

Climate Change Impacts on Wind Extremes: What Are the Trends and What Should Wind Engineers Do?

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Climate variability;
Adaptation;
Resilience;
Wind effects

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What: The inaugural International Association for Wind Engineering (IAWE) webinar series on Equitable Response to Wind Climate Change: Impacts, Adaptations, and Mitigations. This IAWE event was hosted by the IAWE Working Group on Climate Change and aimed to provide presentations from climate, meteorology, and wind engineering experts that were authoritative, informative, and pitched toward an international engineering audience with topics centered on changes to wind under climate change and how engineers might respond to them.

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Where: Online

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1. Motivation

The International Association for Wind Engineering (IAWE) membership has a particular interest not only in the potential impact on extreme wind from climate change but also in how it can encourage an equitable response to climate change given that adaptation options may be limited to wealthier and more technically advanced nations. As such, an IAWE Working Group on Climate Change, cochaired by Teng Wu (University at Buffalo, United States) and Hassan Hemida (University of Birmingham, United Kingdom), was formed in 2024 for the purpose of reviewing and assessing existing climate science data and investigating how climate change will alter wind conditions in different regions (i.e., the Americas, Asia–Oceania, and Europe–Africa). In addition, the Working Group has aims to review current adaptation plans (e.g., robust decision-making) and mitigation strategies (e.g., advancing codes and standards) that help us fight against climate change with an equitable response. The webinar series is one of the activities undertaken to achieve this.

2. Webinar series overview

This inaugural IAWE webinar series hosted by IAWE was held over the first 3 weeks of December 2025. The time of day for the live webinars, 1400 UTC, was chosen to suit the presenter's availability and/or working hours. Recordings of each webinar were made, and links to the recorded webinars are available through the official IAWE website (<https://iawe.org/working-groups/webinar-series/>). The organizing committee was comprised of members for the IAWE Webinar Task Group on Climate change, who are either active researchers in wind climate or wind engineering, and is a subgroup of a the wider IAWE Working Group on “Equitable Response to Wind Climate Change: Impacts, Adaptations, and Mitigations.”

3. Goals

The goal was to deliver a series of three webinars on climate science and its implications for wind engineering and to gain a following from IAWE members and the engineering and climate communities to sustain future related webinar series. We wanted to provide presentations from climate, meteorology, and wind engineering experts that were authoritative, informative, and pitched toward an engineering audience, closing the typically existing gap between the simulation outputs from climate science and the required inputs to wind engineering applications (e.g., aerodynamic loading estimation). The initial series was structured to tell a story starting with climate change science describing projected changes in future winds, first at a global scale and then narrowing down to changes in convective-scale-related phenomena, such as derechos, which are the cause of many extreme winds, with a final perspective on implications for infrastructure systems. Future webinar series aims to cover a diverse range of regional climate changes from around the world and to cover equitable adaptation responses and implications for design standards.

4. Hosts

The webinar series was hosted online via Zoom calls. The meeting host introduced the speaker and moderated the live question and answer session that followed the formal speaker presentation. The advertising was through an email broadcast of invitations to attend with the Zoom link contained in the email, and these invitations were circulated to members of the IAWE and related associations, such as Australasian Wind Engineering Society (AWES) and American Wind Engineering Society (AAWE).

5. Audience

The target audience was the IAWE membership (or similar) and so practicing wind engineers could be from academic, government, private, or nonprofit sectors. Additionally, meteorologists or climatologists who advise wind engineers or who serve on technical standard committees were the target audience. The brief to presenters was that the talks would be pitched to a general engineering audience.

6. Presentations

The topics covered an initial and global overview of wind and climate change and then focused on future trends in thunderstorms (nonsynoptic winds) and tornadoes, and finally in a switch of gears to considerations of climate change effects (in general, not necessarily wind, e.g., sea level rise) on infrastructure life cycles. The presenters tended to follow the style of a broad introduction, followed by a description of the “state of the art” and ending with “challenges” that need to be addressed. Additional details of each webinar are provided below.

a. Webinar No. 1. *The forgotten part of climate change: Winds of change.* The first webinar was presented by Dr. Cesar Azorin Molina of the Desertification Research Centre (CIDE, CISC-UV-GVA) in Valencia, Spain. Dr. Azorin Molina gave an overview of recent observed trends in wind speeds, noting the “stilling” and the recent “reversal” over Northern Hemisphere land areas and the opposite trend over oceans in the Southern Hemisphere. He noted the uncertainties around projections and the need, due to the low quality of much wind data, for careful homogenization of wind records (both mean and gust) in determining historic trends and the need for wind data rescue efforts to be accelerated. This is because these are important when comparing trends from reanalyses and climate models as inconsistencies with observations do exist. He also highlighted the need for extensive checking of anemometer performance and drift in field tests and pointed out the lack of attention wind has received in climate change scientific literature.

b. Webinar No. 2. *Future trends in severe thunderstorms and tornadoes.* The second webinar was presented by Professor Robert (Jeffrey) Trapp, Director of the School of Earth, Society and Environment at the University of Illinois (United States). Professor Trapp presented plots on trends in tornado days and outbreaks in the United States, noting the decreasing trend in parts of the historic tornado alley and an increase in the Southeast United States. It was interesting to note the downward trend in tornado days while there is an upward trend in outbreaks, i.e., fewer days with tornadoes but larger numbers on those days when they do occur. He noted basic damage statistics for tornadoes in the United States (1.5 B per annum) versus severe winds from thunderstorms (0.5 B per annum). He then covered some conceptual material on atmospheric environments favorable for strong convection/thunderstorms (both multicell and single cell) and outlined the different mechanisms/phenomena in these storms that cause extreme wind,

these being downbursts/downdrafts, rear-inflow jets, and mesovortices which are distinct from tornadoes. Some time was spent on current storm (mainly tornado)/damage assessments which document frequency, intensity, and location (FIL) which is useful for current climate understanding, but for future projections, he noted that analyses and projections of proxies, such as CAPE and bulk wind shear, were most widely used. Finally, he discussed climate-model in situ methods which are useful for understanding physical mechanisms for climate impacts on storm dynamics, where actual recent events are resimulated/downscaled within “future/warmed” climates.

c. Webinar No. 3. SEI/ASCE special project: Effects of climate change on life cycle performance of structures and infrastructure systems. The third and final webinar was given by Fabio Biondini, professor of Structural Engineering at Politecnico di Milano, Italy. Professor Biondini gave an overview of the activities of a Structural Engineering Institute/American Society of Civil Engineers (SEI/ASCE) project. He detailed the activities and aims of the various task groups of those projects and highlighted several resources those groups produced, such as ASCE (2024), a book on Effects of Climate Change on Life-Cycle Performance of Structures and Infrastructure Systems: Safety, Reliability, and Risk. While these task groups looked at climate impacts for several parameters (e.g., temperature, rainfall, and sea level rise), there are lessons there for wind engineers, and he called for the need (and this was echoed in the other two webinars) for work to reduce the uncertainty in future climate change wind impact assessments. Finally, he also pointed to the need to address in a consistent way the nonstationarity in trends as there are a variety of approaches being adopted but with no generally well-established method. The SEI/ASCE project has provided an excellent operating model from which the IAWE Task Group on Climate Change has adopted components of its project.

7. Expected outcomes

The December webinar series represented the first chapter of (hopefully) a series from the IAWE Working Group on climate change impacts on wind engineering. Future series are now being planned, and each will have a specific theme related to wind engineering and climate change. We expect the series will enhance international networking and collaboration among engineers and meteorologists through the presentation of the latest research and exposure to the nomenclature and information needs of the engineering community on climate change. We hope the video recordings will provide a useful resource for the engineering community in learning about the state of the art and the many challenges around climate change implications for wind engineering.

Acknowledgments. The IAWE webinar series organizing committee acknowledges the presenters who gave their time and expertise to the series.

Reference

ASCE, 2024: *Effects of Climate Change on Life-Cycle Performance of Structures and Infrastructure Systems: Safety, Reliability, and Risk*. F. Biondini, Z. Lounis, and M. Ghosn, Eds., CIE/ASCE Task Group 2 Reliability-Based Performance

Indicators for Structural Systems, American Society of Civil Engineers, 8 pp., <https://doi.org/10.1061/9780784485804>.