Course offered for the PhD program
in Safety, Risk and Vulnerability
Curriculum in Risk and Resilience Engineering for Natural, Industrialized and Built Environments

and in Civil, Chemical and Environmental Engineering
Curriculum in Wind Science and Engineering
A.Y. 2021/2022 (XXXVII cycle)

(possibility of participation for students in other PhD cycles or other PhD courses)

1. Title

Monitoring and analysis of downburst events and their effects on structural response

2. Course description

This course aims at introducing the students to thunderstorms and the severe weather phenomena associated with thunderstorms. Thunderstorms are the most vigorous clouds (cumulonimbus clouds) in the Earth's atmosphere and they are responsible for hail, lightning, intense rainfall, downburst winds, and tornadoes. Downburst winds, in particular, are a major cause of damages around the globe. Design wind velocities with mean return periods greater than 10–20 years are often associated with such events, but the complexity of thunderstorms makes it difficult to establish physically realistic and simple models to deal with the effects of downbursts on structures. New advances in monitoring thunderstorm outflows and their actions on slender structures and infrastructures are being achieved through the ERC Project THUNDERR (http://www.thunderr.eu/), which is expected to shorten the persistent gap between wind engineering and atmospheric sciences with the aim of designing safer and cost-efficient constructions.
The aim of the course is to provide the basic knowledge of downburst winds and their effects on structures and infrastructures, as well as the advances achieved in this research field through the Project THUNDERR.

3. Course Organization

The course will consist of lectures and tutorials, in which the active involvements of the participants will be required.

1. Monitoring and analysis of downburst events (6 hours)
   - 1.1. Physics of thunderstorms and downburst outflows, wind field measurements trough anemometric and remote-sensing techniques, radar measurements (4 hours)
   - 1.2. Tutorials: analysis of downburst records and horizontal wind field reconstruction by radial wind velocity measurements (2 hours)
2. Downburst effects on structural response (6 hours)
   - 2.1. Introduction to wind actions on structures, peculiarities of thunderstorm loads, structural health monitoring for the safety of structures and infrastructures, introduction to structural identification techniques (4 hours)
   - 2.2. Tutorials: resilience of seaports and transmission lines (2 hours)

4. Teachers

Prof. Massimiliano Burlando, Prof. Maria Pia Repetto, Prof. Giuseppe Piccardo

5. Duration and credits

12 hours (2.5 credits)

6. Activation mode and teaching period

The minimum number of participants to activate the course is 3. The course will be held in January-February 2022.

7. Deadline for registration

The deadline for applications is January 8th, 2022. Please, send an e-mail confirmation to Prof. Massimiliano Burlando, massimiliano.burlando@unige.it.

8. Final exam

At the end of the course, a final oral examination will be held.

9. Recommended references

Aboshosha, H., Elawady, A., El Ansary, A., El Damatty, A. (2016). Review on dynamic and quasi-static buffeting response of transmission lines under synoptic and non-synoptic winds. Engineering Structures 112: 23-46.

Repetto, M.P., Burlando, M., Solari, G., De Gaetano, P., Pizzo, M. (2017). Integrated tools for improving the resilience of seaports under extreme wind events. Sustainable Cities and Society 32: 277-294.

Solari, G., Burlando, M., Repetto, M.P. (2020). Detection, simulation, modelling and loading of thunderstorm outflows to design wind-safer and cost-efficient structures. Journal of Wind Engineering and Industrial Aerodynamics 200: 104142.

Zhang S., G. Solari, P. De Gaetano, M. Burlando, M.P. Repetto (2018) A refined analysis of thunderstorm outflow characteristics relevant to the wind loading of structures. Probabilistic Engineering Mechanics 54, 9-24. DOI: 10.1016/j.probengmech.2017.06.003 – ISSN 0266-8920.

Burlando M., D. Romanić, G. Solari, H. Hangan, and S. Zhang (2017) Field data analysis and weather scenario of a downburst event in Livorno, Italy on 1 October 2012. Mon. Wea. Rev. 145, 3507–3527. DOI: 10.1175/MWR-D-17-0018.1

References to other specific textbooks and journal/conference articles will be provided during the lectures.