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An Error-Reduction Algorithm To Improve Lidar Turbulence Estimates for Wind Energy

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Can We Replace Meteorological (Met) Towers with Lidars?

Photo from Don Buchanan, NREL 19340

Photo by Jennifer Newman, NREL

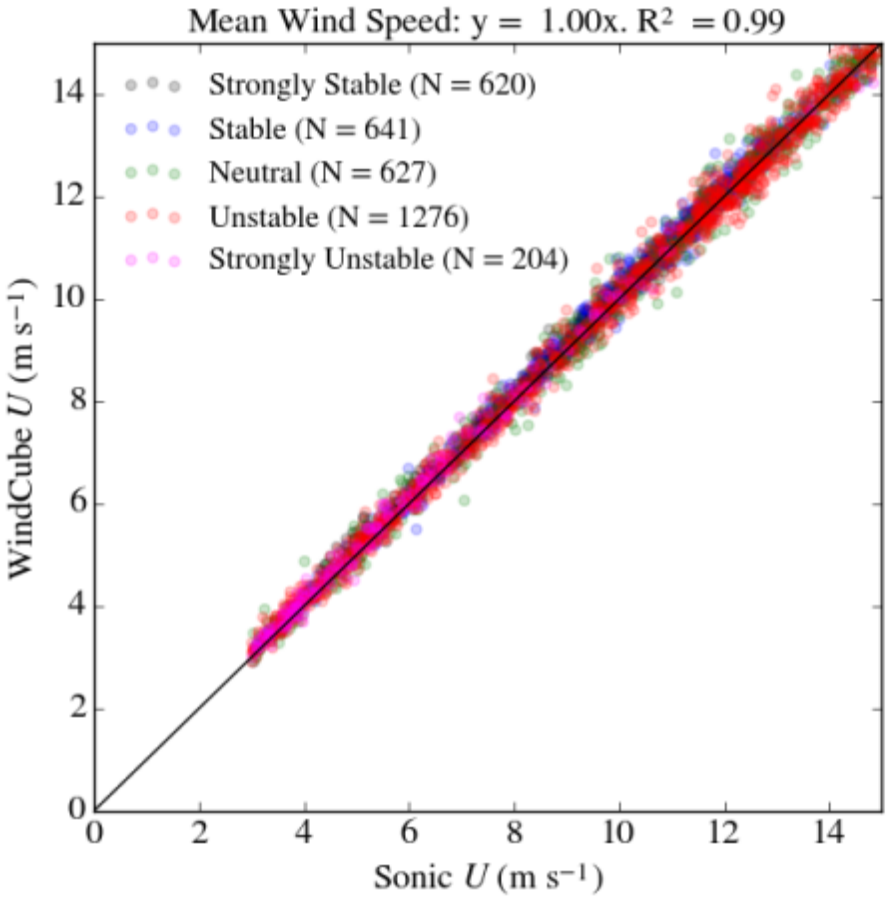
Met Towers

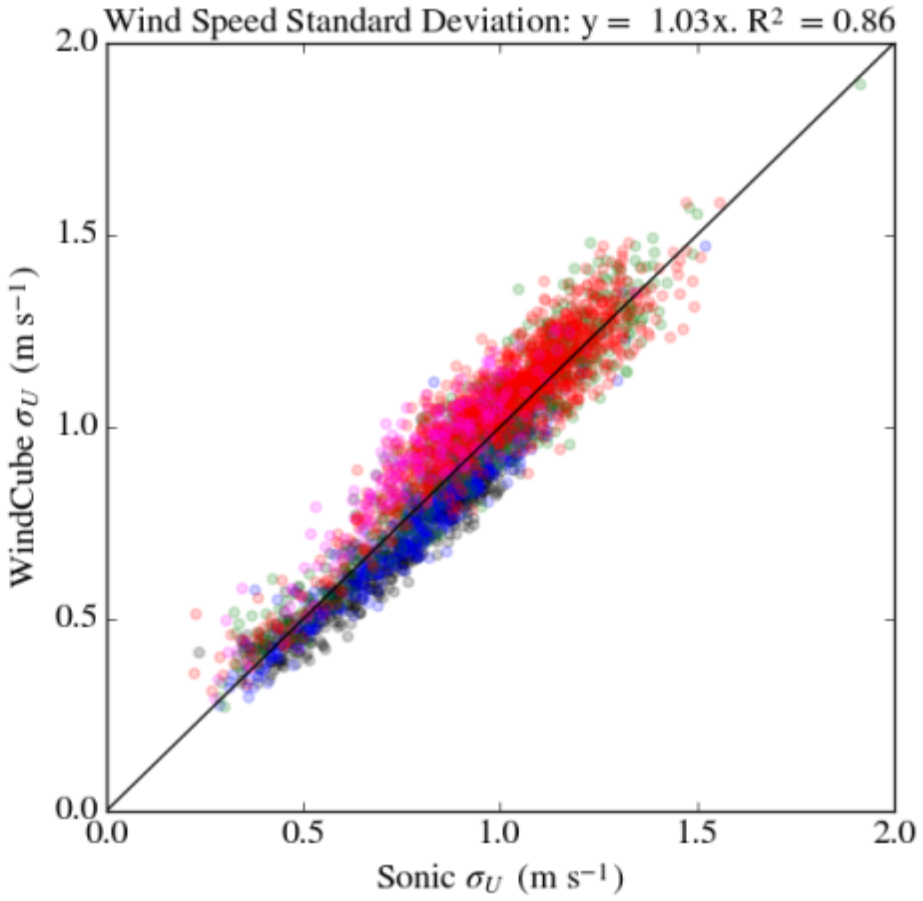
- Costly to build
- Not mobile
- Limited by height
- Measure at a point

Lidars

- Mobile
- Measurements typically extend to 200 meters (m) above ground level
- Measure in a volume

Sample Lidar Measurements—ARM Site

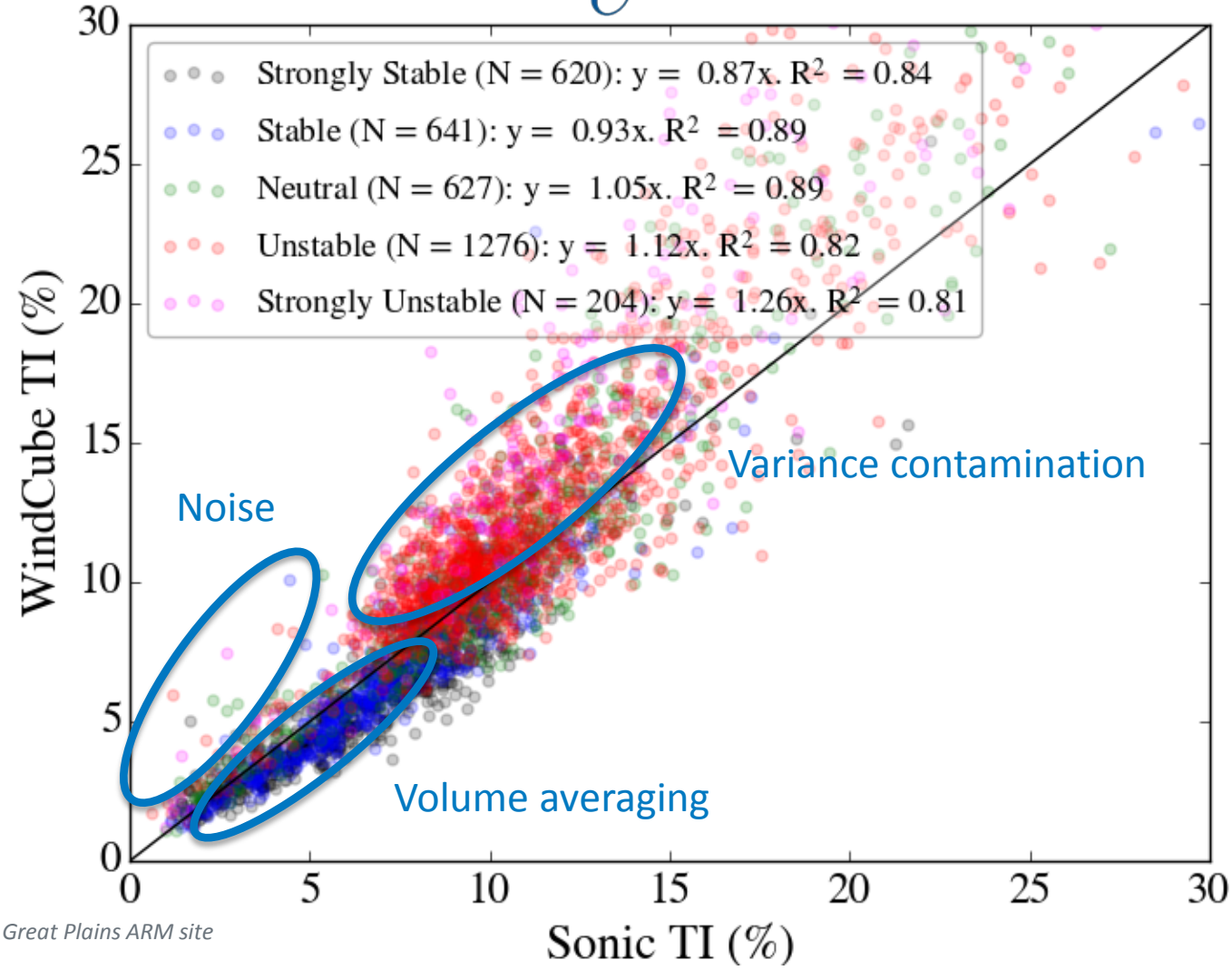




Data from 60 m AGL at Southern Great Plains ARM site

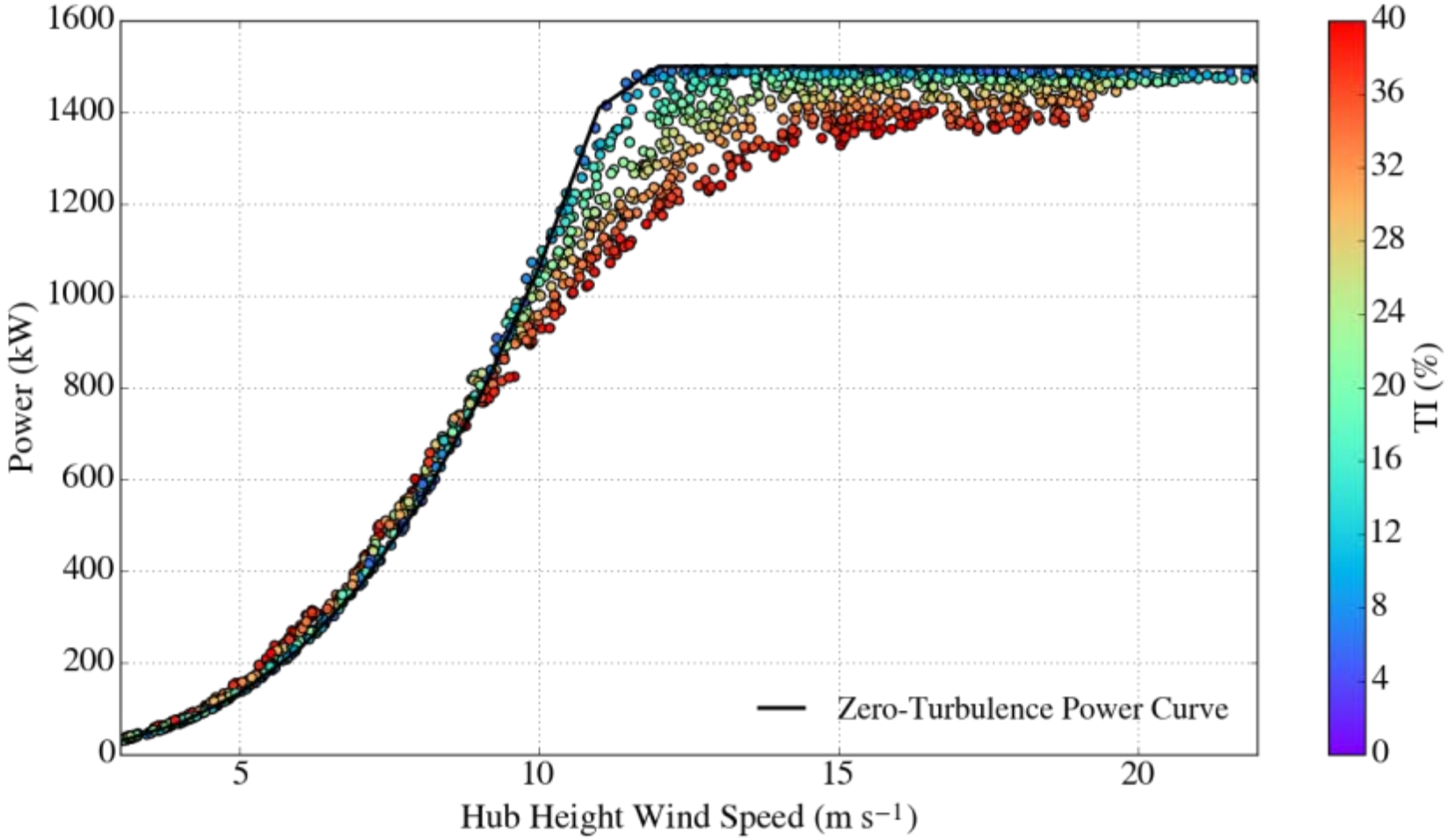
Example of Lidar Versus Sonic Turbulence Intensity (TI)

$$TI = \frac{\sigma_u}{U} \times 100\%$$



Data from Southern Great Plains ARM site

Impact of TI on Turbine Power Curve



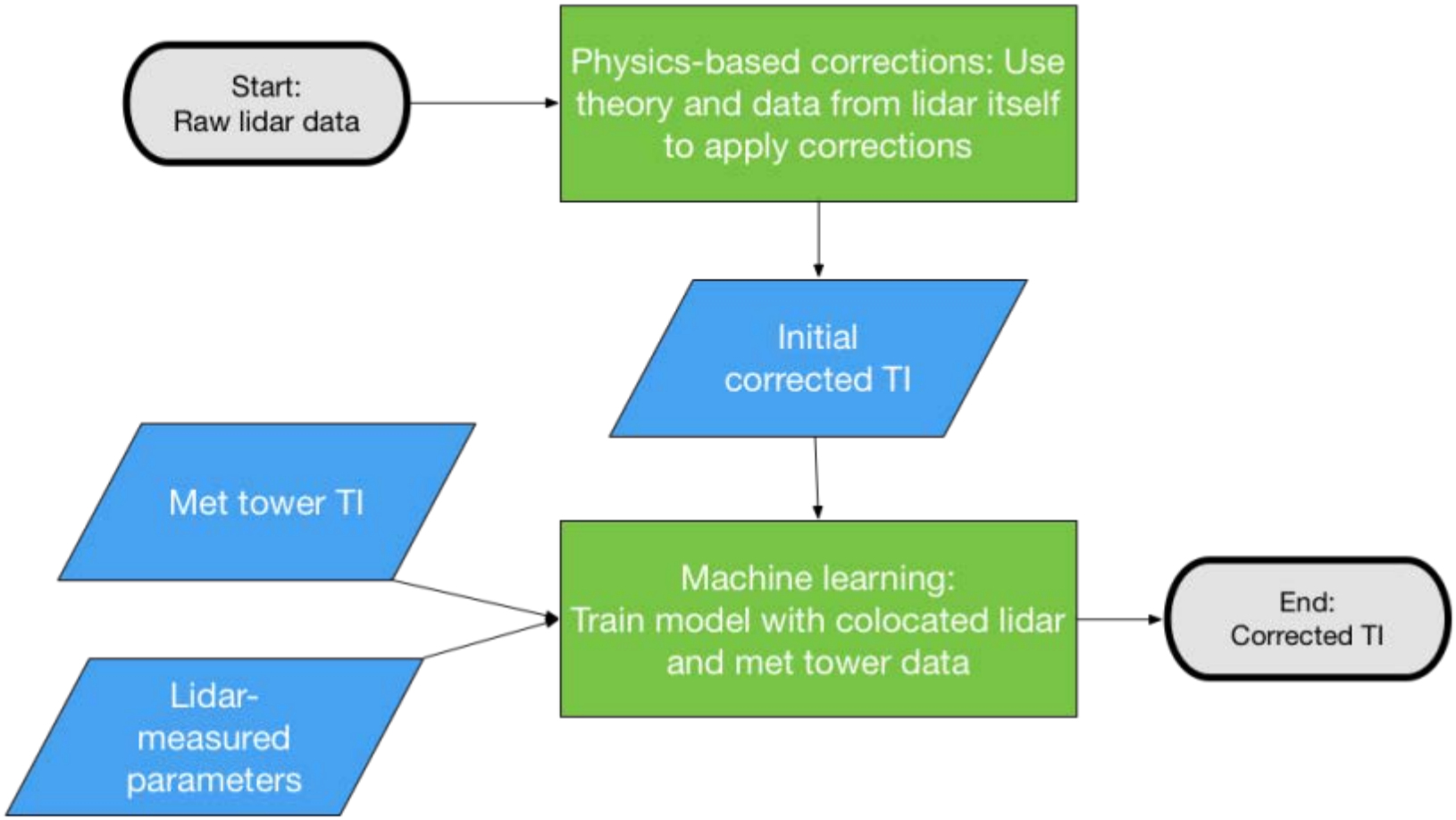
Power curves from FAST simulations of 1.5-megawatt WindPACT turbine. After Clifton and Wagner (2014).

Need for Improved TI Estimates

- The Problem: Lidars measure different values of TI than a cup or sonic anemometer. This makes it difficult to use lidars for resource assessment or turbine site suitability.

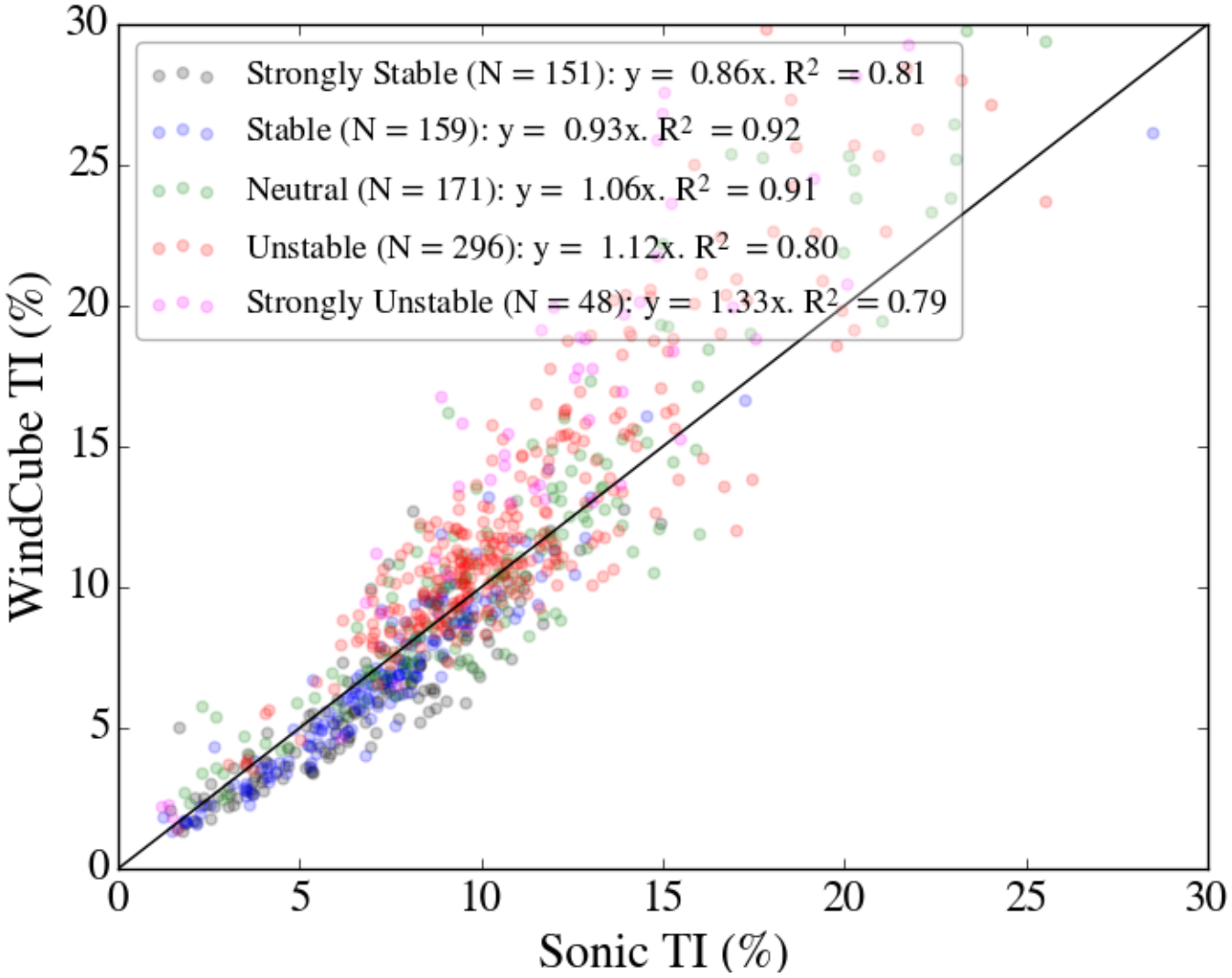
- Proposed Solution: Improve TI estimates using the Lidar Turbulence Error Reduction Algorithm (L-TERRA)

L-TERRA Framework—Patent Pending

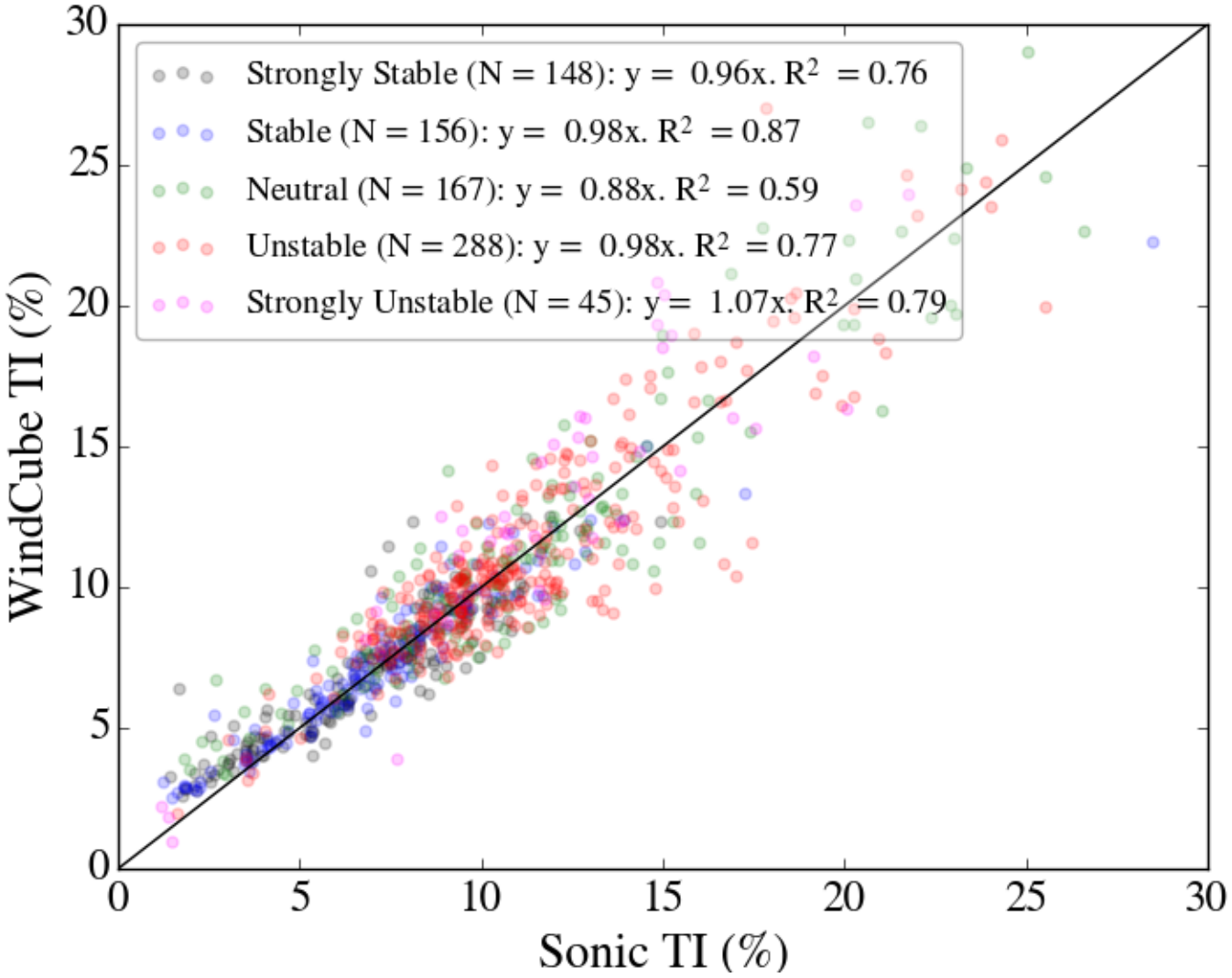


More information: Newman, J. F. and A. Clifton, 2016: improving lidar-derived turbulence estimates for wind energy. *Wind Energ. Sci. Discuss.*, doi:10.5194/wes-2016-22, in review.

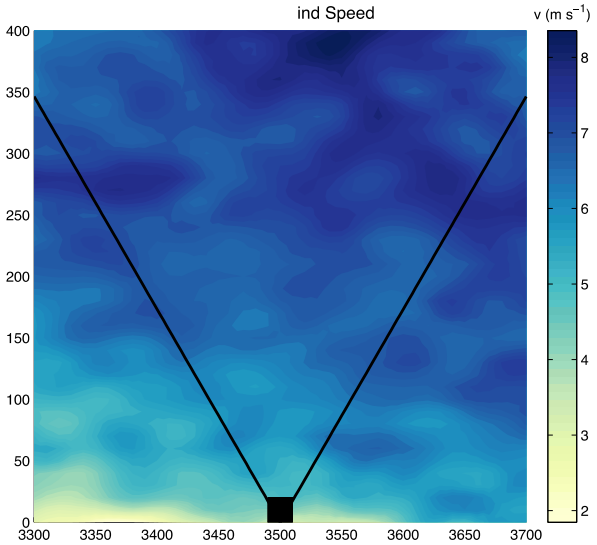
Lidar vs. Sonic TI: Before L-TERRA

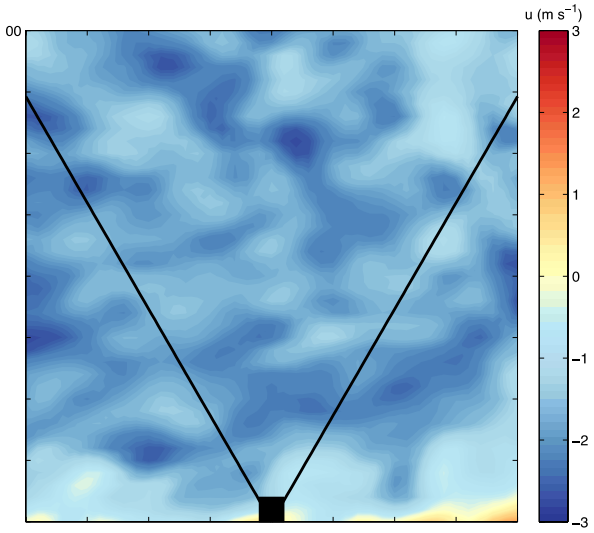


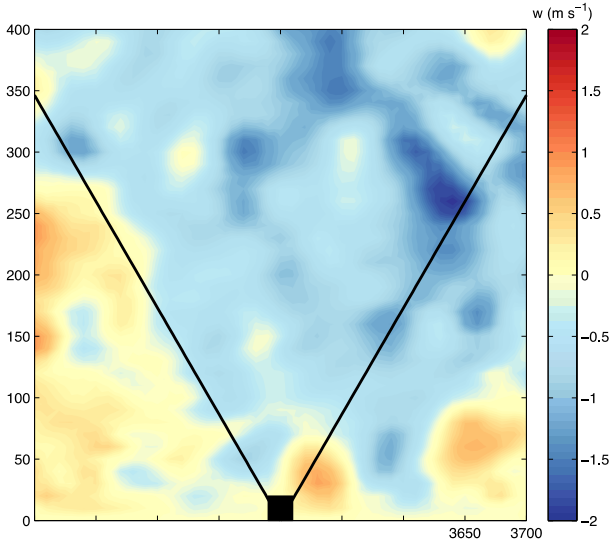
Lidar vs. Sonic TI: After L-TERRA



Examining Error with a Virtual Lidar Tool







- How valid are the assumptions being made in L-TERRA?
- How do different effects combine to produce TI error?

What's Next?

Photo by Jennifer Newman, NREL

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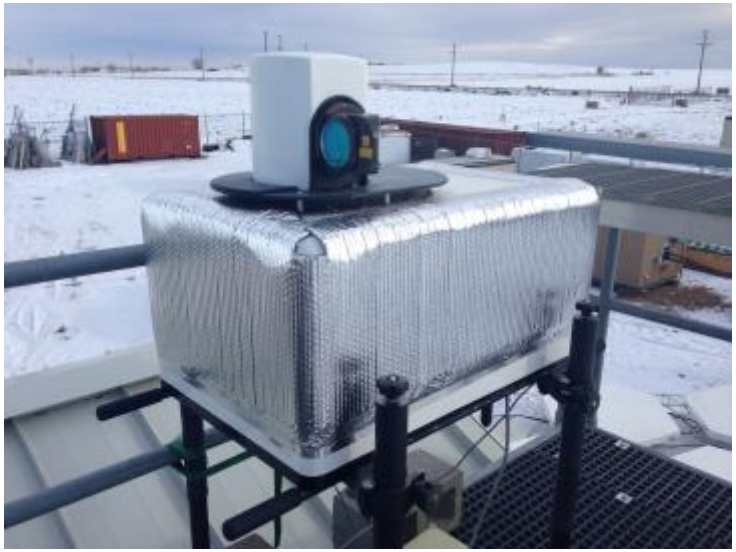
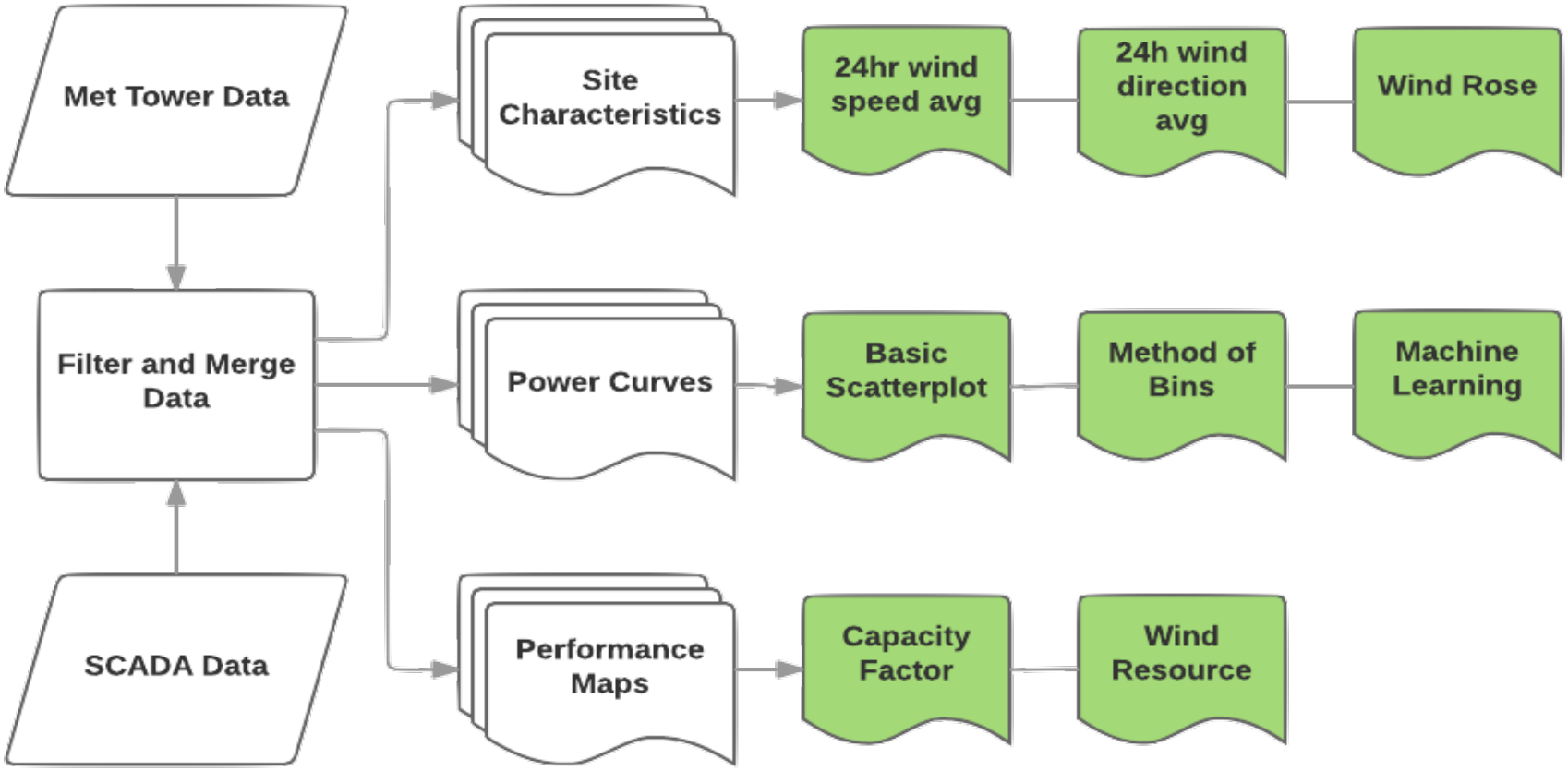


Photo by Jennifer Newman, NREL

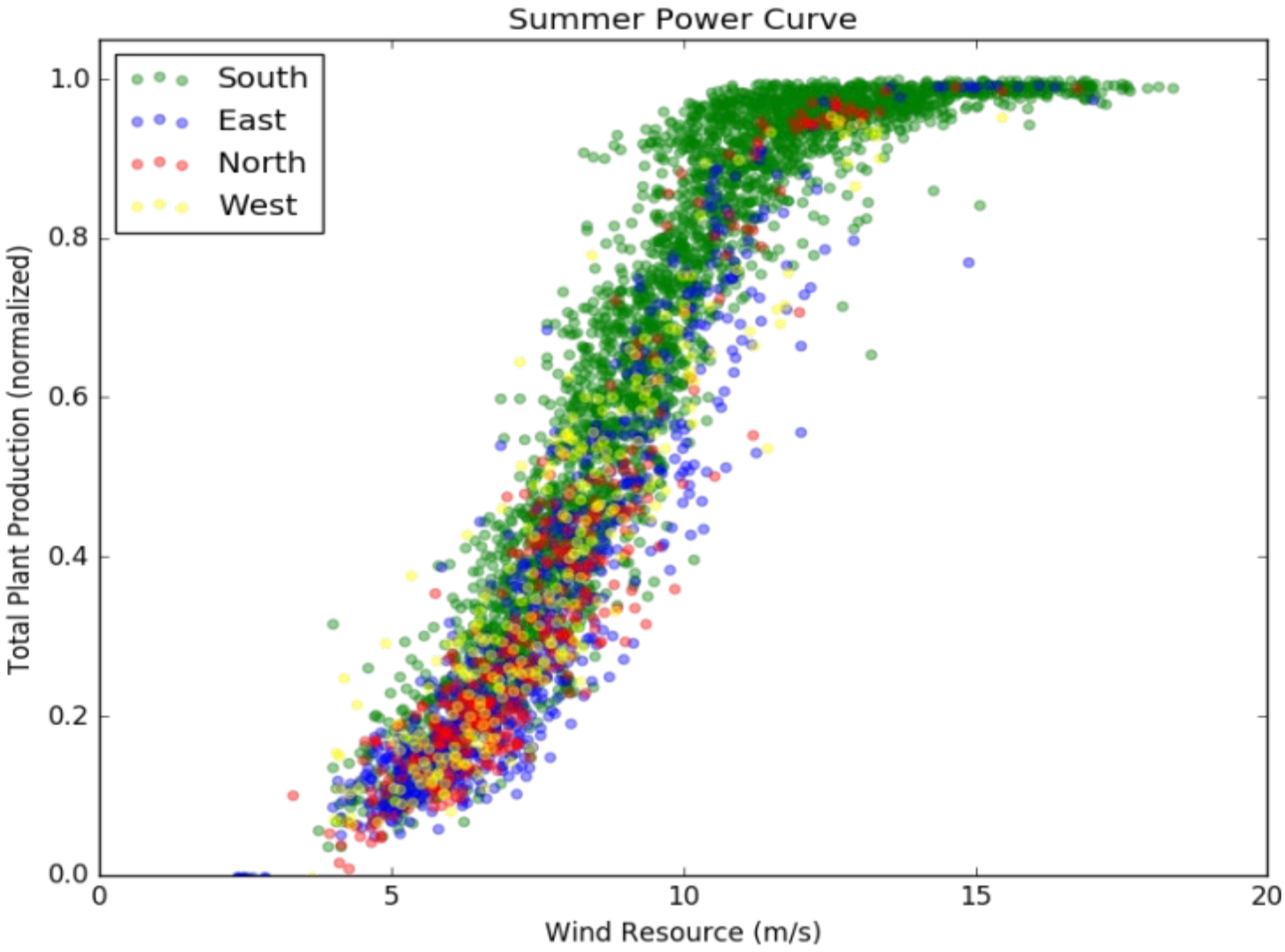
New Toolbox for Operational Wind Plant Data

New Toolbox for Analyzing Operational Plant Data

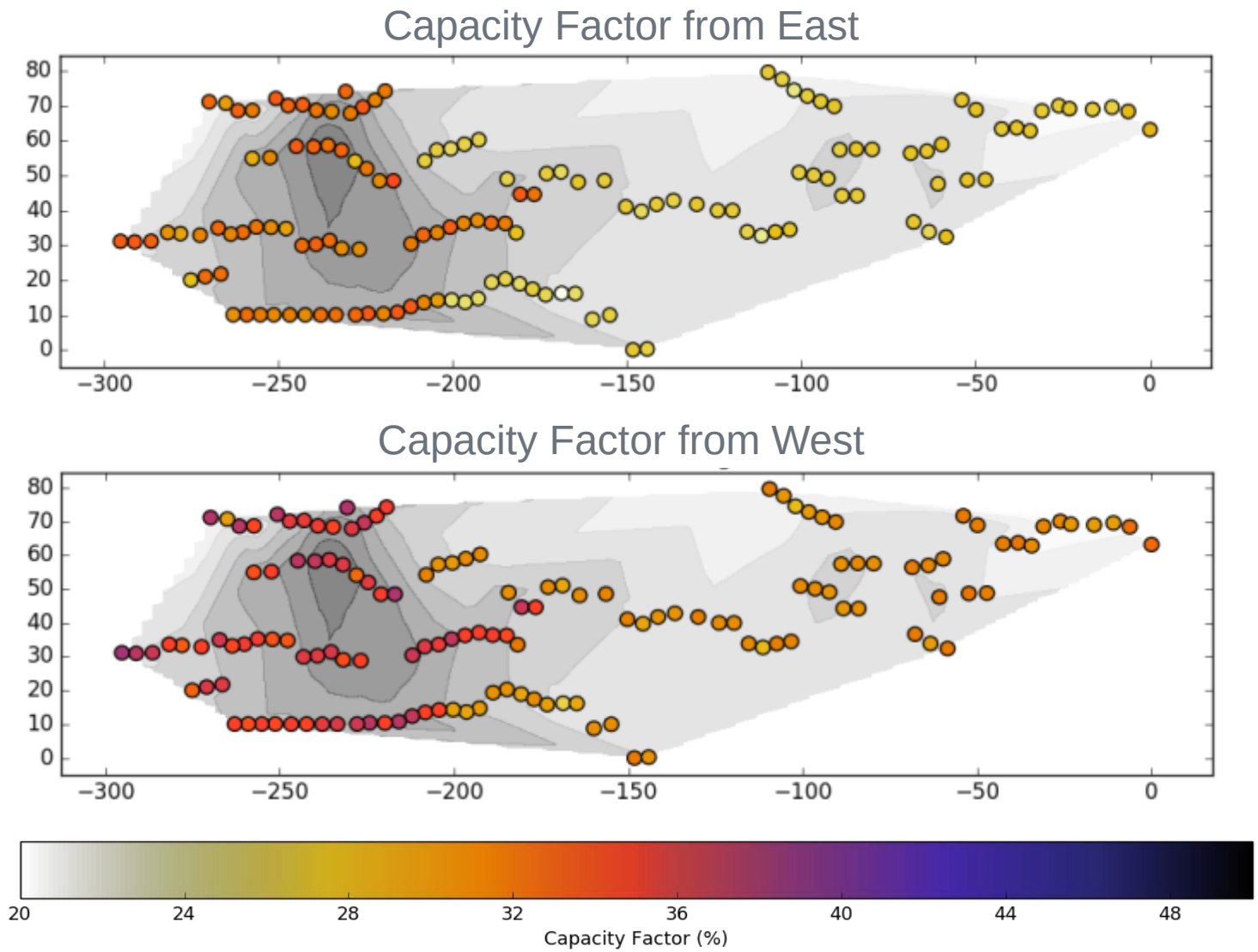
Developed by Elise Penn, undergraduate intern from University of Wisconsin-Madison



Wind Plant Power Curve



Capacity Factor Maps



Axes show normalized distance in rotor diameters.

Contour lines every 5 m.

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