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Atmosphere Work Unit

MORPHOS

Long-Term Drag Coefficients Measurements in the Coastal Zone

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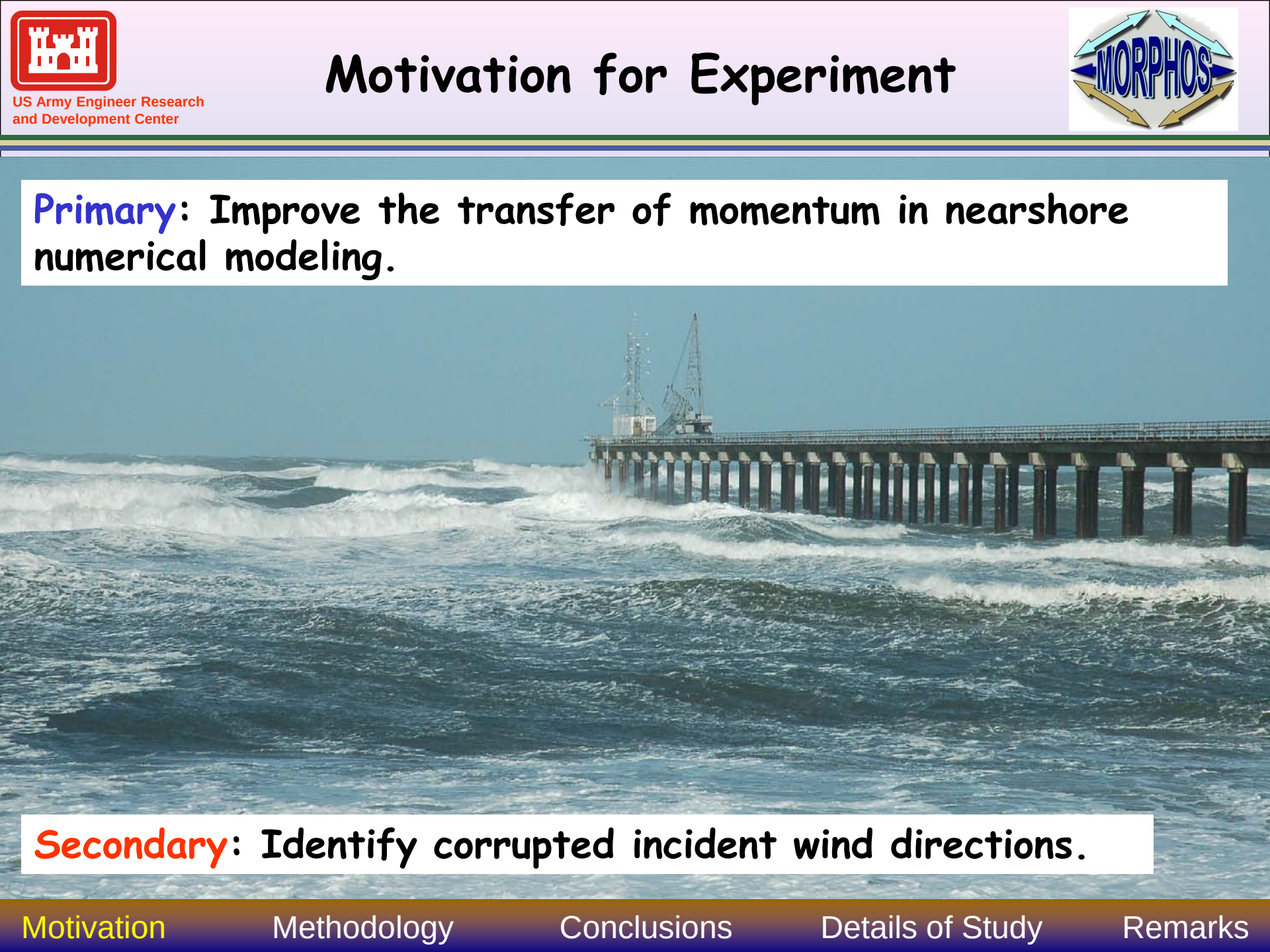
Motivation for Experiment

Primary: Improve the transfer of momentum in nearshore numerical modeling.



Secondary: Identify corrupted incident wind directions.

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Description of Methodology

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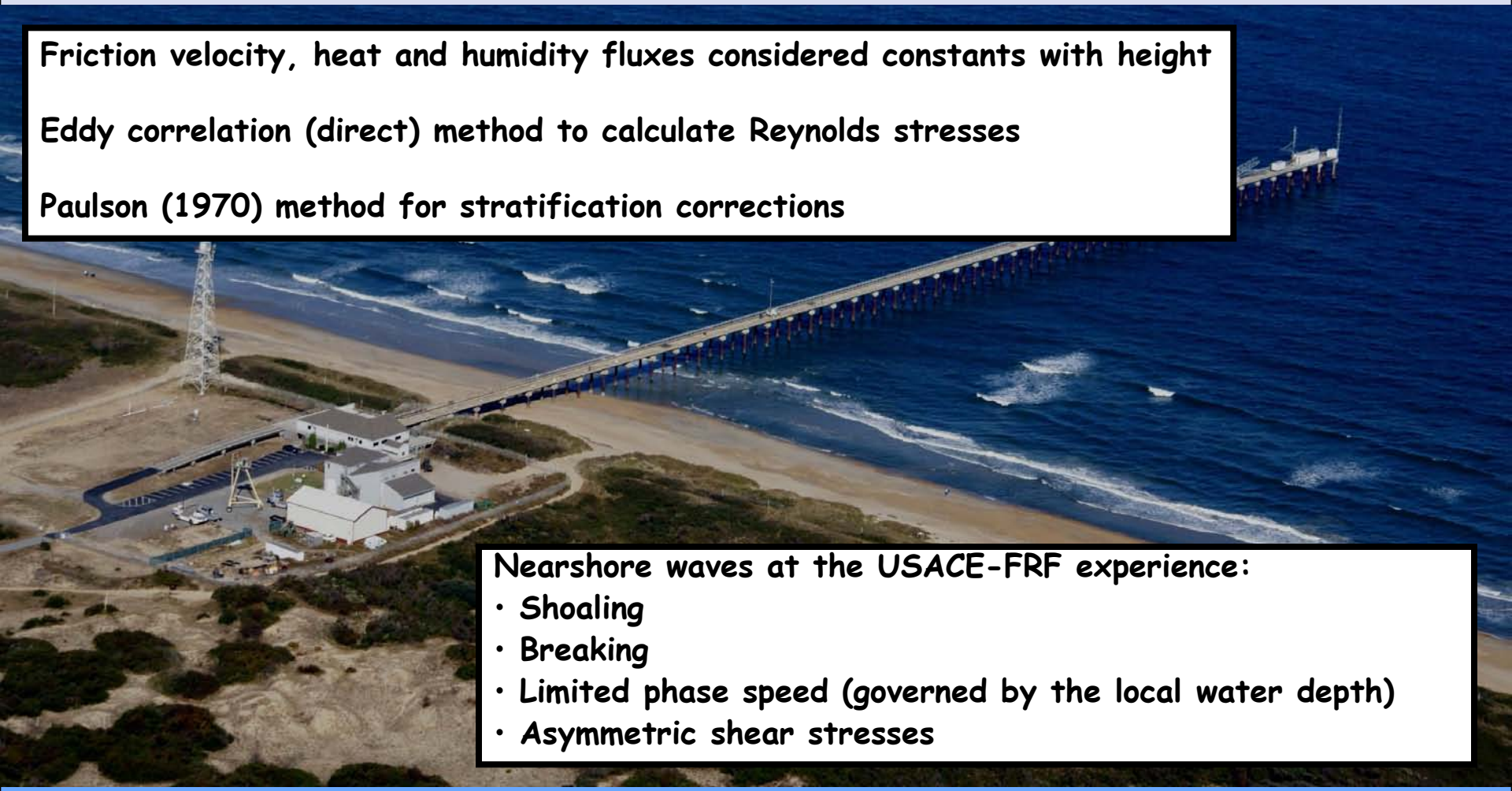
Friction velocity, heat and humidity fluxes considered constants with height

Eddy correlation (direct) method to calculate Reynolds stresses

Paulson (1970) method for stratification corrections



Nearshore waves at the USACE-FRF experience:

- Shoaling
- Breaking
- Limited phase speed (governed by the local water depth)
- Asymmetric shear stresses

Conclusions

1. High-quality momentum flux data have been collected at the USACE-FRF pier in Duck, NC from October 2005 through December 2007.

2. Drag coefficients are calculated for winds greater than 10 m/s.

3. Corrupted measurements are identified.

4. Onshore drag coefficients calculated at the USACE-FRF are less than historical open ocean parameterizations.

5. Measured drag coefficients do increase if the underlying surface current is taken into account; however, measurements are still less than historical parameterizations.

6. The largest onshore drag coefficients are measured between 340 - 10° north.

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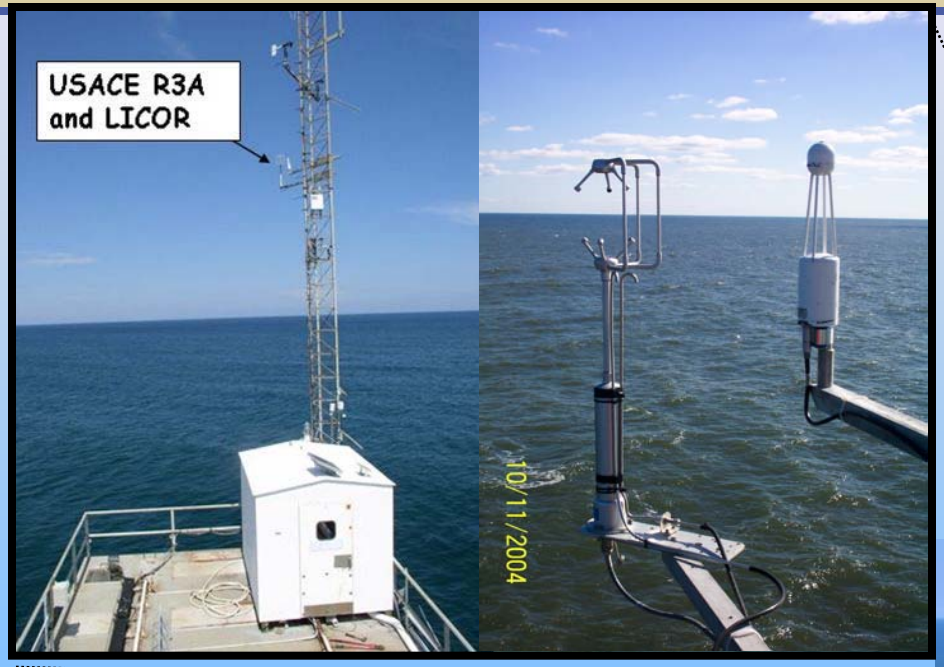
Instrumentation



Gill R3A sonic anemometer

LI-COR LI-7500 CO2/H2O gas analyzer

Positioned 16.7-m above MSL

Sampling rate: 10 Hz

Instrumentation directed 40° north

Data acquisition system: PC in NOAA shed

Pier extends 560-m into the Atlantic Ocean

Pier directed 70° north

Tower positioned above 7.5-m water depth

Onshore winds: 340° - 160° north clockwise

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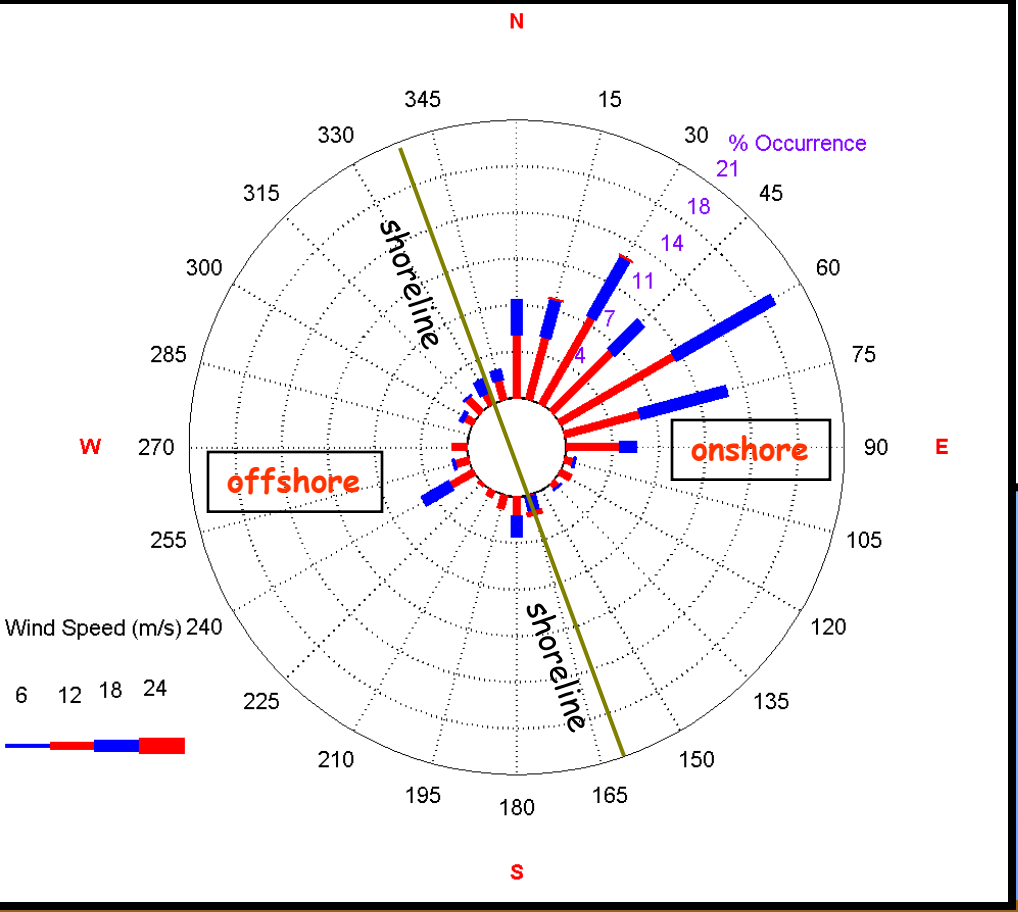
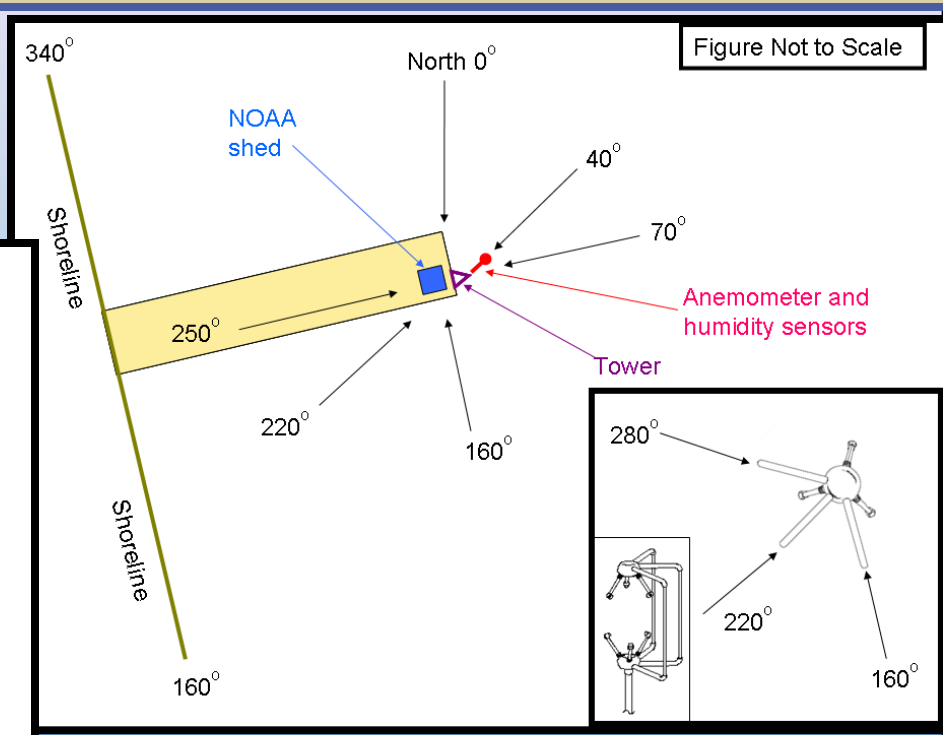
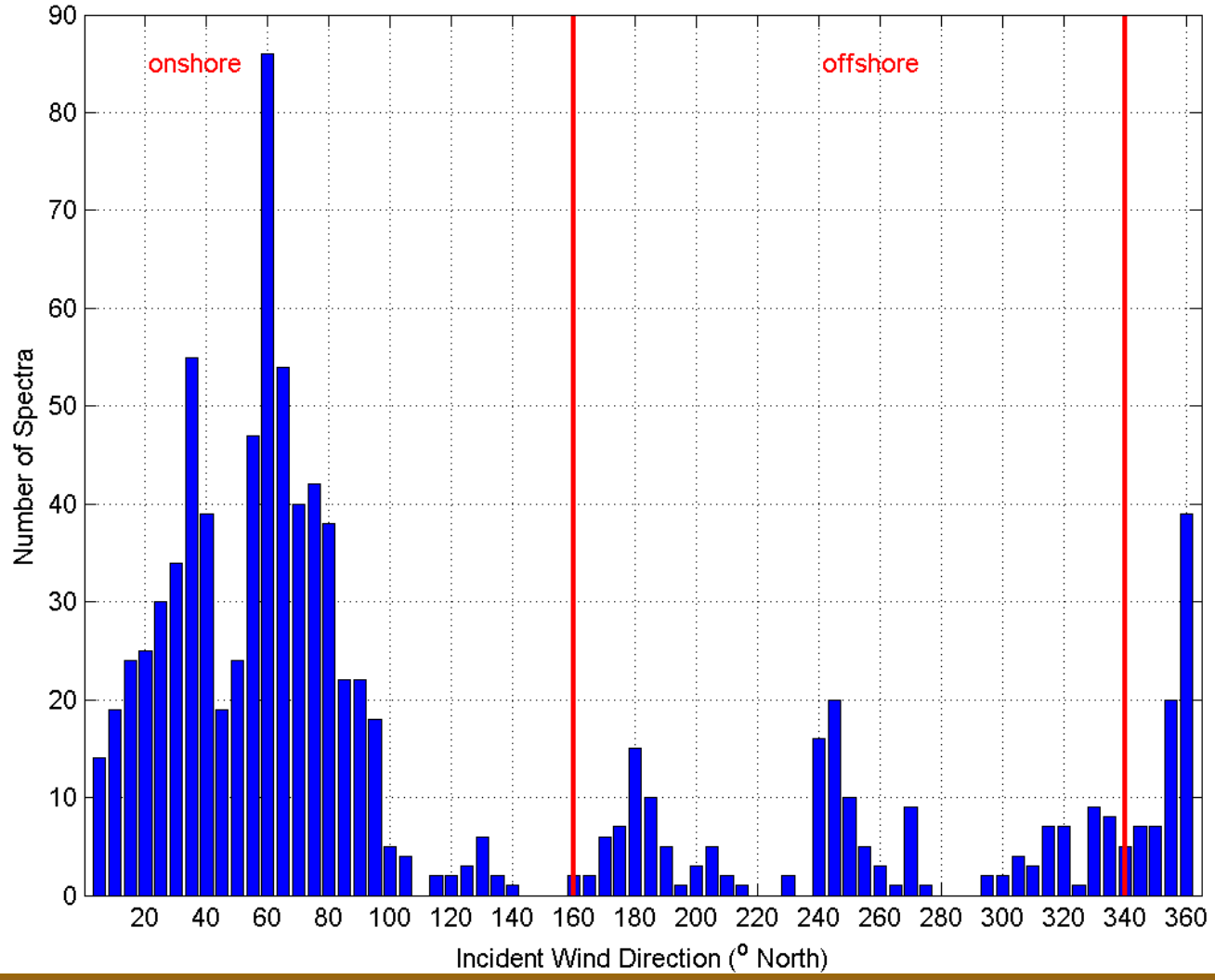
What Direction Did the Winds Originate From?





Onshore vs. Offshore Data

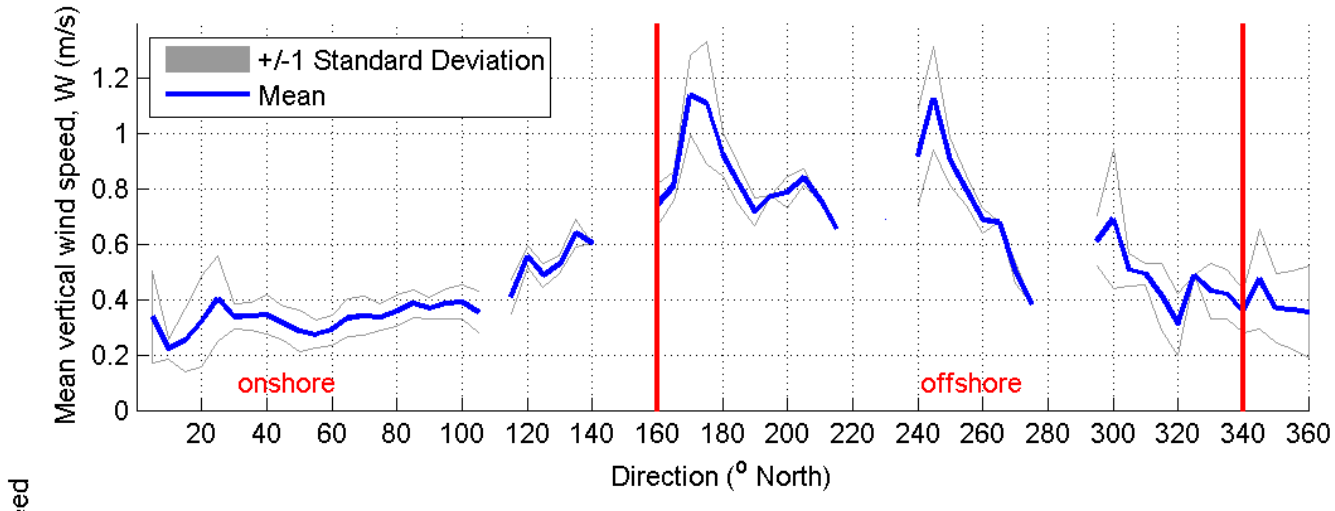


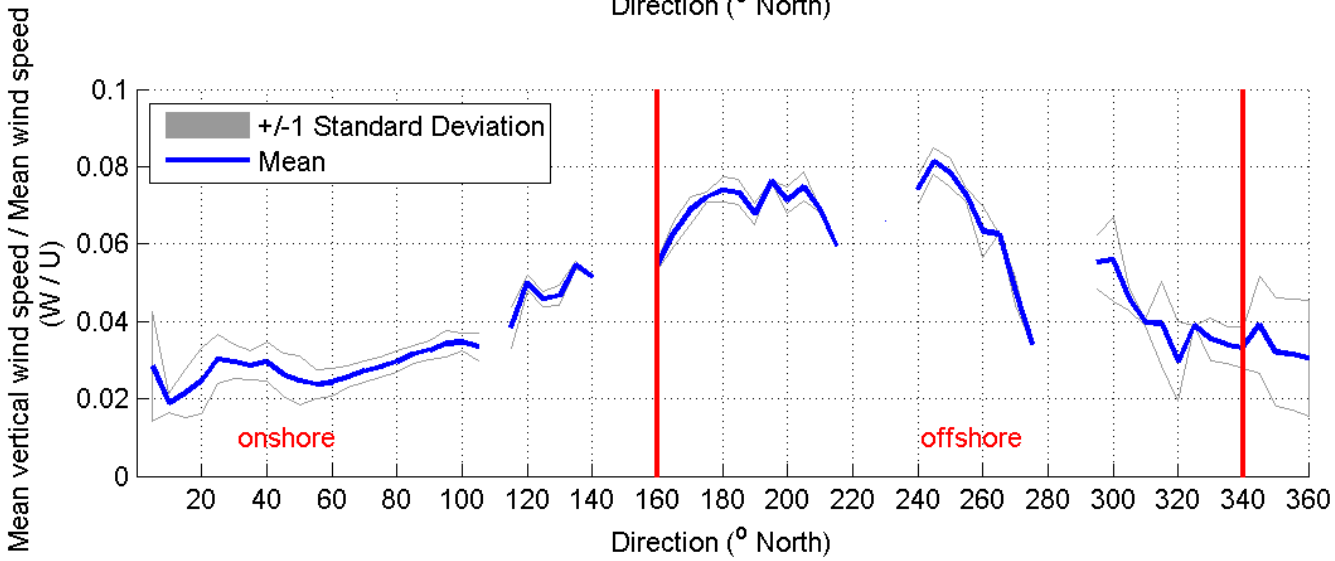
Identify Corrupted Incident Wind Directions

Inspect the following parameters:

1. Mean vertical (W) wind speed
2. Friction velocity
3. Drag Coefficient
4. Auto Spectra

Vertical Wind





5 Sources of Mean Vertical Wind

1. Limited data record

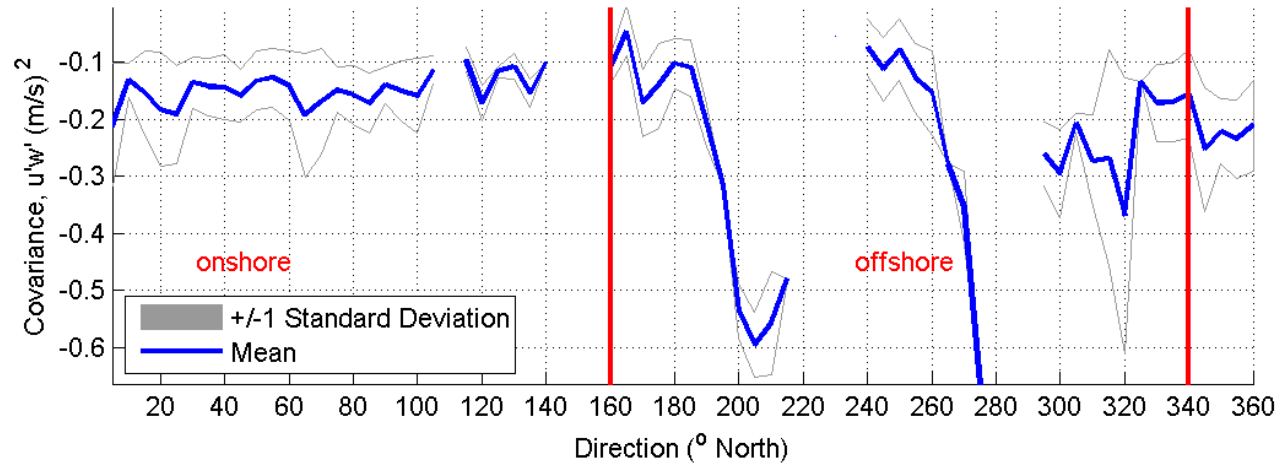
2. Boundary layer horizontal, non-uniformity in the coastal zone

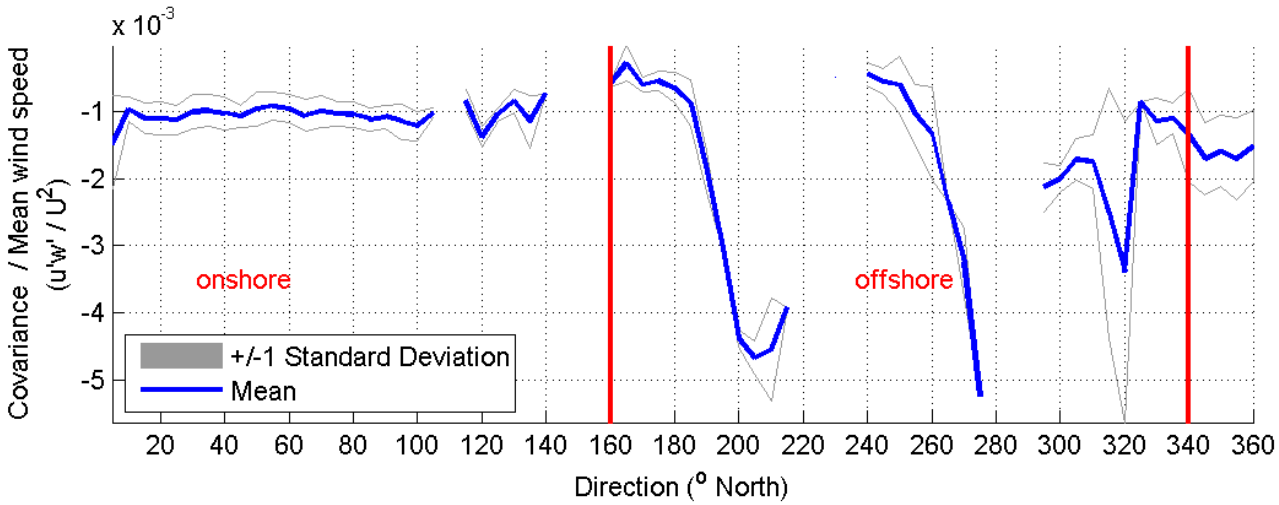
3. Formation of inner boundary layer

4. Misalignment or "tilt" of the anemometer

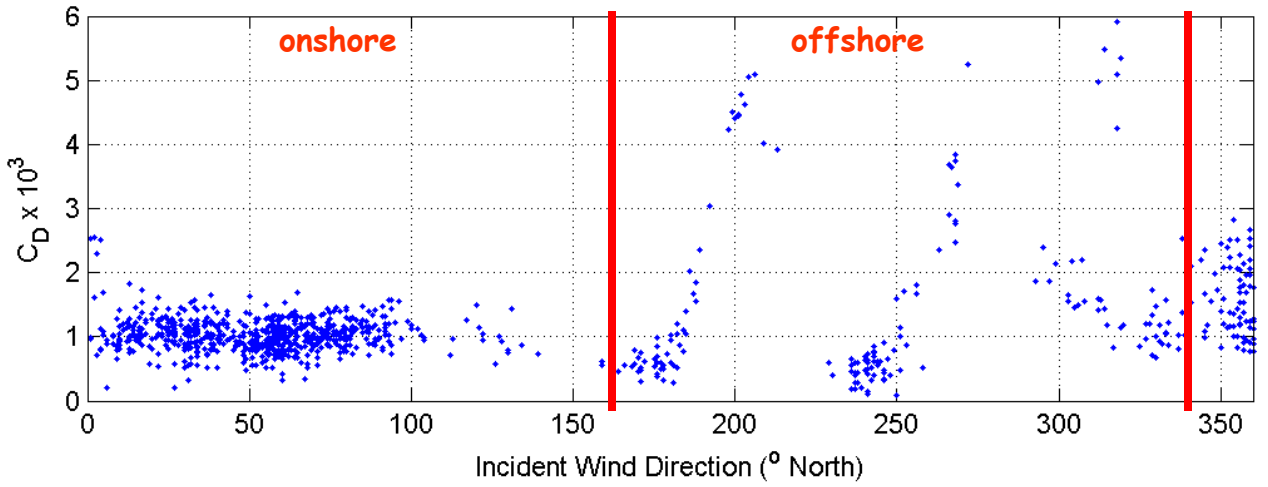
5. Instrumentation/supporting structures distorting measurements

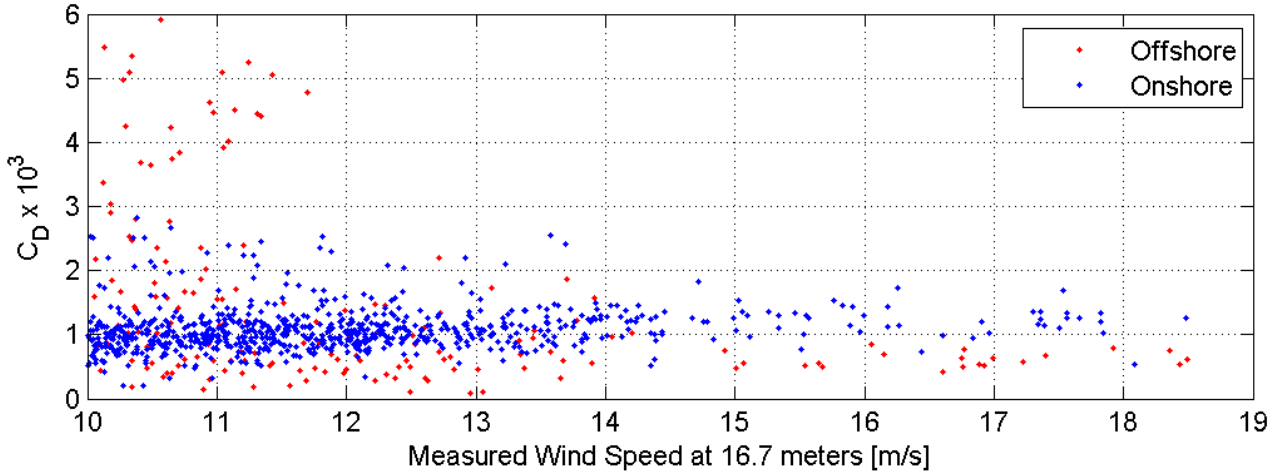
Friction Velocity



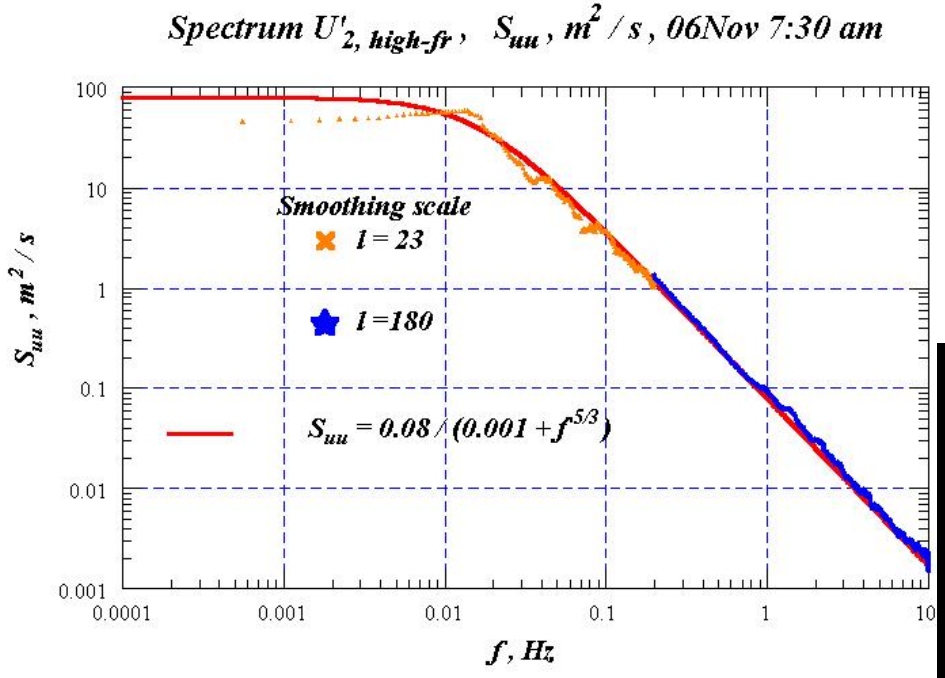


Drag Coefficients





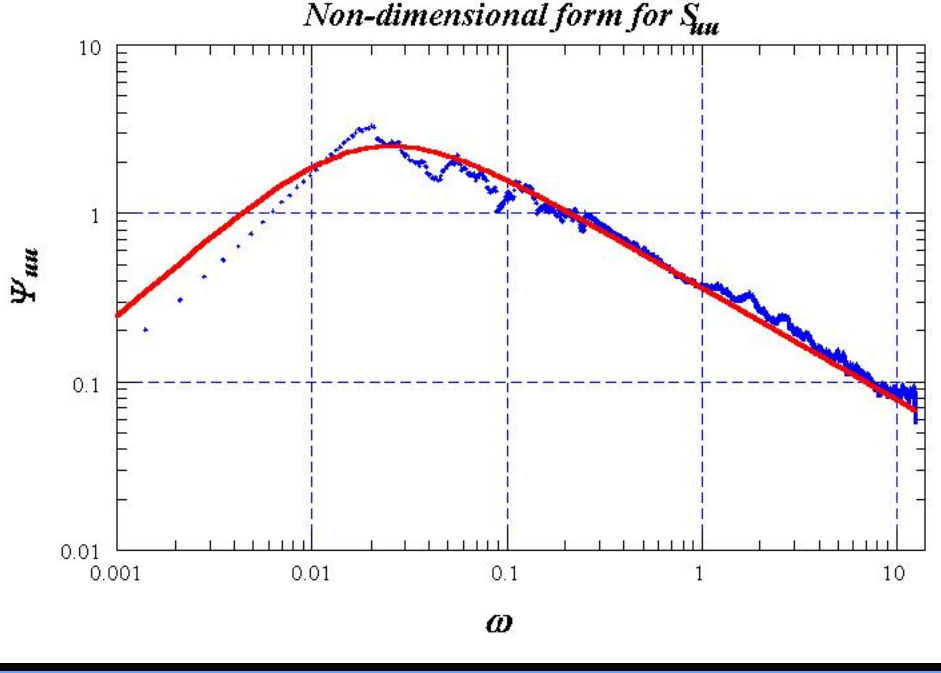
Spectra and Universal Spectra



$$\hat{S}_{uu}(f) = \frac{a_{uu}}{b_{uu} + f^{5/3}}$$

$$a_{uu} = \frac{2}{3} f_{\max}^{5/3} \overline{S_{uu}(0)}$$

$$b_{uu} = \frac{2}{3} f_{\max}^{5/3}$$



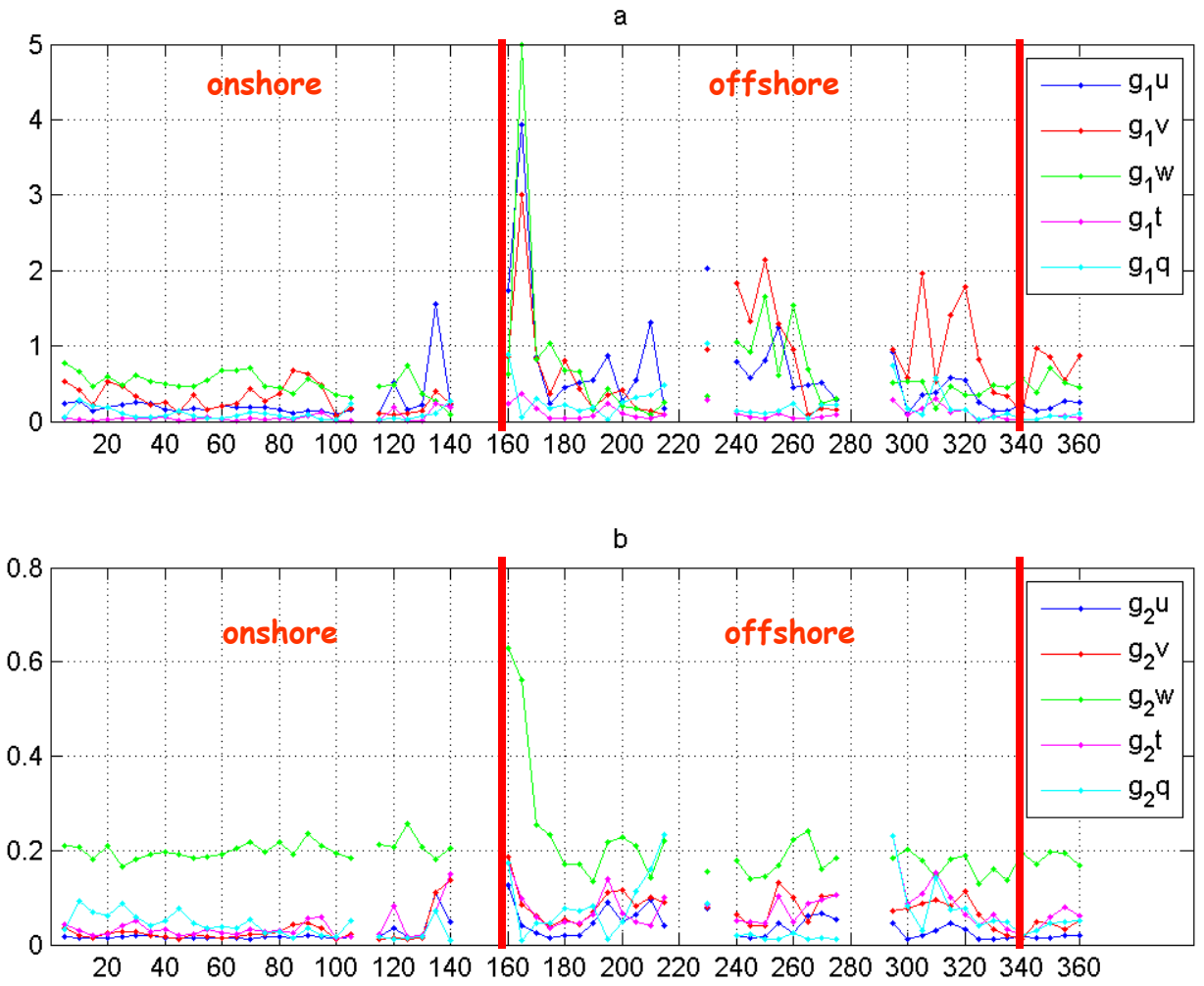
$$\psi_{uu} = \frac{f}{u_*^2} S_{uu}$$

$$\omega = \frac{fz}{U}$$

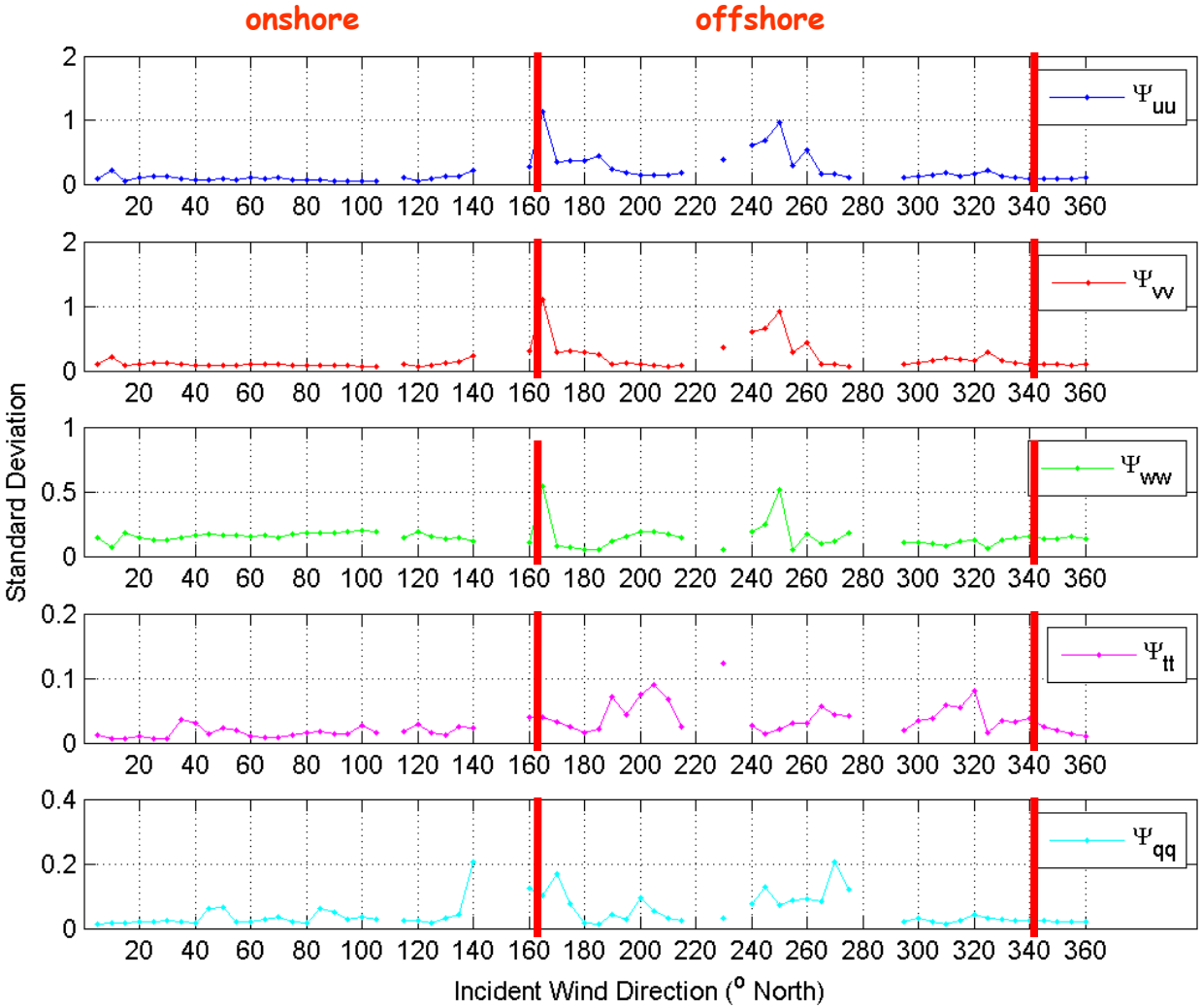
Check Stability of Universal Spectra Approximations

$$g_1 x(\theta) = \frac{a_{xx}}{x_*^{\,2}} \left(\frac{z}{X_z} \right)^{2/3}$$

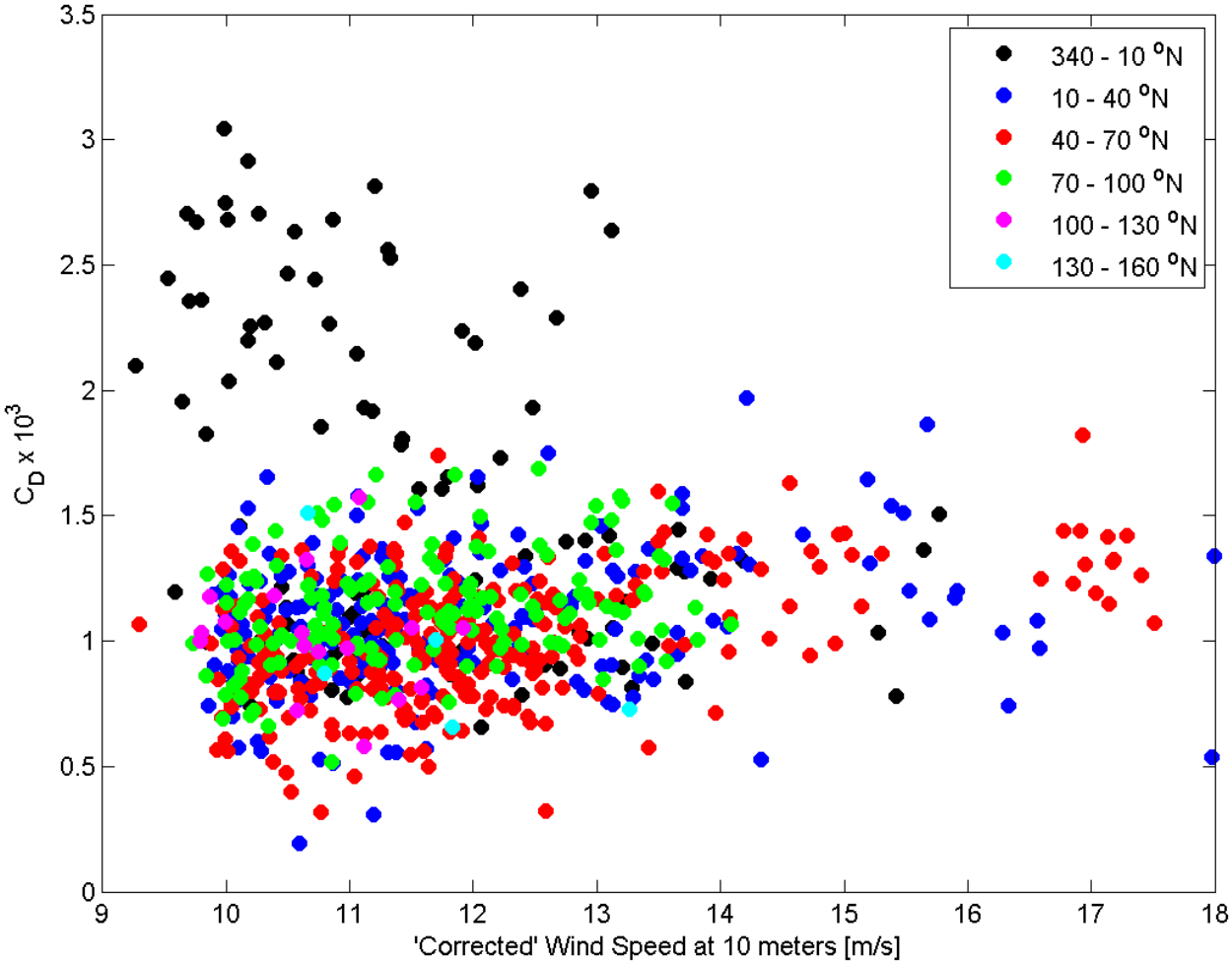
$$g_2 x(\theta) = \frac{b_{xx}^{\,3/5} z}{X_z}$$



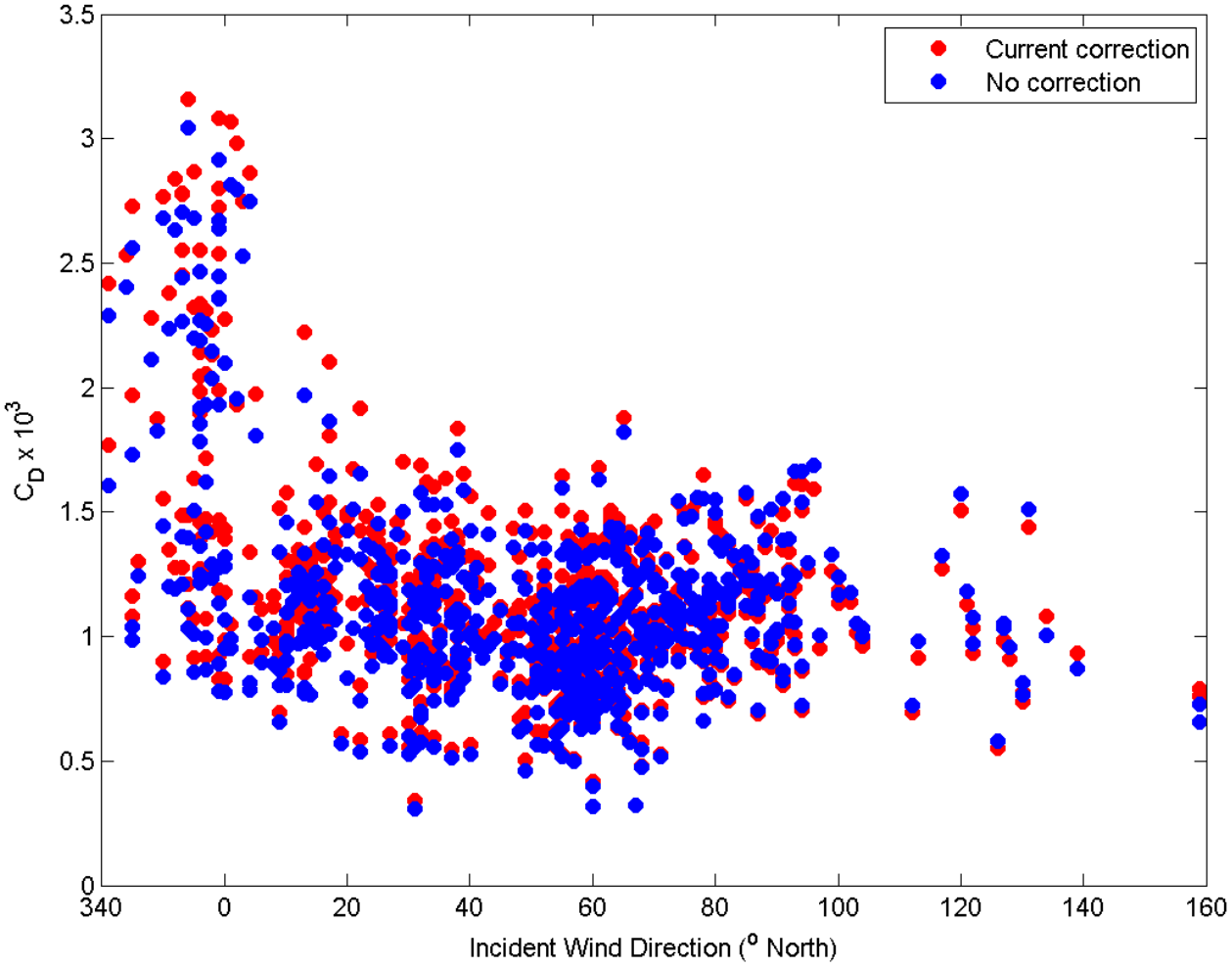
Standard Deviation of Universal Spectra Approximations



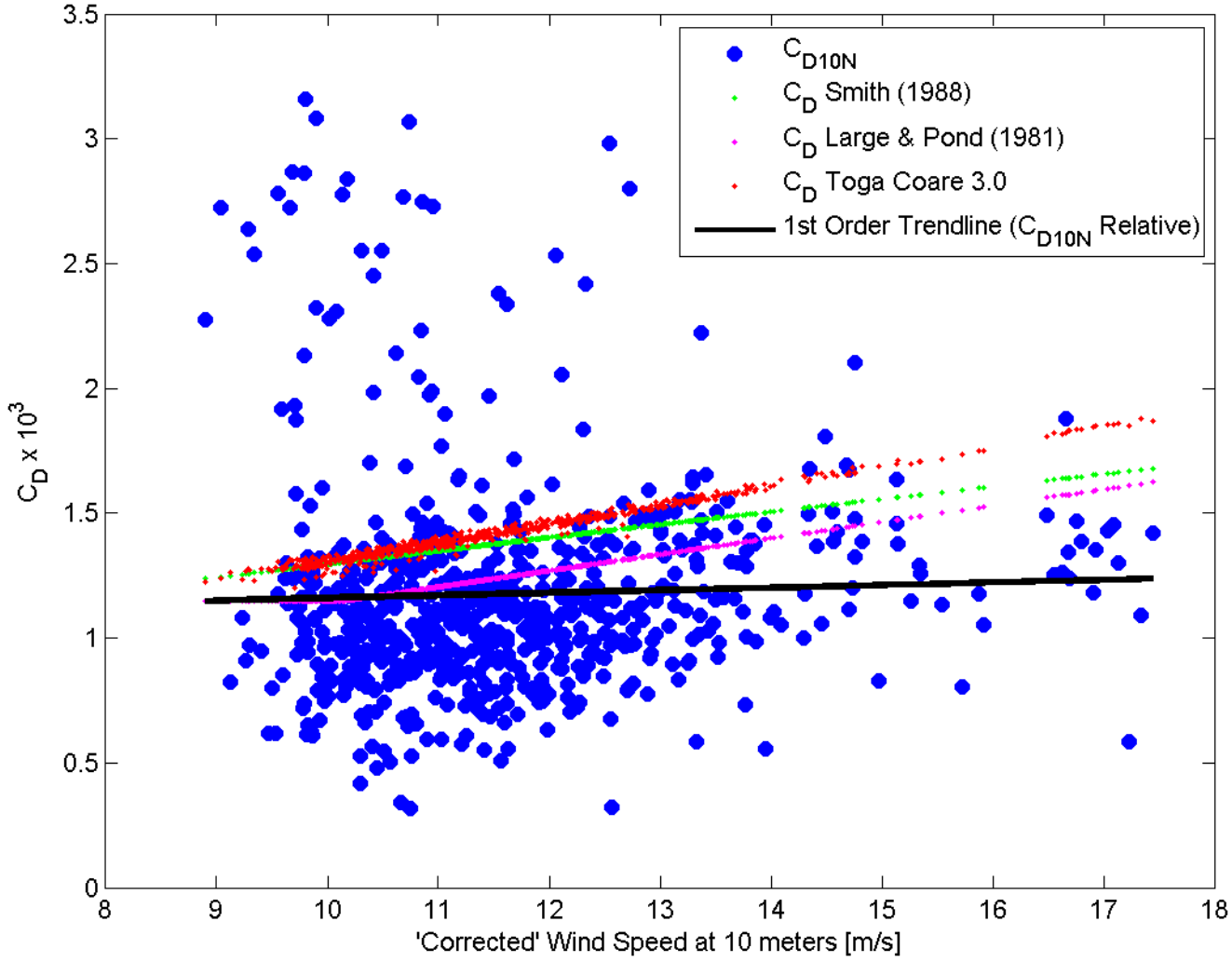
Partition Drag Coefficients



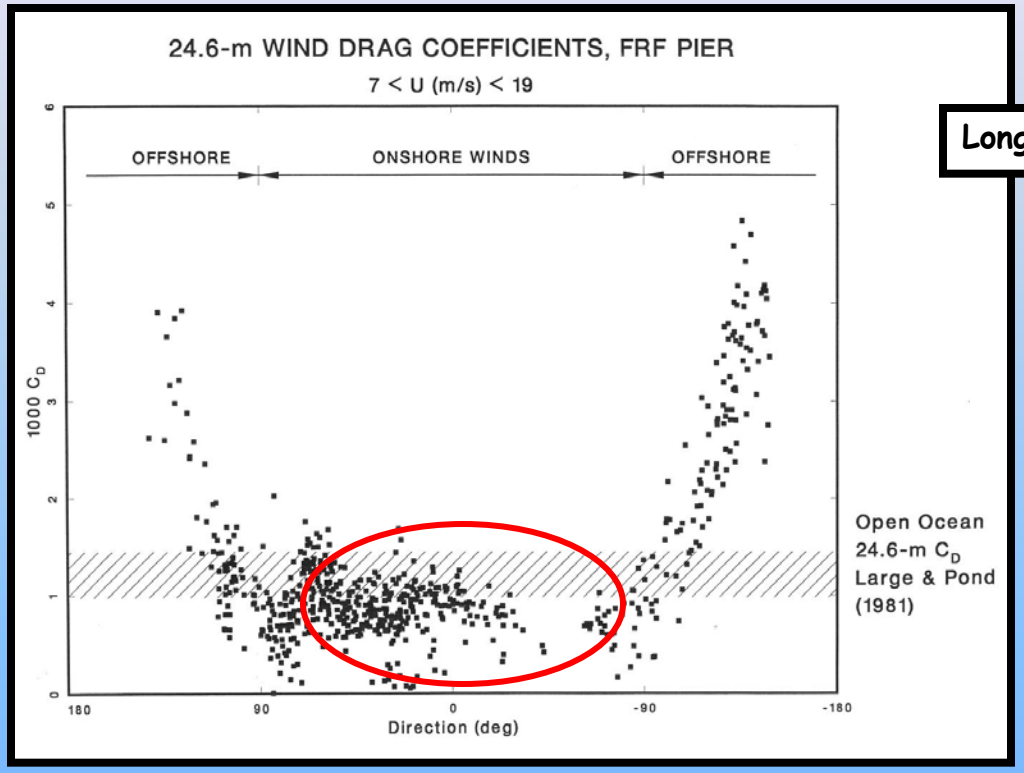
Underlying Surface (Current) Corrections



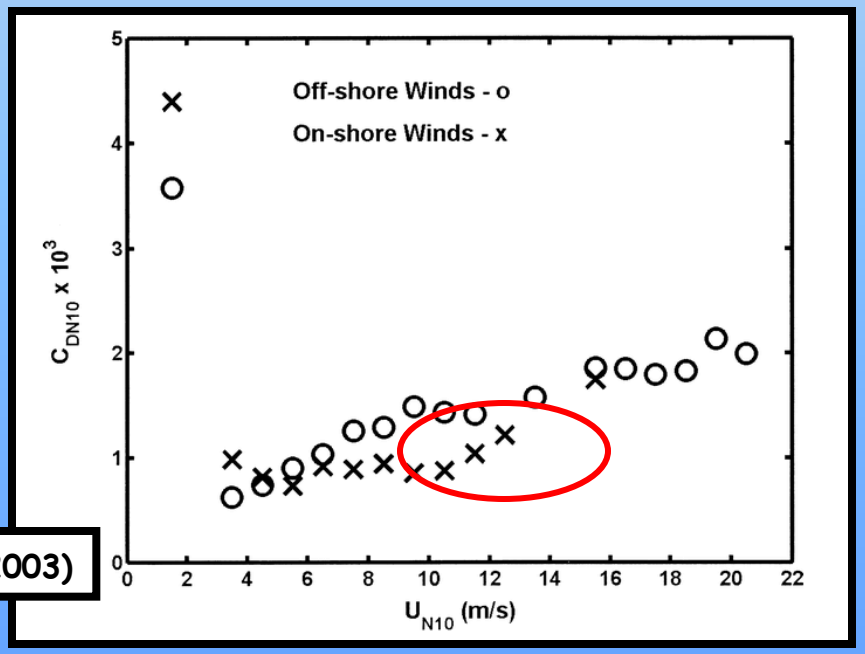
"Updated" Drag Coefficient



Additional Duck, NC Drag Coefficients



Long, C. (1990's)



Frederickson, P. A. and Davidson, K. L., (2003)

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Thank You…

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