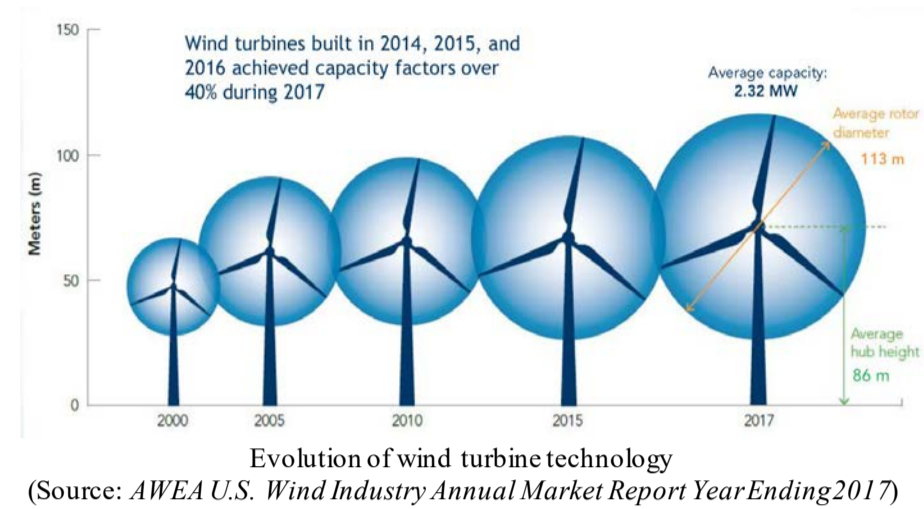


WIND TUNNEL EXPERIMENTAL VARIABILITY OF AERODYNAMIC LOADS FOR WIND TURBINE BLADES

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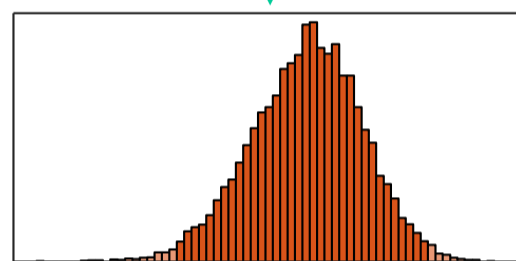
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1. Introduction



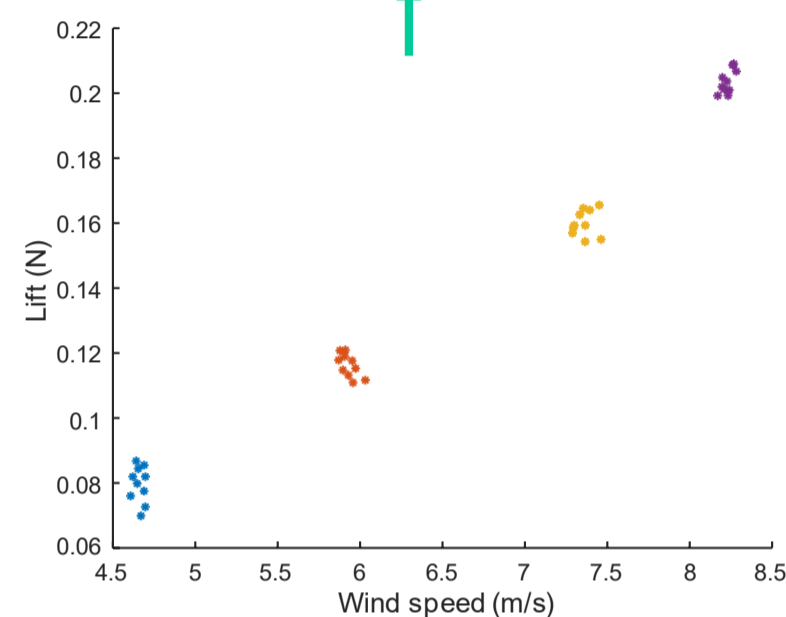
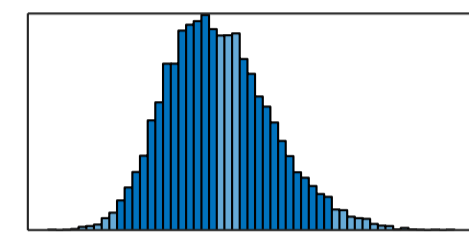
Longer and more flexible blades

Onset of Flutter: aeroelastic coupling of flapwise and torsional modes



Distribution of flutter speed is predicted by including various **uncertainty** sources (aerodynamic loads, structural properties, etc.)

Objective: Quantify uncertainty of input aerodynamic loads by wind tunnel tests



Aerodynamic loads are determined through wind tunnel tests accounting for **experimental variability** (example: lift measured in NEU's wind tunnel)

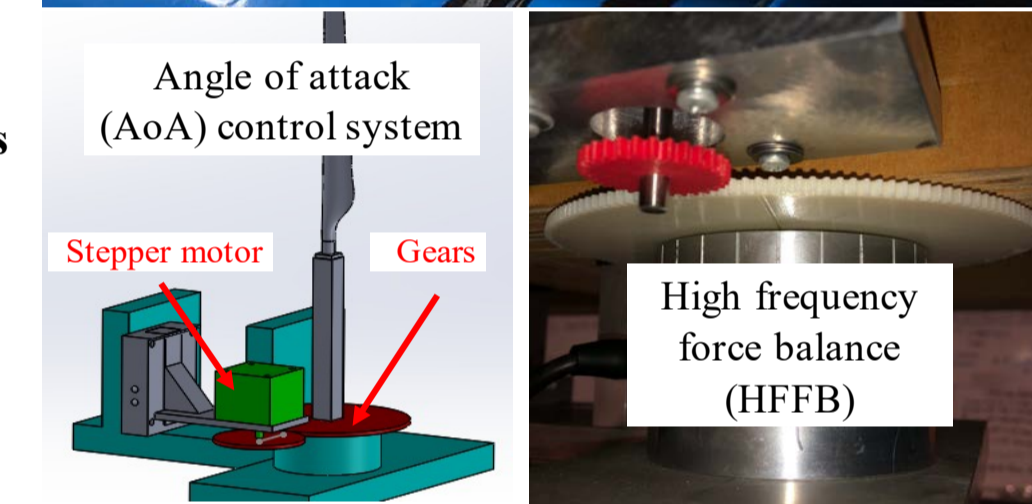
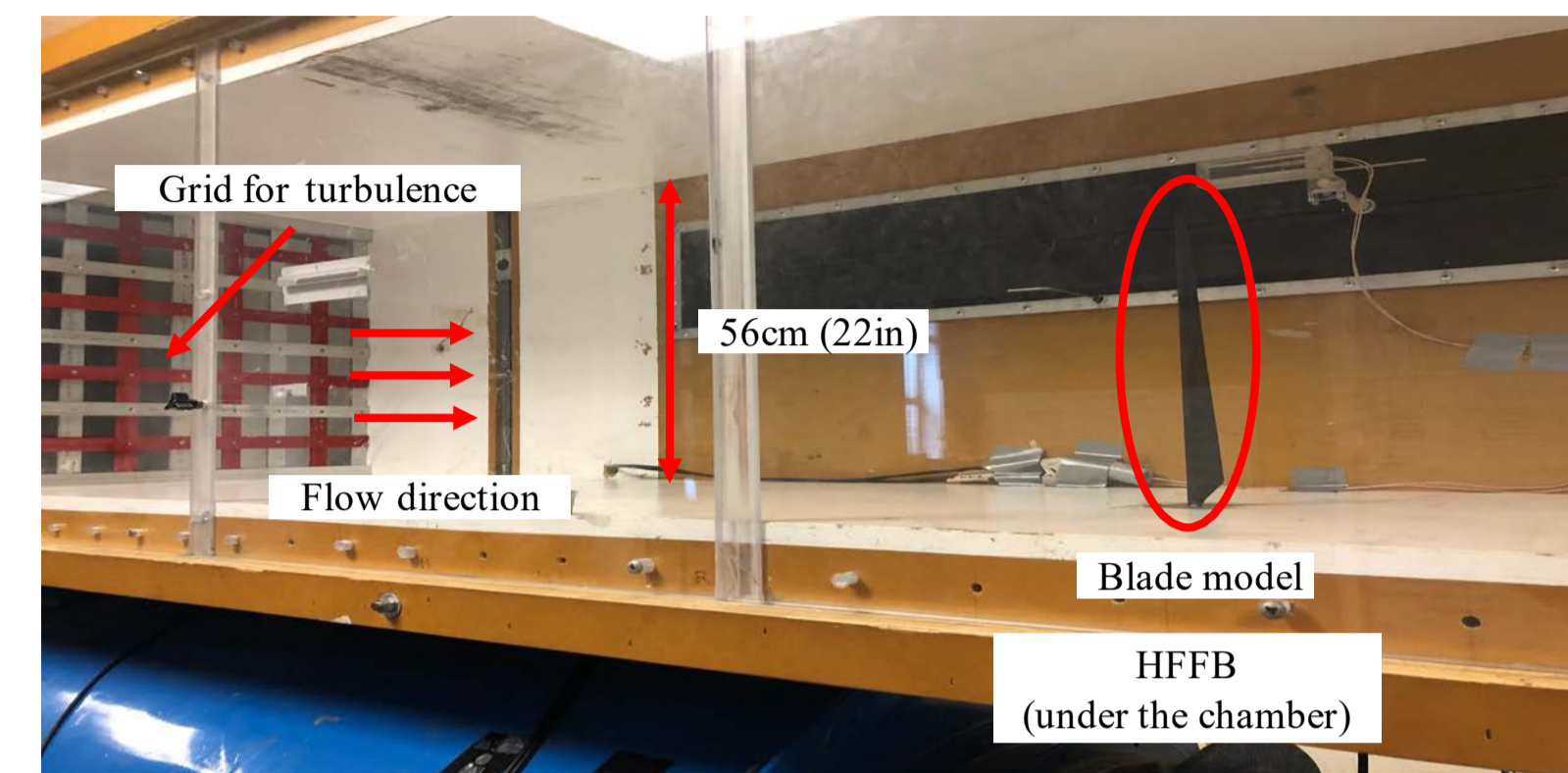
2. Experimental details

Blade specifications

- Reference blade: NREL 5MW
- Geometric scale = 1:200
- Length (radius) = 330 mm

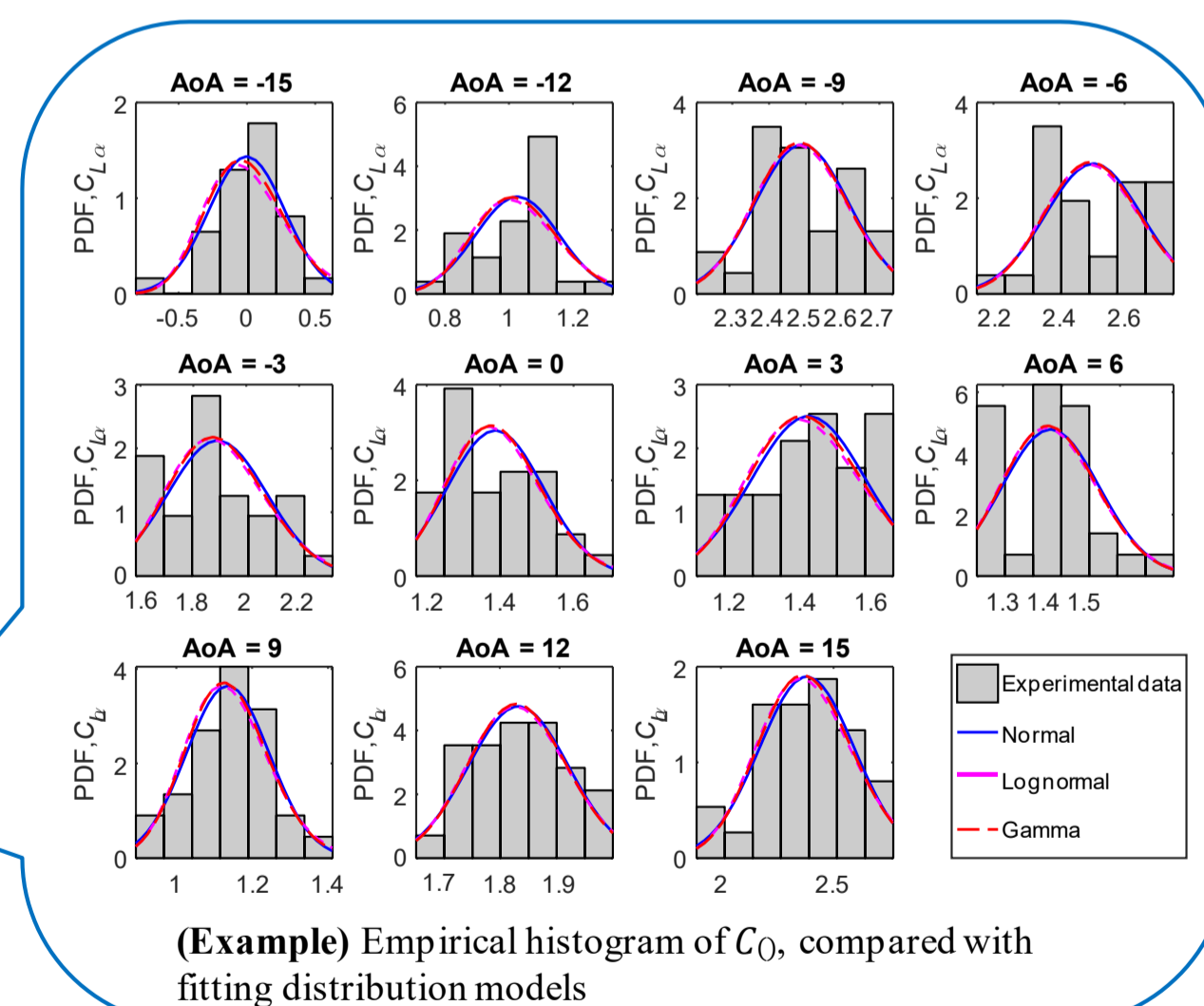
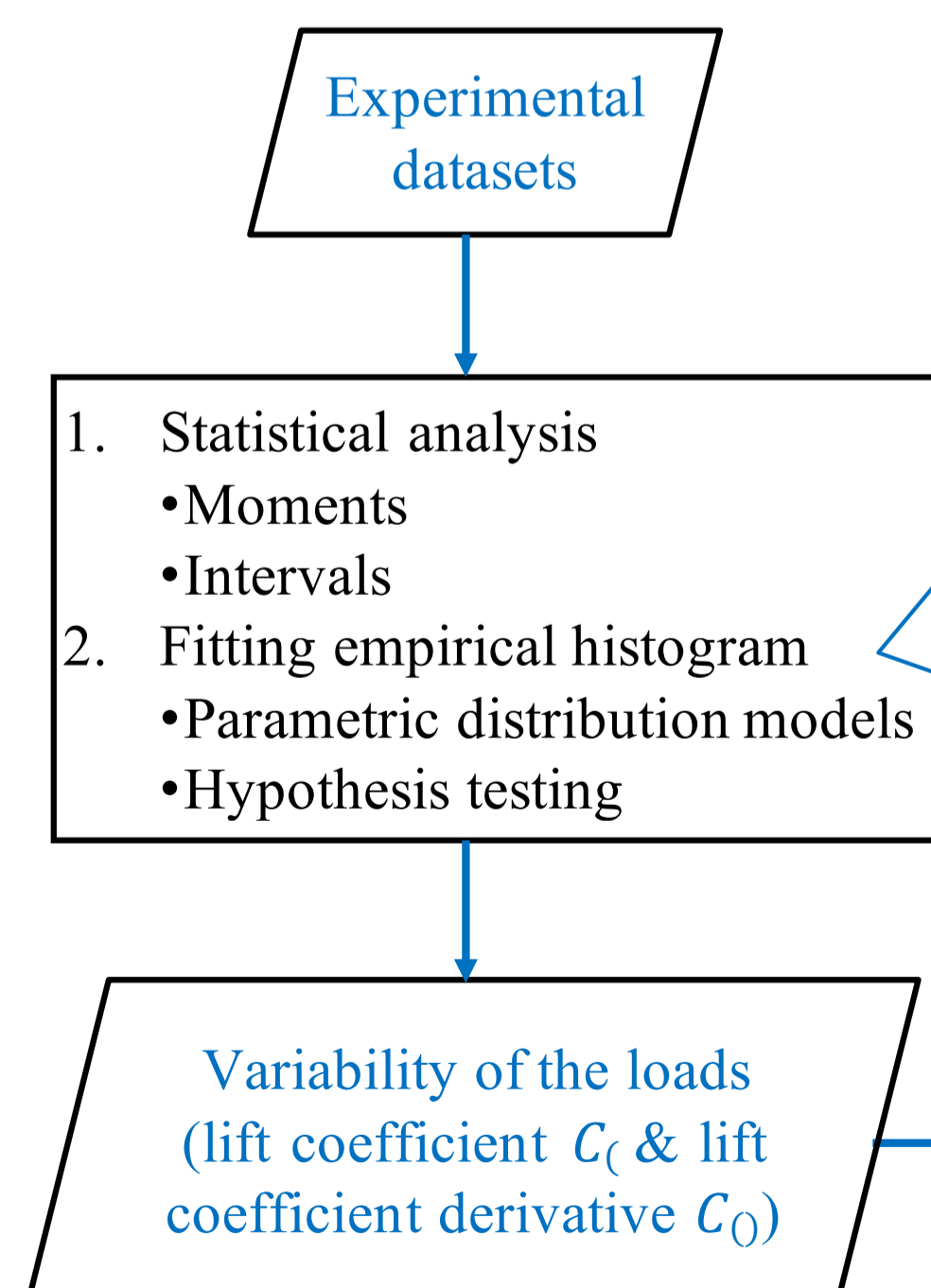
Test procedure

- Angle of attack = $-15^\circ \sim 15^\circ$
- Wind speed = 10 m/s
- Duration of each test = 20 seconds
- Number of tests in each case = 30
- Turbulence intensity = 14.0%



(Top) NEU's small-scale wind tunnel
(Left) (a) Schematic of angle-of-attack control system
(b) HFFB under the chamber

3. Variability analysis



4. Conclusions and future work

- 3D blade model (NREL 5MW with scale of 1:200) was tested in NEU's small-scale wind tunnel under different cases.
- A framework of variability analysis in wind tunnel experimental datasets was proposed.
 - Various blade models will be tested to provide satisfactory datasets.
 - Larger sample size of test results will be considered to support the variability analysis.
 - Influence of turbulence effects on uncertainty will be examined.

5. References

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Flow chart of variability analysis in wind tunnel experimental datasets