VALEOL

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Presented by Claire Taymans
Summary

WP 2
Task: Investigation of predicted non-linear behaviour of wind turbine blades subjected to gust using incompressible flow model

Overall aim:
• 3D incompressible Navier-Stokes parallel solver with overset Octree/Bodyfitted grids

What we already have:
• 2D natively parallel Navier-Stokes solver with Quadtree grids.
• 3D natively parallel Navier-Stokes solver with Octree grids.

WP 4
Task: Collection of in-service wind turbine data
• Meteorological mast and sensors on a blade have been installed
• All data are well collected

WP 5
Task: Comparison between experimental data and numerical simulation
2D Natively Parallel Navier-Stokes Solver with Quadtree grids

- Finite volume solver with semi-Lagrangian method
- Fractional step method
- Order of convergence: 2 in space and 1 in time
- Validation with analytic solution (Taylor-Green Vortex) and test cases (flow around cylinder, around airfoil)

Figure: Pressure and X-Velocity around a FFAST Crank airfoil
2D Natively Parallel Navier-Stokes Solver with Quadtree grids

Figure: Quadtree mesh around a FFAST Crank airfoil
Adaptive Mesh Refinement

- Case of moving bodies on Quadtrees
- Grid adaptation process to follow the body
- Validation with comparison between 2 cases:
  - Fixed body with an inflow of 1 m.s\(^{-1}\)
  - Moving body with a velocity of 1 m.s\(^{-1}\) in a fixed flow

*Figure: Comparison of drag coefficient*
3D Natively Parallel Navier-Stokes Solver on Octree grids

- Work in progress
- Now, only a 1\textsuperscript{st} order method has been implemented

Figure: Preliminary results of X-Velocity around a sphere with and without grid
Experimental Work
Installation of Meteorological Mast

- The 50m height mast has been installed from 7 to 9 March in Brittany (France).
- We have 5 anemometers, 2 wind vanes and 1 barometric pressure sensor
Installation of sensors on the blade

- Sensors have been installed from 21 to 23 March
- 10 strain gauges, 6 pressure sensors
- Several wavelengths are used in the optical fibre which allow to have several sensors for 1 fibre.

Figure : Pressure sensor
Figure : Strain gauge
Figure : Work on the elevating platform
Position of sensors on the blade

Figure: Position of the 6 pressure sensors on the blade
Installation of sensors on the blade

- Installation of 4 optical fibres connected in the hub of the wind turbine to an inquiry system.
- Every sensor is connected to the others in the fibre
  - 1 line on the pressure surface of the blade with 3 strain gauges and 1 pressure sensor
  - 1 line on the leading edge of the blade with 2 strain gauges and 2 pressure sensors
  - 1 line on the trailing edge of the blade with 2 strain gauges and 2 pressure sensors
  - 1 line on the suction surface of the blade with 3 strain gauges and 1 pressure sensor
Data Collection and Analysis

- We collect wind velocity at 5 different heights with a sampling of 1s
  - Will allow to compute the atmospheric boundary layer
  - Wind turbulence will be computed and will be characterized for the terrain

- Collection of strain and pressure on a in-service wind turbine
  - will allow the analysis of blade structural behaviour
  - Almost no experimental data is available for real wind turbines

- Data of wind velocity, strain and pressure on a blade will be correlated

- Comparison with numerical simulations will be done by using as input:
  - Wind velocity
  - Wind turbulence
Future Work

WP 2

- Improve the order of convergence for 3D code
- Implementation of wall functions
- Couple the CFD code with structural model

WP 4

- Identification of gusts in the experimental data
- Analysis of wind and blade data
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