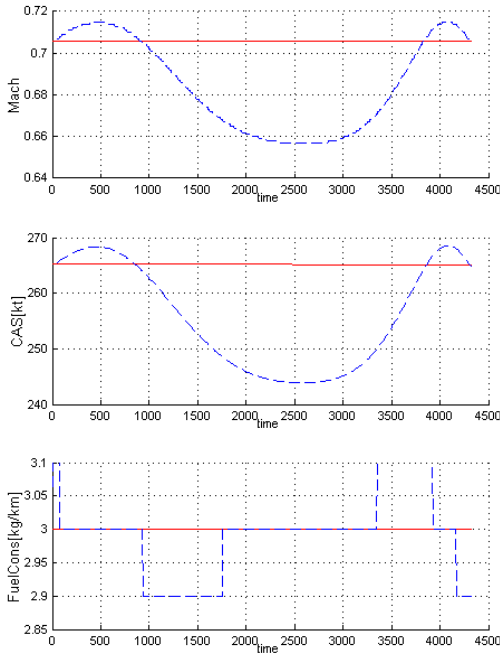
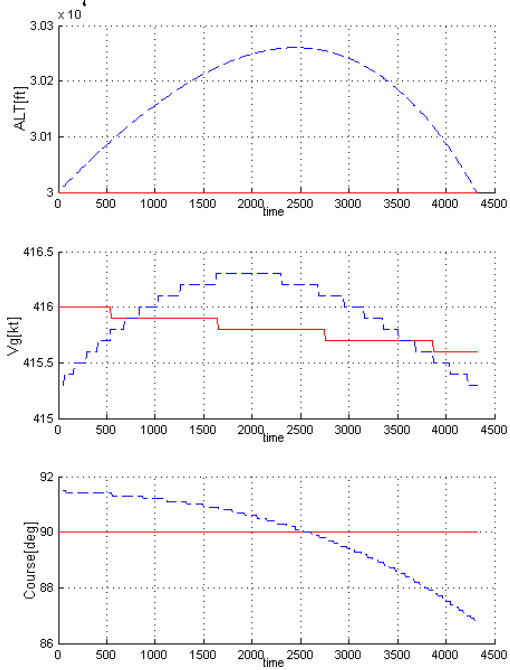
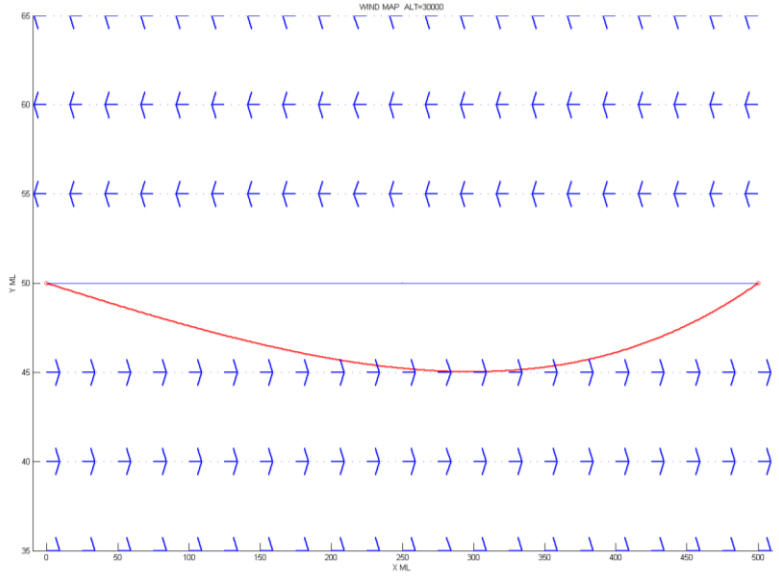
Online optimization - Results/1

Constant wind, optimal nominal conditions

Input	Value	Notes
Range [nmiles]	500	
Time [sec]	4327	
Direct Ground-Speed [kt]	416.46	Optimal airspeed
Reduction in Fuel [kg]	90	3.24%

Total_fuel_Contract = 2782, Total_fuel_Optimized = 2692

— (simres) contract_results.dat
 - - - (simres) best_results.dat



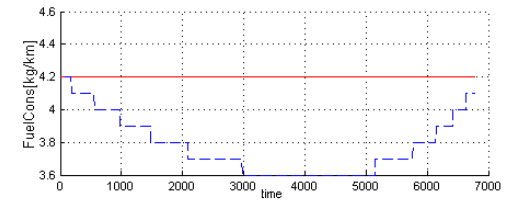
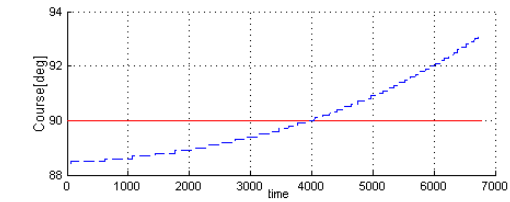
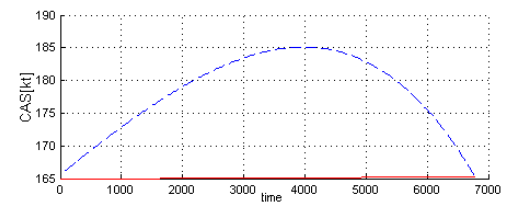
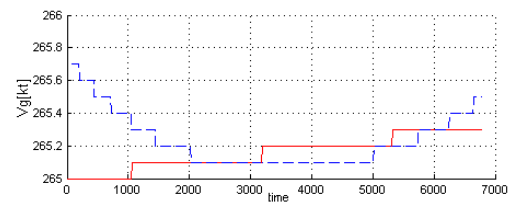
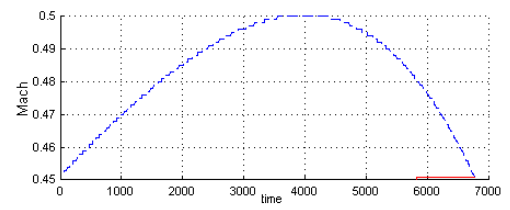
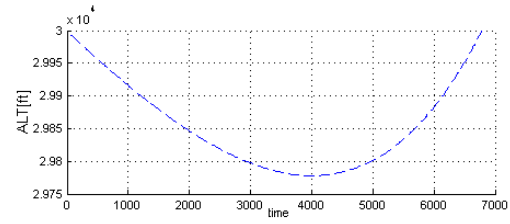
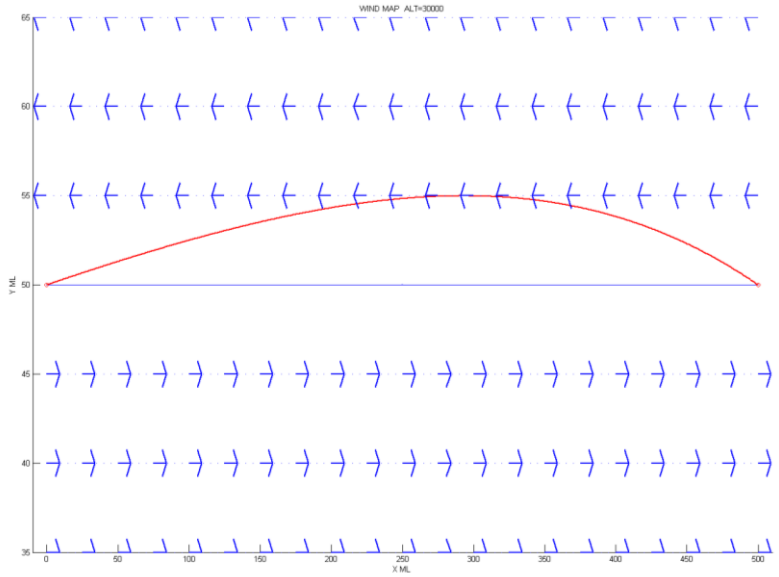
Online optimization – Results/2

Constant wind, very low airspeed conditions

Input	Value	Notes
Range [nmiles]	500	
Time [sec]	6790	
Direct Ground-Speed [kt]	265	Fitted to Mach=0.45
Reduction in Fuel [kg]	129	3.32%

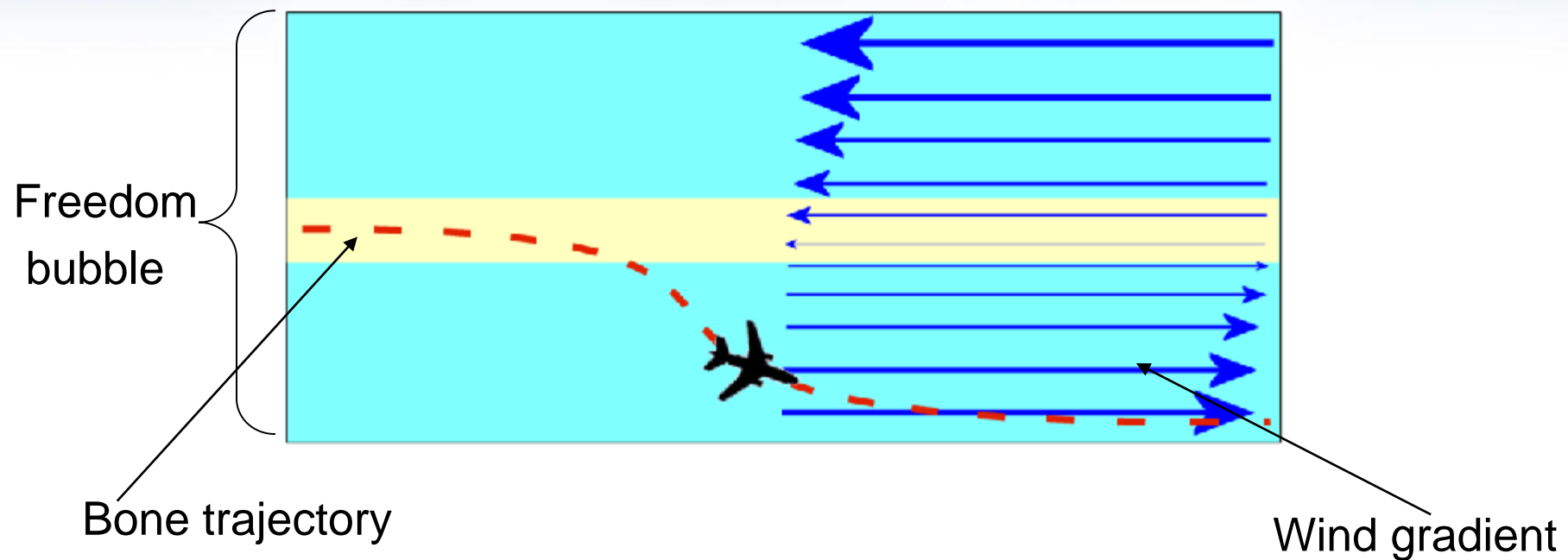
Total_fuel_Contract = 3888, Total_fuel_Optimized = 3758

— (simres1) contract_results.dat
 - - - (simres) best_results.dat



Wind exploitation logic – concept/1

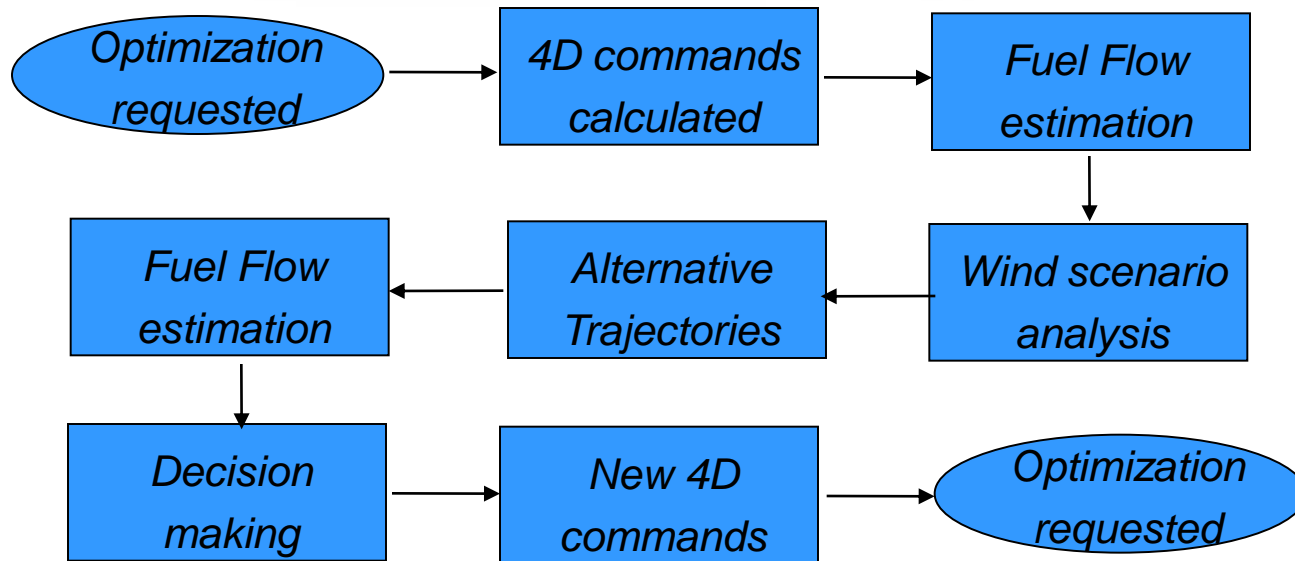
Driving concept



Knowing local wind within its freedom bubble, aircraft can use it to reduce fuel consumption

Wind exploitation logic – concept/2

- Algorithm flow-chart



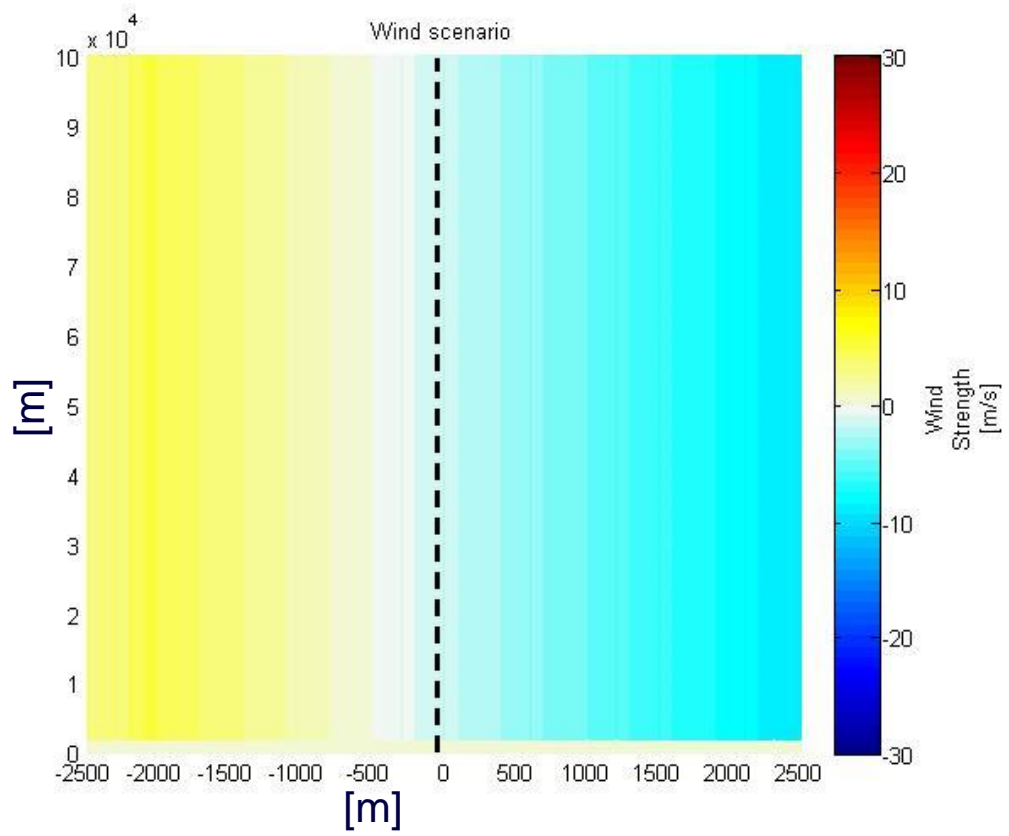
- Update of contract not requested!

Simulation demo

- Demo setup:
 - B737-500, 50000 Kg, $h = 20000$ ft
 - Contract leg:
 - 80 km
 - no altitude change
 - optimal mach
 - “main stream” method for wind exploitation

Simulation scenario 1

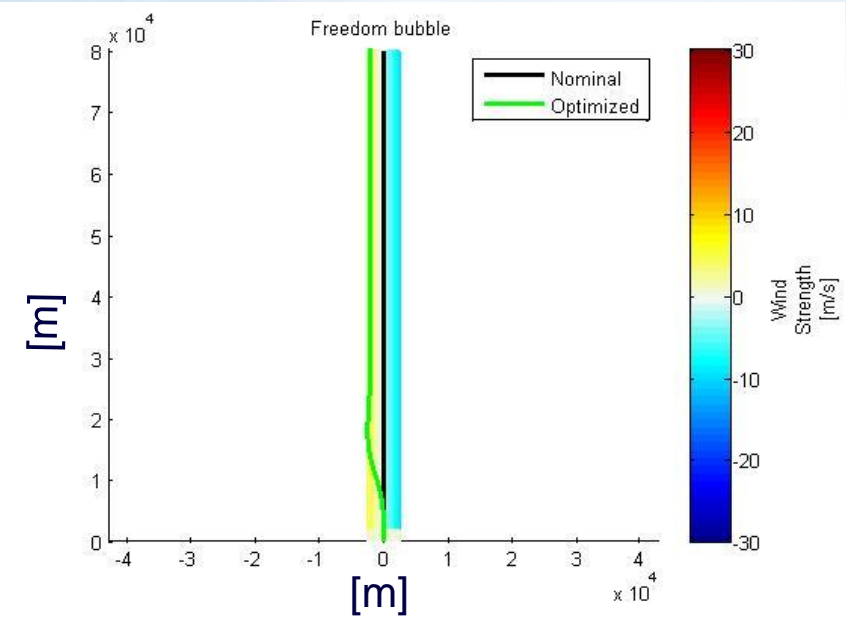
- Wind scenario



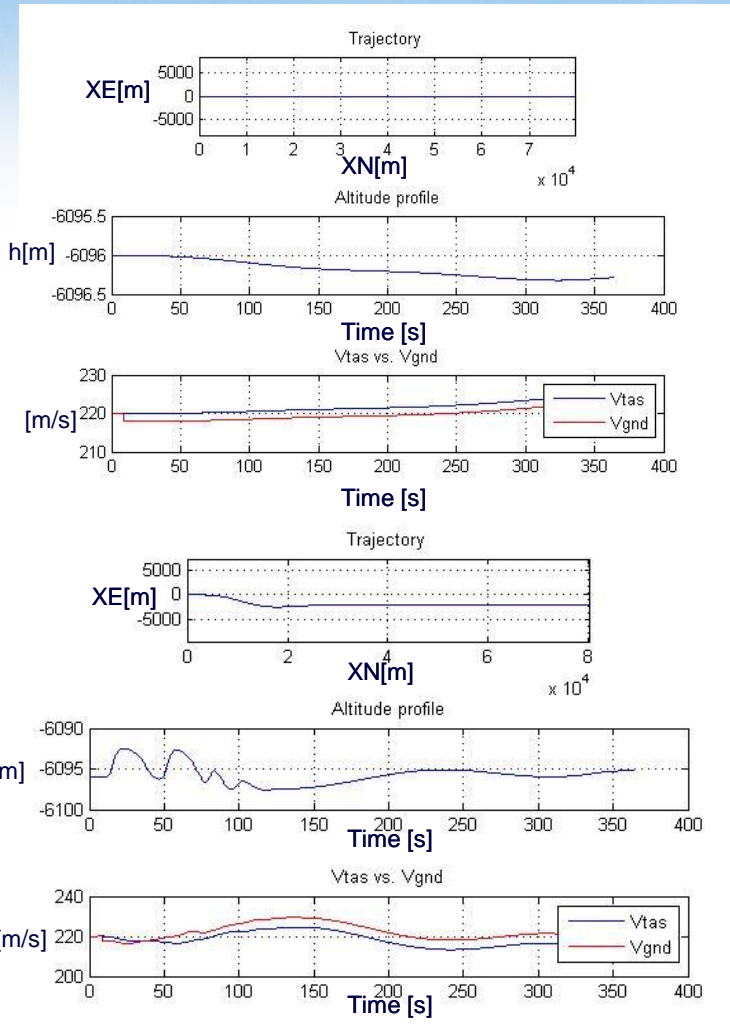
- Light (3 m/s) tail wind on left of freedom bubble
- Moderate (-10 m/s) head wind on right of freedom bubble

Simulation scenario 1 results

- Wind scenario:

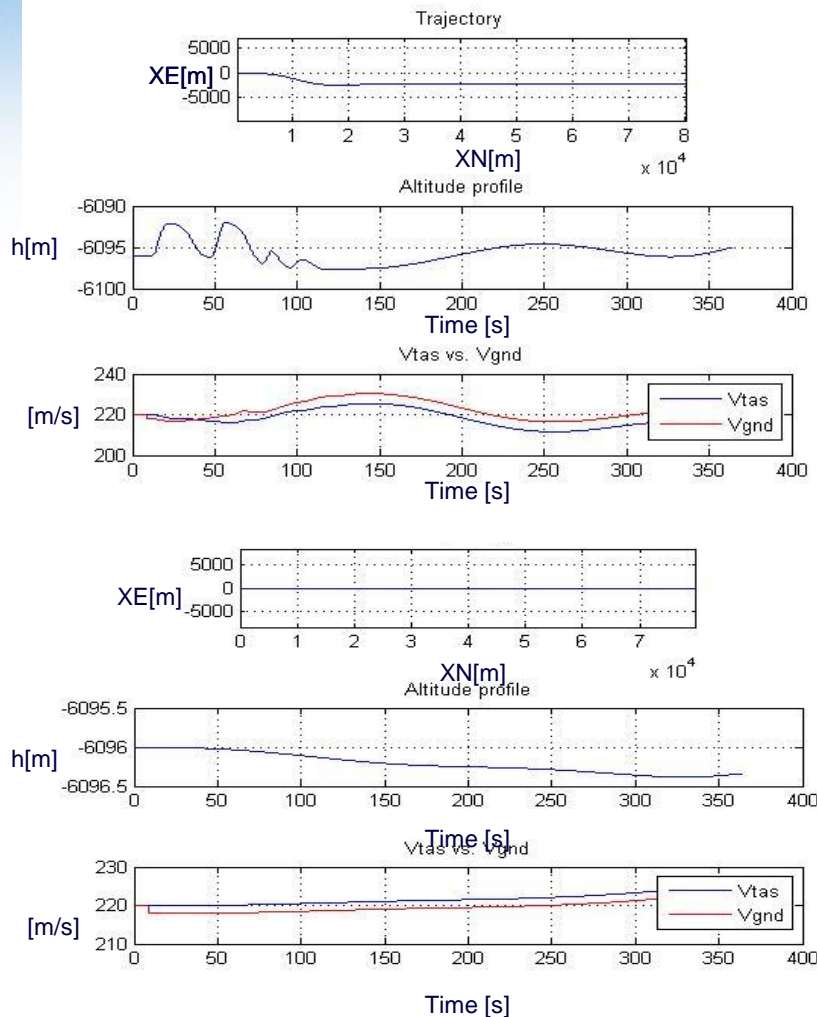
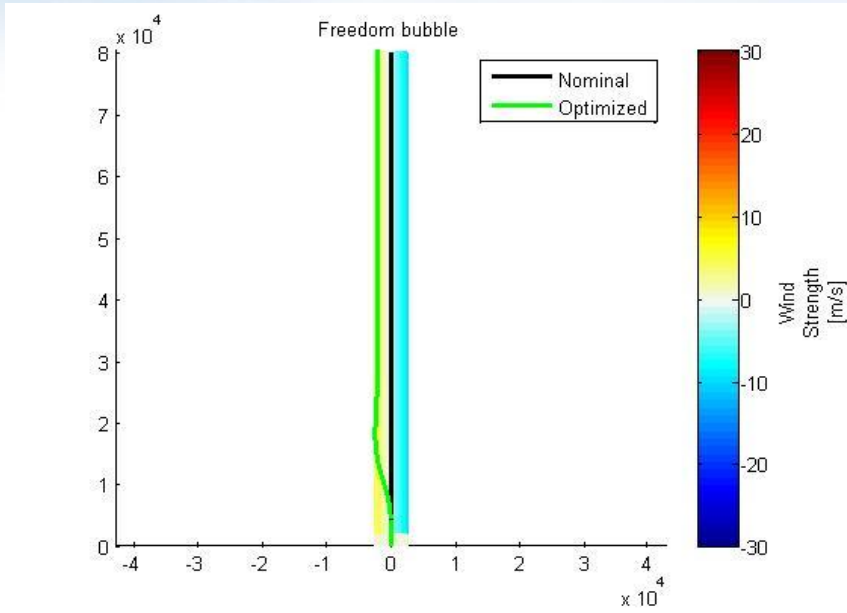


- Optimizer follows “tail wind zone”.
Fuel saving is 3.4%



Simulation scenario 2 (increased mass) results

- Wind scenario:



- Optimizer follows “tail wind zone”.
Fuel saving is 2.1%

Simulation scenario 3 (no favorable wind) results

- Wind scenario:
- Optimizer decided not to maneuver: standard 4D tracking

