Discussion of Critical Wind Measurement and Instrumentation Issues and Research Priorities to Overcome Barriers to Wind Energy Integration

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AWS Truewind

Headquarters: Albany, NY

- Mapping
- Energy Assessment
- Project Engineering
- Performance Evaluation
- Forecasting

- Industry Leader & Consultant for 25 Years
- Full spectrum of wind plant design, development and evaluation services
- Project roles in over 60 countries
- Offices in Austin, TX and Barcelona, Spain; 100 employees

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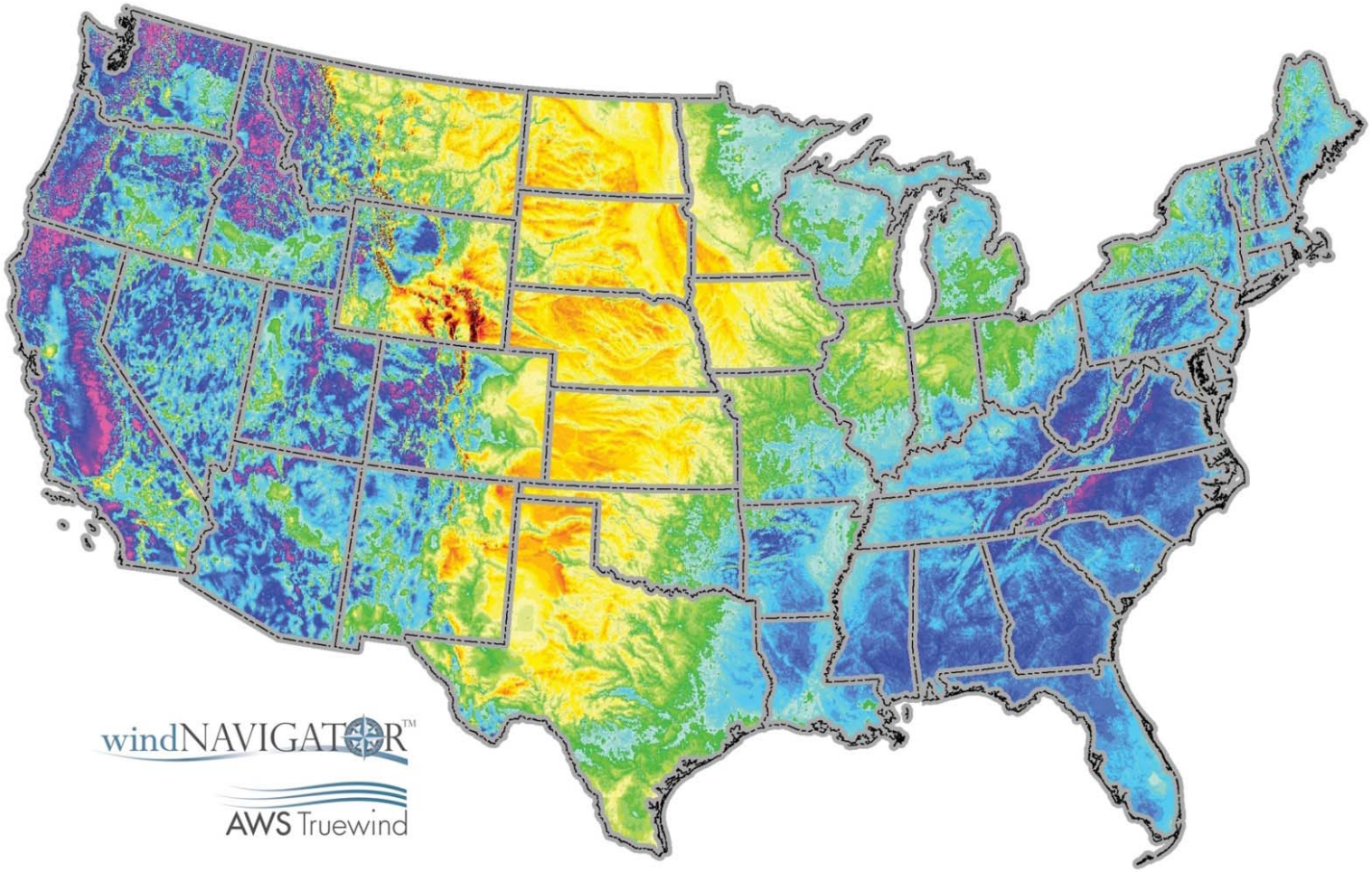
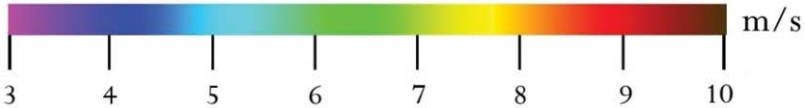
WIND RESOURCE OF THE UNITED STATES





Mean Annual Wind Speed at 80m

Collaboration With Labs

- NREL: Mesoscale Mapping of US Wind Resources (including offshore)
- NREL: Eastern Wind Integration & Transmission Study
- NREL: Offshore Wind/Wave Measurements & Modeling
- LLNL: California Wind Power Climate Change
- LLNL: WindSENSE Observational Targeting & Control Room Integration

Conventional Wind Industry Measurement

- **Heights up to 60 m**
- **Tubular pole supported by guy wires**
- **Installed in 1-2 days without concrete using 3 people**
- **Solar powered; cellular data communications**

Remote Sensing

Sodar

Lidar

Satellite

Barriers To Industry Adoption of New Technologies & Research

- Clients (developers) have limited budgets
- Mentality to keep things simple and understandable (clients aren't meteorologically adventurous)
- Most clients won't take risks if banks won't accept
- Few US industry standards
- No recognized field testing facilities used by industry
- Slow learning and adoption curve (e.g., acceptance of mesoscale models took years)

Wind Power Forecasting

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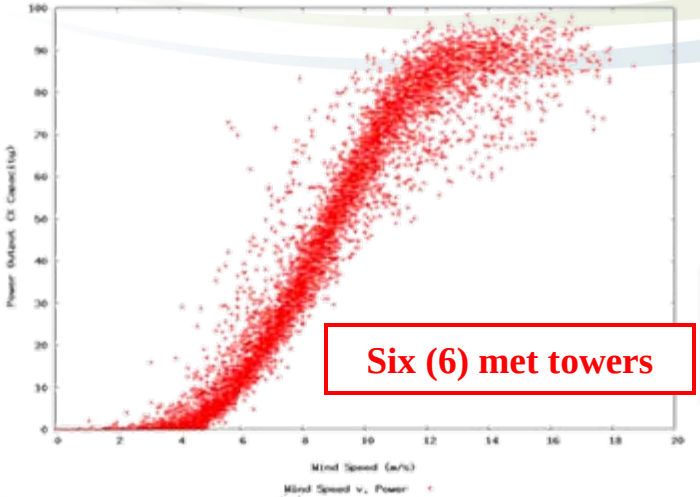
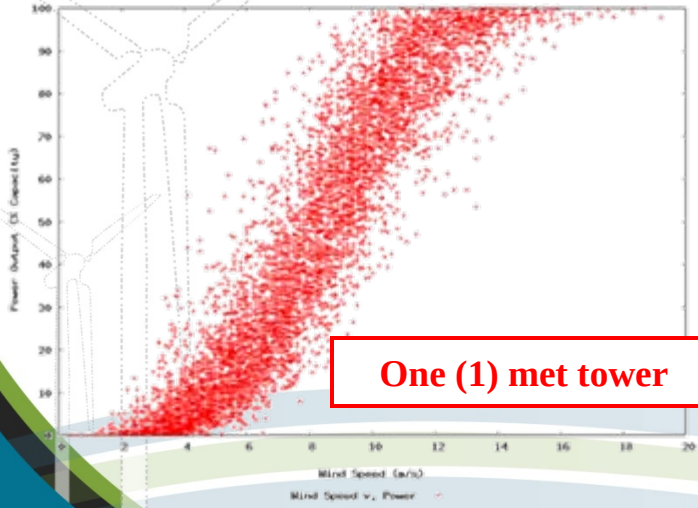
2 adjacent wind plants

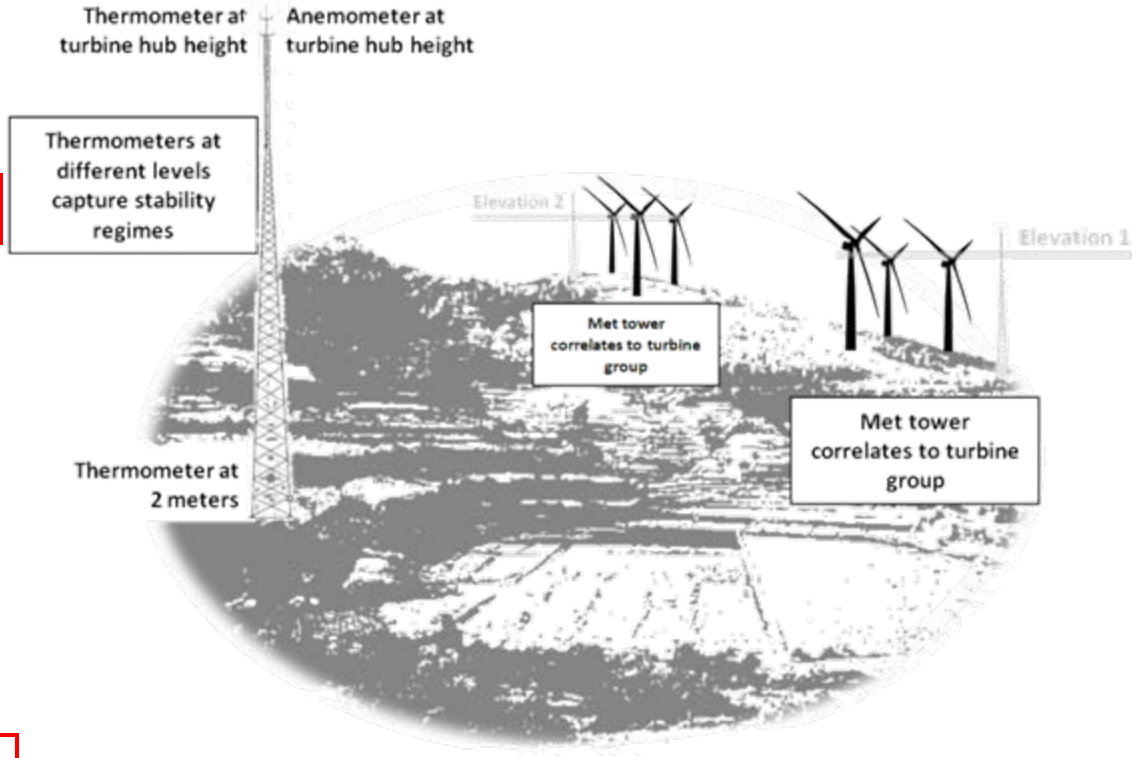


Six (6) met towers



One (1) met tower

Recommended On-Site Met. Measurements



MEASUREMENT-RELATED AREAS WHERE LABS CAN HELP

Wind Climatologies

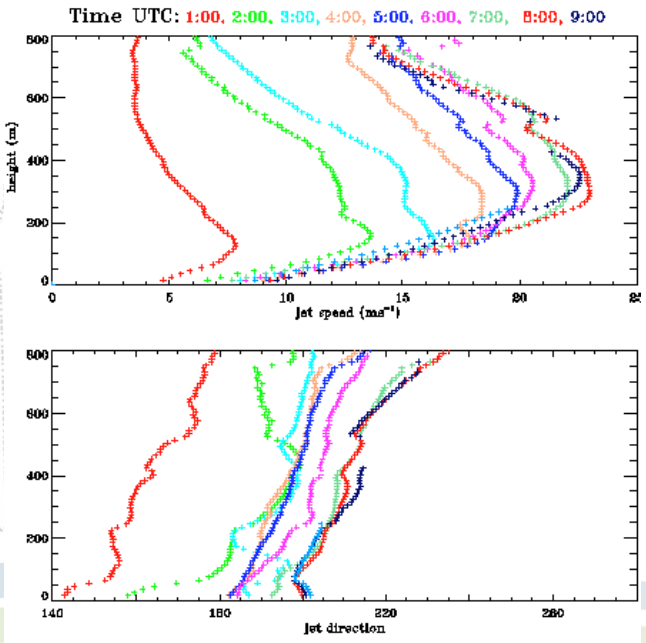
- Discontinuities in climate records at NWS stations
  - Identify the issue (conversion to ASOS and IFW)
  - Recommend efforts that NOAA should/could take to help industry make appropriate corrections
  - Recommend NOAA collaborate with industry when future changes to observation networks are contemplated
  - MCP technique is predominant industry approach to adjusting short-term measurements (1-3 yrs) to the long-term
  - Surface stations, rawinsondes & reanalysis data are used as references
  - Sites and reference stations are often not in same wind climate

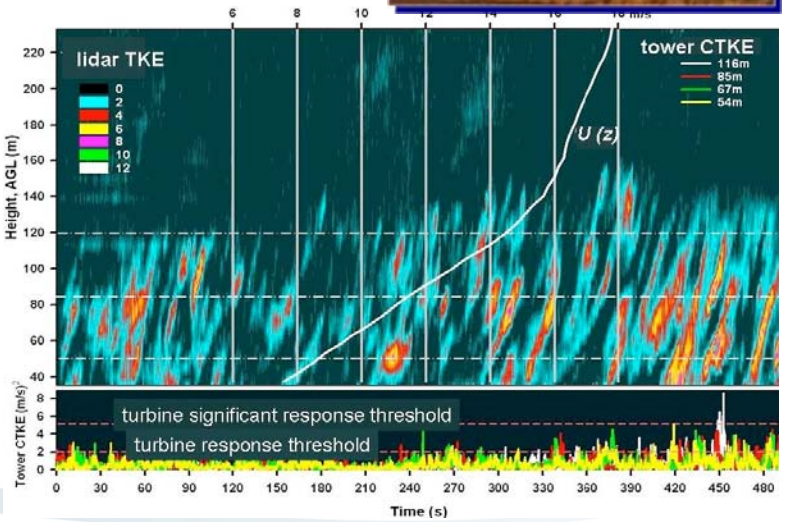
Boundary Layer Measurements

- Instrument package upgrades at strategic NWS locations within wind development regions
- “Permanent” tall towers and other measurement systems (lidar) to measure shear, stability, turbulence
- Access to research instrumentation
- Assist industry with using existing specialized measurement networks
- Offshore (oceans and Great Lakes)

Boundary Layer Measurements

- Targeting time-varying turbulence and shear structure of atmosphere
- Model validation & development





Pichugina et al., 2005

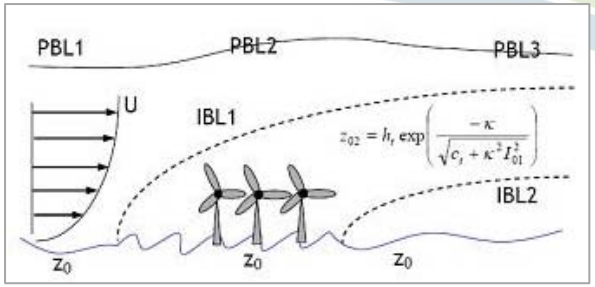
Banta et al., 2008

Remote Sensing Test Facilities

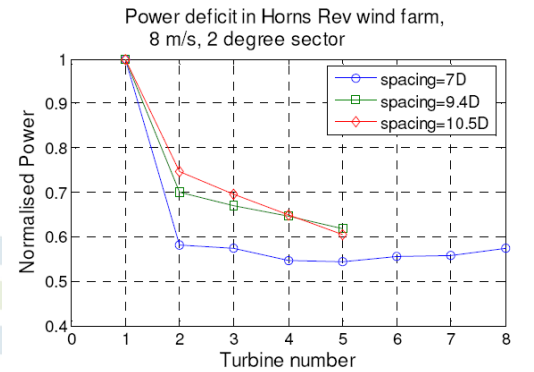
- For testing lidar and sodar technologies
- Co-located tall reference met mast
- Third-party comparison studies & certification
- Standardized acceptance test planning
- Availability would accelerate industry adoption of remote-sensing technologies

Wake Effects

- Need to capture details of flow within deep arrays
- Define impact of turbine arrays on surrounding region

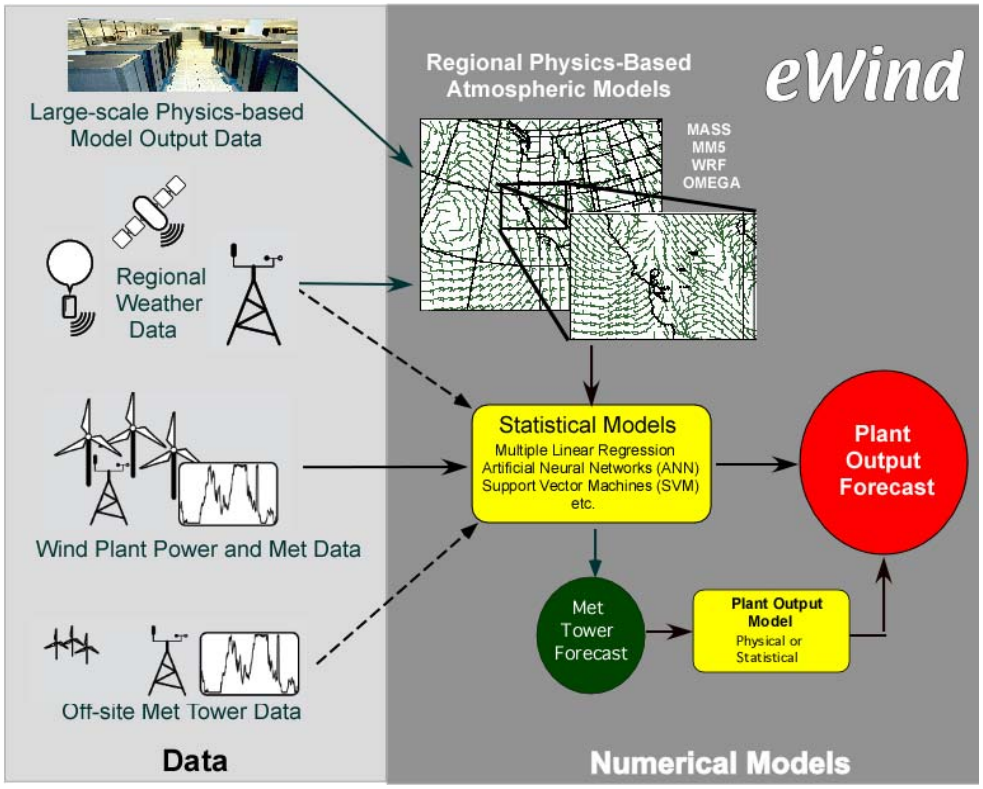


R. Barthelmie IU/UE



Short-Term Forecasting

- Observational targeting of appropriate technologies (towers, lidar, sodar, mini-dopplers), plus data assimilation



Final Thoughts

- Public Datasets Tailored to Wind Industry Needed
- Industry Not Incorporating Remote Sensing Technologies Fast Enough
- Characteristics of Boundary Layer Shear, Turbulence Not Well Understood (and few groups care)
- Need Improved Wind Farm Modeling Tools
- Improved Short-Term Forecasting Needs Much More Strategically Sited Input Data
- Lab-Industry Collaboration Essential to Smart Growth of Wind Energy

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Thank You!