The THUNDERR portal: a science gateway to share thunderstorm outflow research advances

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ABSTRACT

In the context of the European Project THUNDERR - Detection, simulation, modelling and loading of thunderstorm outflows to design wind-safer and cost-efficient structures - a large database is being built concerning an extensive anemometric network in the High Tyrrhenian area, which is mainly focused on downbursts detection and analysis. The database, which at present consists of about 1.4 TB including indexing and metadata, increases every day of more than 20 million of new measures. This database represents the first step to create a science gateway for sharing also software tools and experiences concerning the identification and analysis of downburst events. To this extent, an initial set of selected thunderstorm events will be released soon to the public through a Web portal, and more events will be added over time. The perspective is to gather contribution throughout the wind engineering and atmospheric science communities in order to enhance research on thunderstorms.

1 INTRODUCTION

Wind is the most destructive natural phenomenon - over 70% of the damage and fatalities caused by the nature are due to the wind (Tamura and Cao, 2012; Ulbrich et al., 2013) - so its actions are crucial for the safety and cost of structures, infrastructures and territory. Their evaluation is thus a cornerstone of engineering and atmospheric sciences, and a societal need.

The European climate and that of many other countries are dominated by synoptic cyclones and mesoscale thunderstorms. The genesis and evolution of cyclones is known since the beginning of the 20th century. Thunderstorms are complex, mysterious and destroying phenomena that result in loading often more severe than cyclone ones.

Despite a huge amount of research carried out on this issue in the last decades, however, this matter is still dominated by large uncertainties; even more, there is not yet a shared model of the thunderstorm outflow and its actions on structures like that developed by Davenport (1961) for the extra-tropical cyclone and still used in the engineering field to calculate structures.

This happens because the complexity of thunderstorm downbursts and their short duration makes difficult to establish physically realistic and simple engineering schemes. Besides, the available data is very limited and subdivided among different institutions, relying on different storage and access mechanism. This reality can be defined as data pools or silos, and it is common to many industrial and scientific sectors. The key drawback is that the sharing, federation and integration of data between pools requires a considerable effort because of the lack of commonly agreed standards and frameworks.

A common approach to overcome these issues is represented by the development of science gateways. They represent ecosystems of services, applications, and data for supporting activities in an increasing number of many scientific, engineering and education projects and communities (Lawrence, 2015). This paper presents the oncoming first release of the THUNDERR portal, a science gateway aimed at sharing data, visualization and analysis tools for the wind science and engineering community.

2 MONITORING NETWORK AND DATASET

In the framework of the European Projects "Wind and Ports" (Solari et al 2012) and "Wind, Ports and Sea" (Repetto et al 2017, 2018), an extensive in situ wind monitoring network has been created in the Northern Tyrrhenian and Liguria Sea. This is generating an unprecedented amount of high quality wind measurements that, in addition to their institutional role of supporting port activities, represent an extraordinary source of information to carry out thunderstorm outflow research advances (Zhang et al. 2017).

As far as the Italian network is concerned, which includes the Ports of Genoa, Savona, Livorno, and La Spezia, the measurements of 24 ultrasonic anemometers, 6 meteorological stations, and 3 LiDAR wind profilers are gathered with a sampling frequency that varies from 1 to 10 Hz. This means that every day more than 20 million of new measures are collected. The first instruments were installed in 2010 and since then the network has grown up to the current size, which will increase to include another 11 three-axial ultrasonic anemometers and 1 LiDAR scanner by the end of Spring 2018.

The first step towards the development of the THUNDERR portal has been the setup of a MySQL database having a table for each instrument. At present it has a size of about 1.4 TB including indexing and metadata. Within the database, a thunderstorm is represented by a record in a dedicated table identified by the tuple (port, anemometer, peak time). The peak time identifies the 10-min time interval in which the peak value has been registered.

Figure 1: The THUNDERR portal access from the windyn.org website.

3 THE THUNDERR PORTAL

The THUNDERR portal is going to become publicly available through the website of the Wind Engineering and Structure Dynamics research group, www.windyn.org, as shown in *Figure **1***. Users will select one of the available thunderstorms and the website retrieve the corresponding raw data from the database. For this reason every new thunderstorm released to the community will be inserted in the proper table of the database and it will be immediately available.

Each thunderstorm outflow is associated with a set of parameters describing the main characteristics of that event as reported in Solari et al. (2015) and in Zhang et al. (2017); the data corresponds to a 10-hr time interval centred around the time in which the peak value has been registered. Users will download this data and/or visualize the graphs representing the wind speed and direction directly in the webpage, as shown in *Figure **2***. In particular, graphs will be created at runtime on the basis of about 360,000 measures representing a thunderstorm outflow record using the D3 Javascript library.

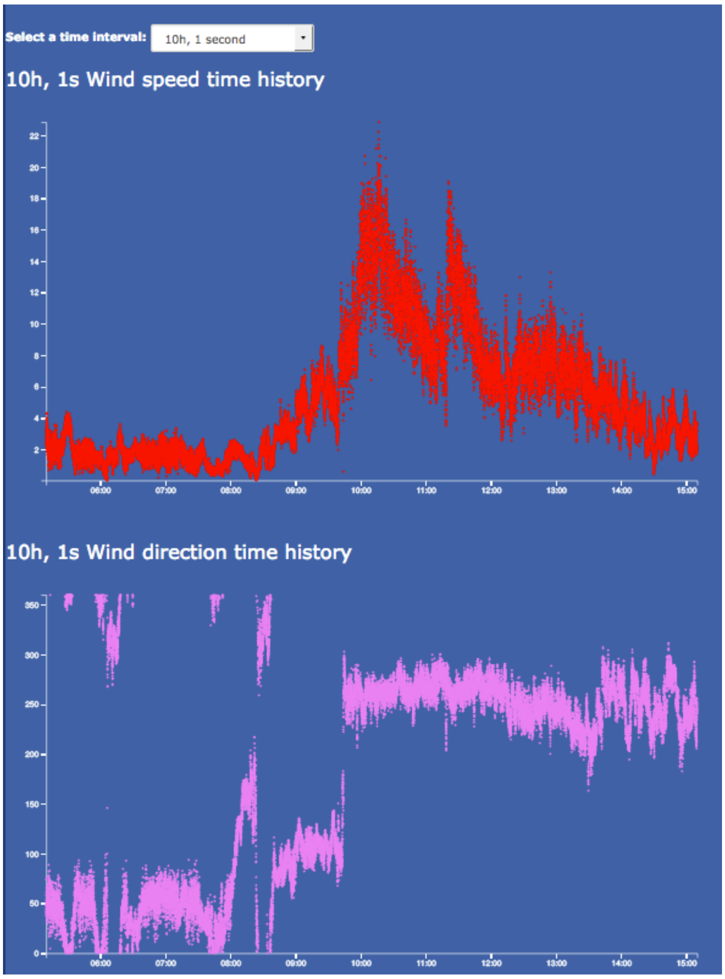

Figure 2: Diagrams representing the wind speed and direction of the selected thunderstorm

Three users groups have been defined: anonymous users, who will see the list of public thunderstorms and the corresponding graphs; registered users, who will be able to download data; expert users, who will be able to upload their own data and analyse them as well. Both the registration and the inclusion in the expert group have to be requested to the portal administrators.

In fact, in perspective, registered and expert users are supposed to be granted the possibility to perform analyses on the data using a dedicated computational infrastructure and co-operate to improve the discussion on thunderstorm identification and analysis.

The portal is based on PortalTS, which is an original Web Portal based on Typescript and NodeJS that represents an effective solution for the development of science gateways (D'Agostino, 2018).

4 CONCLUSIONS AND FUTURE DEVELOPMENTS

This paper presents and describes a new science gateway, called THUNDERR portal, which is being realised in the framework of the European Project "THUNDERR - Detection, simulation, modelling and loading of thunderstorm outflows to design wind-safer and cost-efficient structures". It is created to share thunderstorm outflow research advances within the wind science and engineering community and is intended to become a key tool for data sharing over the Internet of thunderstorm events. By the time of Project THUNDERR, which started in September 2017 and will last 5 years, it will be upgraded regularly by integrating new analysis tools.

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