



# THE WIND ENGINEER

## NEWSLETTER OF AMERICAN ASSOCIATION FOR WIND ENGINEERING

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### Multivariate Simulation for Assessing the Joint Wind and Ice Hazard in the United States

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**R**eliability-based design of infrastructure requires the probabilistic assessment of jointly occurring natural hazards. As infrastructure design practices evolve, it is important that multiple hazards are considered, e.g., wind and storm surge in a hurricane, an earthquake and tsunami, or wildfires driven by high temperatures and strong winds. These jointly occurring hazards in some cases can be more devastating than the single hazard. This paper will describe the assessment of two jointly occurring hazards, wind and ice. For locations in the U.S, wind and ice (e.g., freezing rain (FR)) are hazards whose properties are of interest for design of transmission lines and other energy infrastructure (e.g., wind turbines).

#### Methodology

First, all the data (wind speeds, precipitations and the weather observation parameters (to check if freezing rain occurred or not)) from 8 stations in the Midwestern US were collected from ISD database [1]. Quality control

is exercised to remove any spurious (i.e., not physically plausible) data points. Then two models for the simulation are constructed (simple model and sophisticated model). Figures 1 & 2 show the simulation procedures for both models.

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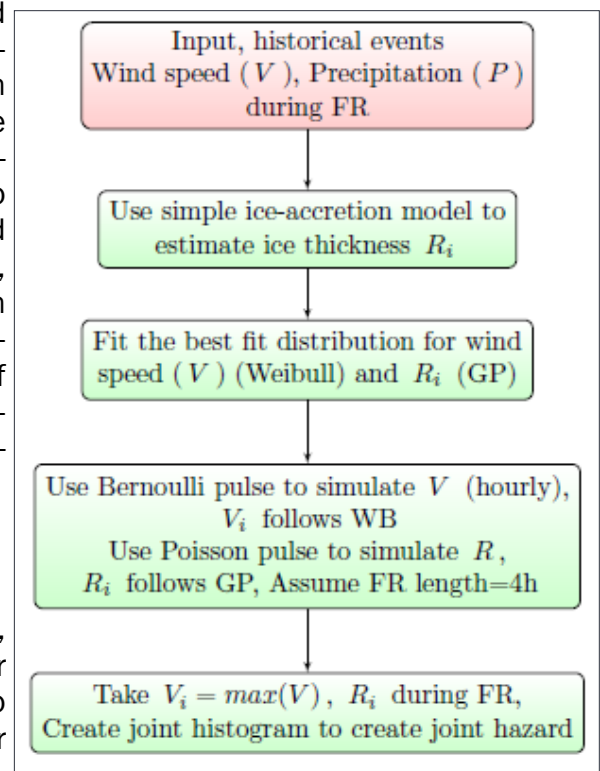


Figure 1. The procedure of the simple model



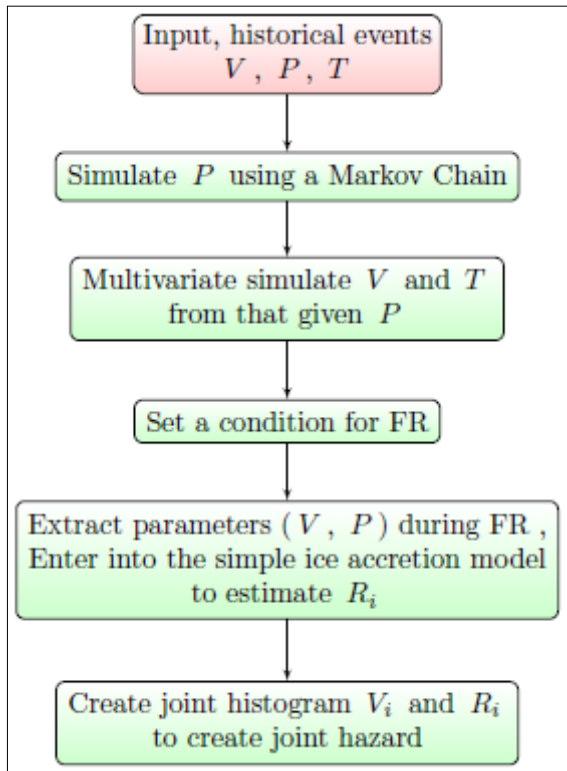


Figure 2. The procedure of the sophisticated model

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## Results

Figure 3 compares the 50 year MRI joint gust wind and ice thickness for the different locations (sophisticated model), the result from the simple approach [2] (for a superstation [3] (8 stations)) and the design value pair from ASCE 7 [4]. In general all the joint hazard contours confirm the extreme conservatism of the 50 year design value in ASCE 7. Regarding the relative behavior of each station to each other, the present results confirm the trends presented in ASCE 7. Interestingly, the simple model [2] represents a reasonable upper bound for much of the simulated data.

Figure 4 compares the results for a superstation [3] (8 stations) between the simple approach (10,000 year simulation) [2] and the new sophisticated approach (8,000 year simulation). Overall the simplified approach is more conservative than the new approach especially for the ice thickness since an extreme distribution was used for ice thickness (GP distribution) while for the new approach, ice thickness were

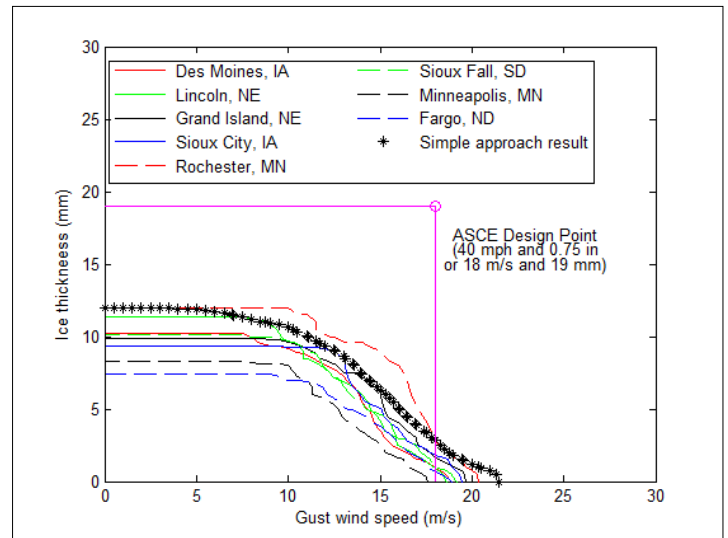


Figure 3. 50 year MRI Joint Hazard Curves (sophisticated model) for different Midwestern US stations

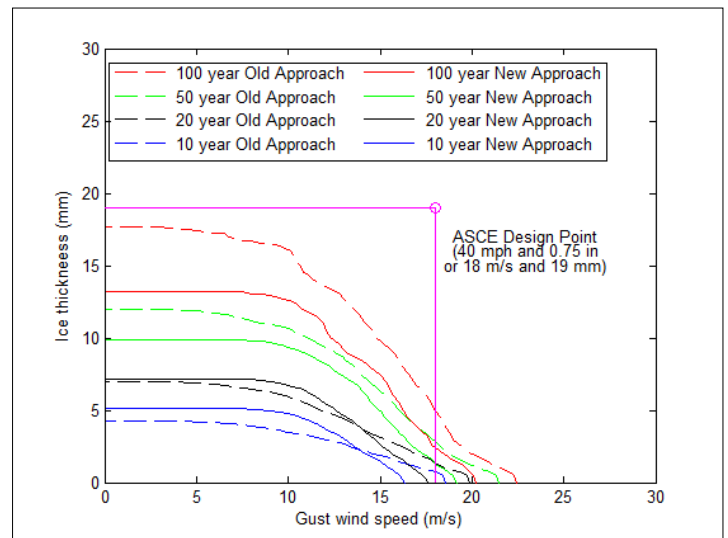


Figure 4. Comparing sophisticated and simplified approaches for the Midwestern US superstation

calculated based on the meteorological parameters. However, both approaches confirm that the design values recommended in ASCE 7 [4] are too conservative.

## Summary

Firstly, independent treatment of joint wind and ice hazards (i.e. the ASCE 7 [4] approach) leads to overly conservative results for this set of stations. The 50 year coupled design values for gust wind speed and ice thickness actually belong to much higher MRI (>500 years). Secondly, the current version of the wind-ice map in ASCE 7 [4] is risk inconsistent with the general use wind maps in ASCE 7 [4] in that the general

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wind load provisions deal with a load factor of 1 and MRI's of 300, 700 or 1700 years rather than the 50 year MRI that was associated with previous versions of the standard with a load factor of 1.6 and seemingly retained in the combined wind and ice provisions. To solve this problem, the joint hazard approach (as indicated in this paper) should be used to deal with FR events. This approach could be used for any station. Also, for typical structures, the gust wind speed and ice thickness pair (following each joint hazard line) which maximizes the relevant load combination should be selected. When all of these pairs for all stations are established, new wind and ice maps for different MRIs could be generated. Noting that, these maps will depend on types of structure as well as load combination selected. Finally, a simple ice-accretion model [5] has been used for more than 16 years in this arena. This model was developed with many conservative assumptions and it is time to developing a better model that is calibrated against experiment data.

## References

- [1] *The Integrated Surface Database (ISD)*, National Climatic Data Center (NCDC), U.S. Department of Commerce <http://www.ncdc.noaa.gov/oa/climate/isd/index.php>
- [2] H. Nguyen Sinh, F.T. Lombardo, C.W. Letchford and D.V. Rosowsky, Characterization of the Joint Wind and Ice Hazard in the Mid-western United States, 12th International Conference on Applications of Statistics and Probability in Civil Engineering, Vancouver, Canada, 2015.
- [3] Lombardo F.T. Improved extreme wind speed estimation for wind engineering applications. *Journal of Wind Engineering and Industrial Aerodynamics*, pp. 278-284, 2012
- [4] ASCE. Minimum design loads for buildings and other structures. Reston, VA: American Society of Civil Engineers, 2010.
- [5] Jones K. F., Thorkildson R. and Lott J.N., The development of the map of extreme ice loads for ASCE Manual 74. *Electrical Transmission in a New Age*: pp. 9-31, 2002.

## AAWE Elections

AAWE members in good standing have until September 4, 2015 to cast their votes to elect a new President-Elect and 3 members of the Board of Directors. Members can vote through: <https://www.surveymonkey.com/r/PB9JGYL>.

### President-Elect Candidates

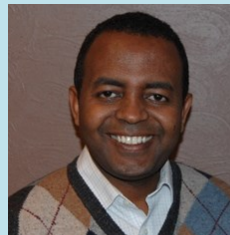


**Jon Galsworthy**



**Write-in**

### Board of Directors Candidates



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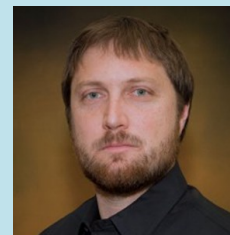
**Kyle Butler**



**Steve Camposano**



**John Kilpatrick**



**Murray Morrison**



**Write-in**

## Kareem elected President of IAWE

Former AAWE President, Dr Ahsan Kareem, Robert M. Moran Professor of Civil Engineering and Geological Science of the University of Notre Dame, was elected President of the International Association of Wind Engineering at the recent 14th International Conference on Wind Engineering held in Porto Alegre, Brazil.

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