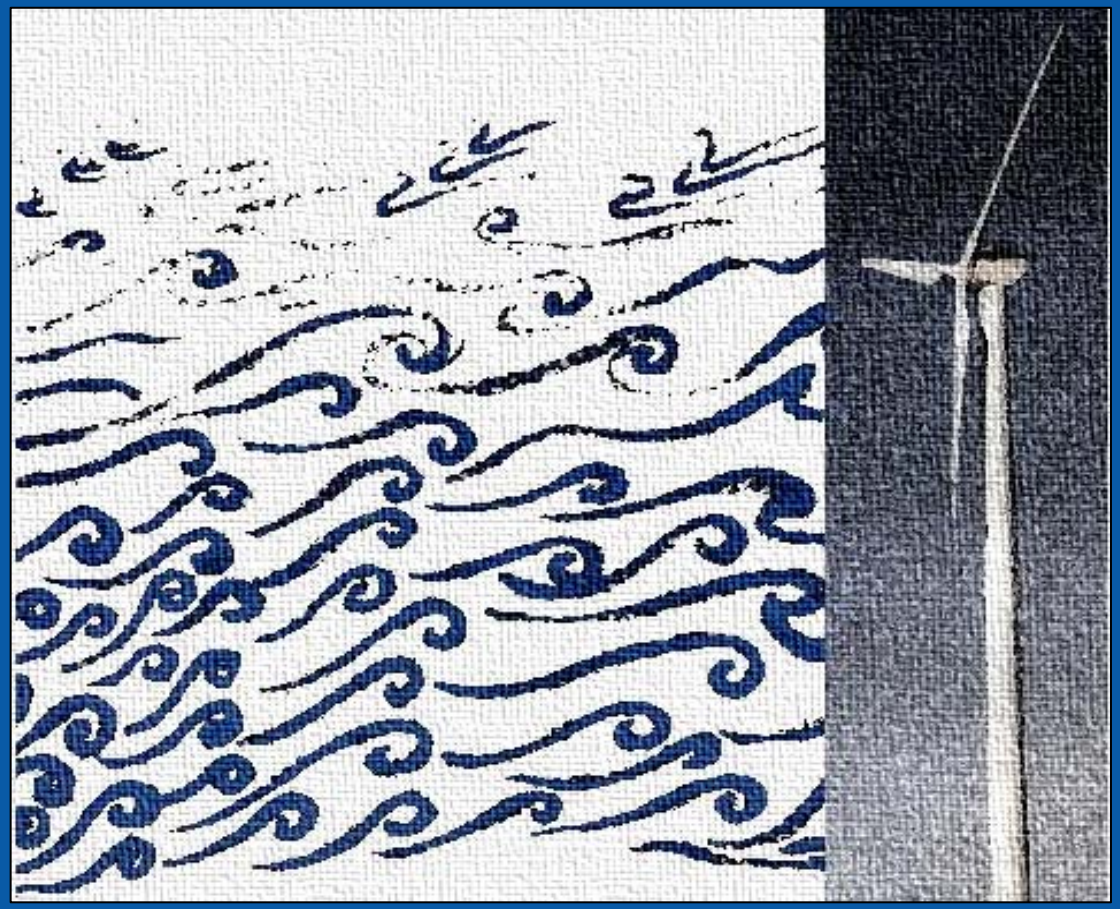
National Renewable Energy Laboratory
Innovation for Our Energy Future

TurbSim Workshop: Code Use Recommendations Additional Analyses for Discussion



National Wind Technology Center

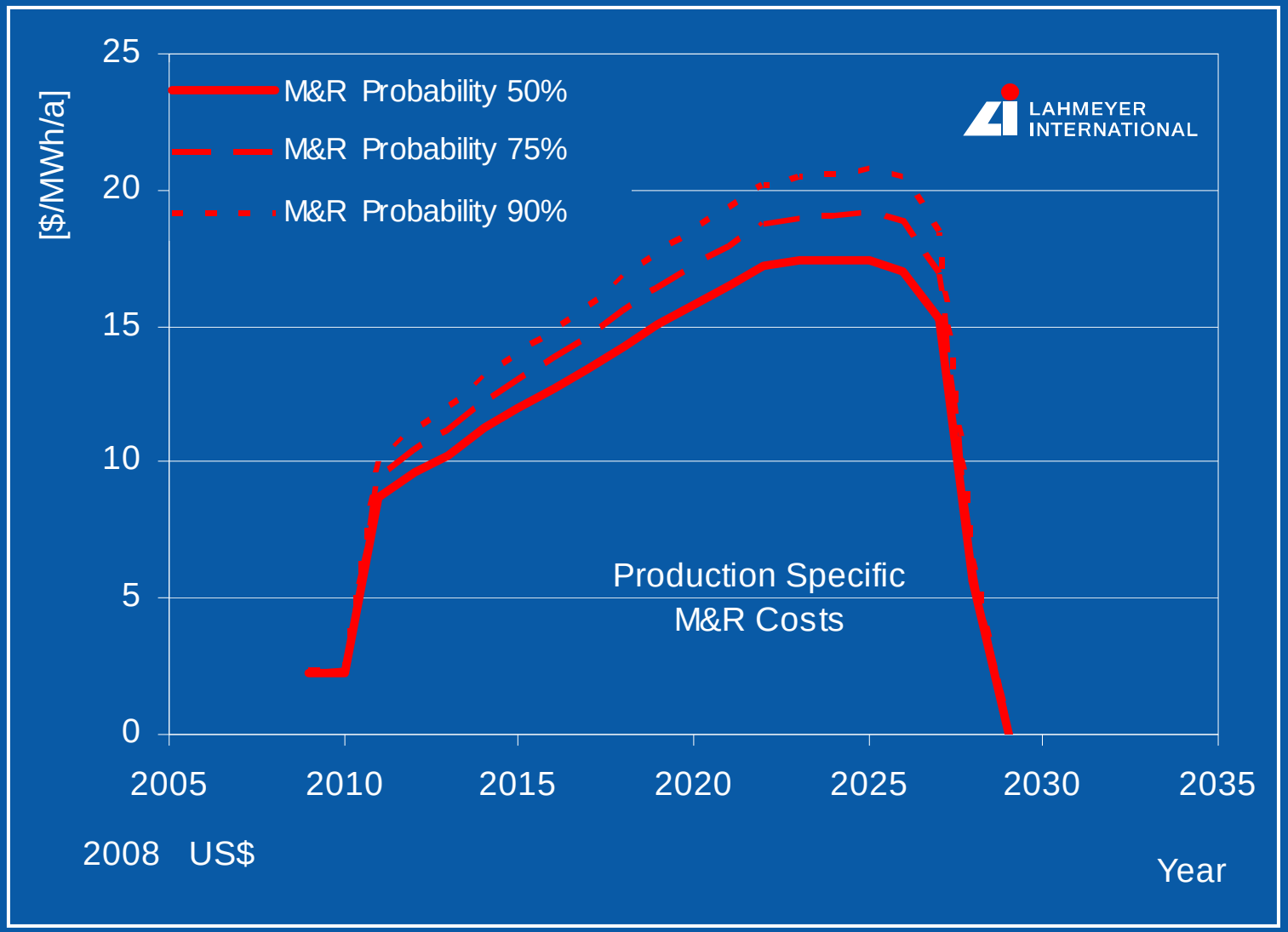
Neil Kelley

September 22-24, 2008

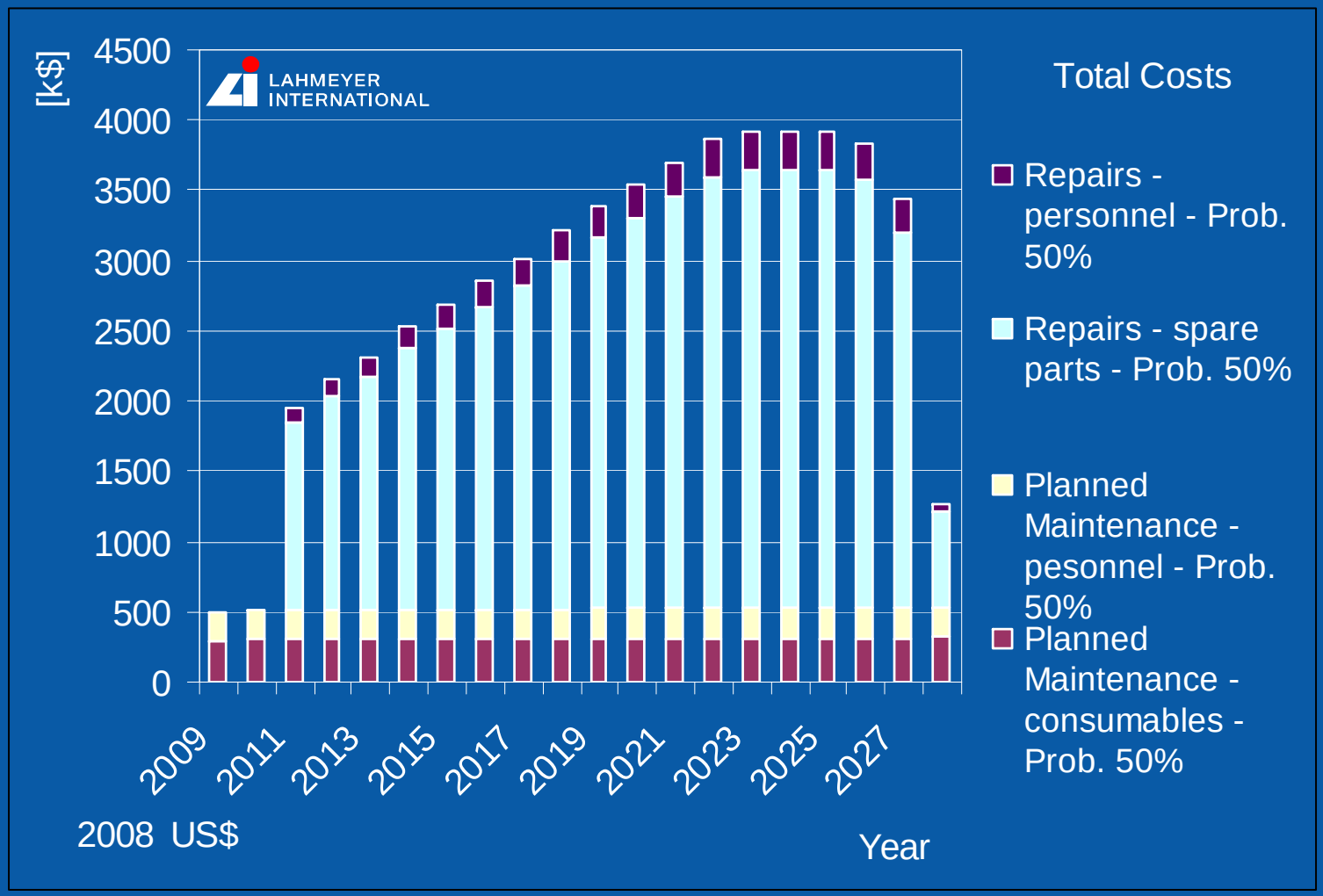
NREL is a national laboratory of the U.S. Department of Energy Office of Energy Efficiency and Renewable Energy operated by Midwest Research Institute • Battelle

Code Use Recommendations

- Use preferred turbine design criteria with IEC NTM as excitation
- When design has reached desired level of completion run at least the TurbSim KHTEST option and compare the IEC results for the same hub-height wind speeds
- Be sure to run cases in which the hub-height wind speed is just below, at, and slightly above rated
- If time permits, run the NWTCUP with coherent structures and the GP-LLJ with and without structures
- Always run ensembles with at least 31 realizations (seeds) for each of the above categories.
- Analyze available target resource data by time-of-day; i.e., over an hour period at the minute.



Source: Matthias Henke, Lahmeyer International



Source: Matthias Henke, Lahmeyer International

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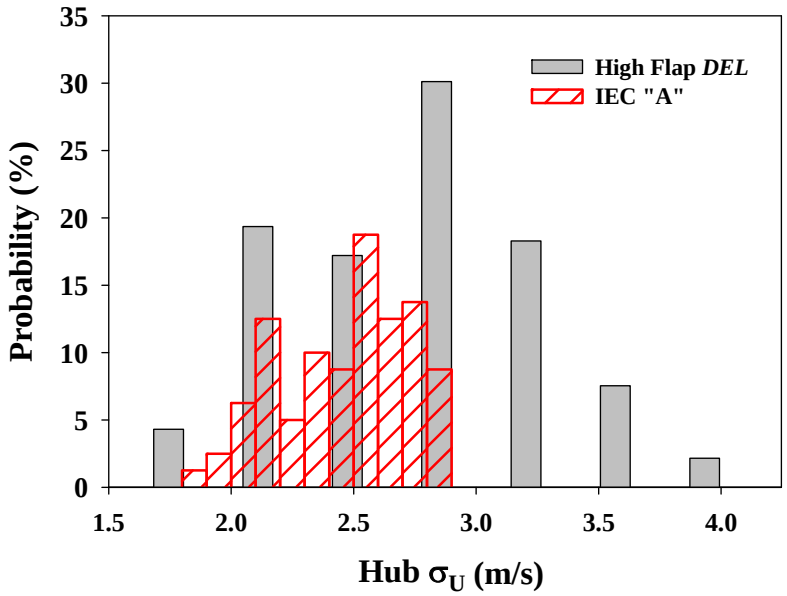
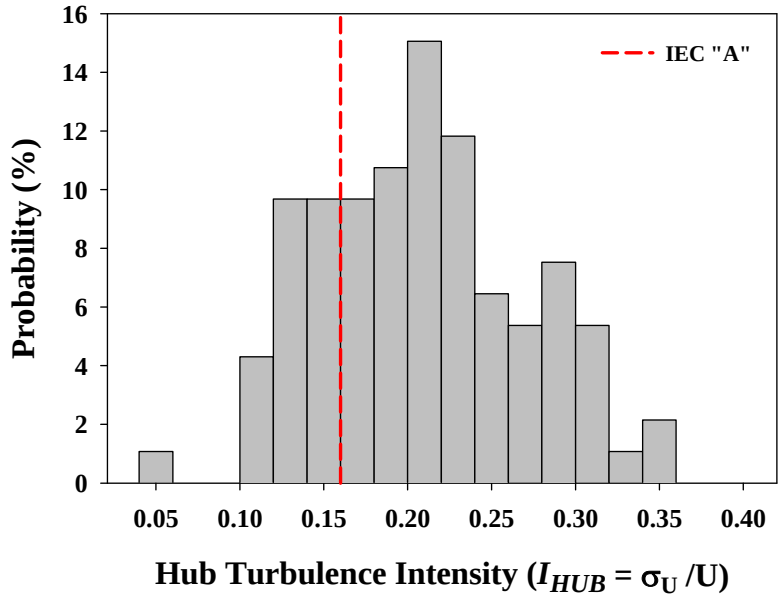
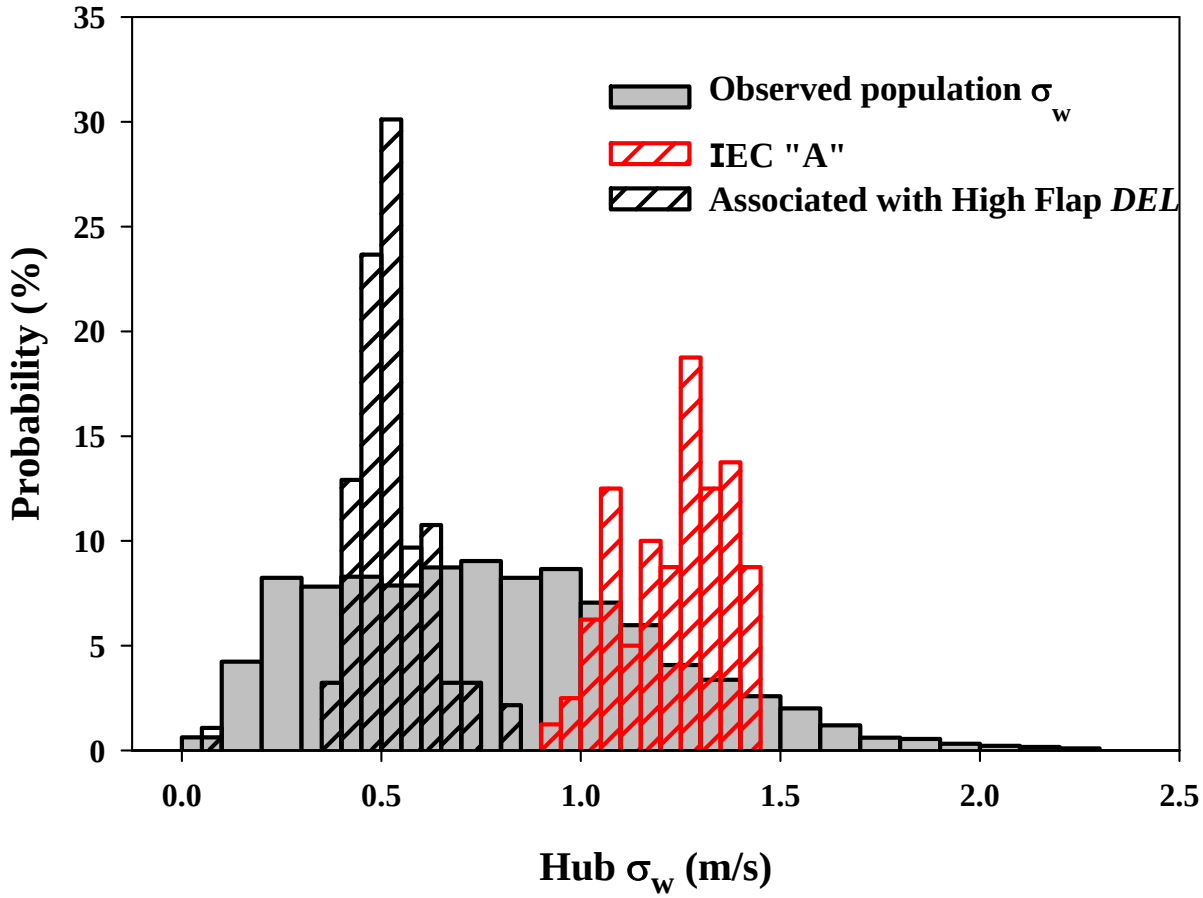
NWTC ART Turbine Distributions of Hub σ_U and Turbulence Intensity (I_{hub}) associated with High Values of Root Flapwise BM *DELs*

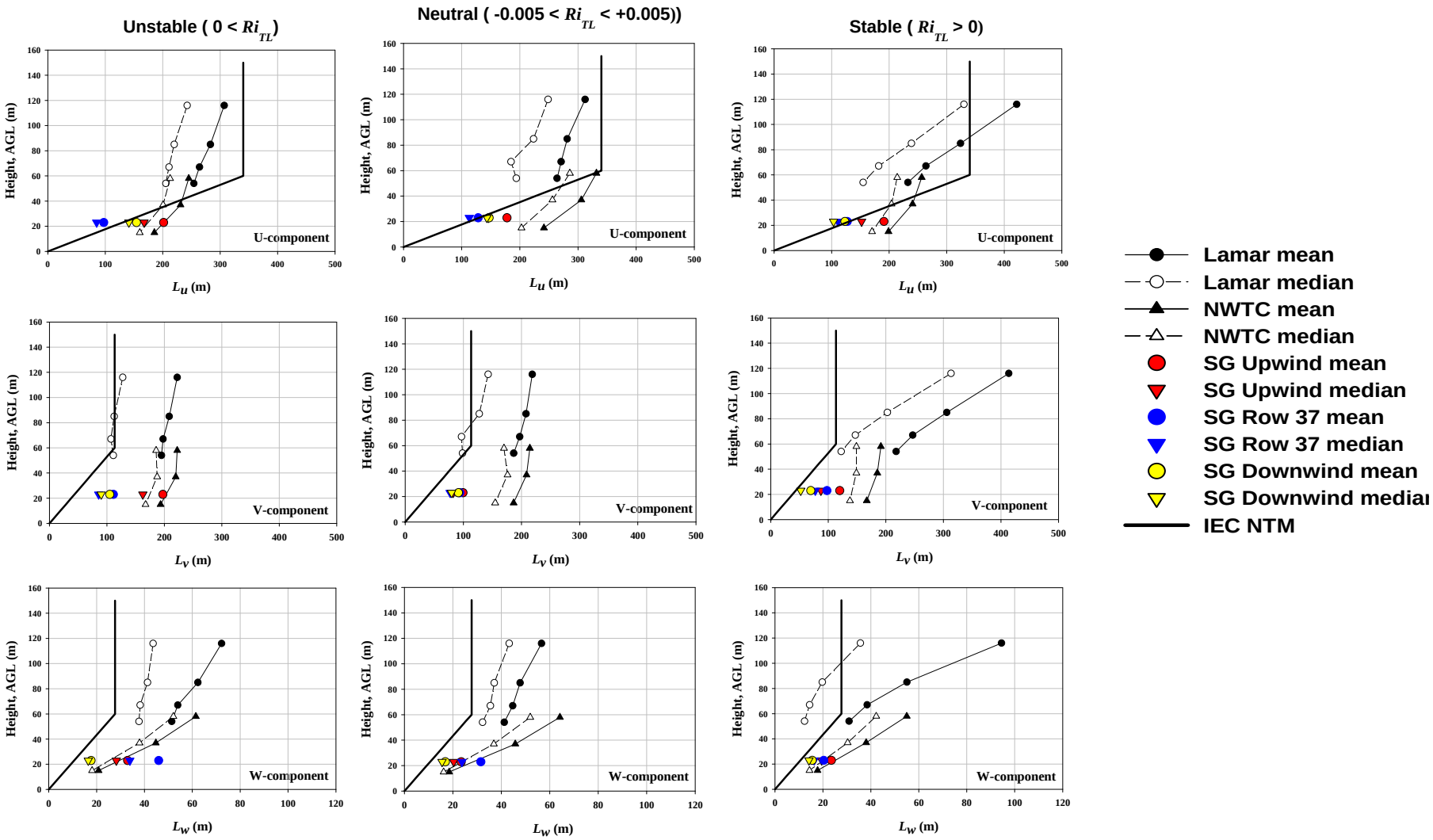




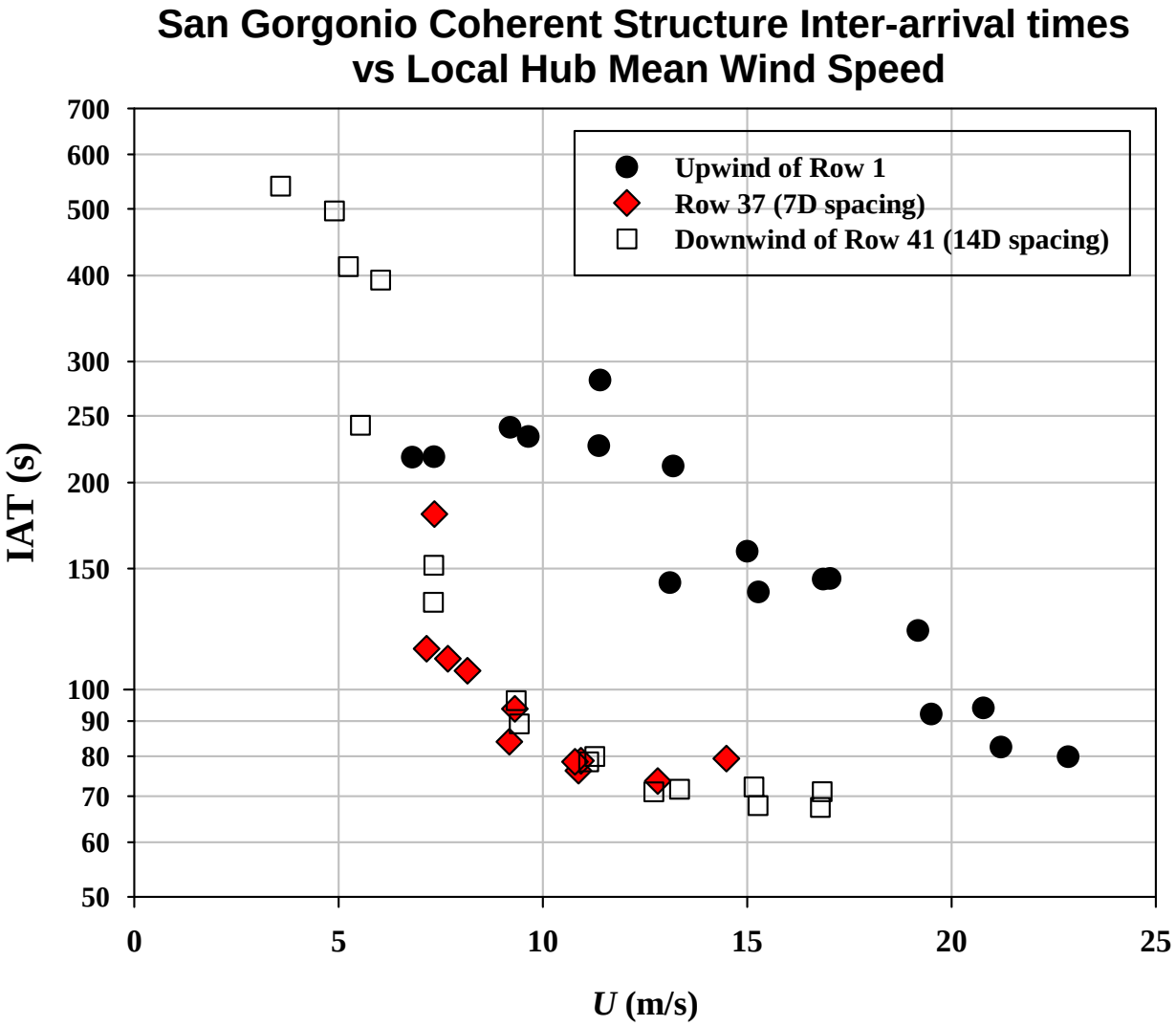
NWTC ART Turbine Observed Distributions of Hub σ_w for Entire Available Population and Associated with High Values (P95) of Root Flapwise BM *DELs*



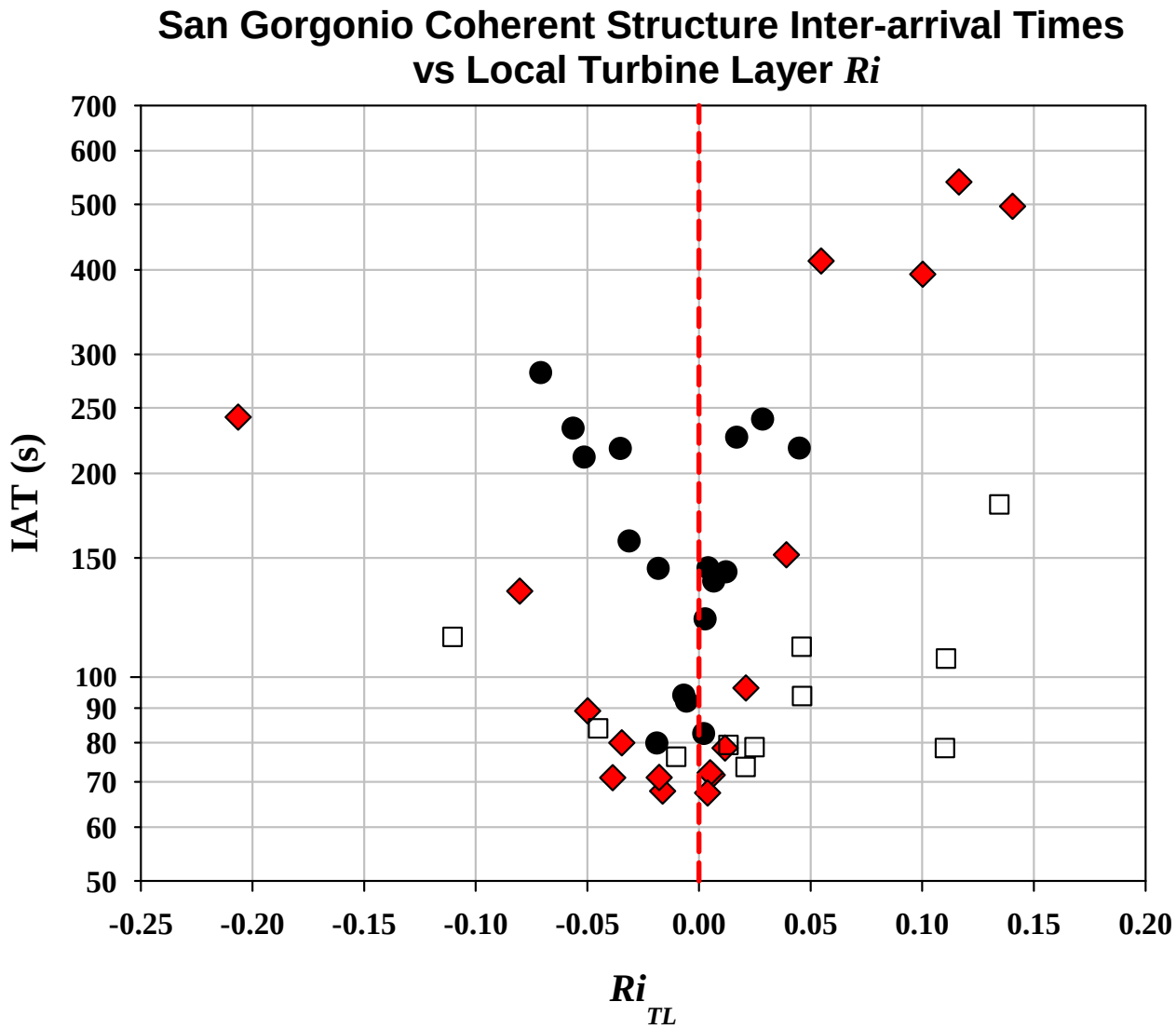
Observed Integral Length Scale Comparisons



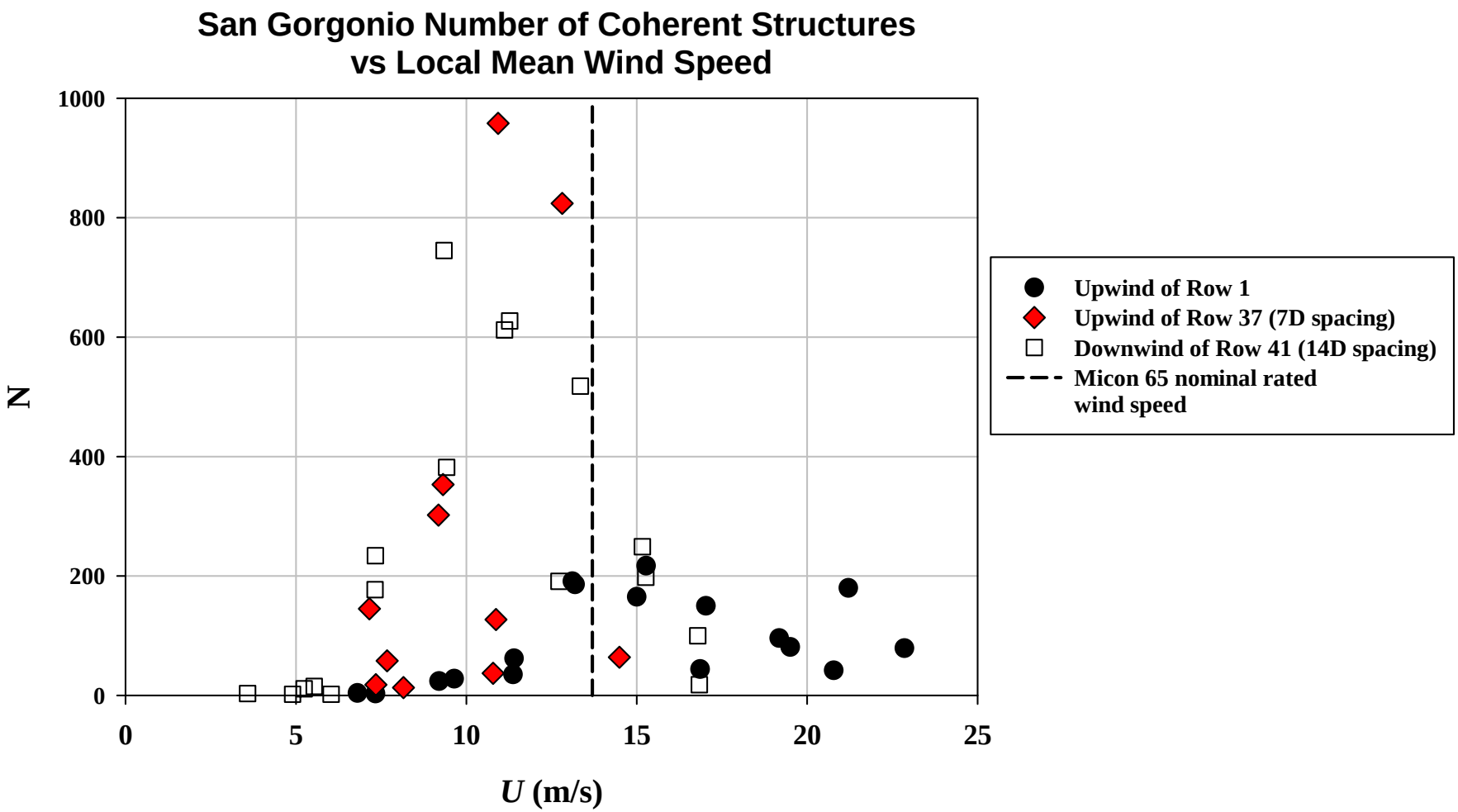
San Gorgonio Coherent Structure Characteristics



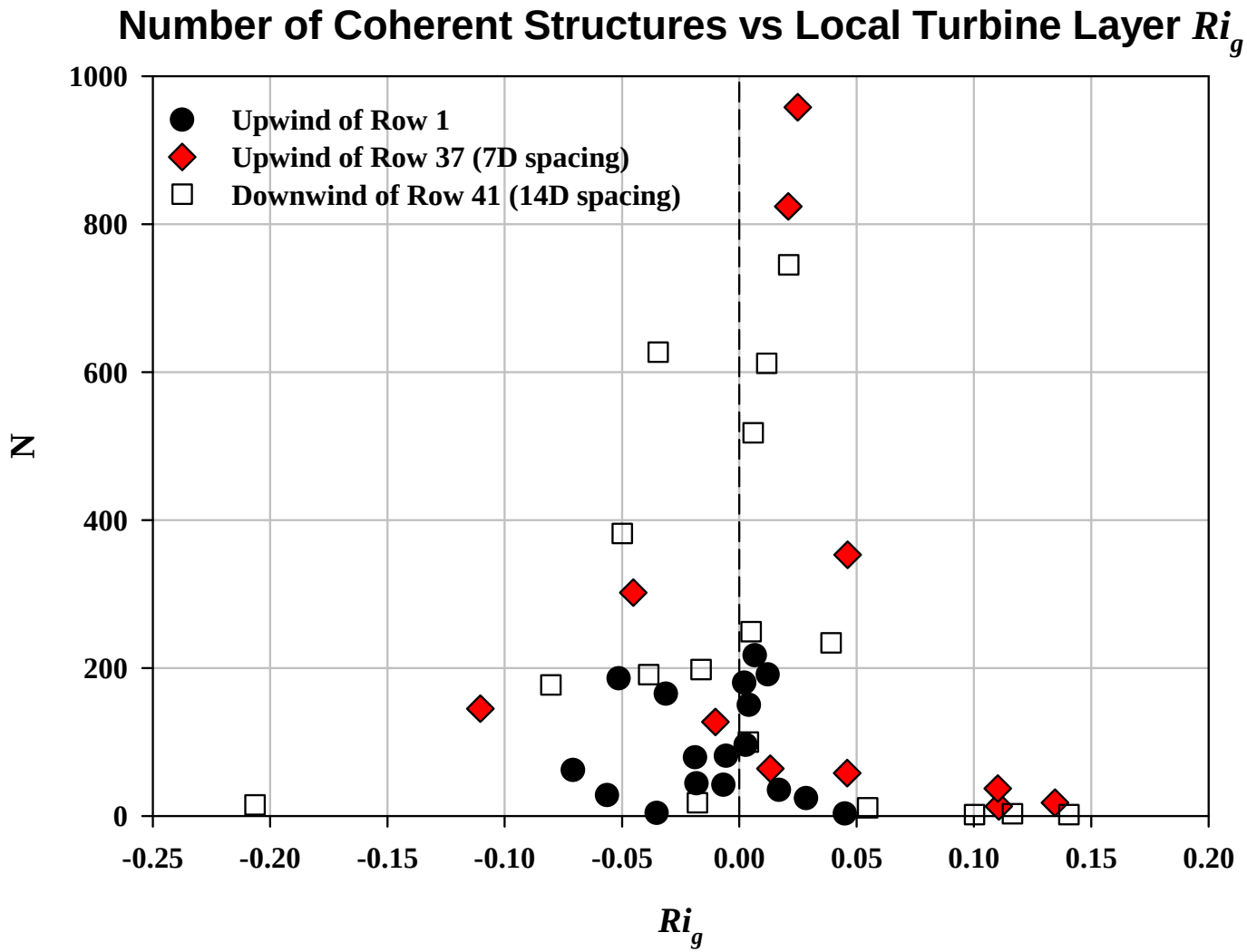
San Gorgonio Coherent Structure Characteristics – cont'd



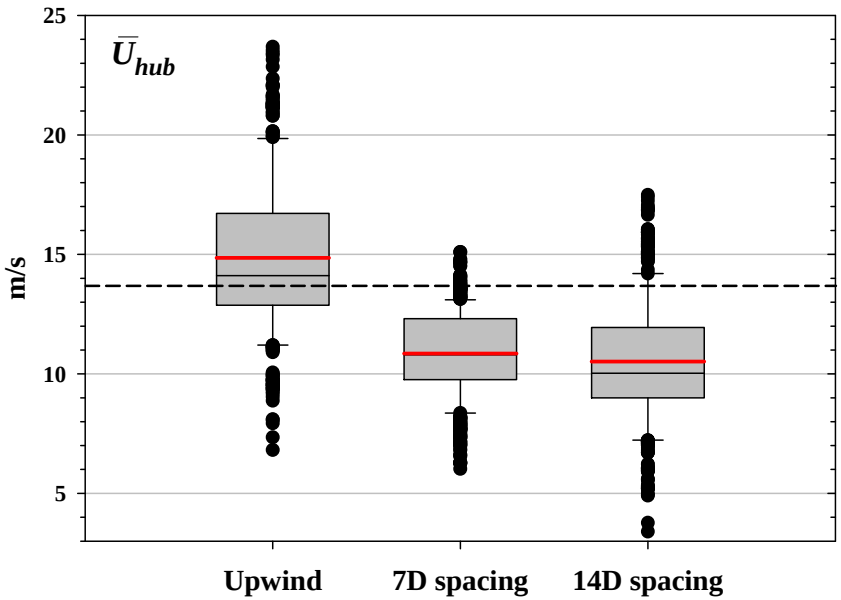
San Gorgonio Coherent Structure Characteristics – cont'd

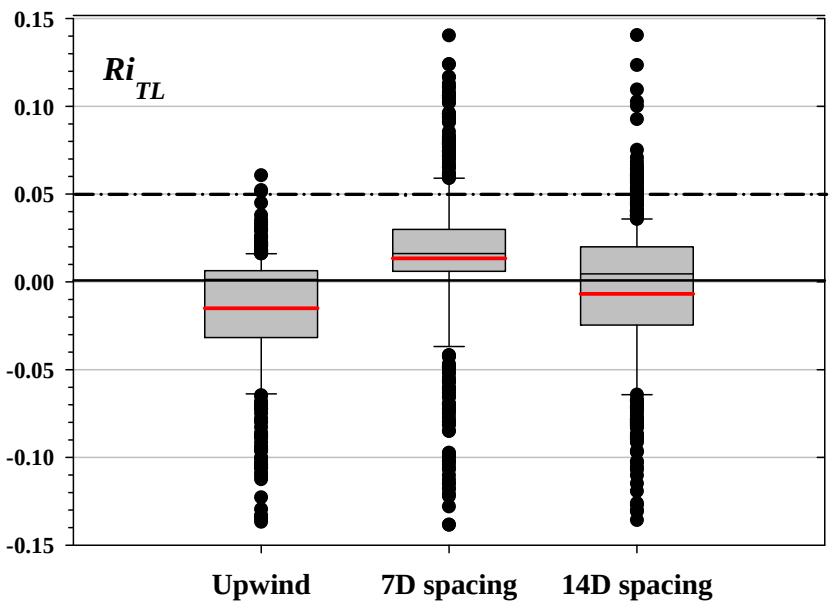


San Gorgonio Coherent Structure Characteristics – cont'd



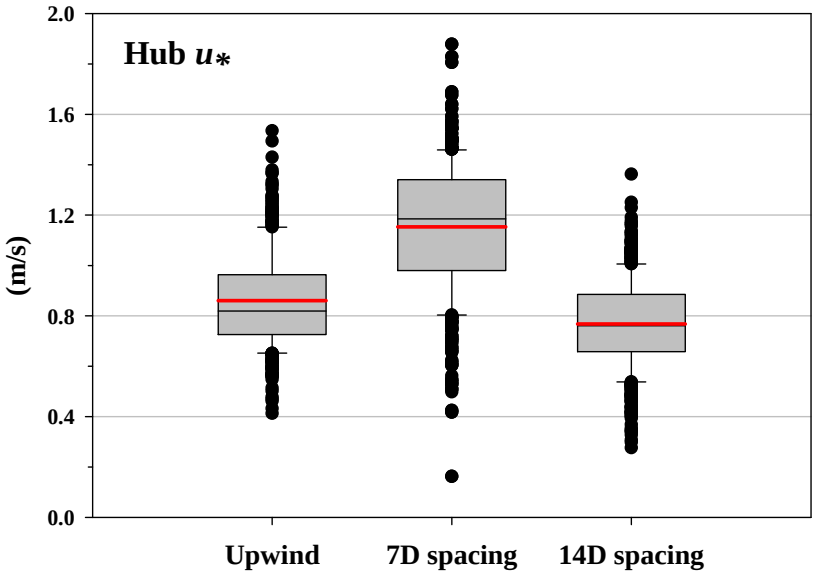
San Gorgonio Hub Statistics

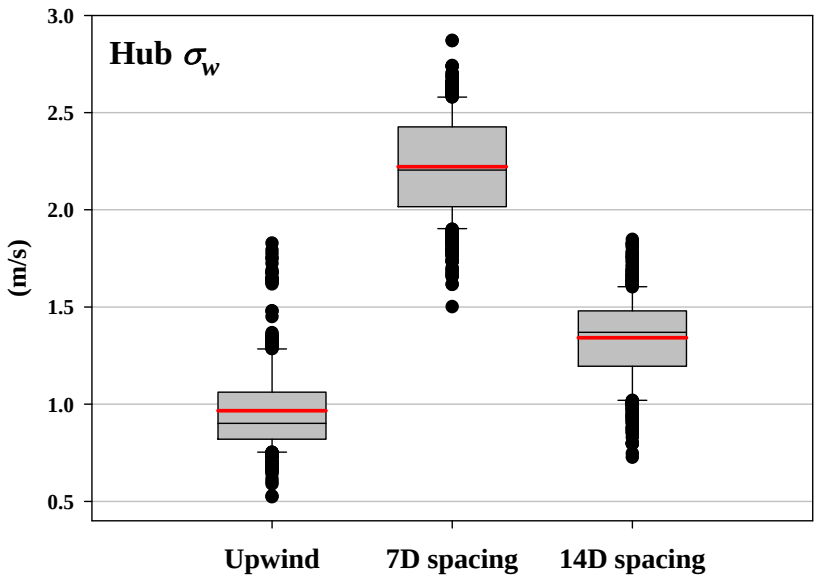




P05 < ● > P95

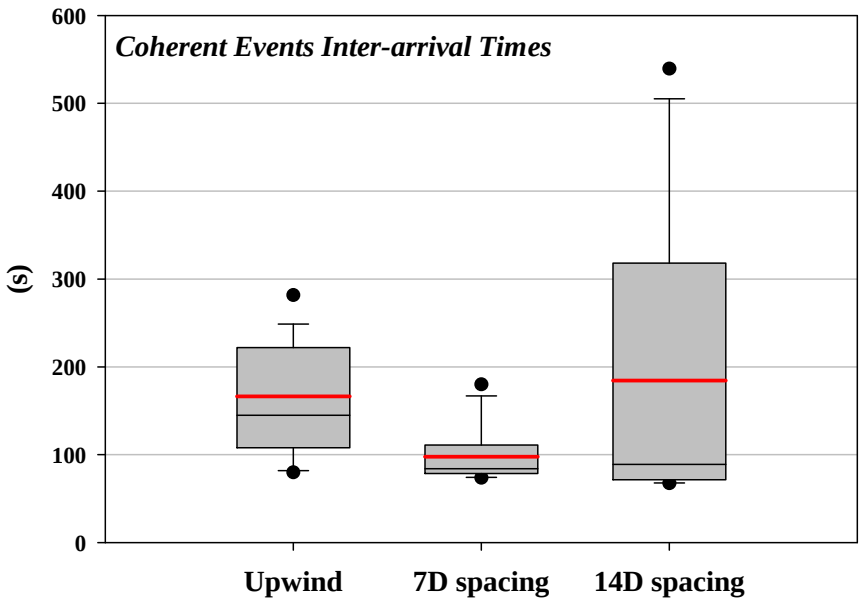
San Gorgonio Hub Statistics – cont'd

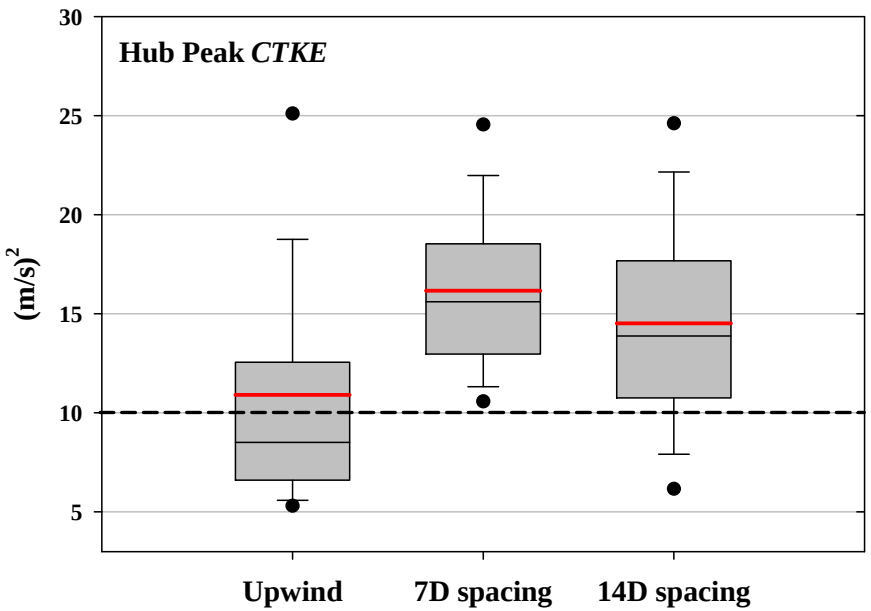




P05 < ● > P95

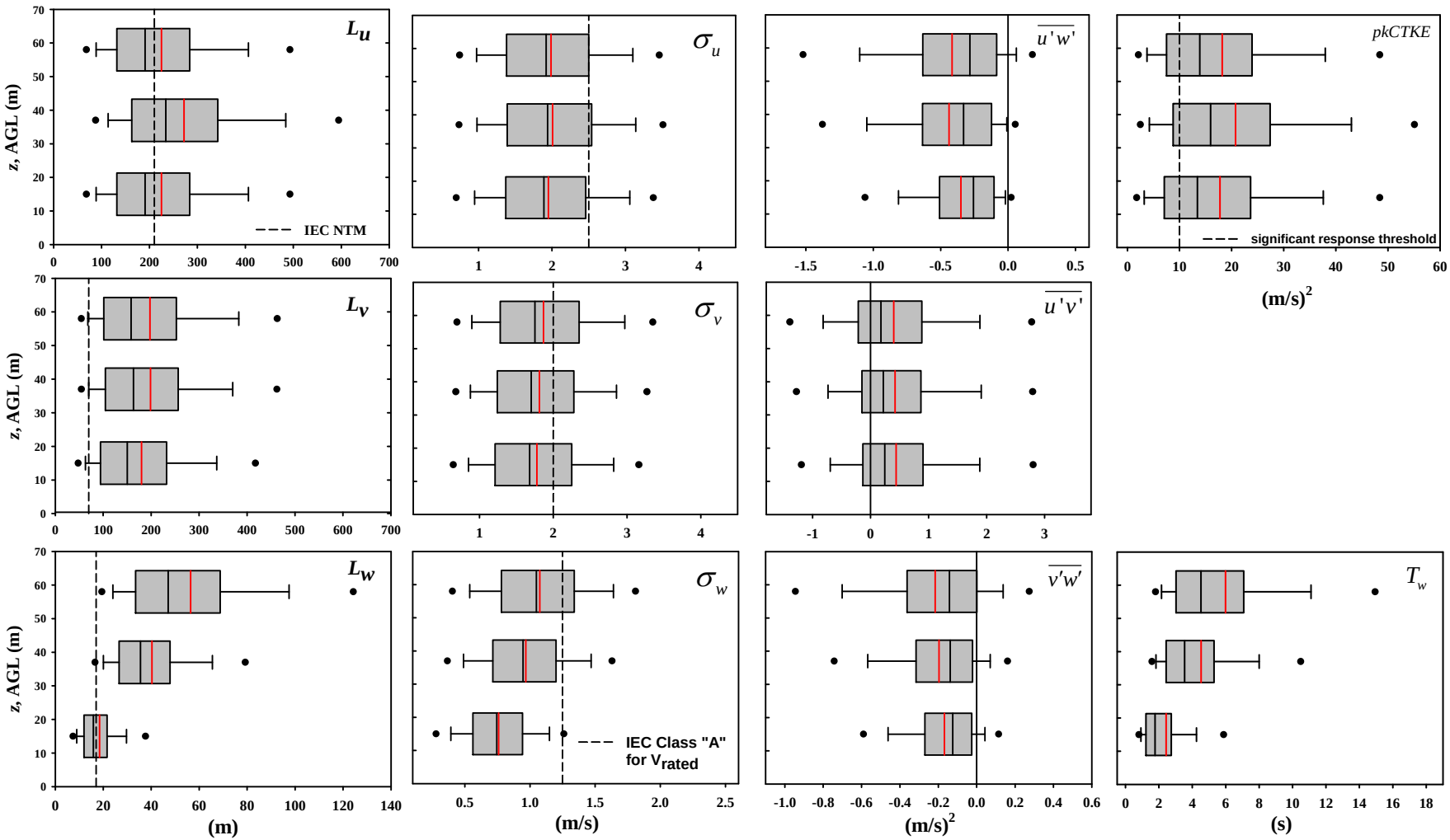
San Gorgonio Hub Statistics – cont'd



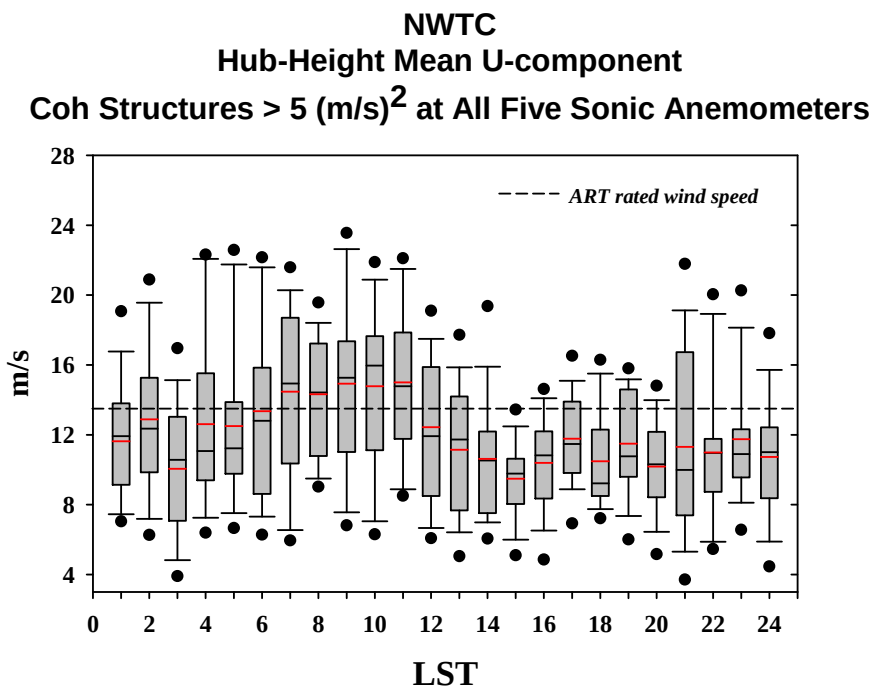


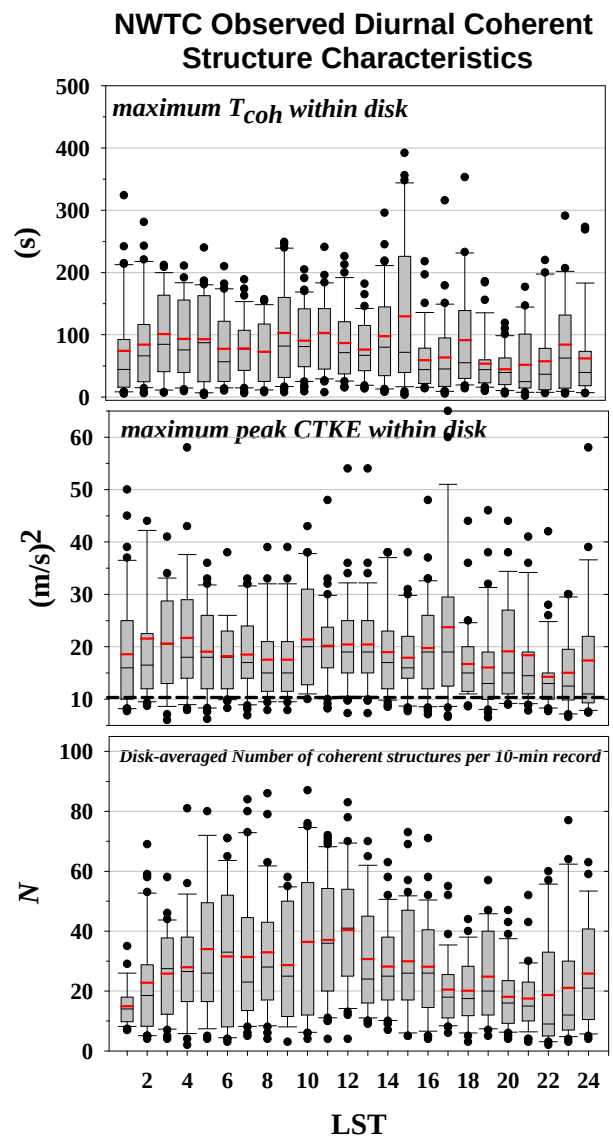
P10 < ● > P90

NWTC Turbulence Parameter Comparisons

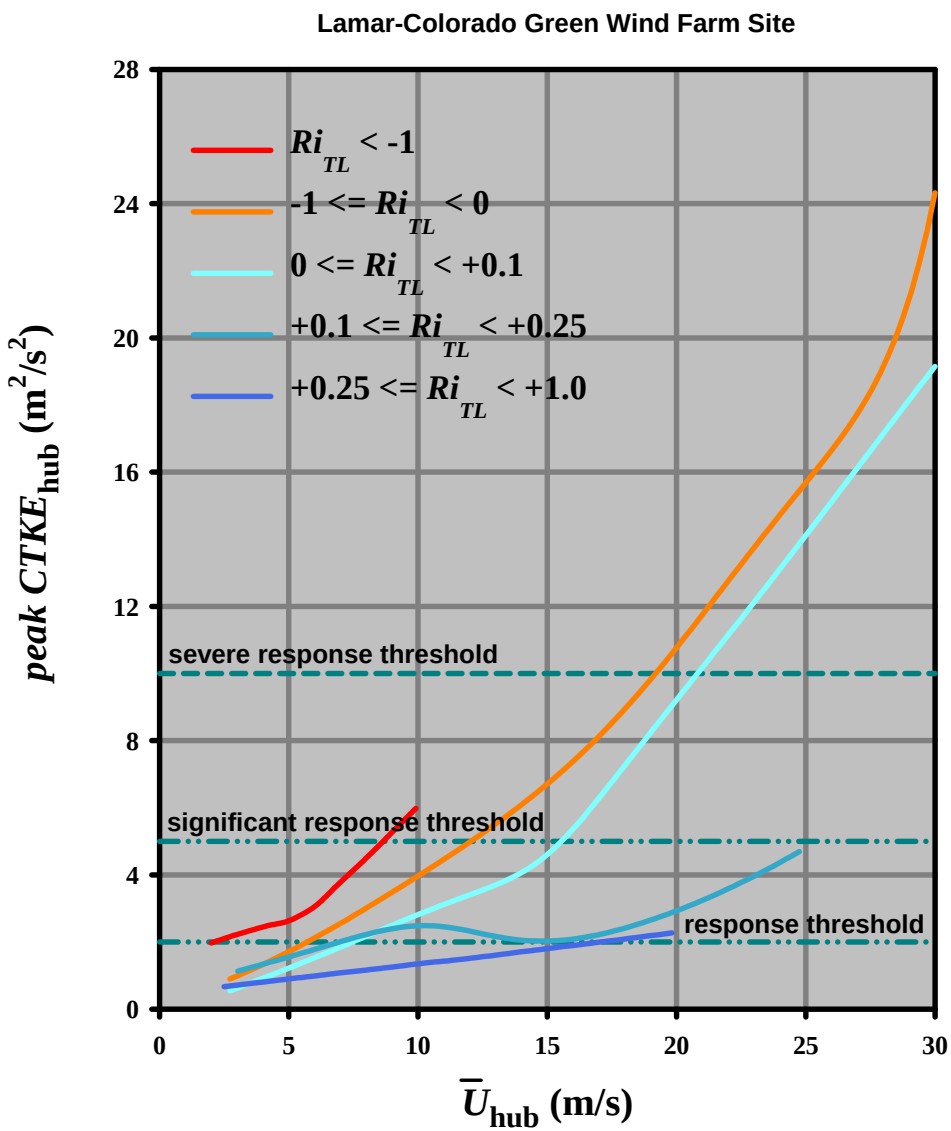


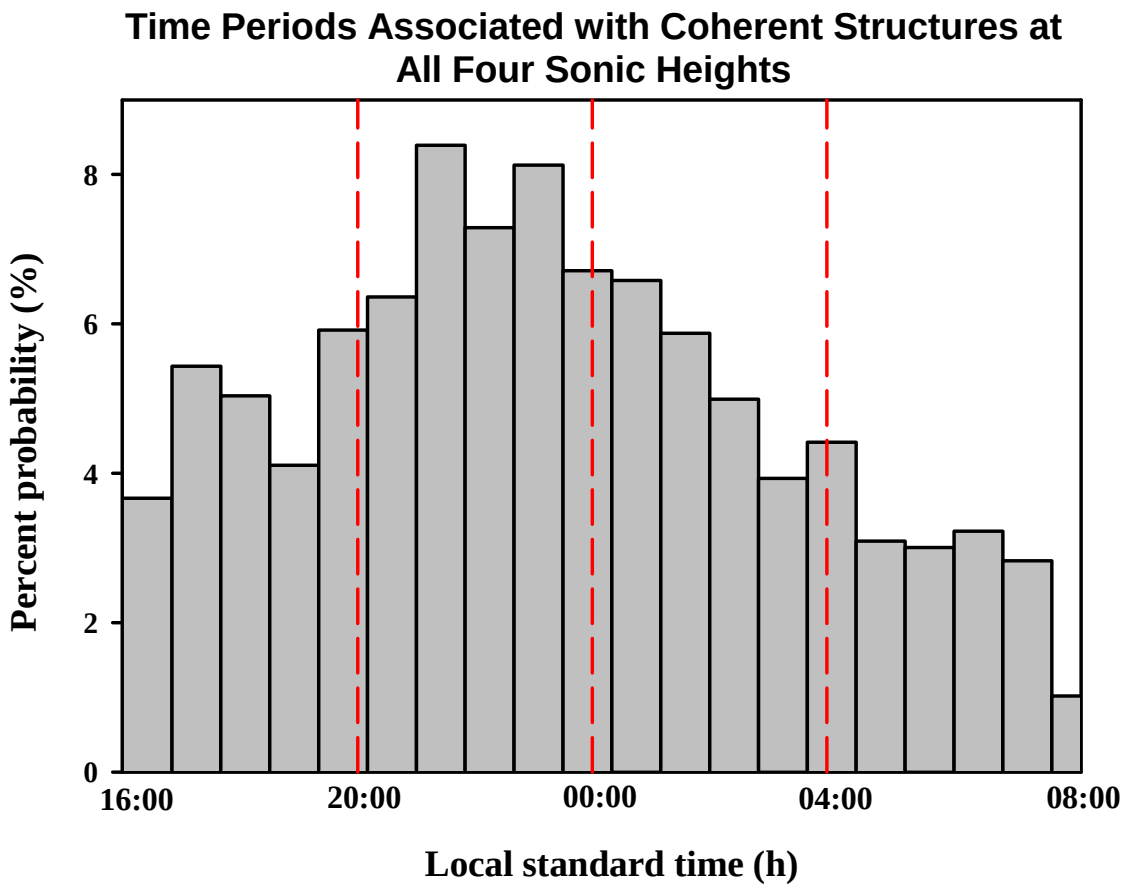
NWTC Diurnal Variation of Coherent Structure Characteristics with Structures at All Stations



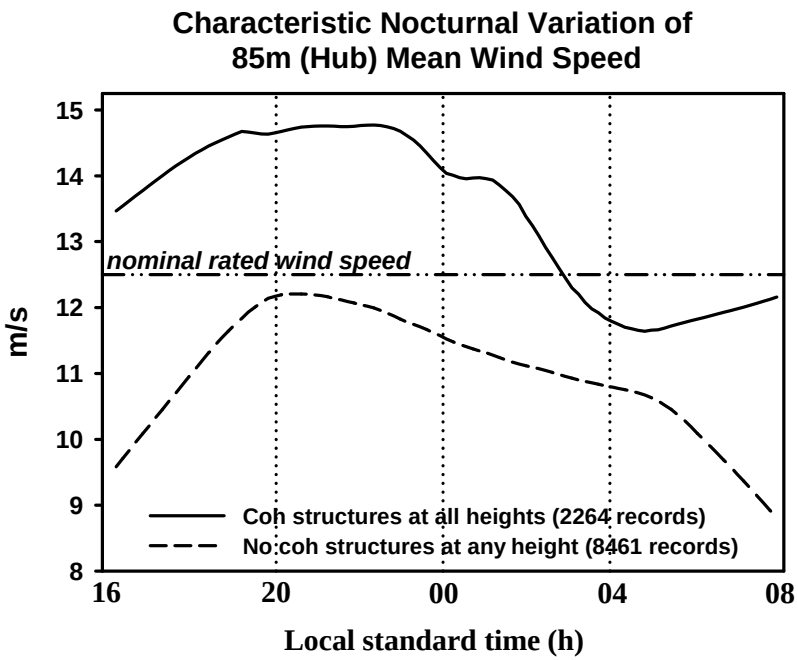


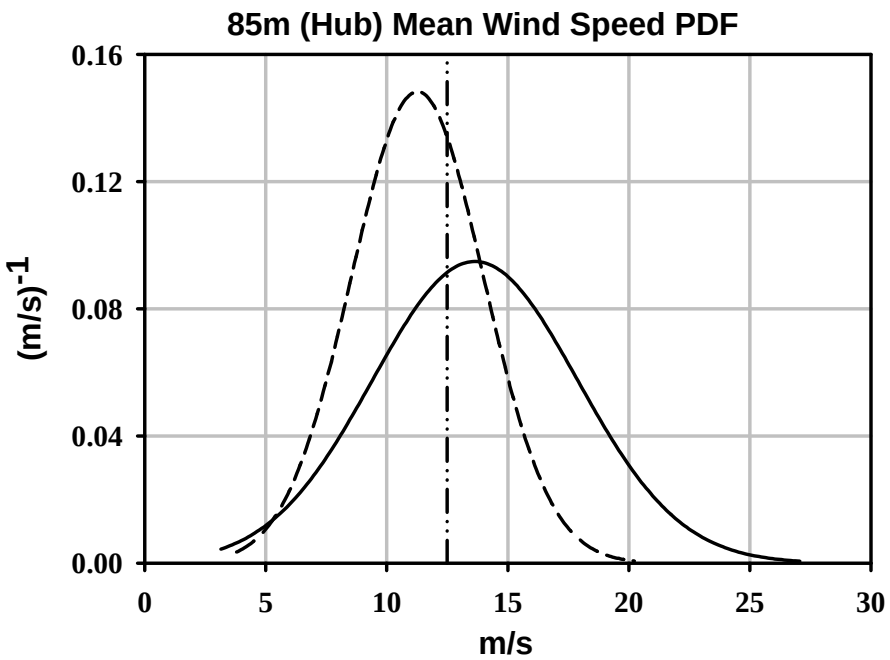
Lamar pk CTKE vs Wind Speed & Stability



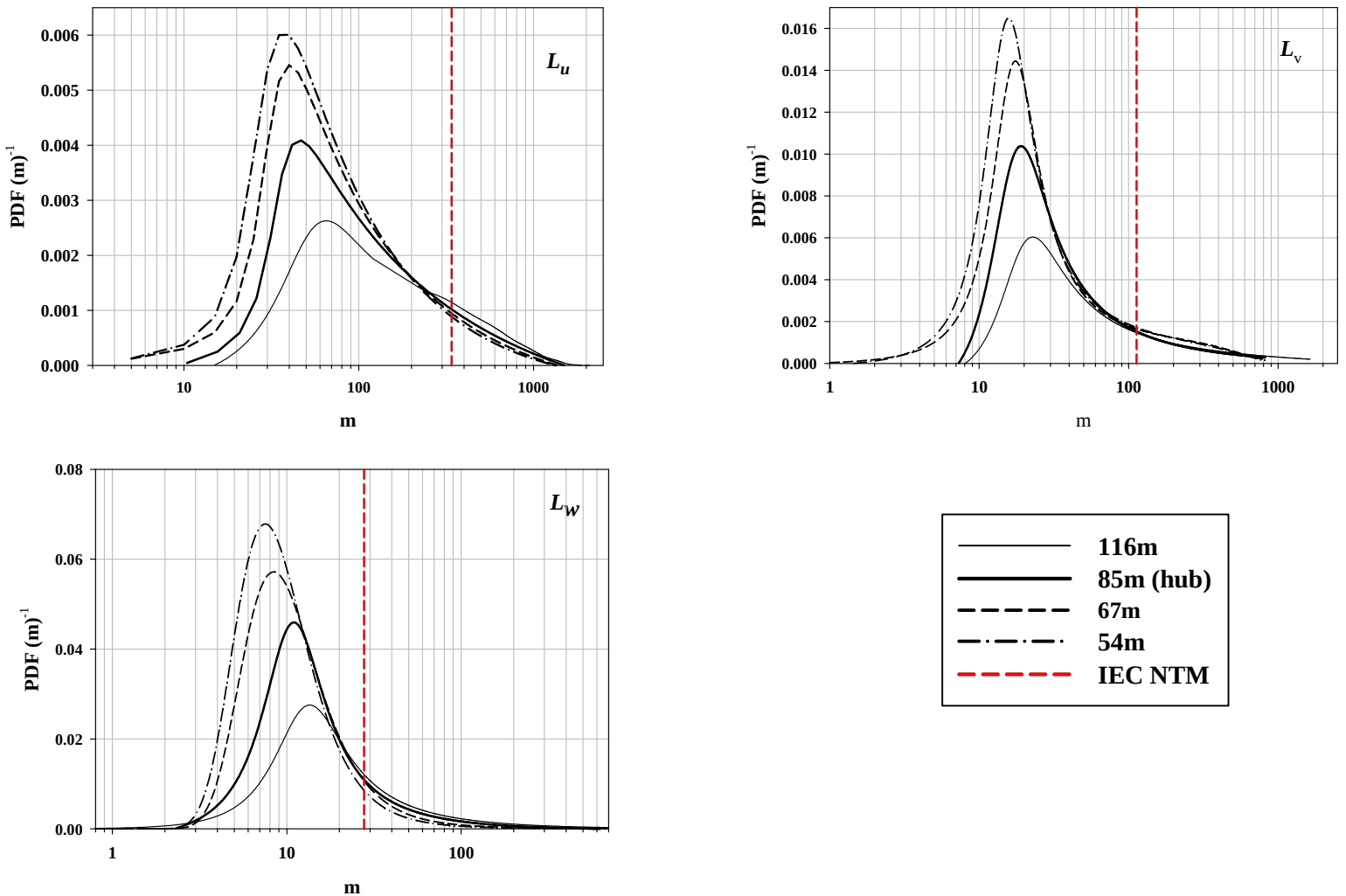

Time Periods Associated with Coherent Structures at
All Four Sonic Heights
Percent probability (%)
0
2
4
6
8
16:00
20:00
00:00
04:00
08:00
Local standard time (h)

Lamar

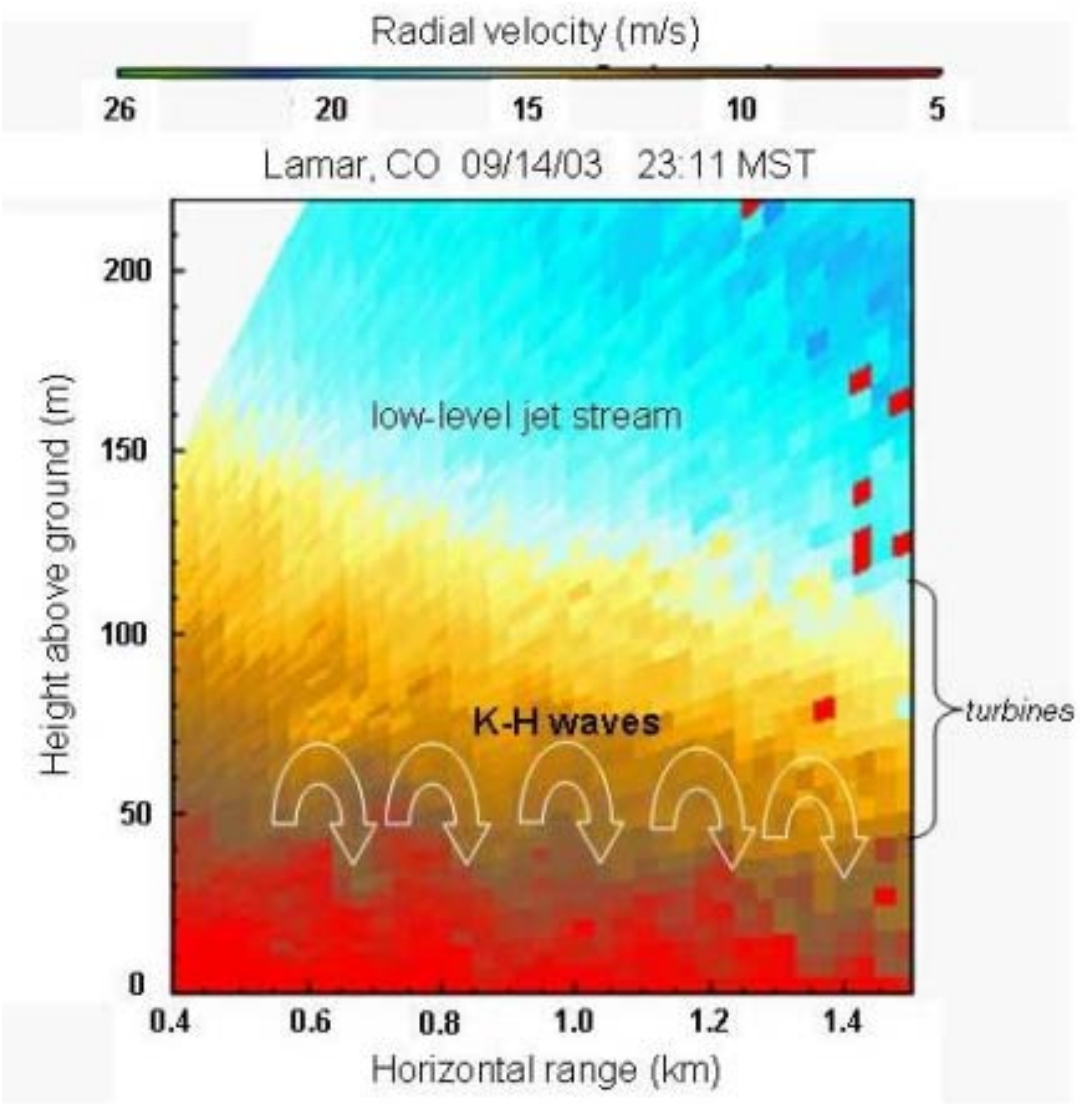

Characteristic Nocturnal Variation of
85m (Hub) Mean Wind Speed
m/s
15
14
13
12
11
10
9
8
nominal rated wind speed
Coh structures at all heights (2264 records)
No coh structures at any height (8461 records)
16
20
00
04
08
Local standard time (h)


85m (Hub) Mean Wind Speed PDF
(m/s)-1
0.16
0.12
0.08
0.04
0.00
0
5
10
15
20
25
30
m/s

Lamar Length Scales

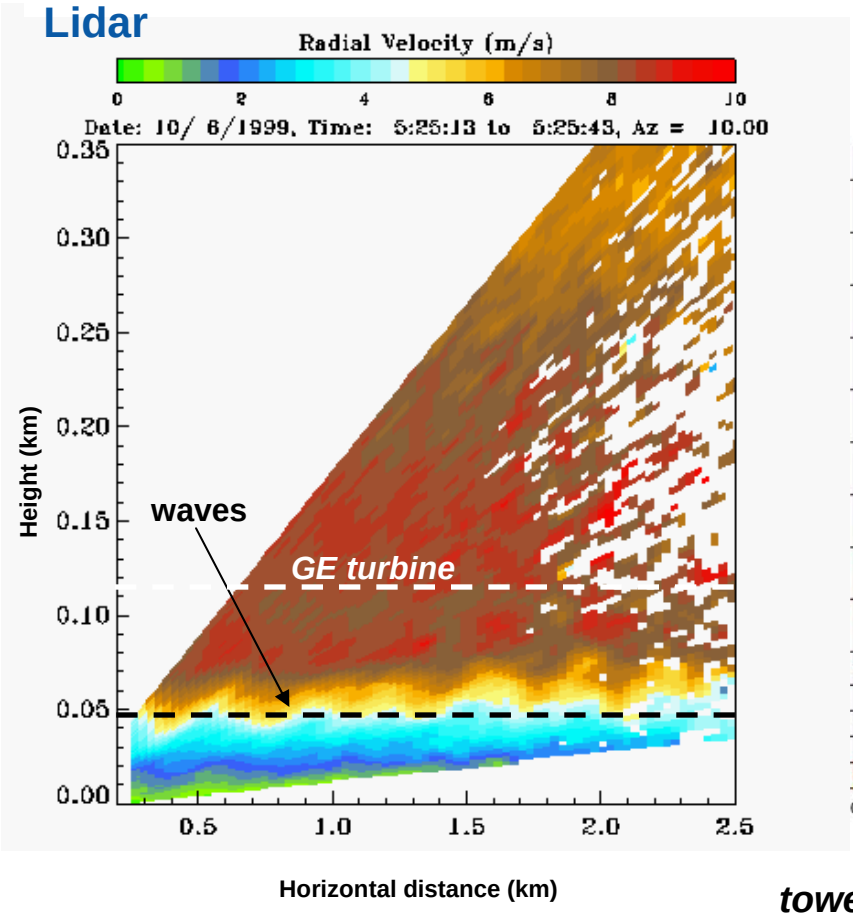


NOAA HRDL Vertical Scan Example



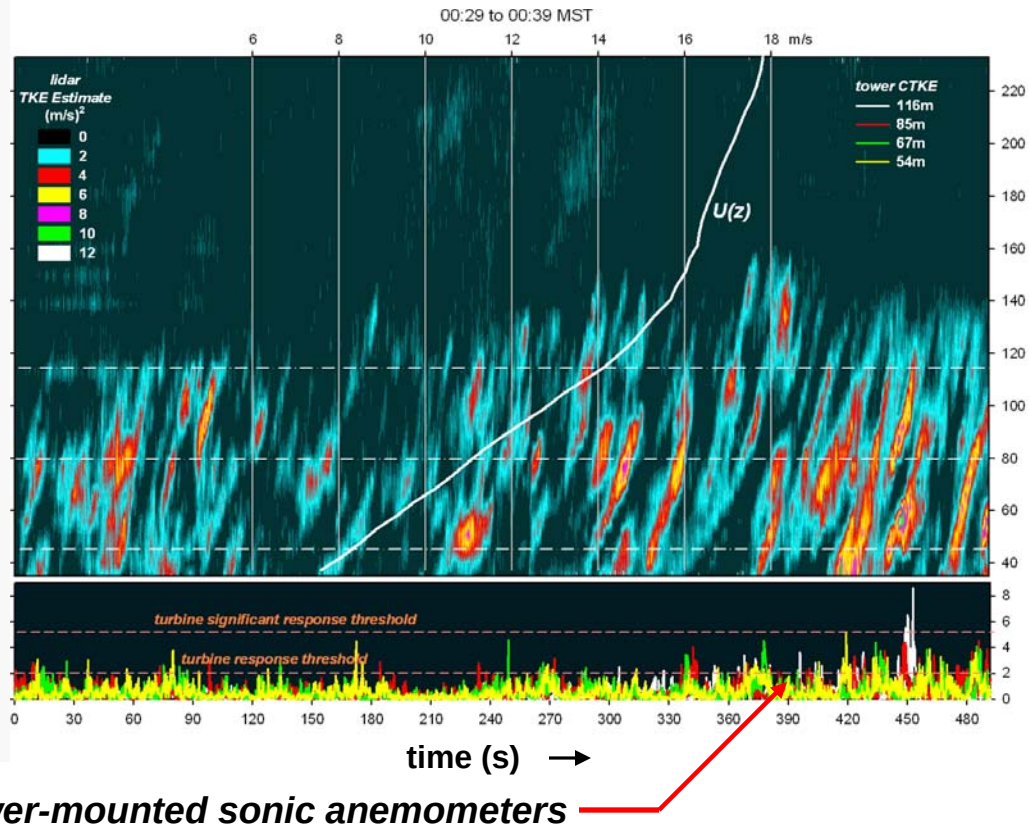
LIDAR OBSERVATIONS OF COHERENT STRUCTURES

Observation of Wave Motions Associated with Low-Level Jet in Southern Kansas Using NOAA HRDL Lidar



Courtesy: R. Banta, NOAA/ESRL

Coherent Turbulent Structures Under Low-Level Jet in Southeast Colorado From NOAA HRDL Lidar Data



tower-mounted sonic anemometers