SCOLARSHIP NO. 1

Task D of Project. Wind tunnel tests

Thanks to several distributed sensors the wind monitoring network realized for previous European Projects provides a fine description of the local time structure of downbursts and, at LiDAR sites, also of their vertical profile. However, this is not enough to derive a detailed description of the space structure of a phenomenon that runs out in a few kilometers in horizontal and in a few hundred meters in vertical.

Wind tunnel tests are fundamental tools to fill this gap. However, they are usually developed in facilities that generate small-scale downbursts in which capturing details of outflows and turbulence is almost impossible. The WindEEE Dome at UWO is a unique laboratory designed and built to simulate and detect large-scale downbursts. Under this point of view it guarantees the possibility to carry out the analyses planned for this task.

Availing of the potential of this laboratory or another new laboratory with the same potential, a comprehensive and unprecedented set of downbursts will be generated on varying the downdraft diameter, its translational speed and the terrain roughness. The space-time structure of the wind speed will be measured at different scales and results will be processed by signal analyses.

Some wind tunnel simulations of downbursts will also be carried out in smaller scale laboratories, aiming to interpret the key and still mostly unknown role of scale effects.

Field measurements and possibly CFD simulations will be used as reference data to check the accuracy of wind tunnel tests and as bases to build downburst models.

Co-tutoring Agreement and Joint Ph.D.

There is a longstanding collaboration between the University of Genoa (UNIGE), the University of Western Ontario (UWO), and the Wind Engineering Energy and Environment (WindEEE) Research Institute (eee.windeee.ca). The WindEEE Dome assures the possibility of making the tests planned for this project or the necessary support to develop them in a new emerging facility. UNIGE and UWO have signed an agreement for international research co-operation. It is planned that this Ph.D. position is co-tutored by UNIGE and UWO and a joint double Ph.D. is awarded.

SCOLARSHIP NO. 2

Task E of Project. CFD simulations

Thanks to several distributed sensors the wind monitoring network realized for previous European Projects provides a fine description of the local time structure of downbursts and, at LiDAR sites, also of their vertical profile. However, this is not enough to derive a detailed description of the space structure of a phenomenon that runs out in a few kilometers in horizontal and in a few hundred meters in vertical.

CFD simulations are fundamental tools to fill the gap represented by local and sparse field measurements. CFD has been applied full-cloud, sub-cloud and impinging wall jet models. The full-cloud model offers a comprehensive representation of the phenomenon but fails in allowing a fine resolution close to the ground. Thus, wind engineering usually adopts the sub-cloud and impinging jet models making recourse to unsteady RANS and LES. URANS suffer from the inherent modelling of Reynolds stresses and their results in terms of turbulence are essentially filtered; LES simulates both large and small scales but it is numerically very demanding at the spatial scale related to downbursts. The use of LES in sub-cloud models is far from being well-established.

The wind monitoring network realized for previous European Projects and the co-operation with the Technische Universiteit Eindhoven (TU/e) and its well-known research group in CFD create unique conditions to carry out a frontier research that may contribute to remove many shortcomings and to produce clear indications on the best CFD tools that provide suitable estimates of the slowly-varying mean speed and of the turbulence field. It is planned that analyses will be carried out by sub-cloud and impinging wall jet models using RANS and LES. Special attention will be devoted to imposing realistic boundary conditions. Results will be processed by signal analyses. Field data and possibly wind tunnel tests will be used as reference data and as bases to build downburst models.

Co-tutoring Agreement and Joint Ph.D.

There is a longstanding collaboration between the University of Genoa (UNIGE) and the Urban Physics and Environmental Wind Engineering Research Centre (www.urbanphysics.net) at TU/e, a world leading authority in CFD. UNIGE and TU/e recently signed a co-operation agreement for the international co-tutoring of PhD students in the field of CFD simulations. It is planned that this Ph.D. position is co-tutored by UNIGE and TU/e and a joint double Ph.D. is awarded.

SCOLARSHIP NO. 3

Task F of Project. Weather scenarios

There is a persisting large gap between research in atmospheric sciences, mainly focused on the genesis and life-cycle of thunderstorms, and in wind engineering, which analyses velocity measures aiming to develop thunderstorm models for actions on structures. The wind monitoring network realized for previous European Projects and the co-operation with Freie Universität Berlin (FUB), Germany and its research group in meteorology and severe storms are unique conditions to fill this gap and to share expertise between atmospheric sciences and wind engineering.

Starting from field data, extensive information will be gathered during thunderstorm events, e.g. those provided by Global Forecast System (GFS), Meteosat Second Generation (MSG) geostationary satellites, Radar Doppler, lightning and thunderstorm networks. In addition to the open data that can be downloaded from Internet, co-operation agreements will be made with specific institutions. The joint analysis of the whole of this information will be used to study and classify weather scenarios in which thunderstorms occur, pursuing the attempt to link weather conditions and wind speed records. Special attention will be given to the difference between dry and wet downbursts.

Results will be applied to calibrate some criteria developed to separate intense wind events, to develop research in downburst forecasting, and to formulate probabilistic models and simulation techniques that take into account the relationships between downbursts and their synoptic scenarios.

Task G of Project. Damage survey

Two previous European Projects arose from the frequent disasters (fatalities and injuries of people, collapse of cranes and other structures, stacked container overturning, accidents during the entry of ships in ports) and malfunction (paralysis of cities, closure of ports, suspension or deferral of activities) caused by windstorms in High Tyrrhenian Sea ports. The monitoring network generated by these projects is producing a huge amount of wind data that will be used to trace damage and losses due to major storms, separating the consequences of cyclones from those of thunderstorms. Analyses of the weather scenarios in which the most striking events occurred will be carried out.

Thanks to the involvement of FUB and of the European Severe Storm Laboratory (ESSL) similar studies will be made on sample areas of Italy and Europe to classify intense wind events and to quantify their effects depending on whether they are synoptic cyclones or mesoscale thunderstorms.

Co-tutoring Agreement and Joint Ph.D.

To establish a new fruitful collaboration between the University of Genoa (UNIGE) the Institut für Meteorologie of FUB (http://www.geo.fu-berlin.de/en/met/index.html), UNIGE and FUB plan to sign an agreement for international research co-operation aiming to fill the gap between wind engineering and atmospheric sciences. It is planned that this Ph.D. position is co-tutored by UNIGE and FUB and a joint double Ph.D. is awarded.