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Analysis on the wind characteristics under typhoon climate at the southeast coast of China

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ABSTRACT

A wind measurement system was established on Mount Wangye, Fujian, China. Multi-level three-dimensional wind measurements of two Typhoon cyclones have been recorded and analyzed to find the characteristics of the near-surface boundary layer. This paper presents wind speed profiles and related parameters, turbulence intensities, turbulence integral length scales, gust factors, and the characteristics of the fluctuating wind speed power spectra in Typhoon conditions. We found a region-specific wind speed power spectrum and its associated spectrum parameters that can be used for the design of wind-resistant structures in Typhoon prone coastal region in southeast of China.

1. Introduction

With the rapid development of coastal cities, high-rise structures, super large-span bridges and other wind-sensitive projects have increased significantly. Wind resistance becomes a key element of engineering design process. Architectural structures located in different regions are exposed to different climate with different wind conditions. More accurate region-specific wind field representations are crucial for the wind-resistant design of coastal structures. Numerous methods are applied for investigating wind environment and wind characteristics, such as, computational fluid dynamics (CFD) techniques, wind tunnel tests, and wind field measurements (Tse et al., 2014). CFD techniques have been developed for decades for their efficiency and flexibility in changing the simulation conditions (Blocken, 2014; Franke et al., 2011; Fujii, 2005). However, their results may need to be verified by wind tunnel tests or wind field measurements. Wind tunnel tests are widely used for wind-resistant design of structures (Irwin, 1981; Gromke, 2011; Jiang et al., 2003), however, it may be difficult to reproduce the terrain conditions. Full-scale wind field measurements are important to study regional wind characteristics, especially in typhoon prone areas.

Wang (Wang et al., 2018) studied the wind effect on low-rise building with roof overhangs during typhoon attacks. Song (Song et al., 2016) investigated wind characteristics in South China by using wind field measurements and showed that wind profiles varied considerably during the passage of a typhoon. Other characteristics, such as, spectra, turbulence intensities, gust factors were also investigated by numerous researchers (Zhang and Li, 2018; Al-Quraan et al., 2016; Hong and Li, 2018; Li et al., 2017). It is well known that geographical conditions have significant impacts on wind characteristics. Therefore, obtaining good wind-measurements are important in the wind-resistant design in southeast coastal of China due to its topographical features and typhoon prone conditions. In this research, the field measurements and wind parameter analyses of this coastal region in intense typhoon conditions will provide a foundation for subsequent study of structural wind-induced vibrations and disaster prevention.

In this research, a field measurement system was established for recording meteorological data of the coastal region of Fujian Province. It is located on the top of Mount Wangye, Pingtan County, Fujian Province, and started collecting data in November 2016. The system captured the completed landfall process both before and after the passing of the eyes of typhoons Nesat and Haitang in July of 2017. Our results of the near-surface boundary layer typhoon wind characteristics are based on these data collections.

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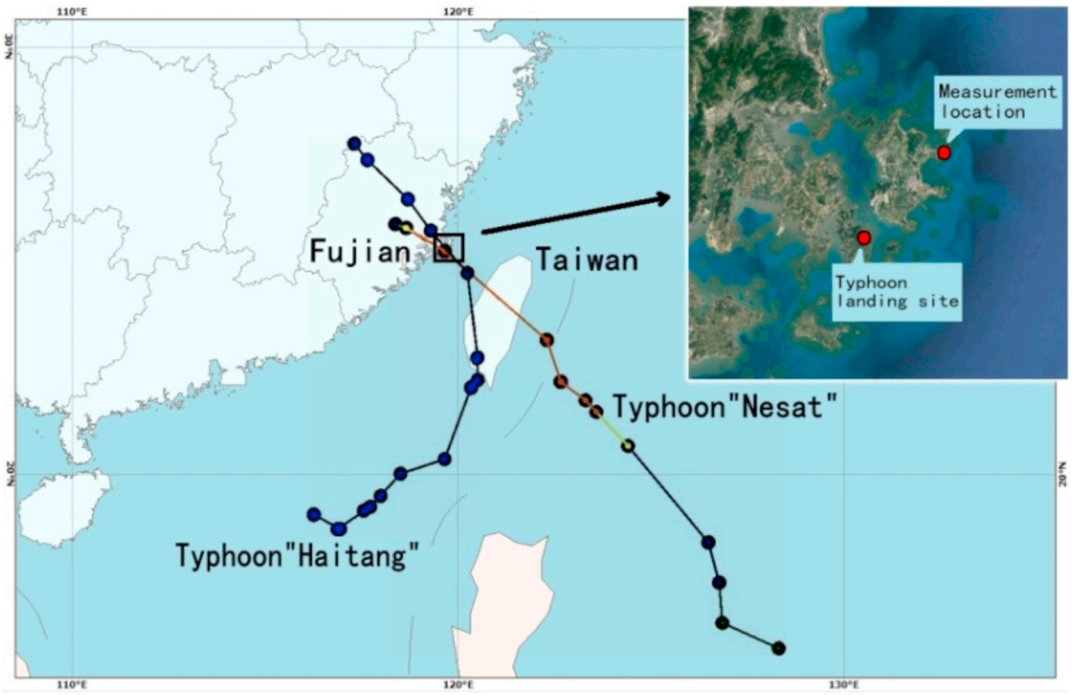

Fig. 1. Topographic map of the Mount Wangye wind measurement tower and surrounding area.

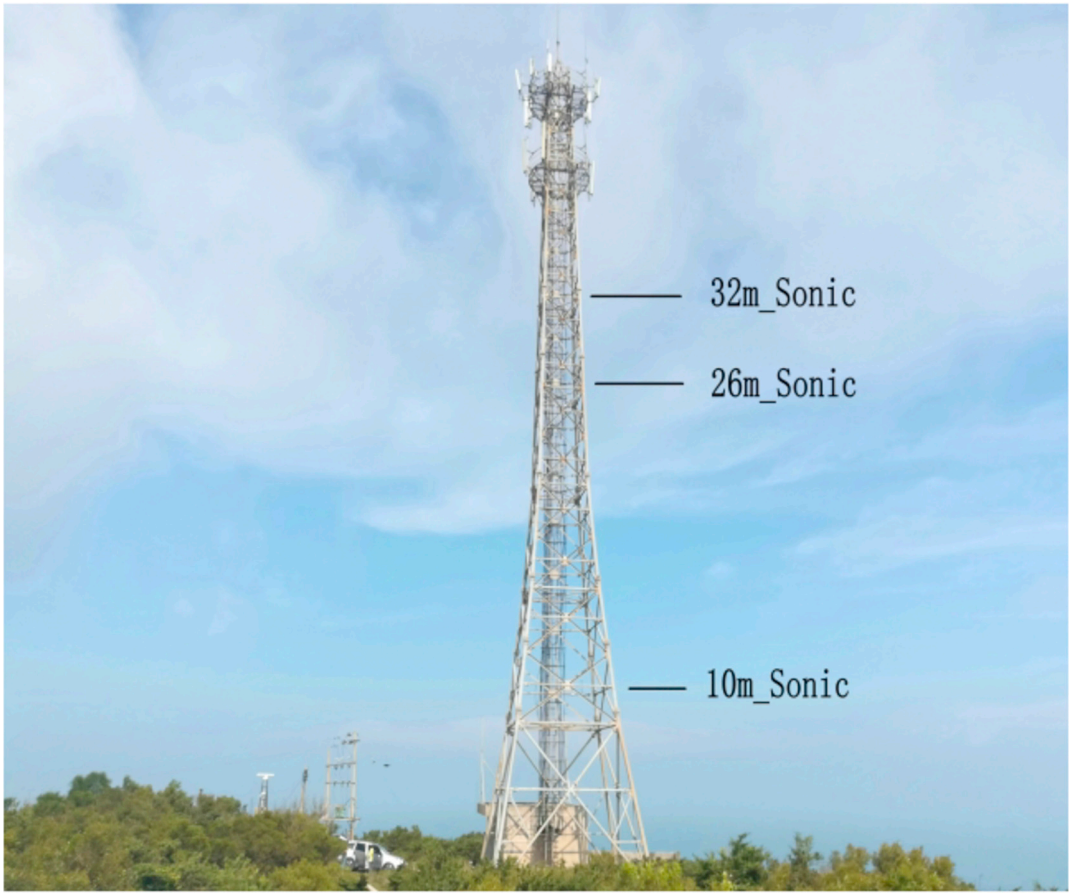

Fig. 2. Mount Wangye wind measurement tower.