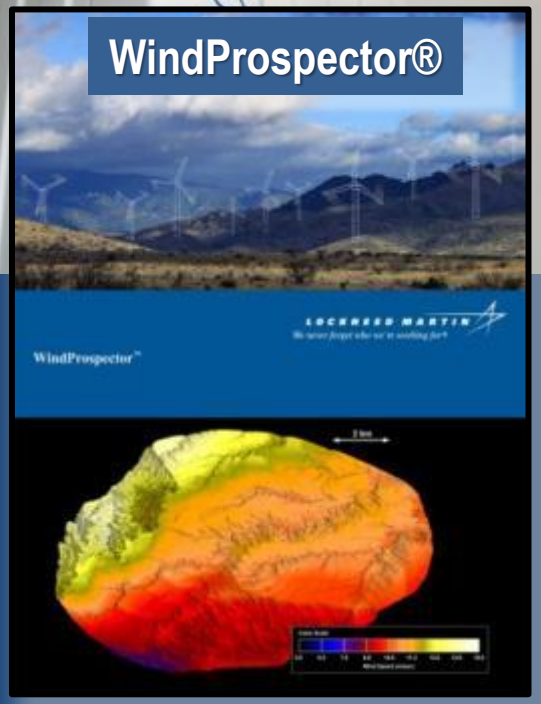
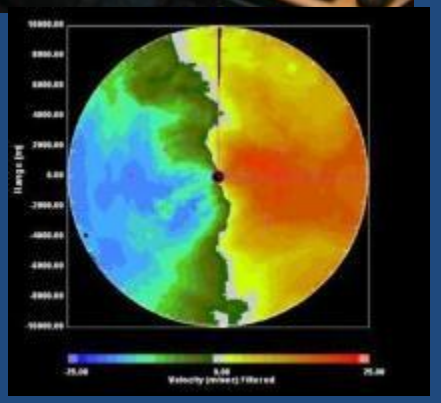
WindTracer®



LOCKHEED MARTIN

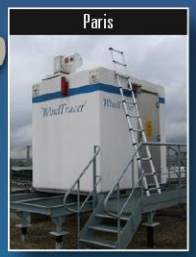
WindTracer® Applications

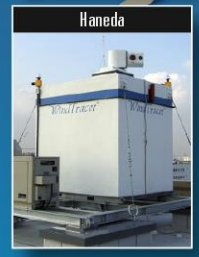
- Wind Hazard Alerting for Aviation Safety
- Wake Vortex Detection for Aviation Efficiency
- Aerosol Plume Detection and Tracking
- Precision Airdrop
- Gunship ballistic winds
- Airborne Applications (CAT, CLRF, PAD)
- Wind Energy Survey and Management
- Boundary Layer Atmospheric Research



WindTracer® Airport Installations

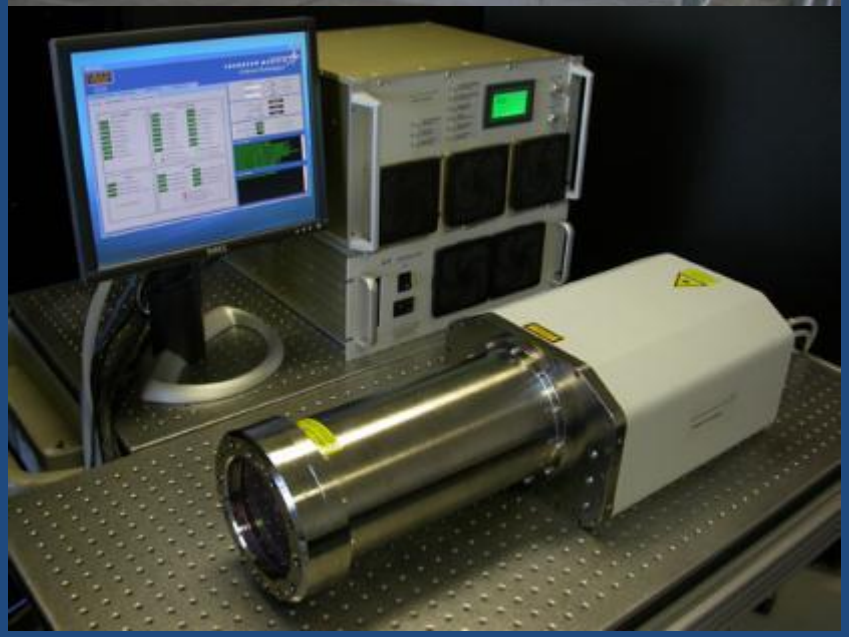
11 Years of Operational Wind Hazard Detection and
Wake Measurements for Air Traffic Management





WindTracer® Capabilities

WindTracer® Lidar Specifications	
Maximum range	33 km
Typical range	400 m to 35 km
Radial Wind Velocity Range	± 38 m/s
Range Resolution	Nominal 80 m
Velocity Accuracy	< 1.0 m/s
Azimuth Scanning Range	0 to 360 degrees
Elevation Scanning Range	-5 to +195 degrees
Resolution	0.001 degrees
Pointing Accuracy	±0.1 degrees
Wavelength	1617 nm
Pulse Energy	2.5 mJ ± 0.5 mJ
Pulse Repetition Frequency	750 Hz
Pulse Length (FWHM)	250 - 270 ns
Spectral Width (3dB)	1.4 MHz



WindTracer® Product Evolution

2002 - 2012

9’ x 8’ x 8’

6500 lbs

576 ft³

2014

5’11” x 4’8” x 6’5”

2900 lbs

174 ft³

The Future

~2016

3’x3’x3’

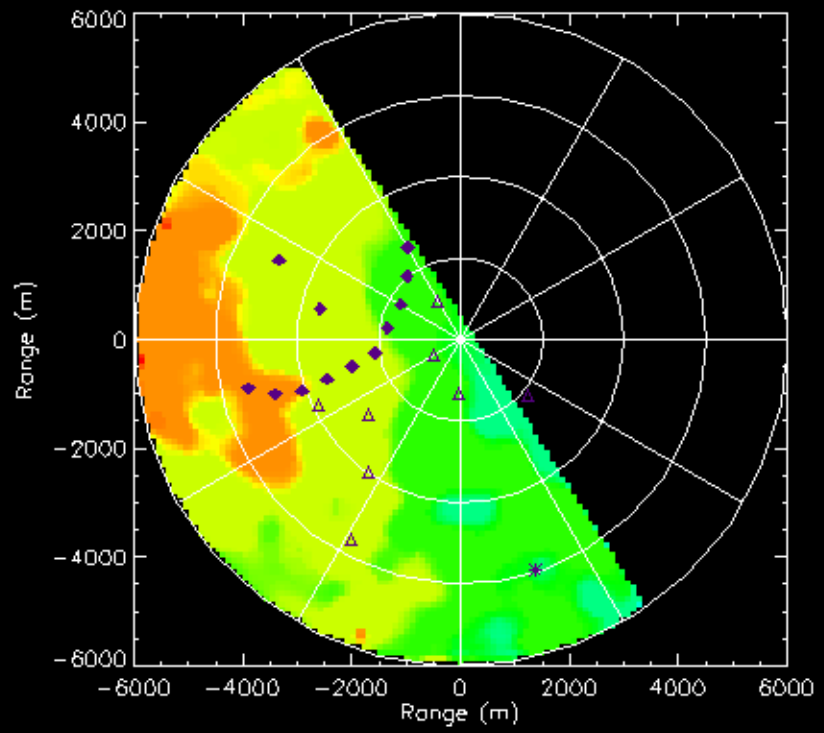
<700 lbs

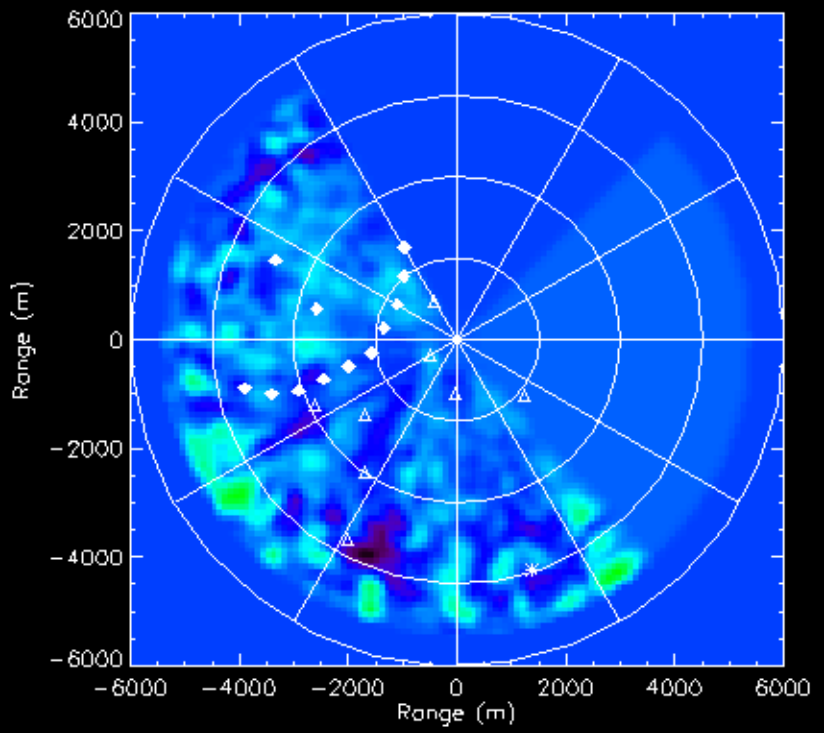
27 ft³

Low SWaP, hardened system enabled through Precision Airdrop (PAD) program

Plume Tracking

- WindTracer® tracking of plume released at Dugway Proving Grounds
- Tracking accuracy of plume centroid validated with point sensors





Wind Energy Deployments

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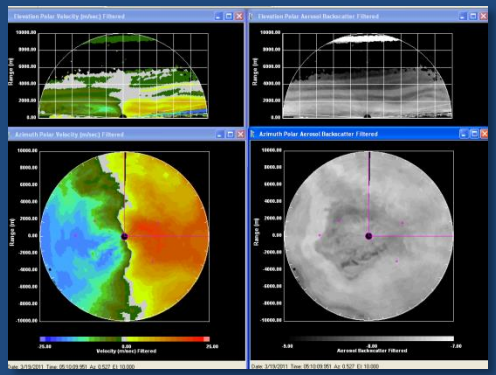
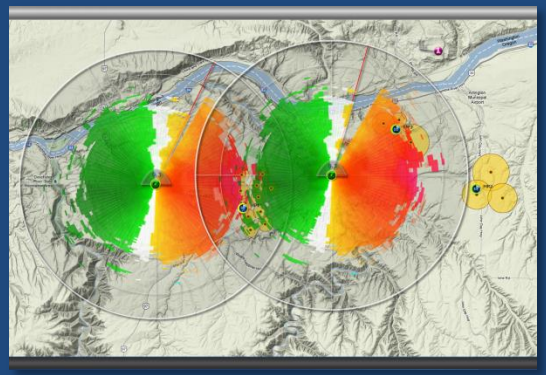
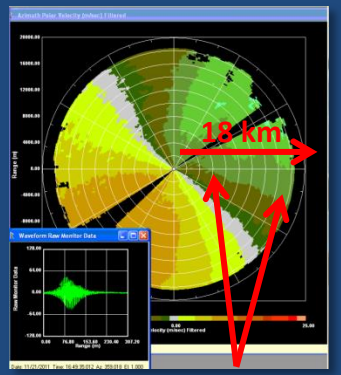
Wind Farm Site Survey in Western USA



Wind Forecasting at Wind Farm in Western USA



Offshore Wind Farm Site Survey in Eastern USA



Wind farm sites

Used Today for Site Prospecting and Wind Forecasting


WindOptimizer™
KNOW
THE WIND
LOCKHEED MARTIN

WindOptimizer Features

LOCKHEED MARTIN

WindOptimizer is an internet-accessible tool that provides real-time wind conditions, predictive forecasting and situational awareness to operate the wind farm.

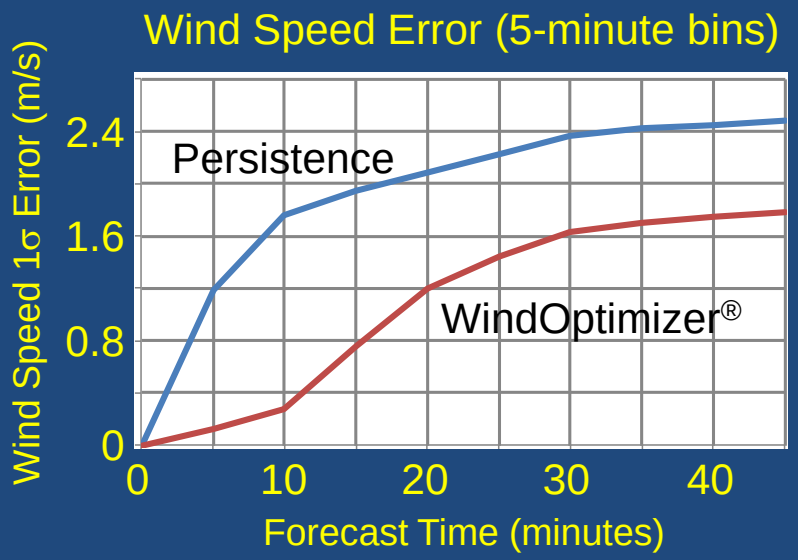
WindTracer® Scan Map

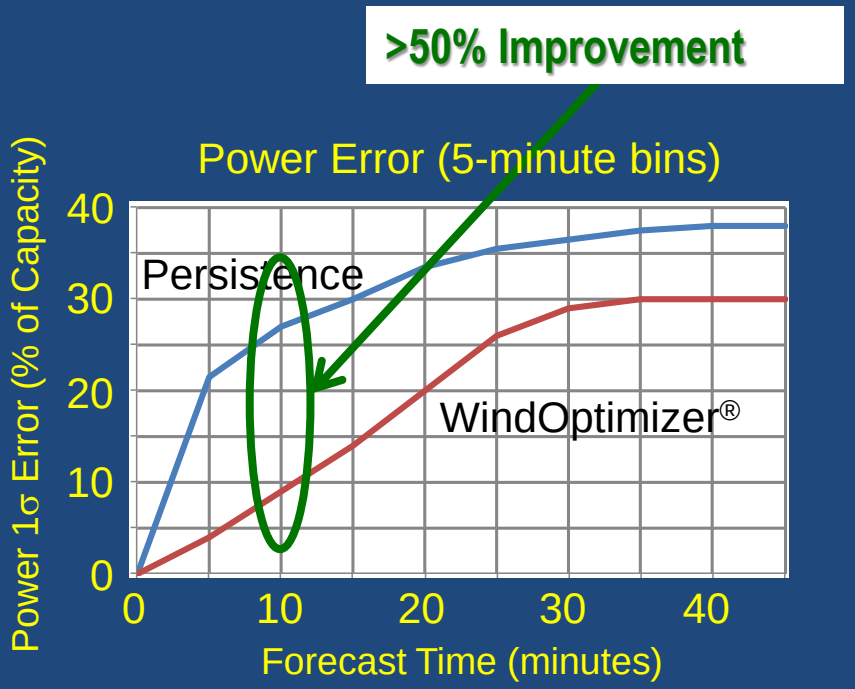
Power & Wind Forecasts

Wind Park Health Diagnostics

Value derived from enhanced energy dispatching and use of balancing reserves

Forecast Improvement: 10 minutes ahead

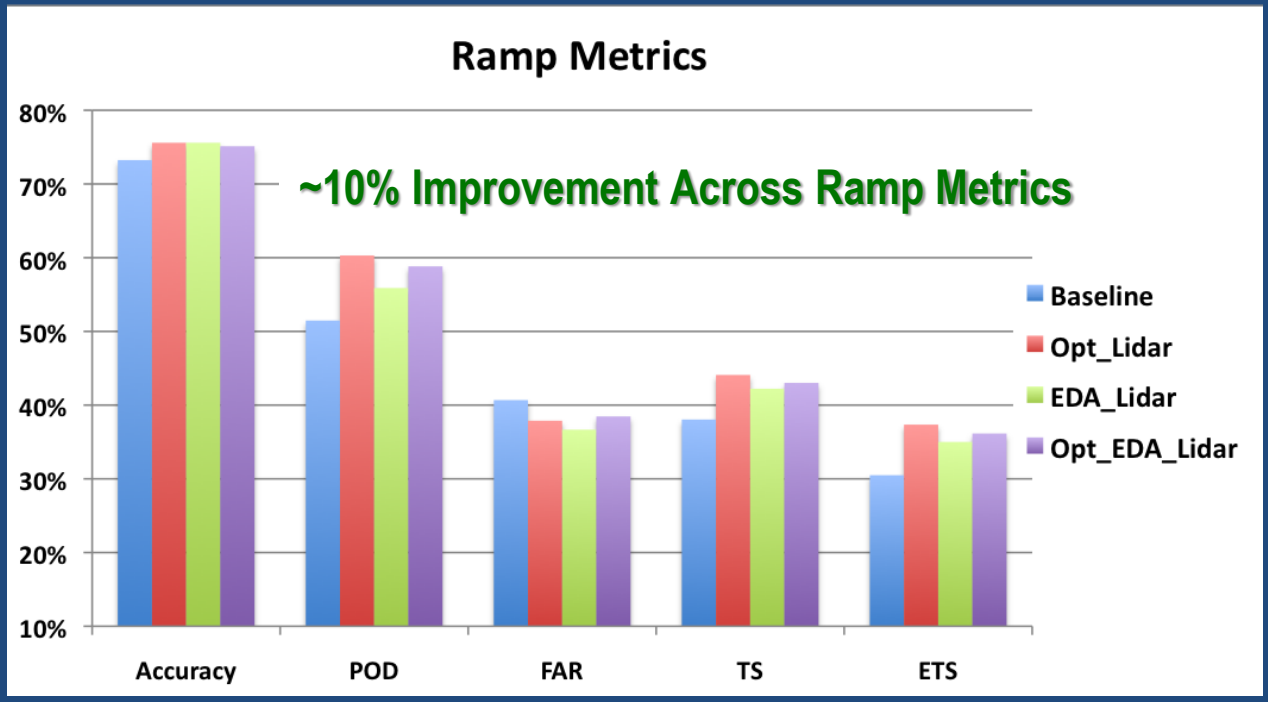




Results from forecasting demonstration for wind farm May to November 2012

>50% Improvement in Power Forecasts versus Current State of Art

Forecast Improvement: 1 hour ahead (T-75)



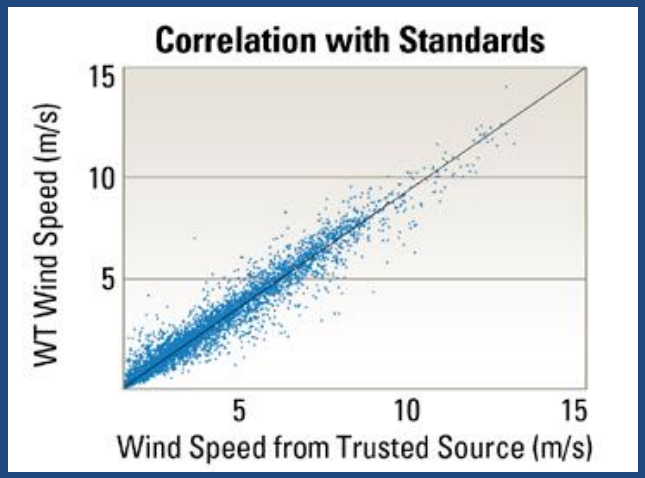
Forecast (T-75 scores)	Probability of Detection	False Alarm Ratio	Threat Score	Equitable Threat Score
Baseline Forecast without Lidar	51.5%	40.7%	38.0%	30.5%
Forecast with Lidar	58.8%	38.5%	43.0%	36.1%
Improvement	14%	5%	13%	18%

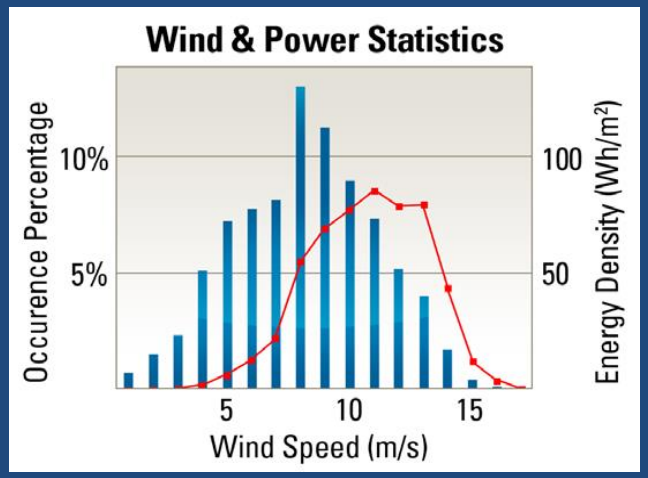
~10% Improvement in Ramp Power Forecasts versus Current State of Art

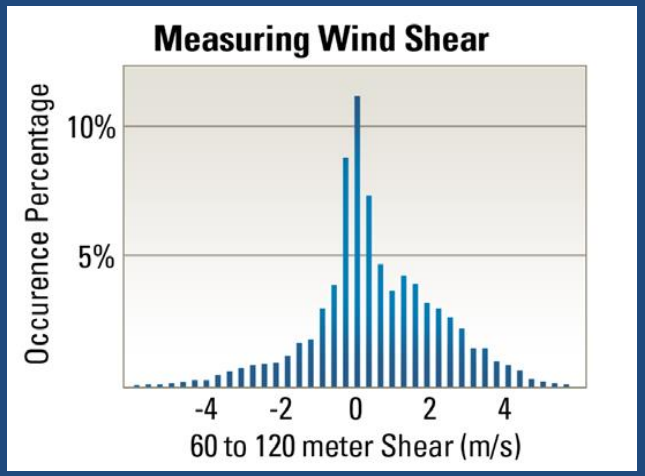

WindProspector™
KNOW
THE WIND
LOCKHEED MARTIN

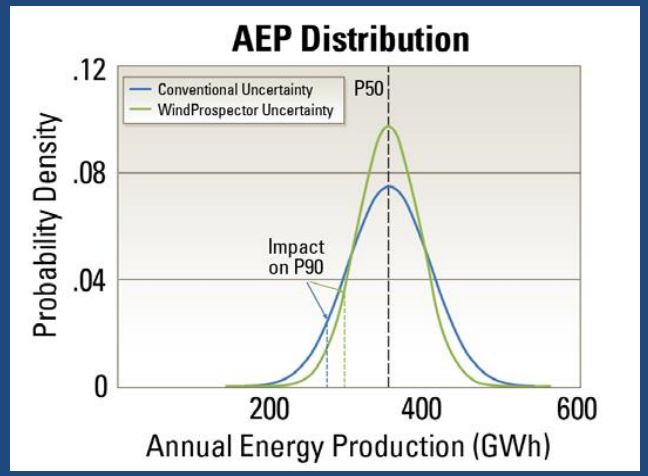
WindProspector Value

LOCKHEED MARTIN









World-first volumetric measurements re-write the rules for investment in new wind farms

Optimizing Turbine Locations

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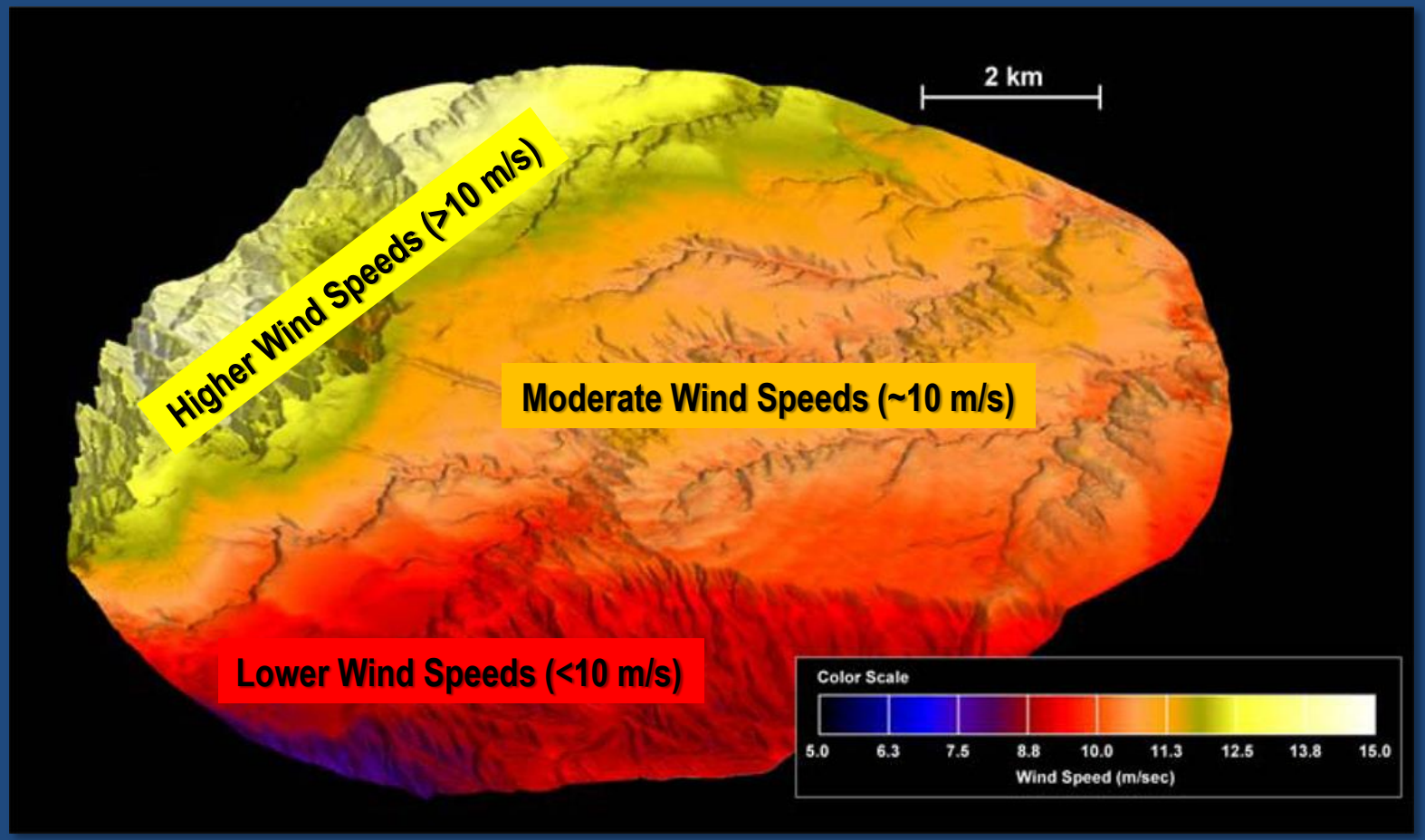
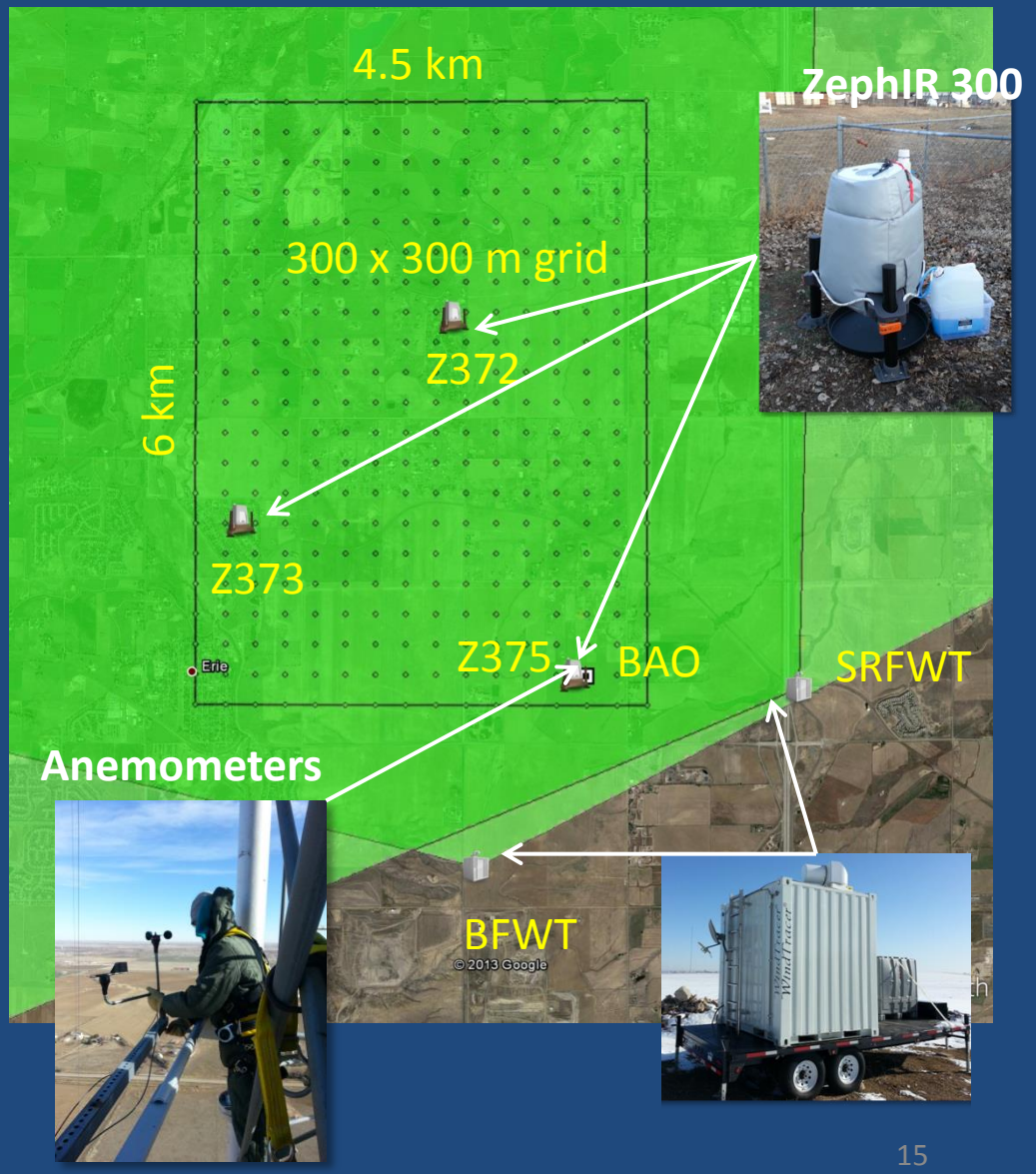


Optimized turbine placement can increase revenue by hundreds of millions of dollars over the wind farm life

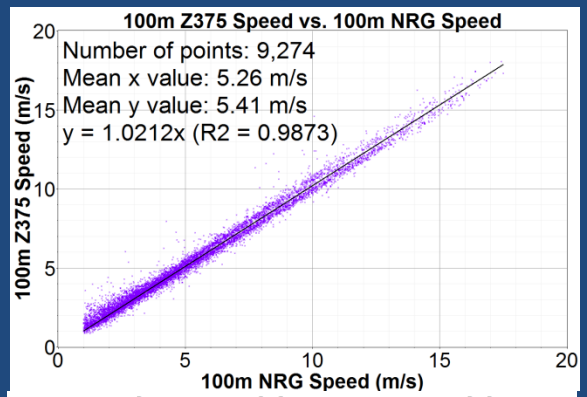
Boulder Atmospheric Observatory (BAO) Study Project Layout

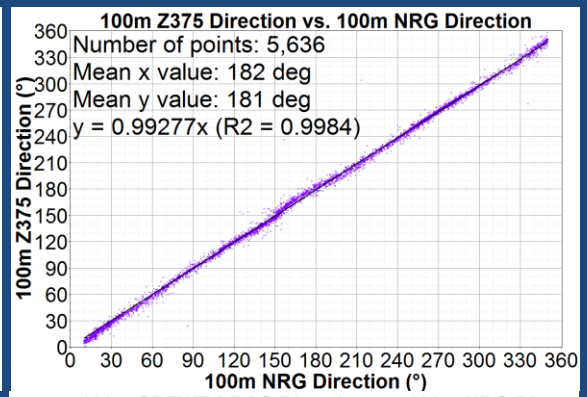
- Objective: Demonstrate WindTracer® meets accuracy requirements for Wind Resource assessment
- Studies:
  - Single-Doppler
  - Scanning Dual-Doppler
  - Staring beam Dual-Doppler
- Inter-comparisons:
  - 3 ZephIR 300's
  - BAO Tower (Erie, CO) Anemometers: 100, 150, & 200 meters
  - 2 WindTracers®



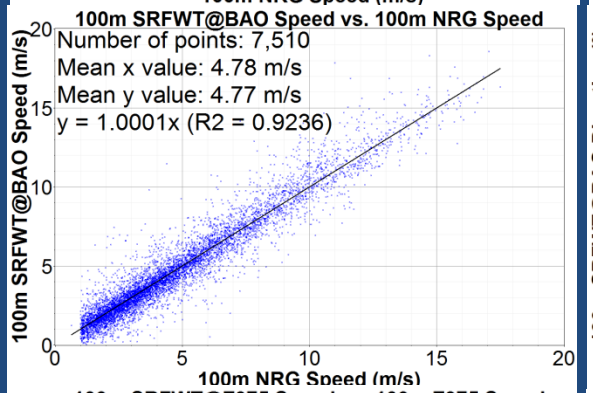
Single Doppler Comparisons

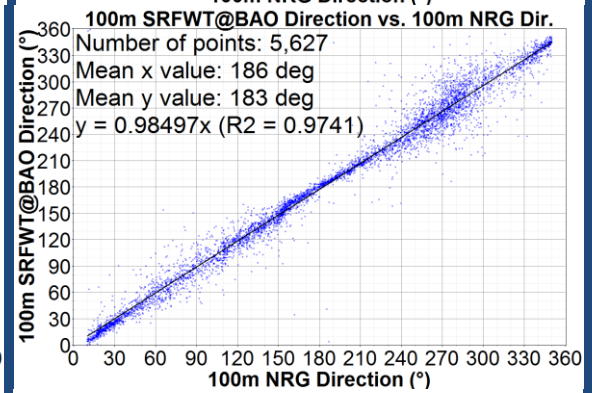
Tower vs. ZephIR 300



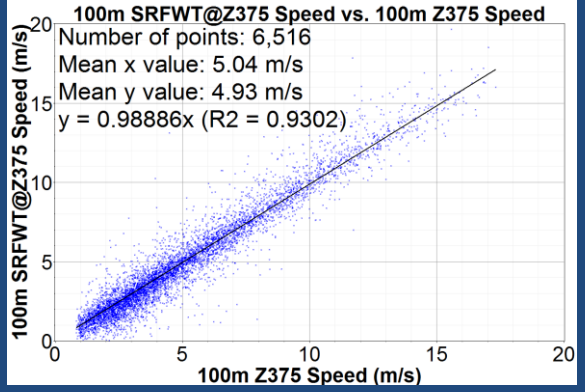


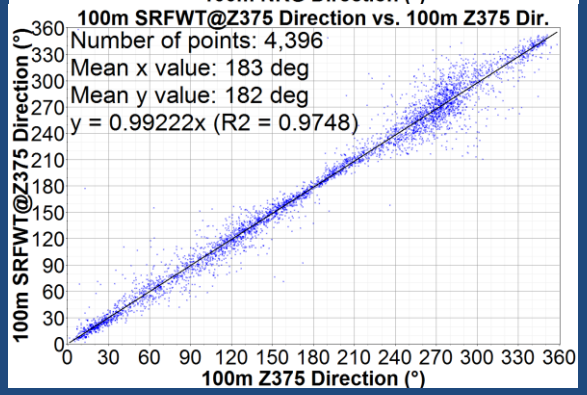
Tower vs. WindTracer





ZephIR vs. WindTracer

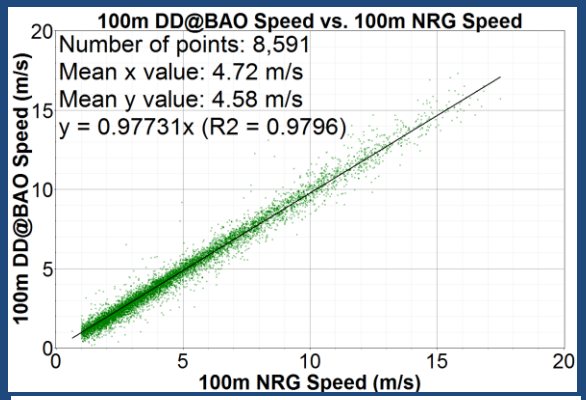


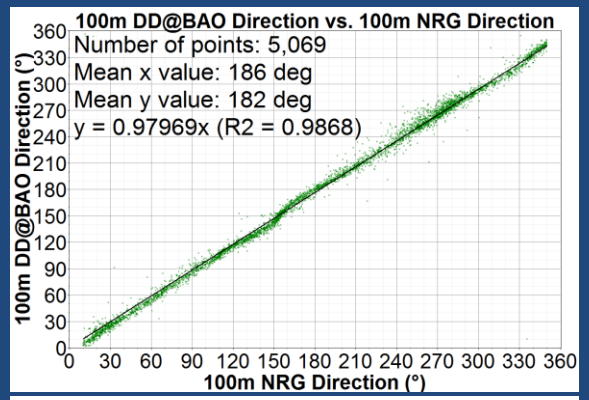


Good agreement between tower, WindTracer & ZephIR in single Doppler studies

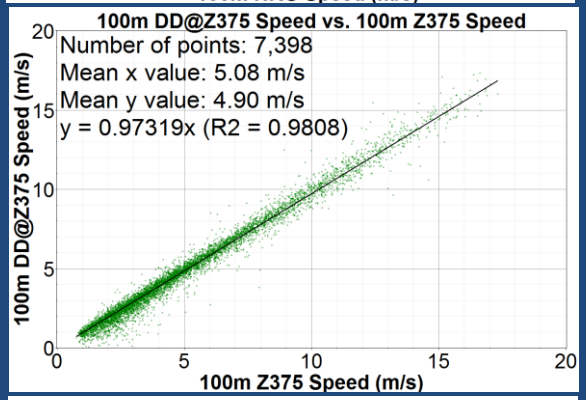
Scanning Dual-Doppler

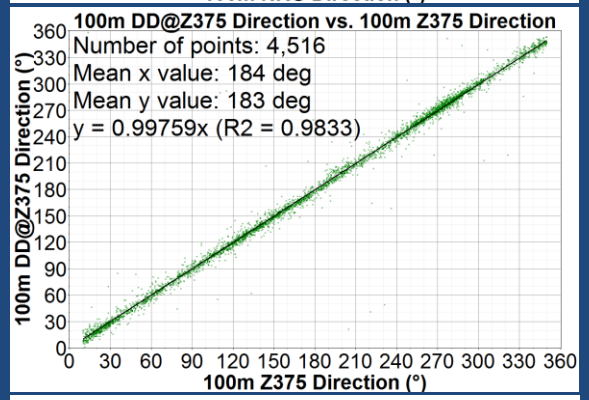
WindTracer vs. Anemometer



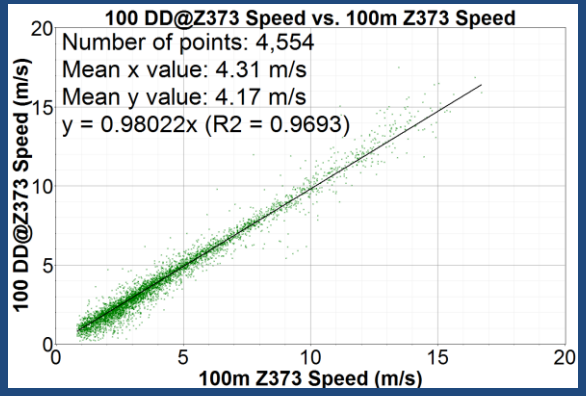


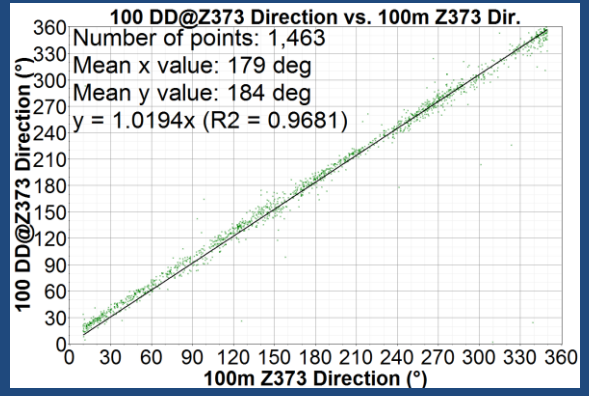
WindTracer vs. Tower ZephIR





WindTracer vs. Remote ZephIR





Good agreement between tower, WidnTracer & ZephIR in Dual Doppler studies

Offshore Wind Energy

- Measurements offshore in Margate, NJ
- Long term validation effort for offshore winds
- 24 / 7 data collections