UNIVERSITAT POLITÈCNICA DE VALÈNCIA

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High-order spectral simulations of the flow in a simplified urban environment



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FINAL DEGREE PROJECT IN AEROSPACE ENGINEERING

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Introduction

UN Environment focuses on:

Resource efficient cities

Resource Augmentation

Material and Energy Intensity Management

Smart and Intelligent Cities

Clean Cities

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Pollution and Waste Prevention

- Pollution and Waste Management
- **Green and Healthy Cities**

Land-use planning for Urban Ecosystem

Mobility Management

Socioeconomic Equity



Development of lifecycle analyses

Promotion of resource efficient smart city solutions

Promotion of Sustainable Consumption and Production practices to prevent unsustainable accumulation of pollution and waste Promotion of the Polluter Pay Principle and Extended Producer Responsibility schemes

- Measuring and analyzing resource use in cities Promotion of transport planning aims to improve mobility, while reducing environmental and social impacts. This includes Just-in-Time and Intermodal Transport schemes
- Social Cents, Economic Parity, Affordability to Pay

SUSTAINABLE CITIES AND COMMUNITIES



Fig. 2 . SDG 11. United Sustainable development program. Retrieved from UN <u>Sustainable Development Communications</u> <u>materials</u>.

Fig. 1. Sustainable cities. United Nations Environment Program. Retrieved from UN Regional Initiatives.

Objectives

- 1. Identify and study the relevant processes and factors in urban turbulent flows
- 2. Develop and integrate the meshing and solution processes
- 3. Design the geometry and mesh
- 4. Set the simulation strategy and parameters
- 5. Obtain the time-averaged quantities
- 6. Analyse and appraise resolution and boundary-layer quantities
- 7. Analyse and discuss the obtained flow behaviour

Historical perspective

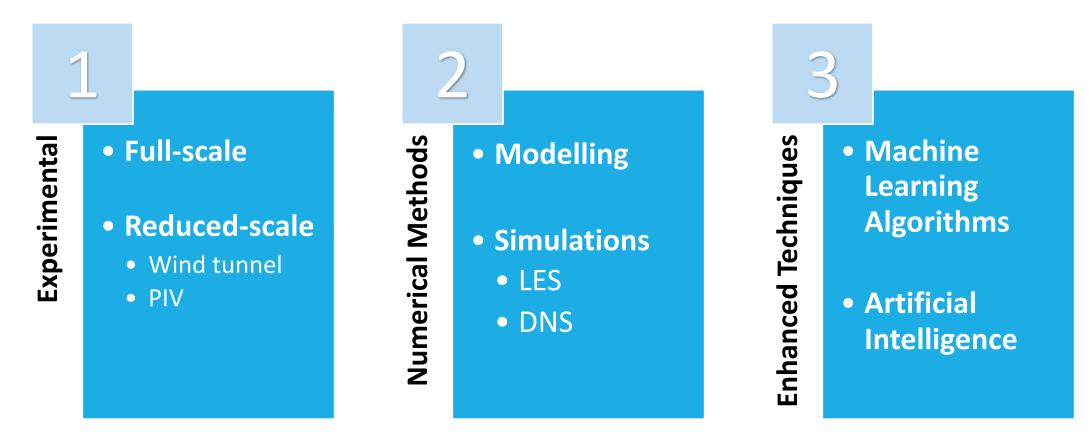


Fig. 3. Historical perspective classification

Tools and setups

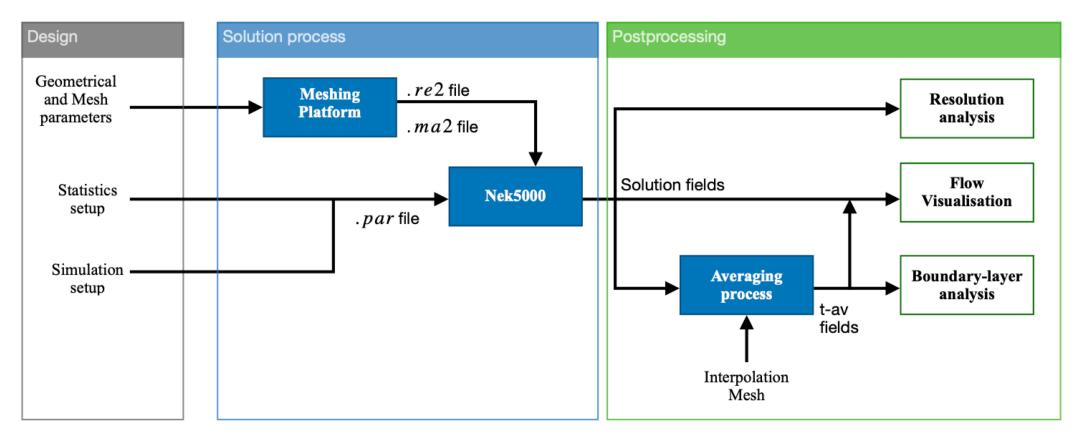
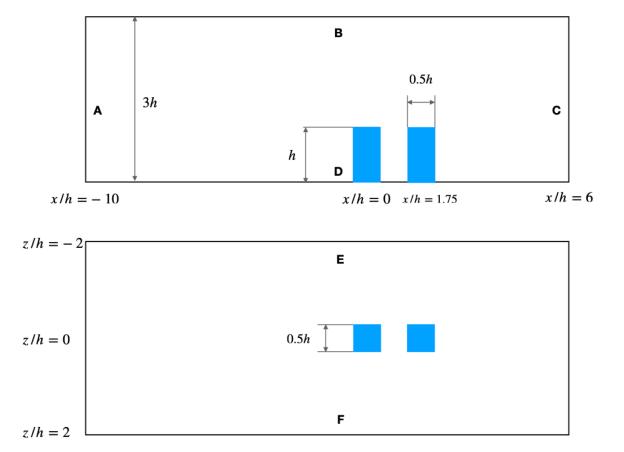


Fig. 4. Design, solution and postprocessing scheme

Final simulation setup



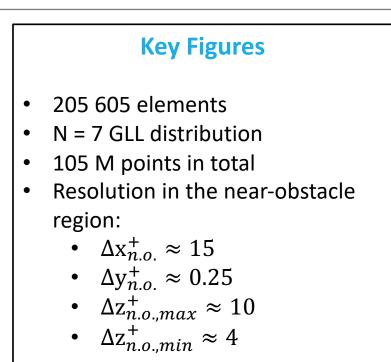


Fig. 5. Diagram showing the final geometry design

Boundary-layer & Resolution analysis

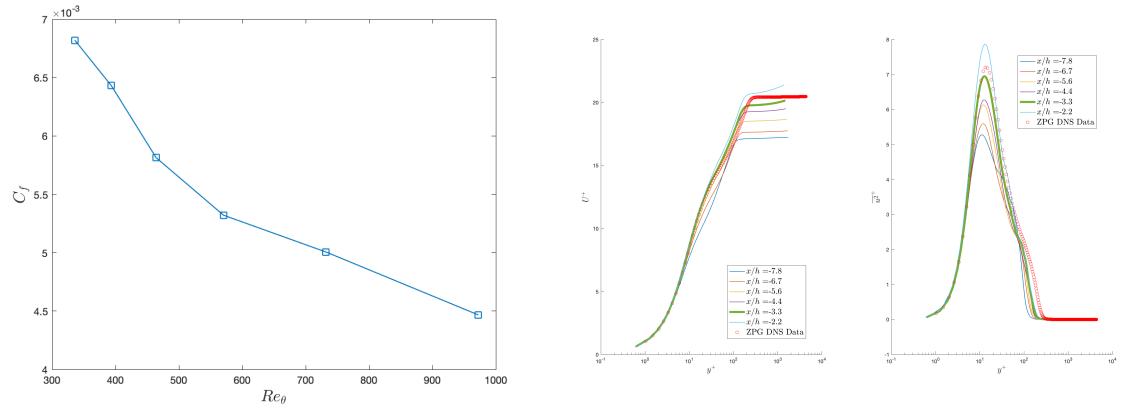


Fig. 6. z-averaged friction coefficient evolution with the Reynolds number evaluated using the momentum thickness

Fig. 7. Normalised z-averaged streamwise velocity (left) and Reynolds-stress tensor component (right).

Results

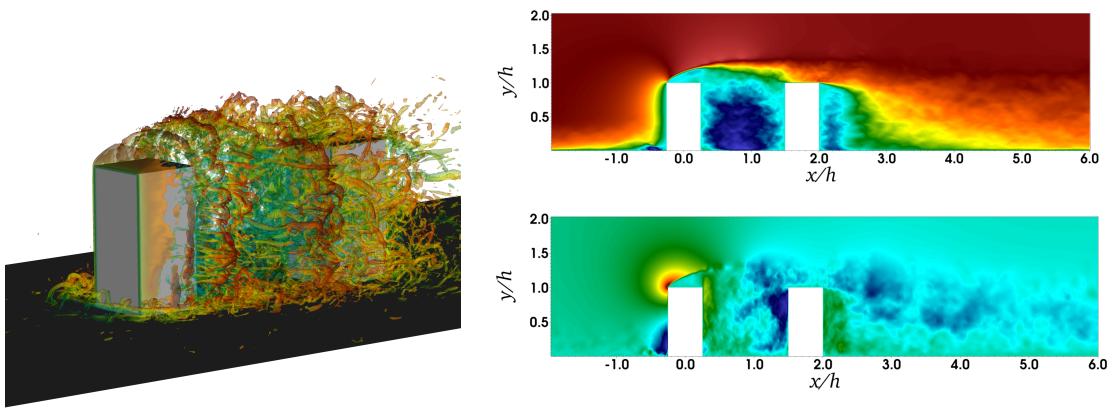


Fig. 8. Instantaneous capture of the vortical structures.

Fig. 9. (top) Time-averaged streamwise and heightwise (bottom) velocities at plane z = 0.

Results

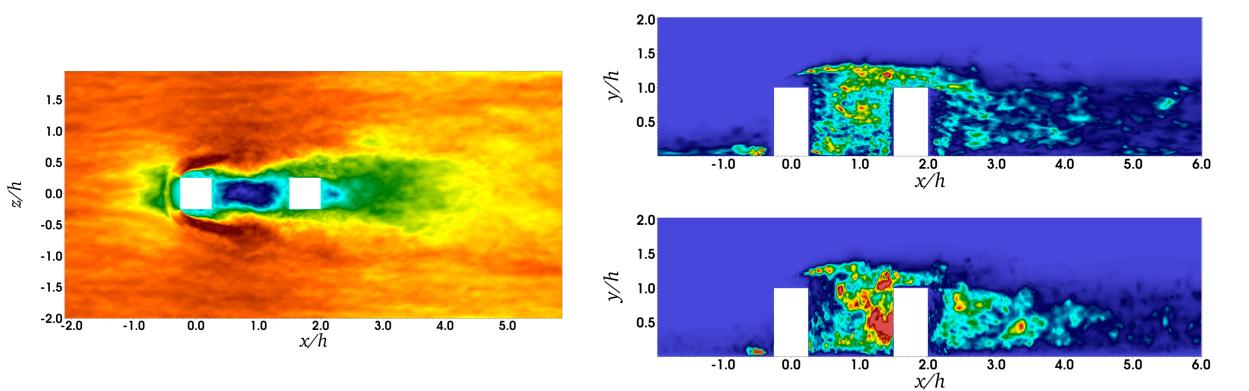
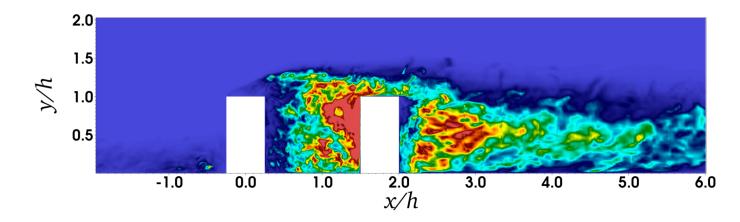


Fig. 10. Time-averaged streamwise velocity fields at y = 0.1

Fig. 11. Time-averaged Reynolds-stresses (top) u^2 and v^2 (bottom) components at plane z = 0.

Results



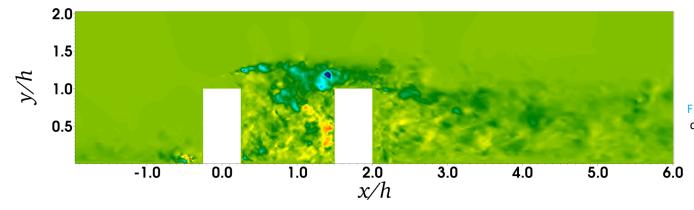


Fig. 12. Time-averaged Reynolds-stresses (top) w^2 and uv (bottom) components at plane z = 0.

Conclusions

- 1. A well-resolved LES was obtained
- 2. The mesh was able to properly represent flow and turbulent boundary-layer quantities
- 3. Flow behaviour matched theoretical expectations
- 4. Cost was constrained within the pre-established limits

