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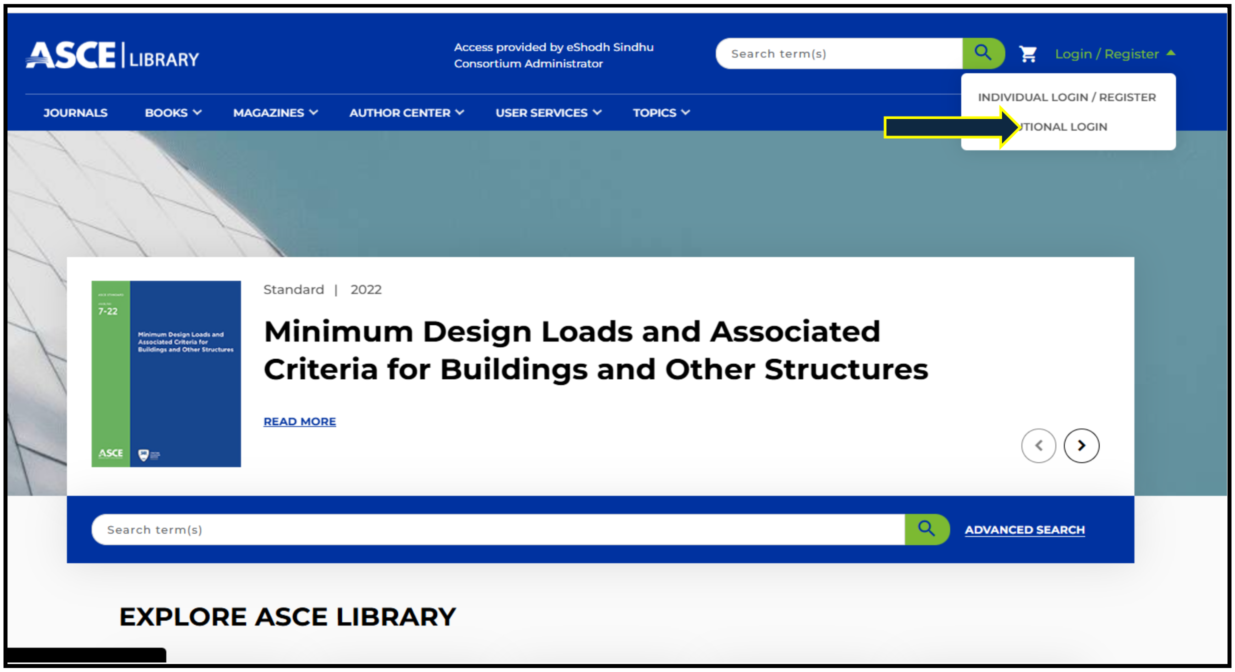

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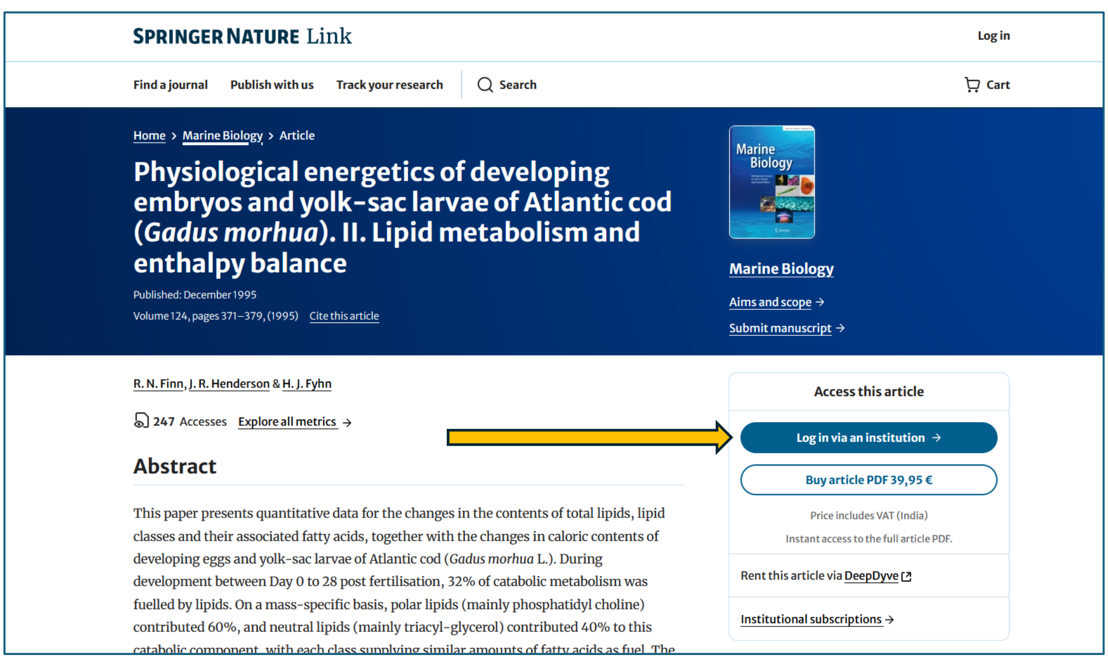

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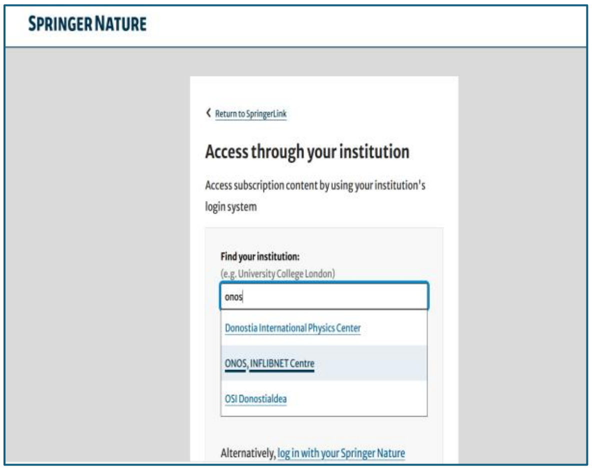

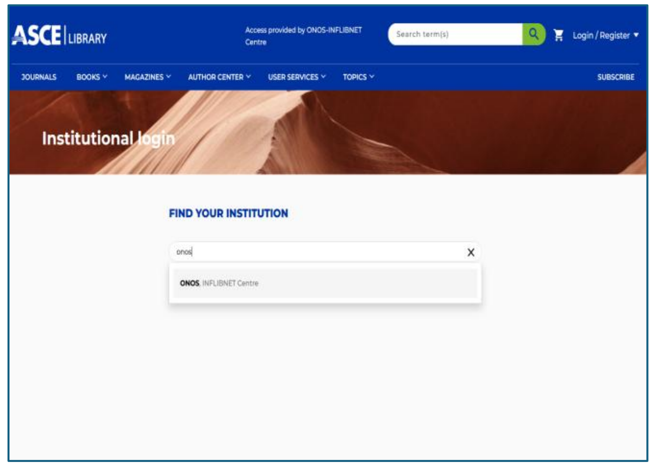

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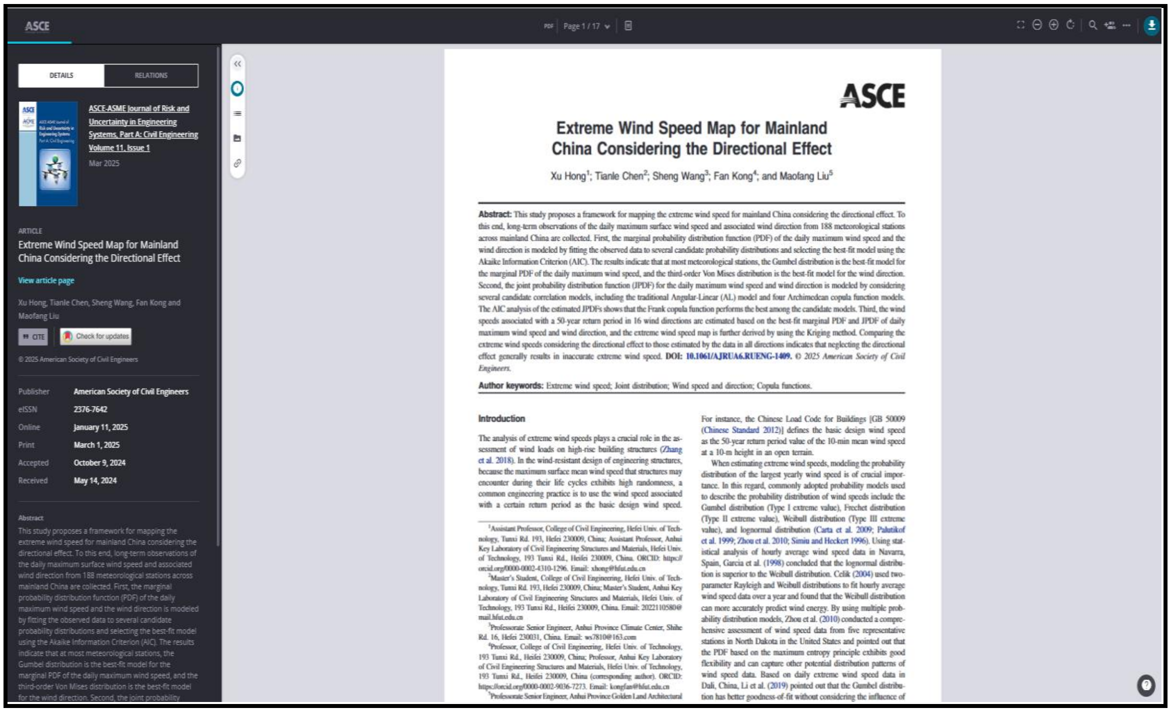

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ARTICLE

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Xu Hong, Tianle Chen, Sheng Wang, Fan Kong and Maofang Liu

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Abstract
This study proposes a framework for mapping the extreme wind speed for mainland China considering the directional effect. To this end, long-term observations of the daily maximum surface wind speed and associated wind direction from 188 meteorological stations across mainland China are collected. First, the marginal probability distribution function (PDF) of the daily maximum wind speed and the wind direction is modeled by fitting the observed data to several candidate probability distributions and selecting the best-fit model using the Akaike Information Criterion (AIC). The results indicate that at most meteorological stations, the Gumbel distribution is the best-fit model for the marginal PDF of the daily maximum wind speed, and the third-order Von Mises distribution is the best-fit model for the wind direction. Second, the joint probability

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Extreme Wind Speed Map for Mainland China Considering the Directional Effect

Xu Hong[1]; Tianle Chen[2]; Sheng Wang[3]; Fan Kong[4]; and Maofang Liu[5]

Abstract: This study proposes a framework for mapping the extreme wind speed for mainland China considering the directional effect. To this end, long-term observations of the daily maximum surface wind speed and associated wind direction from 188 meteorological stations across mainland China are collected. First, the marginal probability distribution function (PDF) of the daily maximum wind speed and the wind direction is modeled by fitting the observed data to several candidate probability distributions and selecting the best-fit model using the Akaike Information Criterion (AIC). The results indicate that at most meteorological stations, the Gumbel distribution is the best-fit model for the marginal PDF of the daily maximum wind speed, and the third-order Von Mises distribution is the best-fit model for the wind direction. Second, the joint probability distribution function (JPDF) for the daily maximum wind speed and wind direction is modeled by considering several candidate correlation models, including the traditional Angular-Linear (AL) model and four Archimedean copula function models. The AIC analysis of the estimated JPDFs shows that the Frank copula function performs the best among the candidate models. Third, the wind speeds associated with a 50-year return period in 16 wind directions are estimated based on the best-fit marginal PDF and JPDF of daily maximum wind speed and wind direction, and the extreme wind speed map is further derived by using the Kriging method. Comparing the extreme wind speeds considering the directional effect to those estimated by the data in all directions indicates that neglecting the directional effect generally results in inaccurate extreme wind speed. **DOI: 10.1061/AJRUA6.RUENG-1409.**

Author keywords: Extreme wind speed; Joint distribution; Wind speed and direction; Copula functions.

Introduction

The analysis of extreme wind speeds plays a crucial role in the assessment of wind loads on high-rise building structures (Zhang et al. 2018). In the wind-resistant design of engineering structures, because the maximum surface mean wind speed that structures may encounter during their life cycles exhibits high randomness, a common engineering practice is to use the wind speed associated with a certain return period as the basic design wind speed. For instance, the Chinese Load Code for Buildings [GB 50009 (Chinese Standard 2012)] defines the basic design wind speed as the 50-year return period value of the 10-min mean wind speed at a 10-m height in an open terrain.

When estimating extreme wind speeds, modeling the probability distribution of the largest yearly wind speed is of crucial importance. In this regard, commonly adopted probability models used to describe the probability distribution of wind speeds include the Gumbel distribution (Type I extreme value), Frechet distribution (Type II extreme value), Weibull distribution (Type III extreme value), and lognormal distribution (Carta et al. 2009; Palutikof et al. 1999; Zhou et al. 2010; Simiu and Heckert 1996). Using statistical analysis of hourly average wind speed data in Navarra, Spain, Garcia et al. (1998) concluded that the lognormal distribution is superior to the Weibull distribution. Celik (2004) used two-parameter Rayleigh and Weibull distributions to fit hourly average wind speed data over a year and found that the Weibull distribution can more accurately predict wind energy. By using multiple probability distribution models, Zhou et al. (2010) conducted a comprehensive assessment of wind speed data from five representative stations in North Dakota in the United States and pointed out that the PDF based on the maximum entropy principle exhibits good flexibility and can capture other potential distribution patterns of wind speed data. Based on daily extreme wind speed data in Dali, China, Li et al. (2019) pointed out that the Gumbel distribution has better goodness-of-fit without considering the influence of

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