Abstracts

Weather forecasting at city scale

By Dr Natalie Theeuwes (KNMI)

Will be available soon.

Can we use city details to improve urban flow conditions?

By Dr Clara Garcia-Sanchez (Delft University of Technology)

It might surprise you that the way we shape our urban areas influences the wind and microclimate patterns that city inhabitants experience. In a world where climate change and urbanization are pushing the comfort boundaries of our cities, the use of computational fluid dynamics (CFD) may be well an appropriate tool to evaluate urban designs and layouts. However, nowadays the disconnection between the architecture and engineering fields renders difficult and inefficient the link between the generation of 3D models and their usage within fluid dynamic applications.

Within this presentation we will introduce some of the projects we are currently working on, at the 3D geoinformation group, tailored to strengthen the connection between open-source generated 3D city models and their exploitation within the open-source fluid dynamics community. The talk is organized around two main parts: first we will introduce specific studies being carried out at the moment where the use of geometry variants is explored to improve current local wind and temperature conditions. Second, deriving from those specific applications, we will overview some of the important bottlenecks that currently prevent an efficient connection between the 3D city model generation and its use in fluid dynamic solvers. Ultimately addressing these can potentially empower architects and engineers to efficiently evaluate multiple 3D designs to explore solutions under stressed climate conditions, which is becoming everyday a more important concern for urban citizens.

Long-term monitoring of wind-induced vibrations in a high-rise building

By Okke Bronkhorst (TNO)

Wind-induced vibrations are an important aspect in the service limit state (SLS) design of high-rise buildings. Most measurements on wind-induced vibrations in high-rise buildings have been performed over short periods of time (1 to 5 days) with wind speeds generally significantly smaller than SLS wind conditions. Relatively little is known about the dynamic properties (i.e. the natural frequency and damping) of high-rise buildings under SLS wind conditions.

Since 2011, a 158 m high-rise apartment tower in Rotterdam (the New Orleans), is continuously being monitored for wind effects. The data obtained in this long-term monitoring campaign allow for a detailed study of the dynamic properties of this high-rise building under increasing wind conditions.

Using the half power bandwidth (HPBW) method and the random decrement technique (RDT), a study was made of the dynamic properties of the New Orleans at different vibration amplitudes. The results show the damping ratio and, to a smaller extent, the natural frequency are amplitude dependent. The results indicate that long-term in-situ monitoring of wind-induced vibrations is needed to obtain reliable estimates for the dynamic properties (particularly the damping) of high-rise buildings.

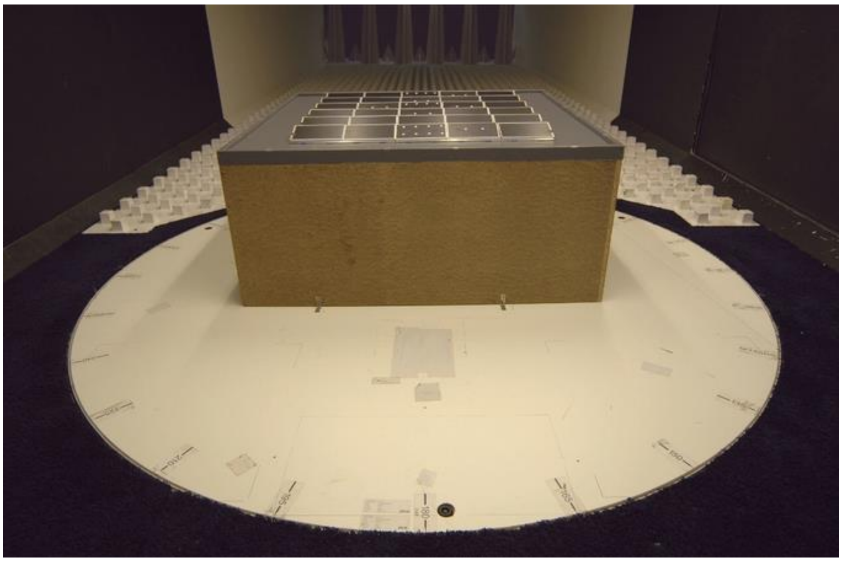
The presentation will address these and other findings of this long-term monitoring campaign.

Wind loading aspects of PV panels on flat roofs

By Ir. Marcel van Uffelen (Peutz)

Elaborate lift tests have been conducted by one of our clients in order to assess the effective rate of coupling between adjacent PV panel mounting structures. Aim of using coupled panels in groups, is that this yields a favorable load sharing effect in which the pressure and suction peaks are averaged over the panels. The lift tests are meant to determine how effective groups of panels can share lift and drag forces within strict limitations posed to the maximum deflections of the lifted panel. A significant reduction of the wind loading is revealed for both panel mounting structures in the corners and the center areas of the roof.

The effect of coupling of panels in groups at the corner of the array amounts to a reduction of lift by approximately 35 % in the corner zone. The effect of coupling of panels in groups at the center of the array amounts to a reduction by approximately 40 % in the center zone. For the drag force the reduction is slightly bigger because of the more effective effect of coupling with respect to drag.



Microscale wind conditions in seaport areas

By Dr Alessio Ricci (Eindhoven University of Technology)

Coastal zones are the most densely settled areas in the world. Estimates indicate that approximately three billion people – about half of world's population – live within 200 kilometres from a coastal line and by 2025 this number is likely to double. In many countries, populations in coastal areas are growing much faster than those in non-coastal areas. In addition, almost 2% of the areas are located in low-elevation coastal zones, as port areas, where almost the 10% of the world's population and the 13% of the world's urban population are concentrated. Seaports and urban areas are important nodes and facilitate about 80% of worldwide trade volume via sea and they are considered in many cases the entry and the exit points of a country's trade. However, the changing climate poses a potential threat for many low elevation coastal zones worldwide so that often port areas result to be also those with the highest concentration of natural disasters and catastrophes. Operating strategies by which to detect possible risk conditions on these areas might be helpful for increasing the safety conditions at work. In this regard, the knowledge of local-scale wind conditions is an essential requirement. On-site measurements, wind-tunnel testing and Computational Fluid Dynamics (CFD) are the most common techniques used to monitor and predict the microscale and local-scale wind conditions, and estimate wind forces on cruise and container ships when manoeuvring in and out of the seaport area.

Weather Research and Forecasting for wind engineering: bridging mesoscale and microscales.

(von Karman Institute for Fluid Dynamics)

Advanced turbulence models are needed for a better representation of the planetary boundary layer (PBL) processes particularly at higher grid resolutions needed for wind engineering applications, 1 km > Δ > 100 m. However, such resolutions fall inside a particular range of scales, the so-called gray-zone of turbulence, where the energy content becomes partially resolved and partly subgrid. The problem is that the traditional subgrid scale (SGS) models derived for large-eddy simulations (LES) models are no longer valid in this zone, since they are originally designed for their own limits (Wyngaard, 2004). A scale-dependent SGS model suitable for the gray-zone is presented, which will link the mesoscale and microscale models in a unified framework. To realize this, high-resolution large-eddy simulations are performed in WRF-LES model (Skamarock, 2008), which will serve as a reference data for the downscaling. We build a full 3D model for all the terms of SGS eddy momentum ($\tau_{ij} = u_i'u_j' = u'u', u'v', u'w', v'v', v'w', w'w'$) and eddy heat ($q_j = u_j'\theta' = u'\theta', v'\theta', w'\theta'$) fluxes in a scale-dependent form, which is valid for the gray-zone. This model is formulated in terms of gray-zone similarity functions, representing SGS contribution as a function of the grid spacing and PBL height. These functions allow a term-by-term blending for all the components of SGS eddy momentum and heat fluxes (τ_{ij} and q_j) between mesoscale and LES limits. As such the SGS eddy momentum and heat fluxes for the gray-zone can be expressed as a function of $\tau_{ij}^{\Delta} = p^{\Delta}(\tau_{ij}^{meso}, \tau_{ij}^{LES})$ and $q_j^{\Delta} = p^{\Delta}(q_j^{meso}, q_j^{LES})$. This leads in turn to a set of generic expressions (6 for momentum and 3 for heat fluxes) which provide a promising framework for bridging mesoscale and the microscales of wind engineering applications.