NOAA Technical Report EDS 28

# Comparison of Mast and Boom Wind Speed and Direction Measurements on U.S. GATE B-Scale Ships

Washington, D.C.
March 1978

**U.S. DEPARTMENT OF COMMERCE**
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# Comparison of Mast and Boom Wind Speed and Direction Measurements on U.S. GATE B-Scale Ships

Center for Experiment Design and Data Analysis

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**U.S. DEPARTMENT OF COMMERCE**
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Abstract. During the 1974 GARP Atlantic Tropical Experiment (GATE), wind measurements were made aboard four U.S. ships with identical microvane and cup anemometers mounted on the forward masts and on booms extending from the ships' bows. Study of the simultaneous wind observations by the mast and boom sensors shows wind speed differences varying from 0 to 1.0 m/s and wind directions varying between ± 15° for relative wind directions from 270 through 0 to 90°. These differences are dependent upon the relative wind direction, the wind speed, the heights of the sensors above sea level, the exposure of the sensor, and atmospheric stability. Wind speed differences are found to increase linearly when the wind direction is on the bow and in some cases nonlinearly when the ship lies normal to the wind. Specific biases in the wind measurements for each of the four ships are tabulated for the benefit of users of the archived GATE surface data.

## 1. INTRODUCTION

Accurate surface wind observations were an important requirement of the 1974 GARP[1] Atlantic Tropical Experiment (GATE) as outlined in GATE Report No. 3 (1974). Synoptic analysis of surface fields, computation of kinematic divergence and vorticity fields, and calculation of surface fluxes of momentum, and latent and sensible heat are all dependent upon wind measurements. Yet, very little has been known quantitatively about wind observation errors aboard ship.

Augstein et al. (1974) compared wind speeds measured on the mast of the ship Meteor with those measured on a meteorological buoy and found that the mast wind speeds are systematically smaller than the measurements at the buoy, with the differences increasing with increasing wind speed. Ching (1976), in comparing wind speed measured by mast and boom sensors during the 1969 Barbados Oceanographic and Meteorological Experiment (BOMEX), found that mast wind speeds

[1]Global Atmospheric Research Program

are strongly affected by the ship's superstructure when the ship is lying broadside to the wind. Seguin and Garstang (1971) found the mast-boom wind speed differences to be influenced by atmospheric stability. Despite these studies, quantitative data have been meager.

Before GATE, the advantages and disadvantages of mounting meteorological instrumentation on buoys versus ships were discussed, with considerations of cost and time ruling in favor of the latter. As a partial solution to the old question of where best to place meteorological sensors aboard ships, and to increase the likelihood of collecting high quality data, four of the U.S. GATE B-scale ships were equipped with identical sensors mounted on both the forward masts and on booms extending from the ships' bows. The microvane and cup anemometers used are shown in figure 1. Their location on the boom is indicated in figure 2 and their positions on the masts of the four ships, the Researcher, Gilliss, Dallas, and Oceanographer, are shown in figures 3, 4, 5, and 6, respectively. Table 1 shows the sensor heights.

Table 1.--Wind sensor heights

| Ship | Boom sensors (m) | Mast sensors (m) |
|---|---|---|
| Researcher | 10.0 | 24.1 |
| Gilliss | 8.2 | 18.3 |
| Dallas | 8.7 | 23.8 |
| Oceanographer | 10.5 | 29.6 |

The wind speed and direction data collected by both mast and boom sensors by the four ships during the three observation Phases of GATE provided an excellent opportunity to examine differences between mast and boom wind observations. In this study, the differences between mast and boom speeds and directions are analyzed both as a function of relative wind direction and of wind speed for evidence of systematic obstructive effects. The influence of atmospheric stability on the wind speed differences is also discussed.

## 2. METHOD OF ANALYSIS AND RESULTS

Data were acquired at a rate of two samples per second and were recorded on pulse code modulation (PCM) analog tape. In subsequent computer processing, these data were edited, corrected for ship velocity and ship heading, and then averaged to produce 3-min averages. The average wind directions were calculated from the u- and v-components; the average wind speeds, from scalar speeds only. The instrumentation, field data collection, and data processing have been described in detail by Seguin et al. (1977).

Twelve 3-min average data sets were used in the analysis, one for each ship for each Phase of GATE. Each Phase lasted roughly 20 days, giving a maximum of approximately 9,600 samples of 3-min pairs of mast-boom data. The wind speed and direction data are relatively free of errors, but gaps do exist as a result of sensor maintenance and interruptions in the recording of ship velocity and ship heading data.

Two methods were used in comparing the mast and boom wind measurements. By the first method, mast-boom differences are examined with emphasis on relative wind direction; by the second, with emphasis on variations in the wind speed. The techniques used are described below, with results presented for each of the four ships.

### 2.1 Differences Calculated by Method 1, With Emphasis on the Changing Relative Wind Direction

Differences were calculated for two wind speed classes, < 5 m/s and $\geq$ 5 m/s, and 72 relative wind direction classes defined by a 30$^{\circ}$ wind direction window that was rotated in 5$^{\circ}$ increments around the compass as shown in figure 7. Because these windows overlapped, individual samples were counted more than once.

#### 2.1.1 Wind Speeds

The mast and boom wind speeds and their differences (mast minus boom) were accumulated and averaged for each of the seventy-two 30$^{\circ}$ windows. By this technique, the data were sorted as a function of the relative mast wind direction and speed, independently of time, with values representing the averages for each of the 30$^{\circ}$ windows for an entire GATE observation Phase. The average mast-boom wind speed differences were displayed as polar plots, and linear plots were prepared of the average wind speeds.

Polar Plots

Figure 8 shows the differences for the *Researcher* during Phase I. The radii in this and subsequent plots represent the magnitudes of the differences in speed, and the angles represent the central angles of the 30$^{\circ}$ windows. Since all directions were computed relative to the ship, with ship heading removed, 0$^{\circ}$ refers to wind on the bow, 90$^{\circ}$ to wind on the starboard (right) side, and so on. The inner curve shows the wind speed differences for mast winds < 5 m/s; the outer curve, for mast winds $\geq$ 5 m/s.

As seen in figure 8, the wind speed differences for the *Researcher* are not symmetrical about the 0 to 180$^{\circ}$ axis, and the pattern for both wind speed classes is about the same. Table 2 shows the angles for the minimum and maximum wind speed differences for the two wind speed classes for all three Phases. The consistency from Phase to Phase and the fact that the angles in any one column do not vary by more than 15 to 20$^{\circ}$ support the validity of the results, suggesting that the patterns observed are related to obstructions on the ship.

The wind speed difference curves for the *Gilliss*, *Dallas*, and *Oceanographer* for Phase I are plotted in figures 9, 10, and 11, respectively. In the case of the *Gilliss*, the differences for high winds are strongly asymmetrical for angles of 270-0-90$^{\circ}$, with fairly large differences (1.0 m/s)

Table 2.--Angles (in degrees) for Researcher minimum and maximum mast-boom wind speed differences

| Phase | Minimum | Minimum | Minimum | Maximum | Maximum |
|---|---|---|---|---|---|
| | | Low wind speed class (< 5 m/s) | | | |
| I | 2 | 80 | 270 | 45 | 207 |
| II | 5 | 105 | 260 | 35 | 310 |
| III | 15 | 90 | 290 | 50 | 320 |
| | | High wind speed class ($\geq$ 5 m/s) | | | |
| I | 0 | 82 | 260 | 45 | 300 |
| II | 357 | 85 | 270 | 50 | 302 |
| III | 7 | 85 | 285 | 50 | 315 |

between 60 and 100$^o$, contrasted with differences of only 0.1 to 0.2 m/s at relative angles between 270 and 330$^o$. The same asymmetric pattern is evident for the low wind speed class.

For the Dallas, the differences also show a characteristic pattern for both wind speed classes for Phase I, as seen in figure 10, as well as for Phase II, based on the tabulations in the appendix. Minimum mast-boom differences occur when the relative wind direction is on the bow. Because of a sporadically bad boom wind sensor during Phase III, the differences for that period, also given in the appendix, are not representative.

The patterns for the Oceanographer are consistent for all three Phases in the case of both high and low wind speeds. Minimum differences between 270-0-90$^o$ are found between 330 and 60$^o$; maximum differences (~0.8 m/s), between 80 and 90$^o$.

## Linear Plots

To examine the variations in wind speeds measured by each sensor on each ship, which might help explain the differences seen in the polar plots, the average speeds were plotted on linear graph paper. Mast and boom data for both wind speed classes (< 5 m/s and $\geq$ 5 m/s) were plotted. With a sufficiently large sample, the average for each class should change very little, and any deviations could then be assumed to be caused by the superstructure of the ship.

Figure 12 shows that low wind speeds on the Researcher in Phase I averaged ~3.0 m/s (within 0.5 m/s) at relative wind directions from 270 through 0 to 120$^o$. Between 120 and 240$^o$, there is a pronounced drop in both the mast and boom wind speeds, a "blind zone" presumably caused by ship obstructions. The low wind speed curves also suggest that the measurements on the mast were noticeably lower for some relative wind directions, such as 90$^o$.

The Gilliss Phase I data are shown in figure 13. Assuming the true average low wind speed is approximately 3.0 m/s, both the mast and boom sensors show lower values between 120 and 250° as a result of the effect of the ship. Between 80 and 130°, the boom wind speeds increase noticeably in comparison with the mast winds for both wind speed classes. On the port side of the ship, the measurements correspond very closely, but on the starboard side the differences are considerable.

As seen in figure 14, the Dallas mast and boom measurements are relatively consistent for the low wind speed class. The "blind zone" appears to be between 110 and 240°. In the case of high wind speeds, the boom averages are noticeably lower than the mast averages at angles between 240 and 280° and between 50 and 80°.

The average wind speeds for the Oceanographer are plotted in figure 15, where the obstructive ship effect is evident between 110 and 270°. Observations for this window were too few for conclusions to be drawn in the case of the high wind speed class. Outside this window, both the mast and boom averages in both wind speed classes are closely matched, with a slight dip in the boom measurements near 80°.

The wind speed difference patterns discussed above illustrate the complex influence of the ship on wind velocity measurements. The fact that these patterns for each of the four ships are consistent from Phase to Phase, and in some cases for both the low and the high wind speed class, support the validity of the analysis and the deduction that the differences observed are related to obstacles on the ships. The linear plots of the average wind speeds show that neither sensor, mast nor boom, is best for all relative wind directions. These plots also indicate that the influence of the various ships on measured velocity varies with wind speed, and that the differences are very small for light wind speeds. This is examined further in section 2.2.

### 2.1.2 Wind Directions

Wind direction differences were computed for each ship in much the same way as were the wind speed differences. Differences in wind direction were not computed when mast wind speeds were < 1 m/s. Since the 3-min average wind direction data used in the analysis were calculated from the u- and v-components of the wind, they were not independent of the wind speeds and biases in the speeds, discussed above. However, these 3-min average wind directions comprise the data that are part of the GATE archive and available to users.

#### Polar Plots

Figure 16 shows a polar plot of the mast-boom wind direction differences for the Researcher in Phase I for the two wind speed classes (< 5 m/s and ≥ 5 m/s). As seen, the differences range from -6 to 2° for mast relative wind directions of 270 through 0 to 90°. Table 3 gives typical magnitudes of these differences for each Phase, and shows that the differences change slightly in Phase II and more noticeably in Phase III. The 8° change at 300° cannot be explained by the rotation of the sensors' bases because of the small change at 60°. Complete tabulations for all Phases are given in the appendix.

Table 3.--Mast-boom wind direction differences (in degrees) for the Researcher at selected relative wind directions

| Phase | 300° | 0° | 60° |
|---|---|---|---|
| Low wind speed class (< 5 m/s) | | | |
| I | -4.5 | -2.2 | 0.9 |
| II | -4.5 | -1.5 | 2.2 |
| III | 3.9 | 5.8 | 4.4 |
| High wind speed class (≥ 5 m/s) | | | |
| I | -5.6 | -2.7 | 1.2 |
| II | -4.6 | -1.4 | 2.5 |
| III | 5.1 | 5.5 | 5.8 |

The Phase I Gilliss mast-boom wind direction differences for both the low and high wind speed classes are plotted in figure 17, which shows differences ranging from -8 to 0° at relative wind directions from 270 through 0 to 90°. Differences for selected wind directions for all three Phases are given in table 4, which indicates an increase in these differences from Phase I to Phase II, and a lesser increase in Phase III. The consistency in the increase between Phases I and II suggests a rotation by one of the sensors relative to the other by approximately 6°.

Table 4.--Mast-boom wind direction differences (in degrees) for the Gilliss at selected relative wind directions

| Phase | 300° | 0° | 60° |
|---|---|---|---|
| Low wind speed class (< 5 m/s) | | | |
| I | -4.2 | -1.0 | -4.9 |
| II | -10.1 | -6.5 | -9.6 |
| III | -8.6 | -8.1 | -14.1 |
| High wind speed class (≥ 5 m/s) | | | |
| I | -4.1 | -0.5 | -4.6 |
| II | -9.2 | -5.6 | -9.8 |
| III | -8.5 | -6.8 | -12.0 |

The *Dallas* Phase I mast-boom wind direction differences for both wind speed classes are small, as seen in figure 18. They range from approximately -7 to 5$^{o}$ for relative wind directions from 270 through 0 to 90$^{o}$. Table 5 shows that this pattern is also true for the other Phases, which is further borne out by the complete tabulations in the appendix. Differences for the *Oceanographer* are also small, as shown by the plot in figure 19 and by table 6, which lists differences at selected relative wind directions for all Phases.

Table 5.--Mast-boom wind direction differences (in degrees) for the *Dallas* at selected relative wind directions

| Phase | 300$^{o}$ | 0$^{o}$ | 60$^{o}$ |
|---|---|---|---|
| Low wind speed class (< 5 m/s) | | | |
| I | -6.5 | 2.5 | 3.6 |
| II | -7.7 | 2.8 | 5.1 |
| III | -7.0 | 2.9 | 4.6 |
| High wind speed class ($\geq$ 5 m/s) | | | |
| I | -6.8 | 2.8 | 4.3 |
| II | -7.7 | 2.4 | 5.0 |
| III | -7.4 | 2.3 | 3.7 |

Table 6.--Mast-boom wind direction differences (in degrees) for the *Oceanographer* at selected relative wind directions

| Phase | 300$^{o}$ | 0$^{o}$ | 60$^{o}$ |
|---|---|---|---|
| Low wind speed class (< 5 m/s) | | | |
| I | 0.6 | -2.2 | -1.6 |
| II | 0.7 | -2.1 | -0.7 |
| III | -0.6 | -2.5 | -1.5 |
| High wind speed class ($\geq$ 5 m/s) | | | |
| I | 1.4 | -2.1 | -2.3 |
| II | 0.9 | -1.8 | -0.8 |
| III | 0.0 | -2.3 | -1.6 |

Linear Plots

For further examination of the mast-boom direction differences seen in the polar plots, linear plots of the average relative wind directions for the central angle of each $30^{\circ}$ window, based on Phase I data from the four ships, are shown in figures 20 to 23. In the case of the Researcher, for example, figure 20 indicates little differences between the mast and boom average wind directions at relative wind angles between 25 and $100^{\circ}$. The variations are considerable, however, in the "blind zone" between 100 and $250^{\circ}$, and approach $5^{\circ}$ at angles between 250 and $20^{\circ}$.

## 2.2 Differences Calculated by Method 2, With Emphasis on Variations in Wind Speed

When this study was begun, one hypothesis to be investigated was that the differences between the mast and boom wind speeds would increase with high wind speeds, and that this increase might be sudden as the true wind speeds reach a magnitude turning the flow over the ship from smooth to rough. To test this hypothesis, four fixed wind direction classes and 11 wind speed classes were defined based on the mast sensors. The mast wind directions were used in sorting the mast and boom wind speeds into one of the four quadrants shown in figure 24. The speeds were then further sorted into 11 subclasses based on the mast wind speeds, with 10 of the classes defined as 1 m/s increments between 0 and 10 m/s, and the 11th consisting of wind speeds $> 10$ m/s. For each class, average wind speed differences were calculated and differences from Phase to Phase in terms of the four wind direction quadrants were examined. These differences were also compared with wind speed differences computed from the logarithmic wind law

$$\Delta u = \frac{u_*}{k} \ell n \frac{z_2}{z_1} ,$$

where $\Delta u$ is the wind speed difference between the mast and the boom, k is von Karman's constant of 0.4, and $z_2$ and $z_1$ are the heights of the mast and boom sensors, respectively. The friction velocity $u_*$ was calculated from $u_* = (\tau/\rho)^{\frac{1}{2}}$, where $\tau$ is the surface stress, and $\rho$ is the air density: $\tau$ being computed from the bulk aerodynamic formula $\tau = \rho C_D u^2$, with a drag coefficient of $C_D = 1.5 \times 10^{-3}$.

Figure 25 shows the Researcher mast-boom wind speed differences in Phase I for quadrant 1. Except at wind speeds $< 1$ m/s, the differences increase nearly linearly. This figure also shows that the differences predicted by the neutral log wind law are greater than the mast-boom differences computed from the data, and that this discrepancy increases with higher wind speeds. Similar plots for the Gilliss, Dallas, and Oceanographer in figures 26, 27, and 28, respectively, also support the fact that the differences increase with increasing wind speed but not as rapidly as predicted by the log wind law. The curves for the Gilliss and Dallas are not as smooth as those for the Researcher and Oceanographer. In the case of the Gilliss, the variations seen at high wind speeds are attributable to the small sample used in calculating the averages, and the sharp deviations in the Dallas Phase III data are the result of a faulty boom sensor.

For the other wind direction quadrants, results vary from ship to ship. The curves for the Researcher for quadrant 2, plotted in figure 29, are similar to those for quadrant 1 (fig. 25), while for the Gilliss the quadrant 2 results in figure 30 suggest a more rapid increase in mast-boom wind speed differences at speeds > 7 m/s during all three Phases than predicted by the log wind law. The reason may lie in a change of flow from smooth to rough, with an obstruction on the ship becoming more prominent. The data sample used is too small, however, to determine the cause of the discrepancies, and the limited sampling in itself may have affected the computations.

The quadrant 4 mast-boom wind speed differences for the Dallas, shown in figure 31, are greater than the theoretical differences calculated from the log wind law, which implies that for this wind direction quadrant some part of the ship acts as an obstruction, increasing the differences between the measurements by the two sensors at higher wind speeds.

As seen in figure 32, the results for quadrant 2 in the case of the Oceanographer do not differ noticeably from those for quadrant 1. The larger differences at high wind speeds (fig. 28) probably stem from the limited number of observations.

## 3. INFLUENCE OF ATMOSPHERIC STABILITY ON WIND SPEED DIFFERENCES

Atmospheric boundary layer stability is linked by definition with the vertical gradients of temperature and wind speed. To determine whether the mast-boom wind speed differences are a function of atmospheric stability, these differences were calculated and plotted in terms of 10 stability classes, based on Researcher Phase III data. Stability was calculated from the bulk Richardson equation (Deacon and Webb, 1962)

$$R_B = \frac{gz}{T} \frac{\Gamma_h}{\Gamma_m^2} \frac{\Theta_o - \Theta_a}{u_a^2},$$

where g is the acceleration of gravity, z is the height of the sensors above sea level, $\Gamma_m$ and $\Gamma_h$ are the profile coefficients for wind and temperature, respectively, $\Theta_o$ is the potential sea surface temperature, $\Theta_a$ is the potential temperature of the air at the level of the boom sensor, and $u_a$ is the wind speed at the boom sensor level.

To isolate the effect of stability, the average mast-boom wind speed differences were subtracted from the speed differences of each stability class. These average speed differences were derived from figure 25 in section 2.2. The results show that the mast-boom differences decrease monotonically from

0.4 m/s to less than 0.1 m/s with increasing atmospheric instability. Figure 33 also shows that sea-air temperature differences first increase sharply from 0.7°C to 2.1°C and then drop off to approximately 1.8°C in the Phase III Researcher data.

## 4. SUMMARY

In this study, differences in mast and boom wind speed measurements aboard four U.S. GATE ships have been examined as a function of relative wind direction and as a function of two wind speed classes (< 5 m/s and ≥ 5 m/s). The results show differences ranging from 0 to 1 m/s for relative wind directions ranging from 270 through 0 to 90°, with difference patterns being consistent from Phase to Phase and from the low wind speed class to the high wind speed class. These difference patterns indicate that wind measurements are very sensitive to permanent ship obstructions, and the plots presented here of average mast and boom wind speeds for the two wind speed classes (cf. figs. 12-15) help delineate the relative wind directions for which the effect of such obstructions is most pronounced.

All four ships were found to have a "blind zone" ranging from at least 120 to 240° due to the ships' masts, the stacks, and other equipment. The size of this zone is nearly the same for both the mast and the boom sensors. There are obstacles, however, that influence the two sensors differently. An example is the Gilliss (cf. fig. 13), where an obstacle on the ship appears to make winds measured on the boom increase sharply in comparison with the mast measurements. Because the mast wind velocities were used in this study as the reference data set, these anomalies seem to lie in the boom data, when, in fact, they may be attributable to the mast data. The mast wind speeds are apt to be more suspect than the boom speeds because the mast sensor on the Gilliss was mounted on a catwalk to the left of the mast; the wind speeds corresponding to relative wind directions of 90° would be influenced by the mast, causing a drop in the speeds measured by the mast sensor and, hence, an apparent increase in the boom wind speeds. Had the boom speeds been used as the reference data set, the anomaly would have appeared in the mast data.

Similarly, the patterns derived for wind direction differences of ± 15° are also consistent from Phase to Phase and almost identical for both wind speed classes. The abrupt changes in average directions (cf. figs. 20-23) indicate that wind direction measurements are also sensitive to ship obstructions. Pronounced variations are found in the "blind zone," and at some angles the mast and boom sensors are not influenced in the same way.

It has been illustrated that the mast-boom wind speed differences increase almost linearly with increasing wind speed and for relative wind directions from 315 through 0 to 45°, but the increase is smaller than would be expected from calculations based on the neutral log wind law. For other wind directions, the reverse is true in some cases. The differences based on the Gilliss and Dallas data show a more rapid increase than predicted by the log wind law, undoubtedly as a result of ship obstructions.

Results also indicate that atmospheric stability is related to the vertical gradient between the mast and boom sensors, with increasing instability being accompanied by a decrease in the vertical wind gradient.

## 5. CONCLUSIONS

The large volume of wind velocity data collected aboard the U.S. ships during the three GATE observation Phases provide an unusually good opportunity for studying differences in wind velocities as measured on the forward masts and on the ships' bow booms. The sensors were identical in design and were carefully calibrated both before and after the experiment.

The results of this study indicate that the quality of the wind data is dependent upon sensor location, the superstructure of the ship, and the relative wind direction and wind speed. The average wind speeds as measured by the mast and boom sensors also suggest that sensors mounted on the boom do not necessarily yield more reliable measurements than those on the mast. On the *Researcher* and *Oceanographer*, for which the data are as good in quality as one could hope to obtain aboard ship, the mast sensors were mounted on small horizontal masts extending forward of the main mast. The differences in the mast and boom wind speed measurements on these two ships were small, and variations at relative wind directions from 270 through 0 to 90$^o$ were not large. Neither of these two data sets supports the theory that relative wind directions normal to the ship significantly affect the mast-boom wind differences. On the *Gilliss* and *Dallas*, in contrast, ship obstructions affected the mast measurements more strongly, as borne out by the results presented here.

Without an absolute measure of wind speeds and directions, it is difficult to say which sensors, mast or boom, most precisely respond to real wind variations. However, this study suggests that both mast and boom sensors can be mounted to yield reasonably good wind observations for relative wind directions from 270 through 0 to 90$^o$, and that the attitude of the ship should be maintained so as to keep the relative wind direction between these angles.

Finally, without prior knowledge of how wind speeds increase with height, it is probably impossible to precisely correct mast wind speeds to 10 m for bulk flux computations. If at some time during an experiment, however, one can determine the expected differences between the mast and boom data as a function of wind speed, relative wind direction, and atmospheric stability, it would be possible to correct the mast wind velocities to the level of the boom observations. This requires that the wind speed, ship's heading, and atmospheric stability be given. It is, therefore, important in future meteorological experiments that ship heading data be retained as a part of the basic data set.

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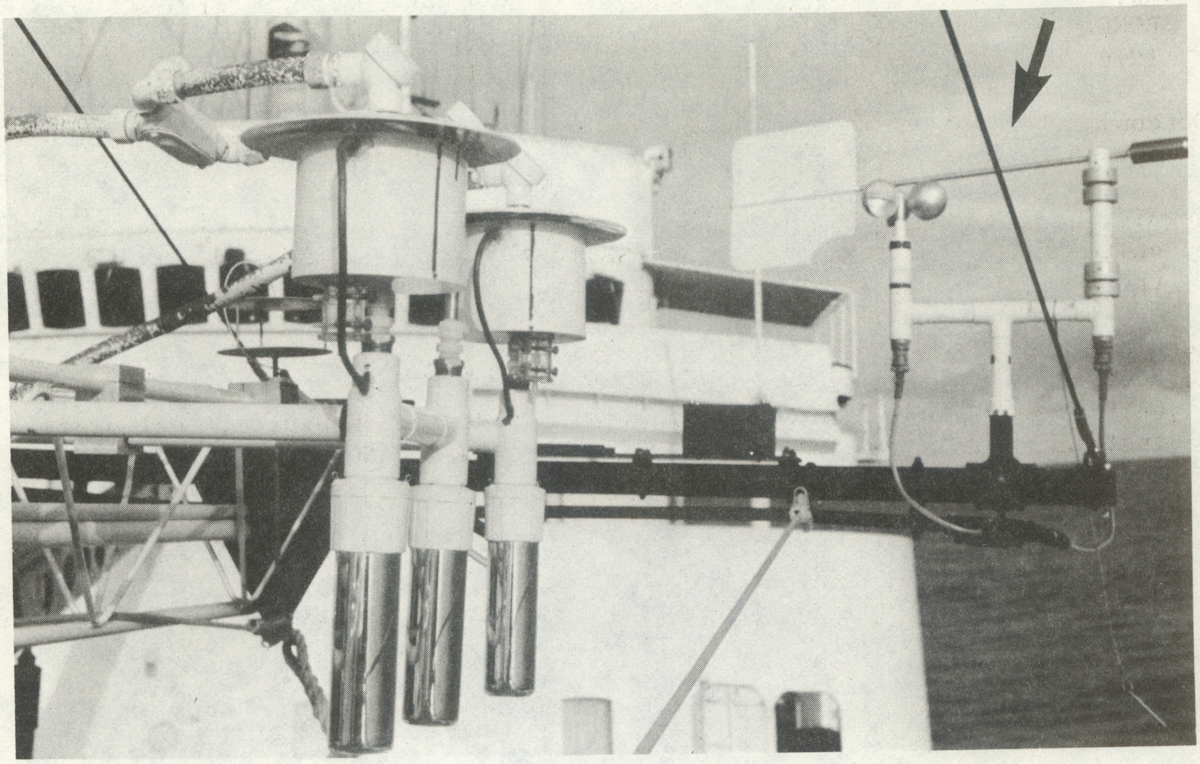

Figure 1.--Microvane and cup anemometer.

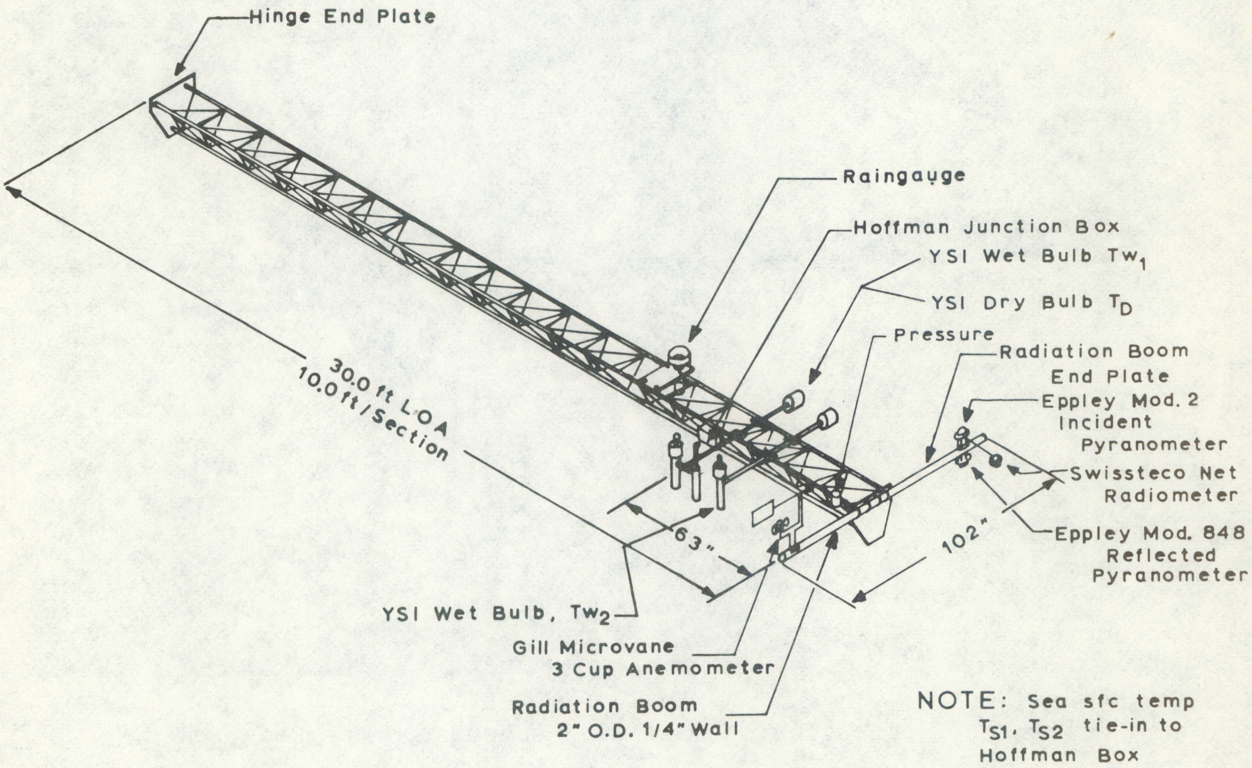


Figure 2.--Schematic of the bow boom.

Figure 3.--Location of mast wind sensors on the Researcher.

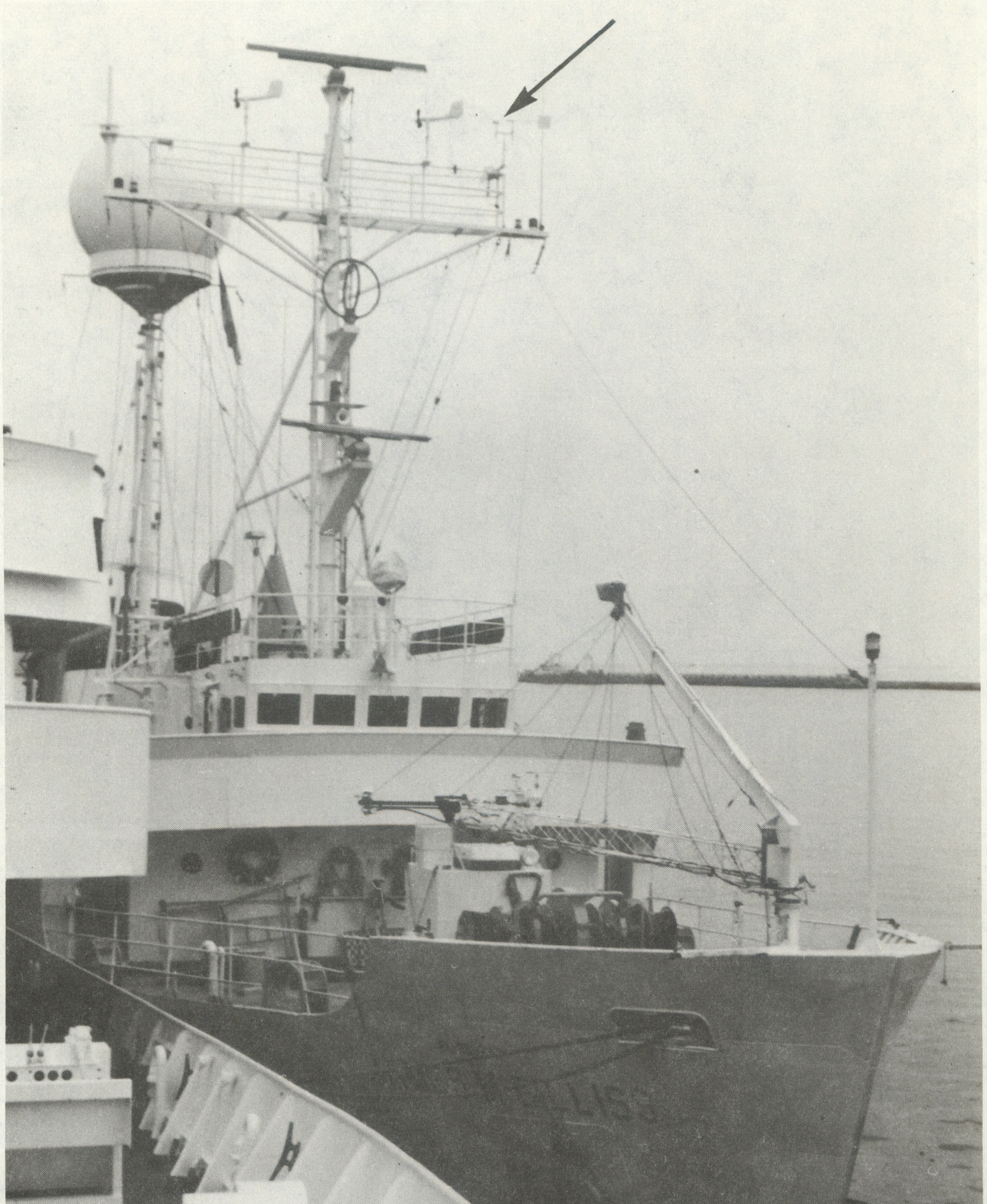

Figure 4.--Location of mast wind sensors on the Gilliss.

Figure 5.--Location of mast wind sensors on the Dallas.

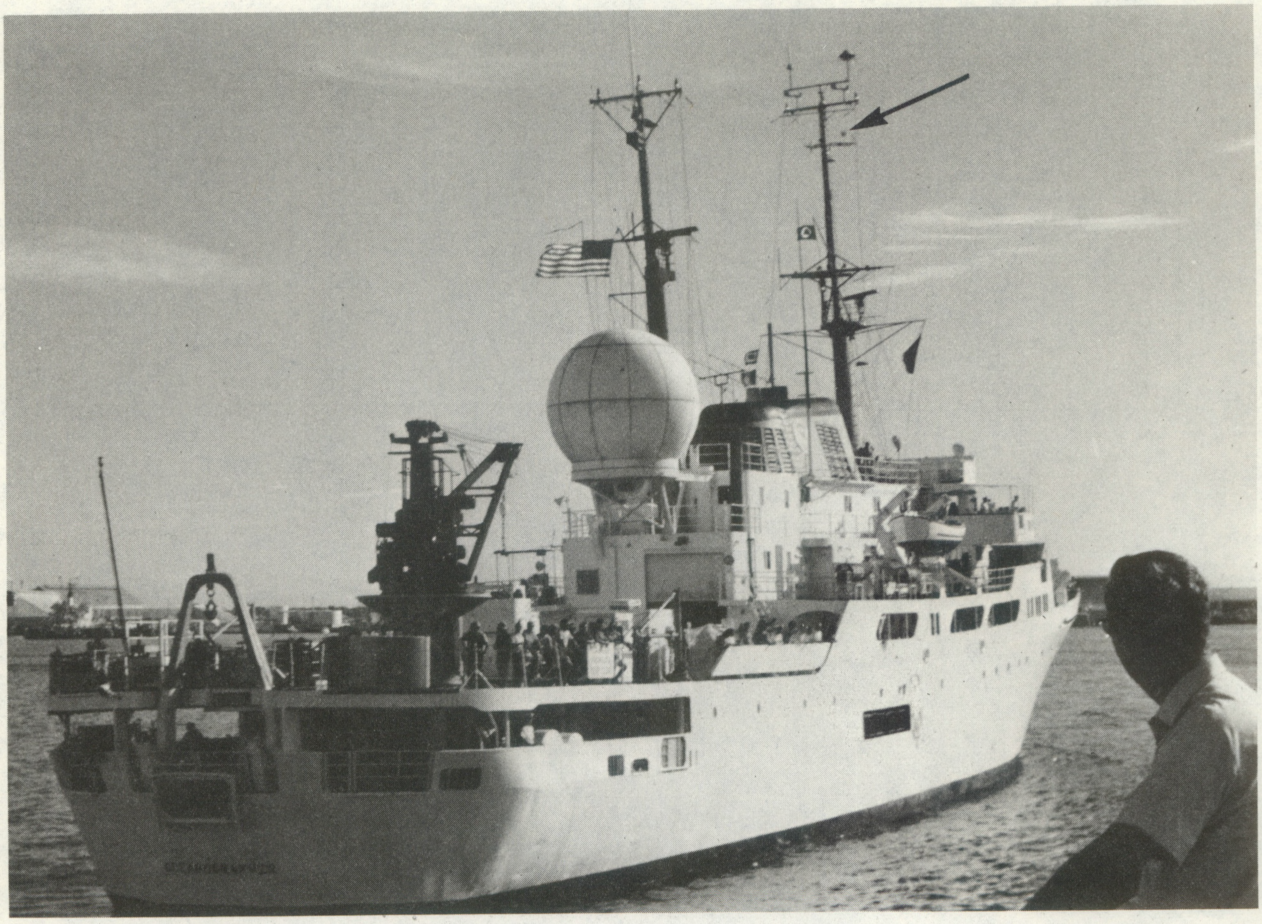

Figure 6.--Location of mast wind sensors on the Oceanographer.

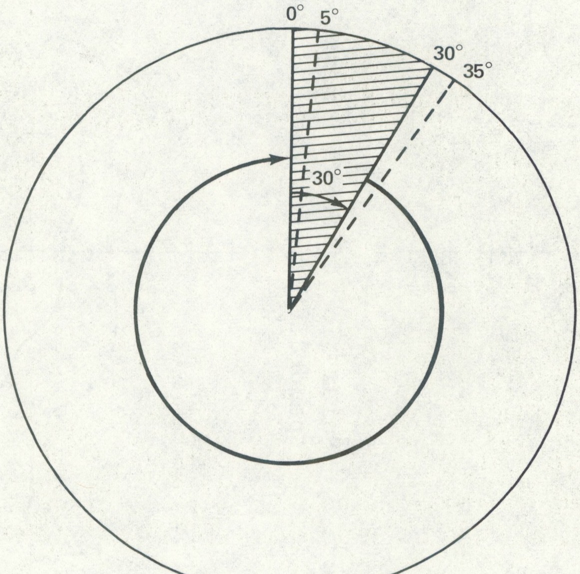


Figure 7.--Schematic of 30° window for sorting wind velocity data.

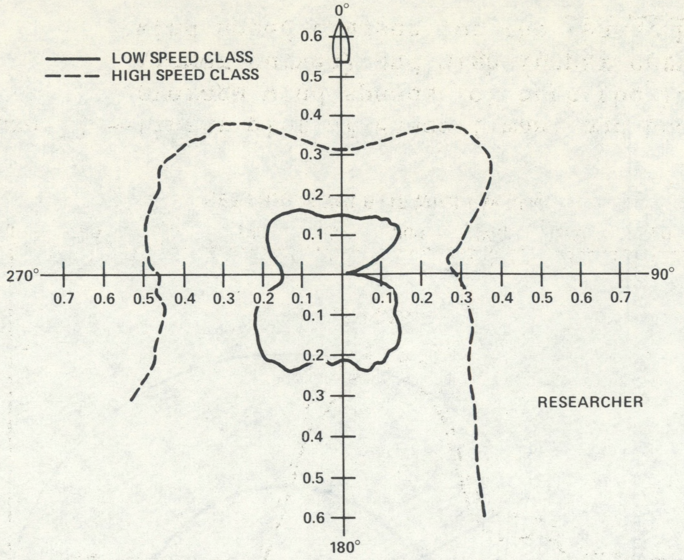


Figure 8.--Polar plot of Phase I mast-boom wind speed differences for the Researcher.

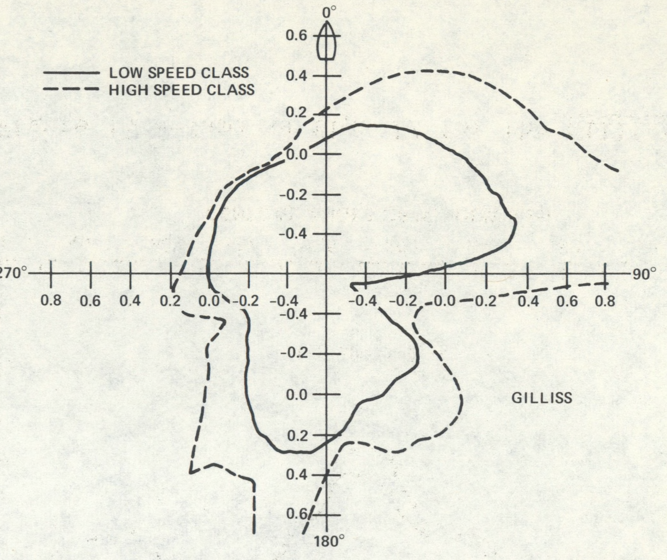


Figure 9.--Same as fig. 8 for the Gilliss.

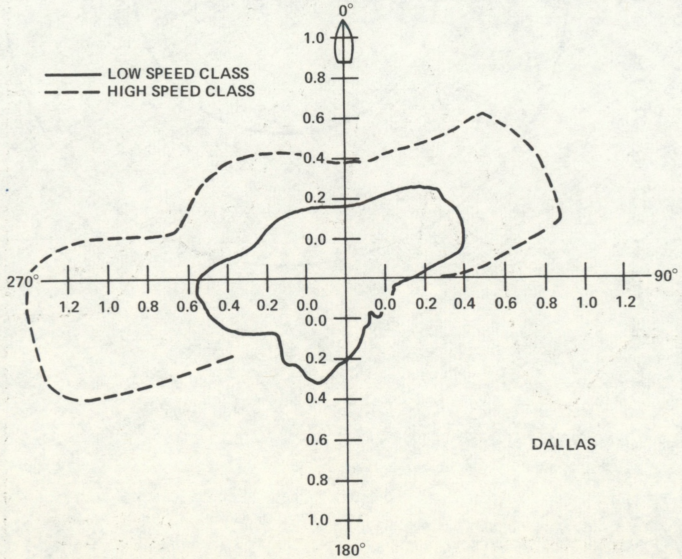


Figure 10.--Same as fig. 8 for the Dallas.

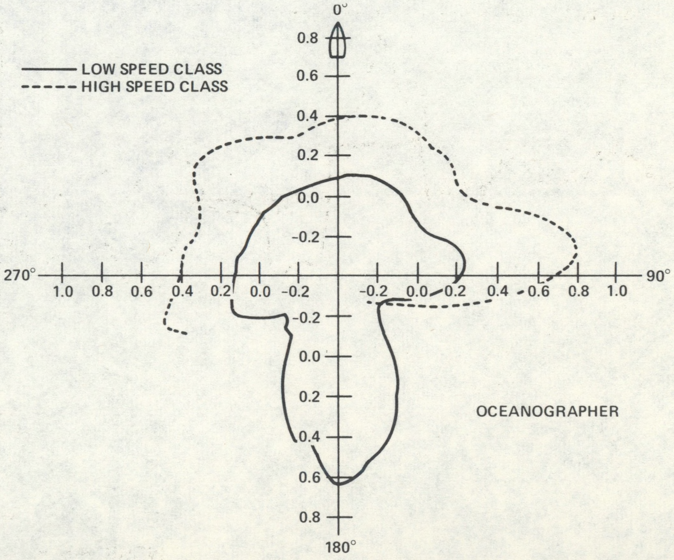


Figure 11.--Same as fig. 8 for the Oceanographer.

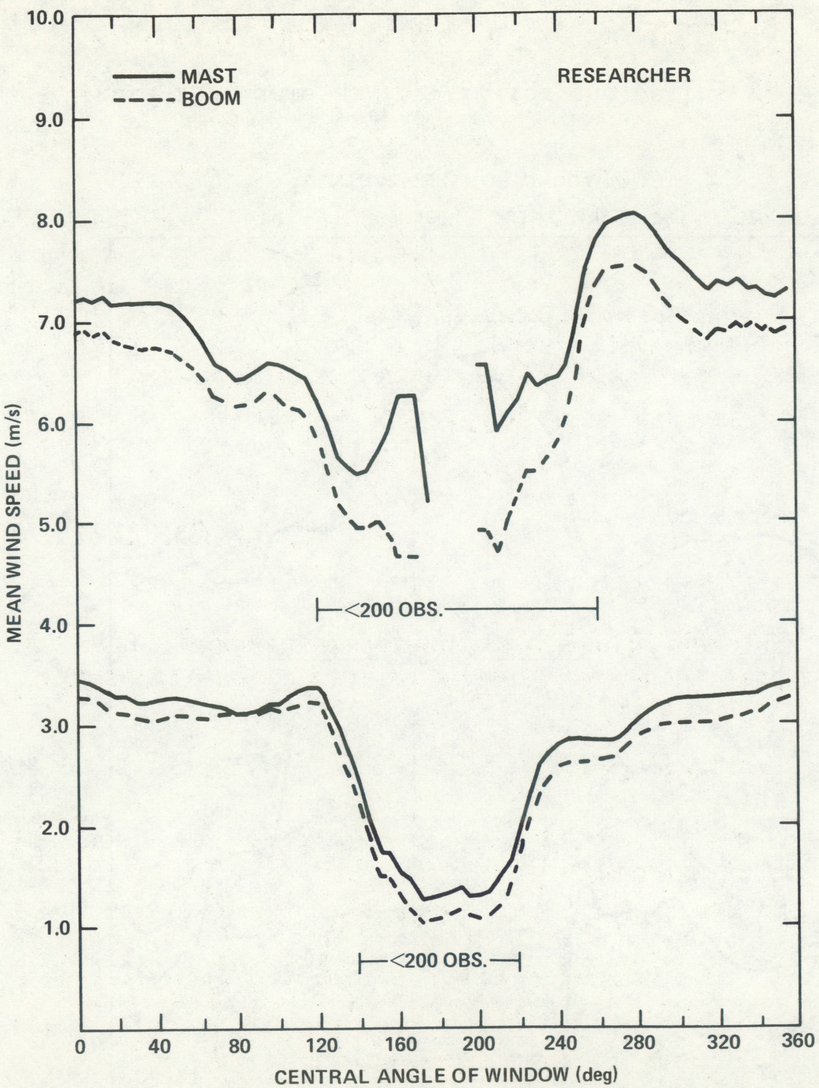


Figure 12.--Linear plot of Phase I mast and boom average wind speeds for both the low (lower curves) and high (upper curves) wind speed classes for the Researcher.

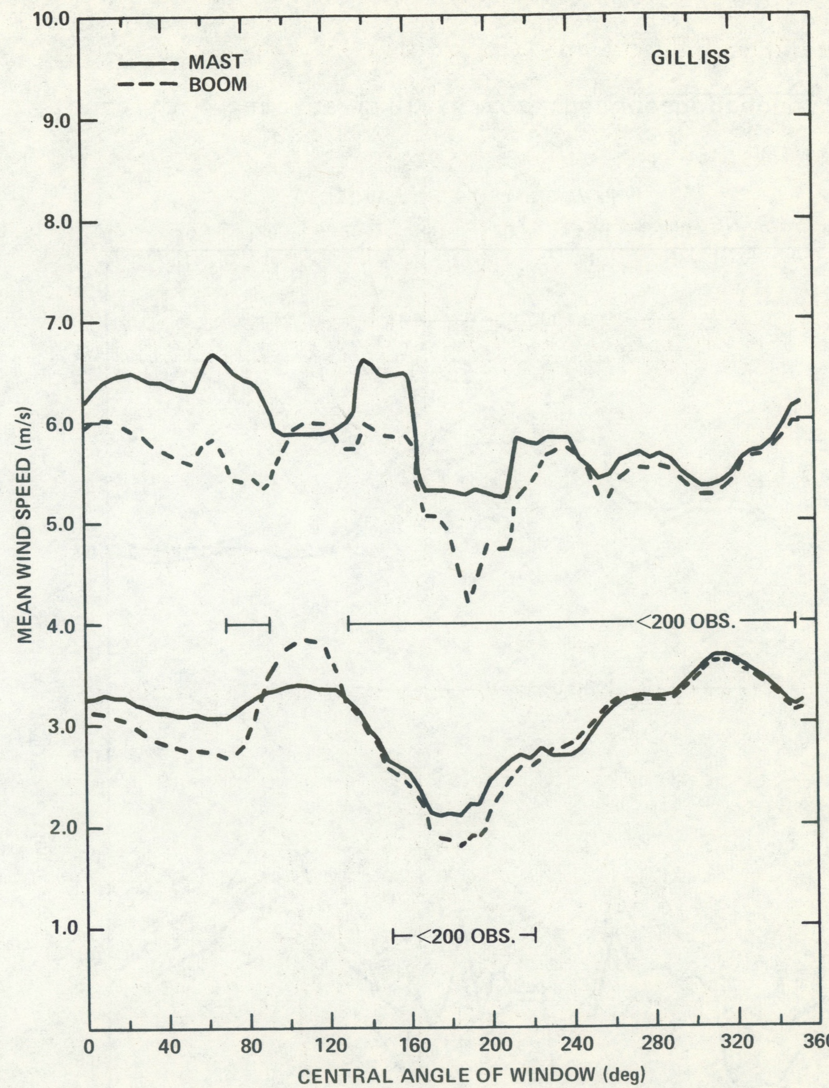


Figure 13.--Same as fig. 12 for the Gilliss.

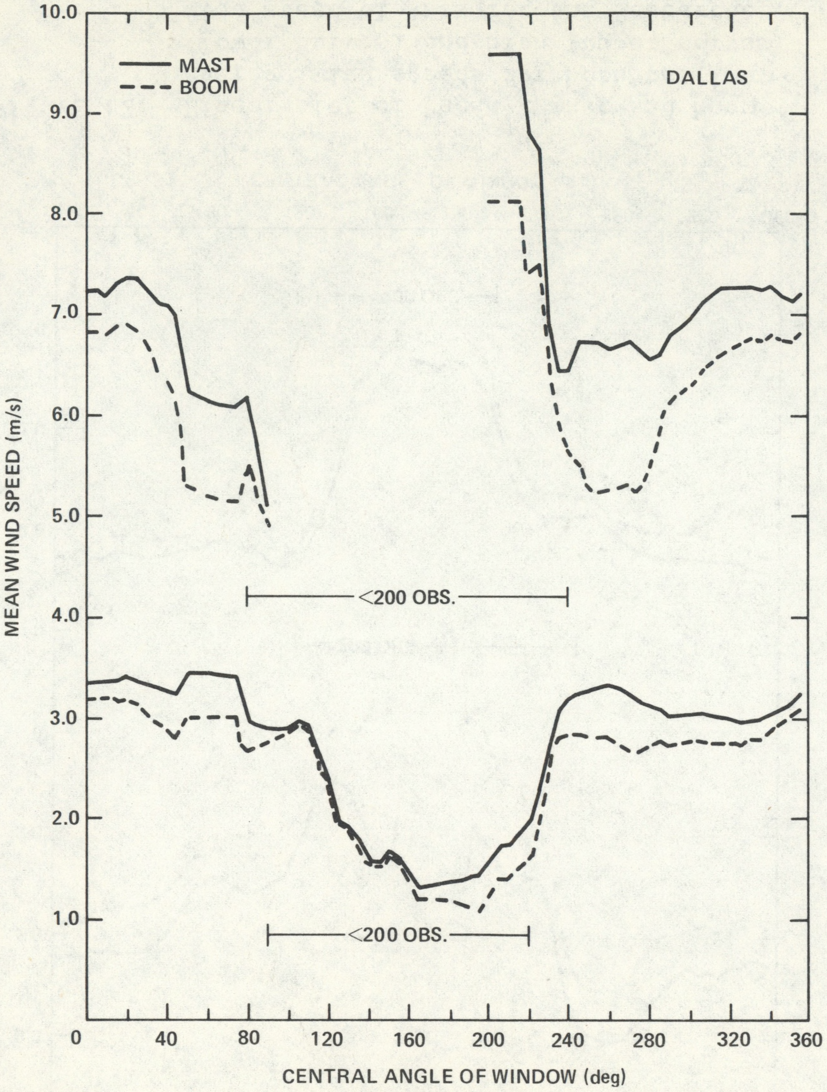


Figure 14.--Same as fig. 12 for the Dallas.

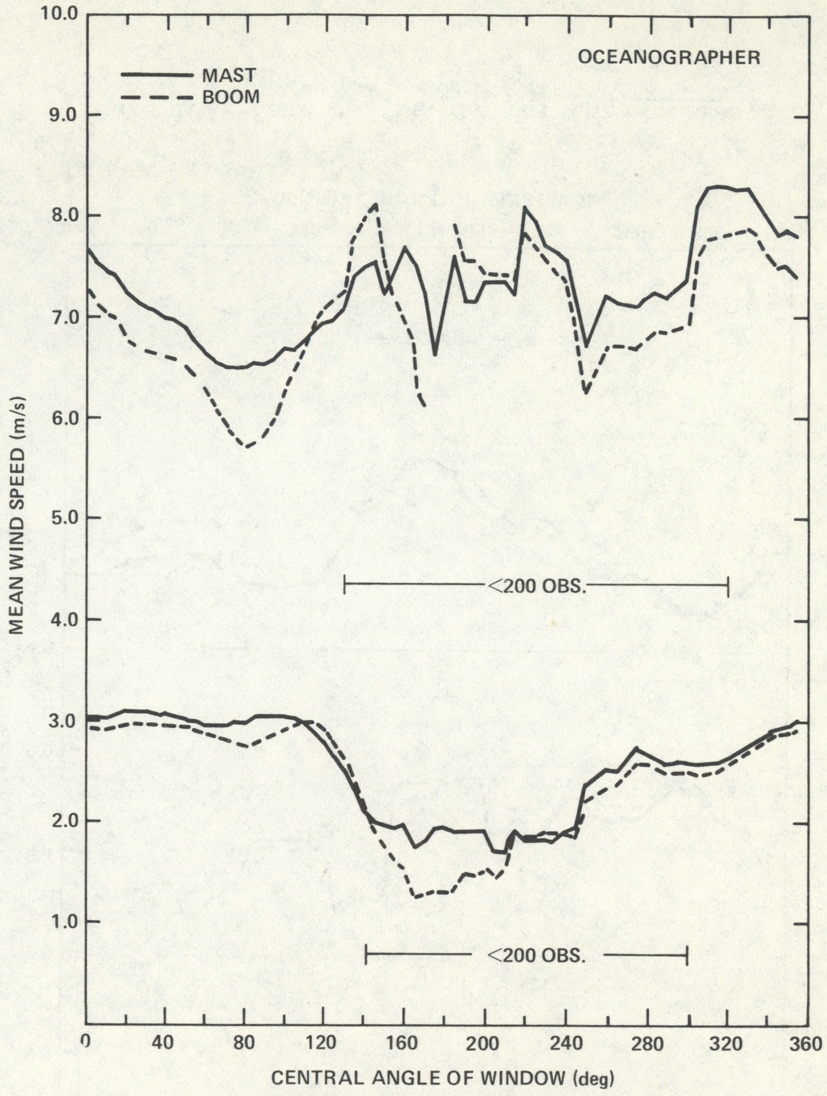


Figure 15.--Same as fig. 12 for the Oceanographer.

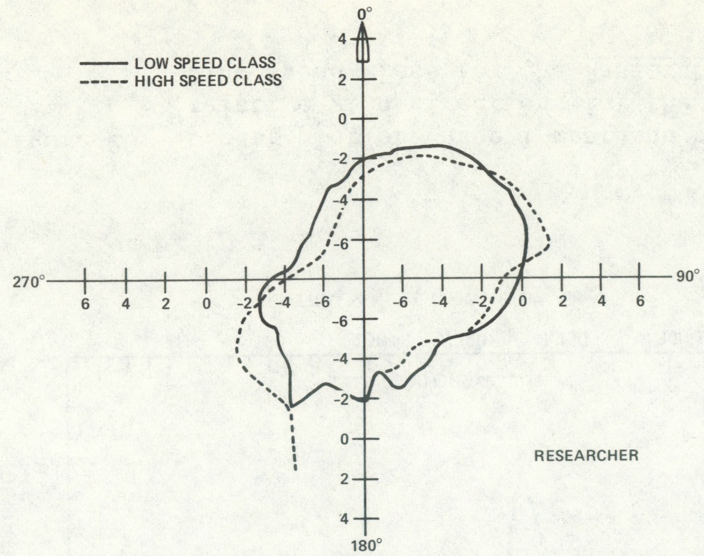


Figure 16.--Polar plot of Phase I mast-boom wind direction differences for the Researcher.

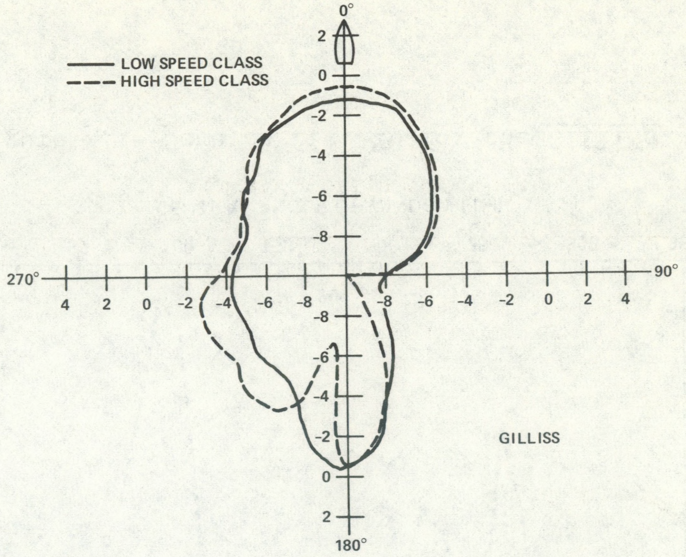


Figure 17.--Same as fig. 16 for the Gilliss.

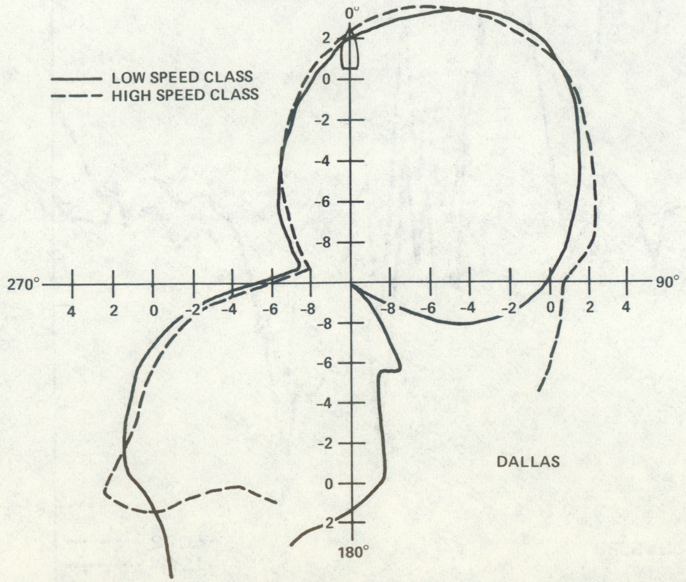


Figure 18.--Same as fig. 16 for the Dallas.

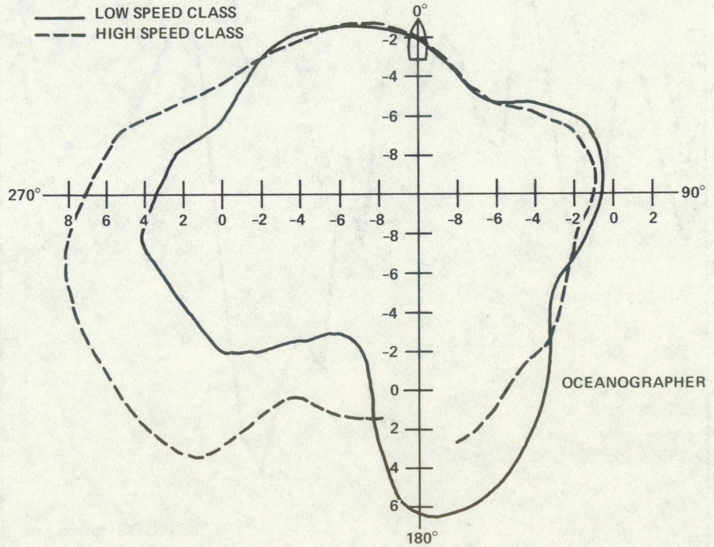


Figure 19.--Same as fig. 16 for the Oceanographer.

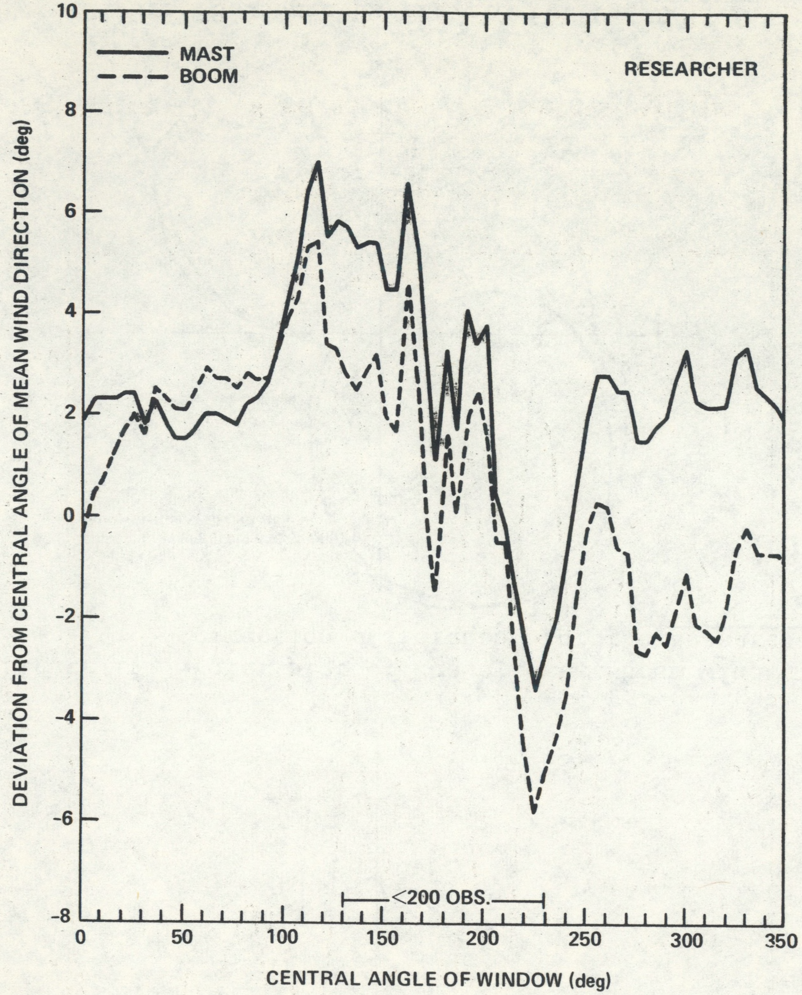


Figure 20.--Linear plot of Phase I mast and boom relative wind directions for the low wind speed class for the Researcher.

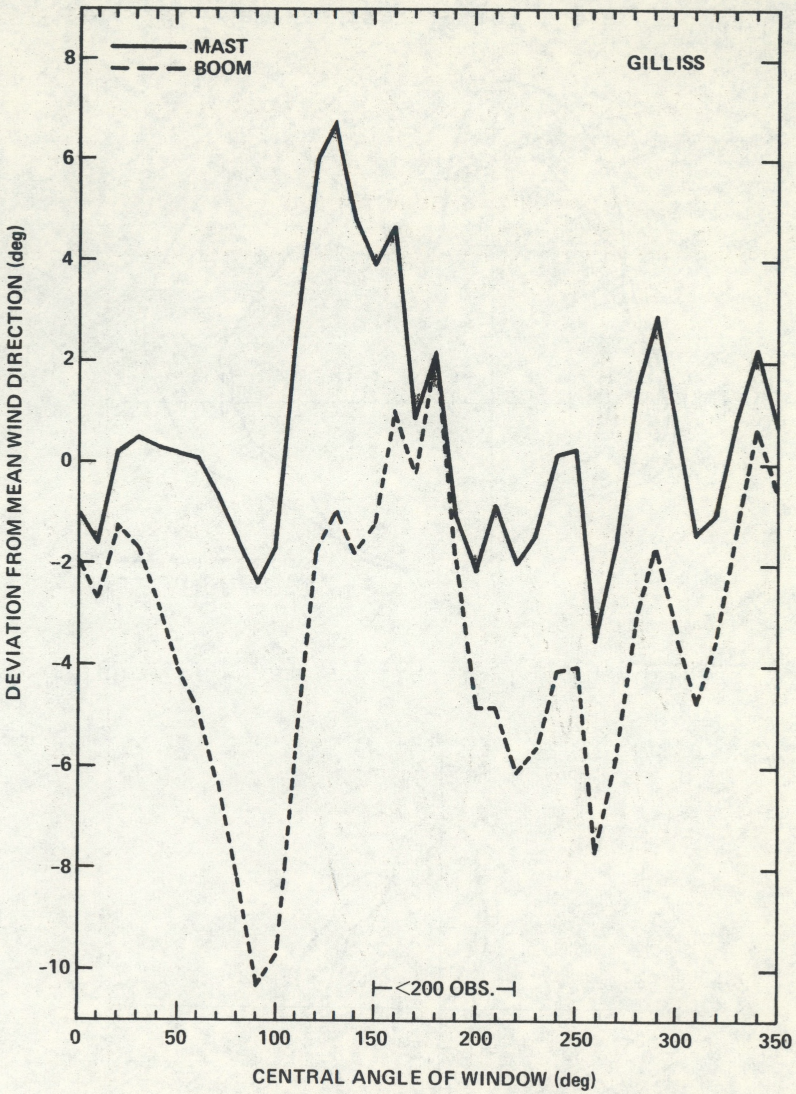


Figure 21.--Same as fig. 20 for the Gilliss.

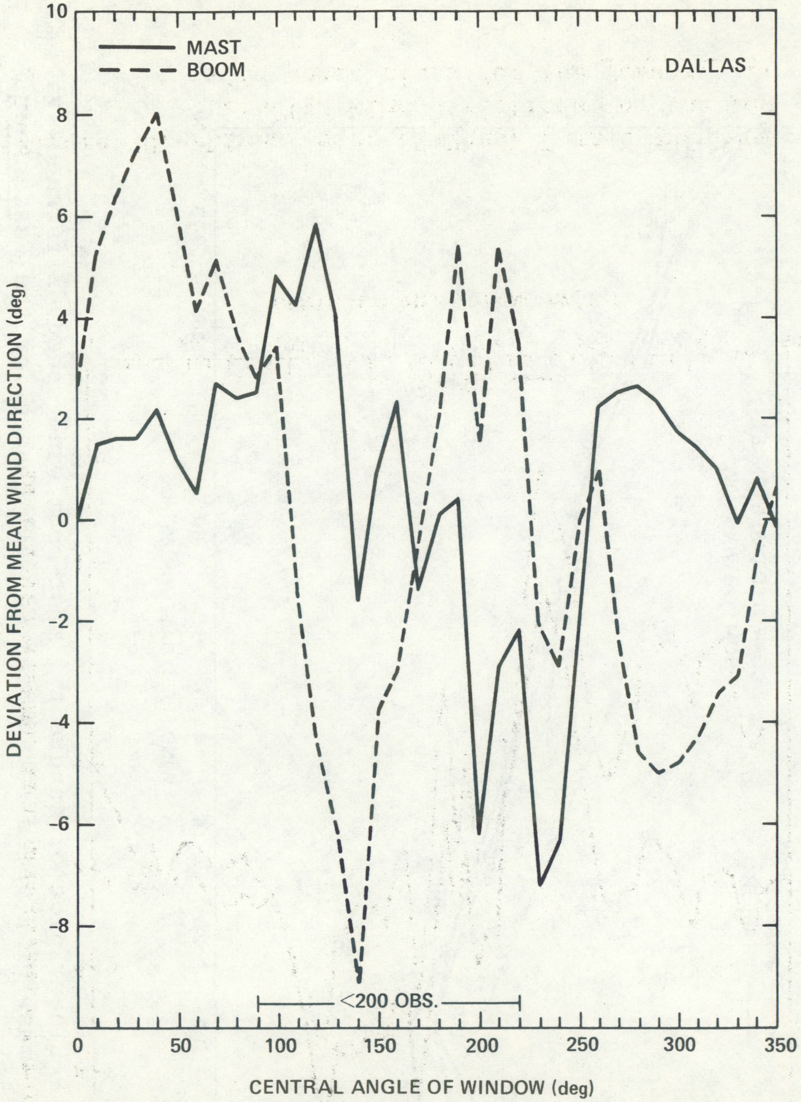


Figure 22.--Same as fig. 20 for the Dallas.

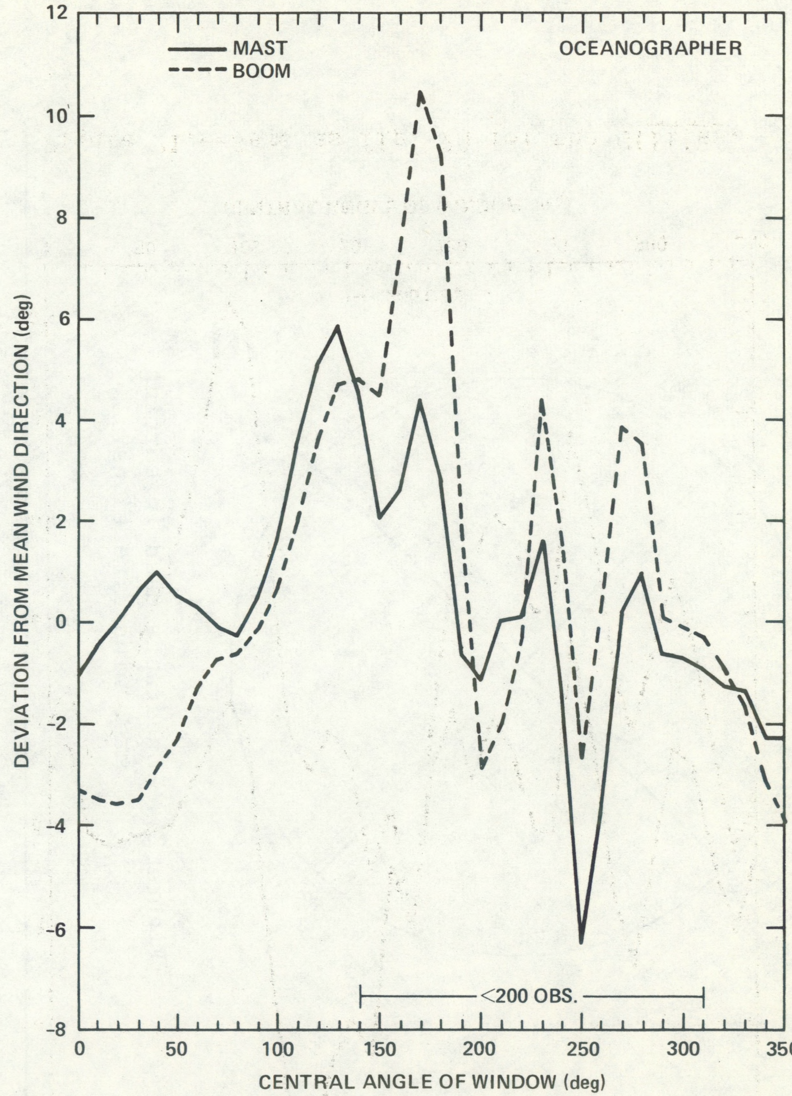


Figure 23.--Same as fig. 20 for the Oceanographer.

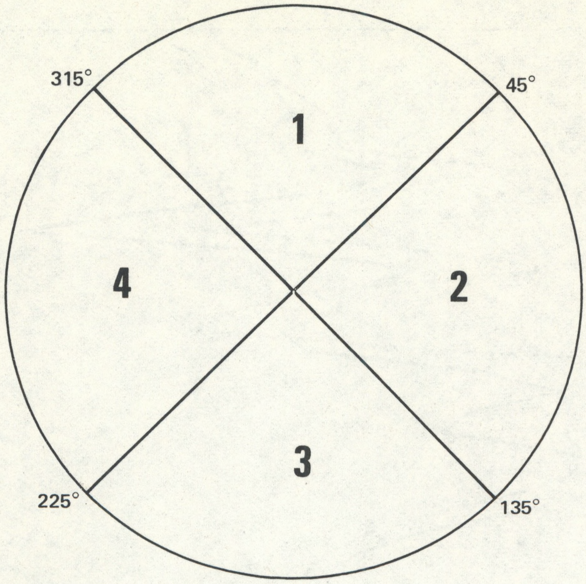


Figure 24.--Quadrants used in sorting mast wind directions.

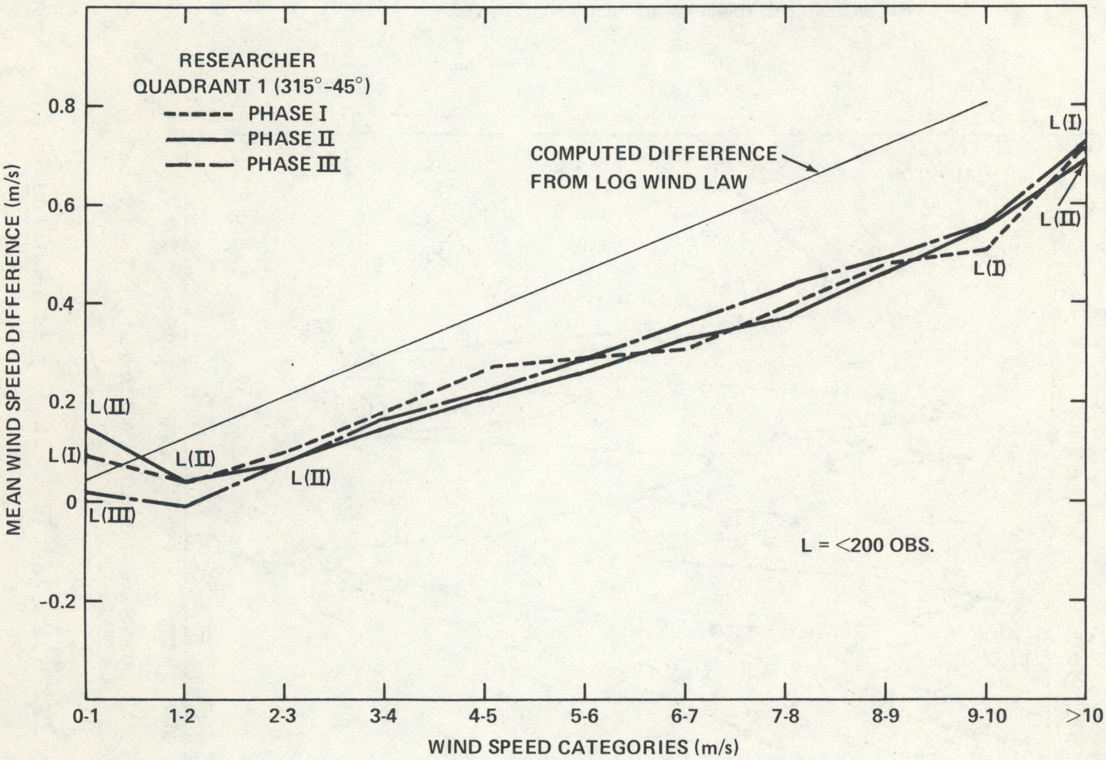


Figure 25.--Linear plot of quadrant 1 mast-boom wind speed differences vs. mast wind speed categories for all Phases for the Researcher.

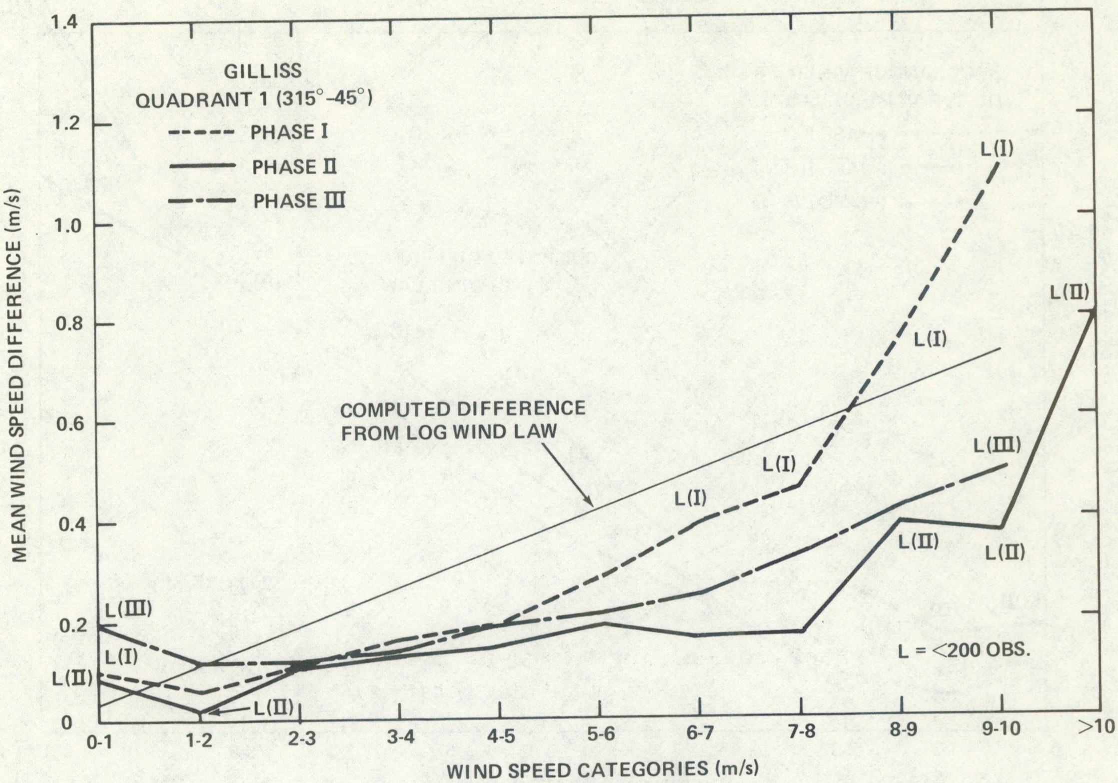


Figure 26.--Same as fig. 25 for the Gilliss.

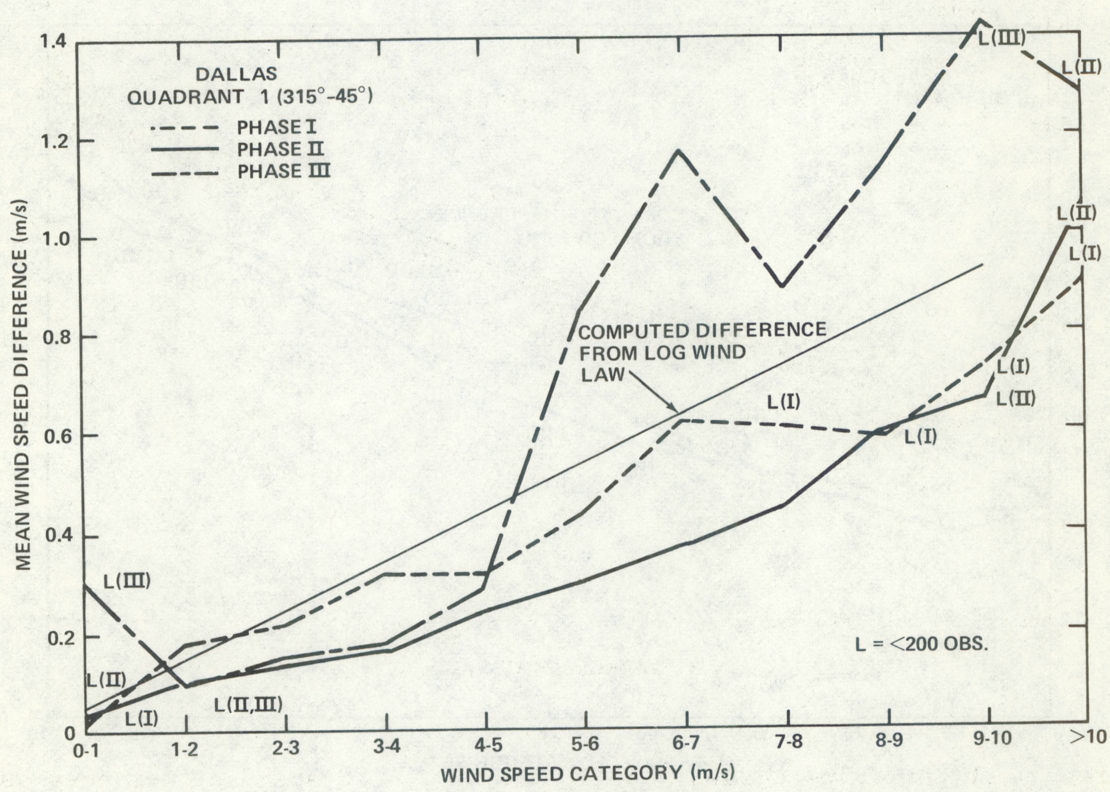


Figure 27.--Same as fig. 25 for the Dallas.

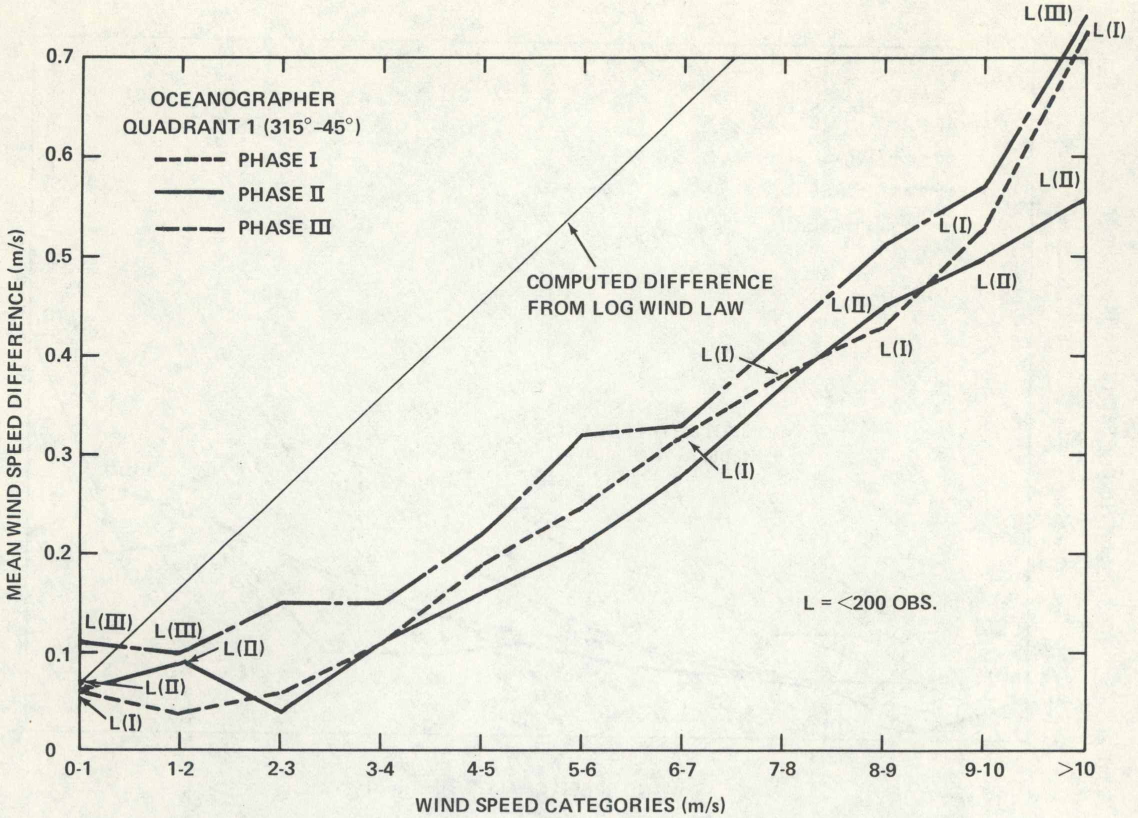


Figure 28.--Same as fig. 25 for the Oceanographer.

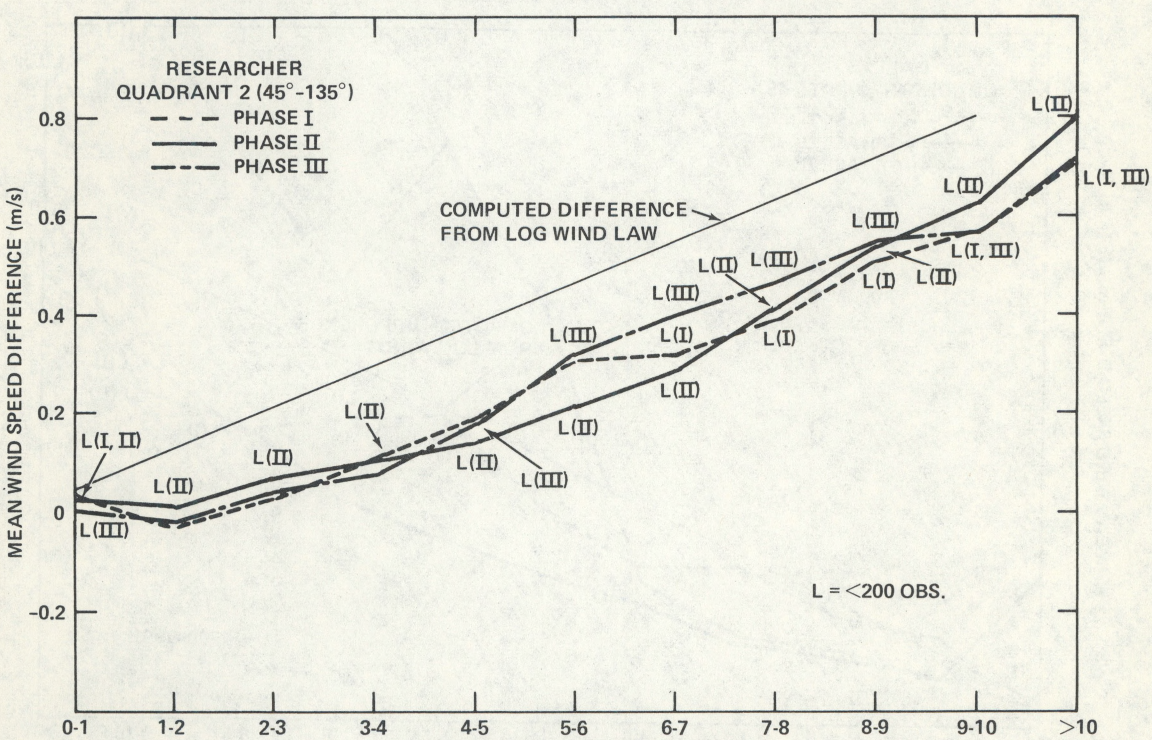


Figure 29.--Linear plot of quadrant 2 mast-boom wind speed differences vs. mast wind speed categories for all Phases for the Researcher.

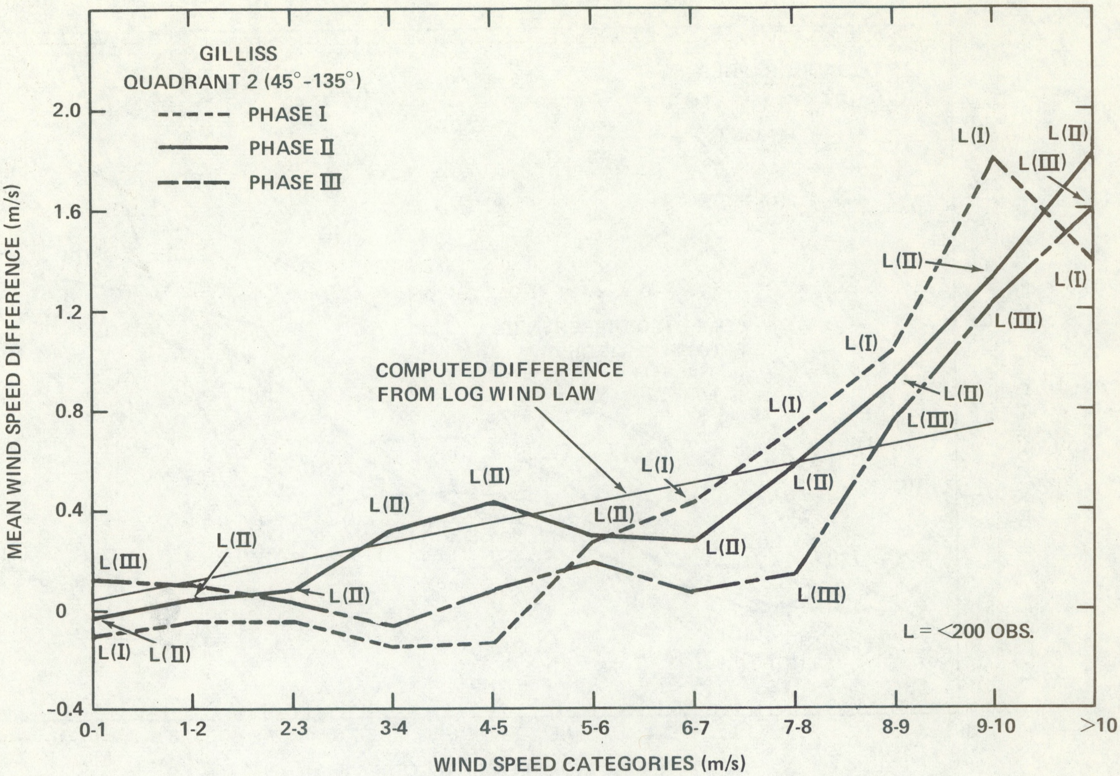


Figure 30.--Same as fig. 29 for the Gilliss.

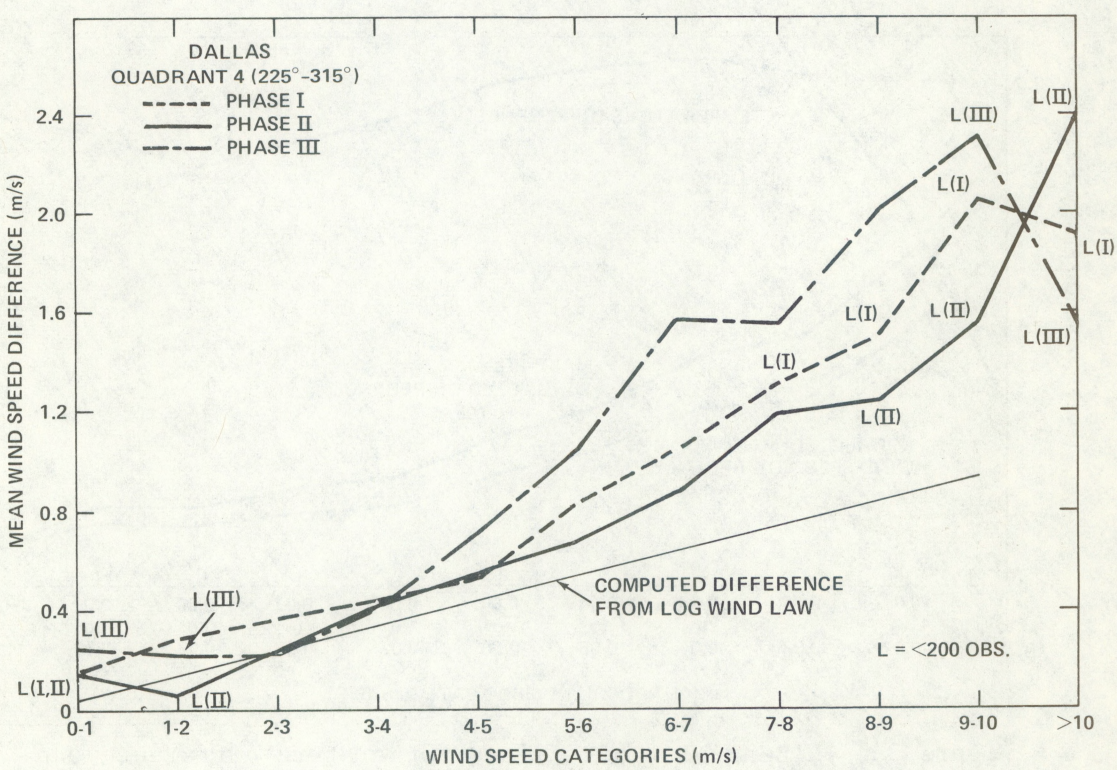


Figure 31.--Same as fig. 29, quadrant 4, for the Dallas.

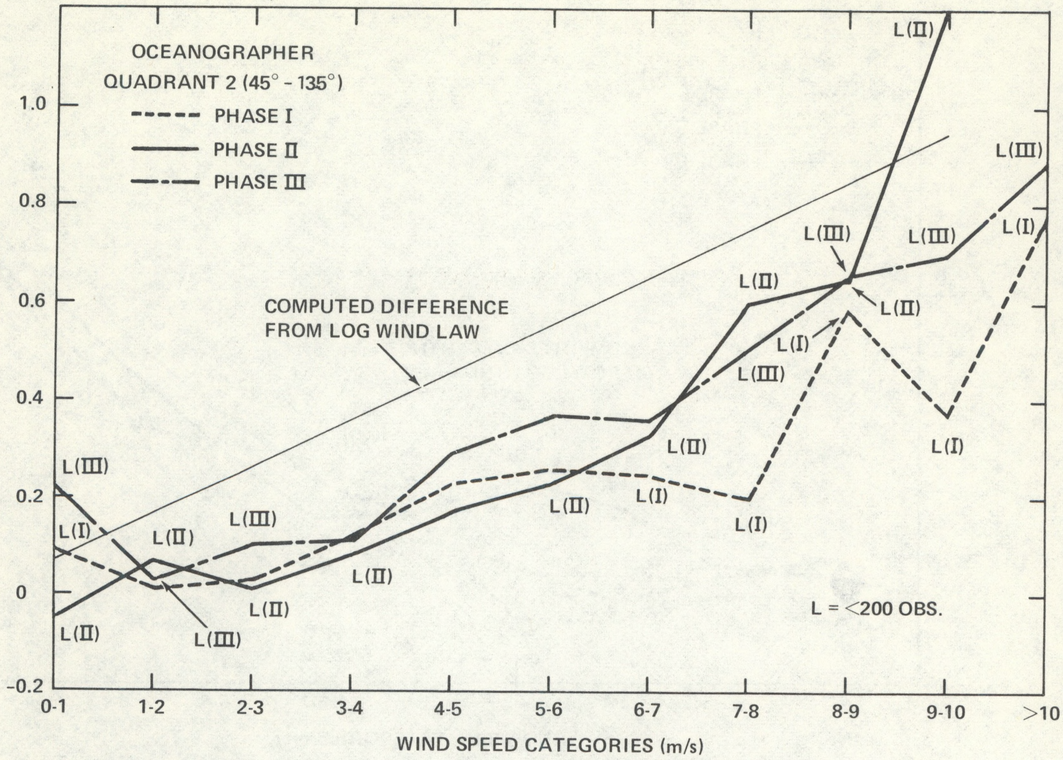


Figure 32.--Same as fig. 29 for the Oceanographer.

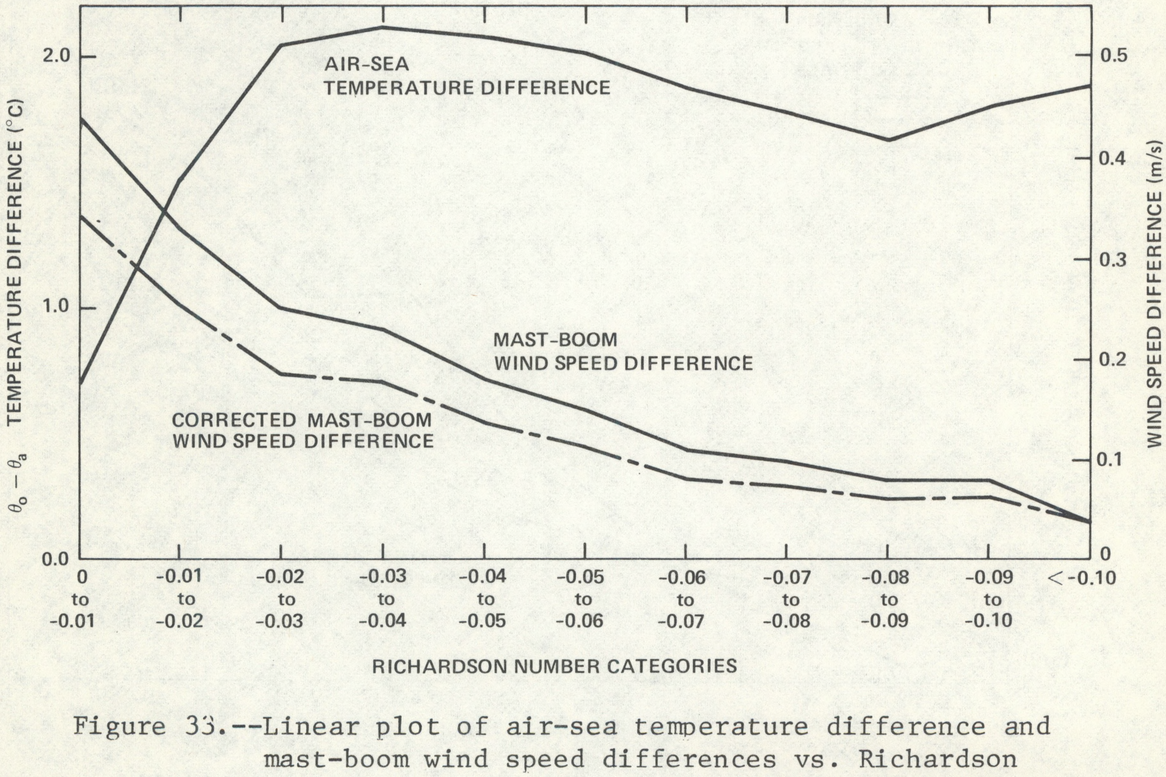


Figure 33.--Linear plot of air-sea temperature difference and mast-boom wind speed differences vs. Richardson number categories for the Researcher, Phase III.

# APPENDIX

## RESEARCHER - PHASE I

| WINDOW | SPEED: LOW WIND SPEEDS: NO. OBSER-VATIONS | SPEED: LOW WIND SPEEDS: MEAN MAST SPEED | SPEED: LOW WIND SPEEDS: MEAN SPEED DIFF. | SPEED: HIGH WIND SPEEDS: NO. OBSER-VATIONS | SPEED: HIGH WIND SPEEDS: MEAN MAST SPEED | SPEED: HIGH WIND SPEEDS: MEAN SPEED DIFF. | DIRECTION: LOW WIND SPEEDS: NO. OBSER-VATIONS | DIRECTION: LOW WIND SPEEDS: MEAN MAST DIR. | DIRECTION: LOW WIND SPEEDS: MEAN DIR. DIFF. | DIRECTION: HIGH WIND SPEEDS: NO. OBSER-VATIONS | DIRECTION: HIGH WIND SPEEDS: MEAN MAST DIR. | DIRECTION: HIGH WIND SPEEDS: MEAN DIR. DIFF. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 515 | 3.5 | 0.2 | 831 | 7.2 | 0.3 | 505 | 0.1 | -2.2 | 831 | 0.7 | -2.7 |
| 10 | 524 | 3.4 | 0.2 | 827 | 7.2 | 0.3 | 513 | 9.7 | -1.5 | 827 | 7.6 | -2.2 |
| 20 | 542 | 3.3 | 0.2 | 707 | 7.2 | 0.4 | 532 | 19.6 | -0.7 | 707 | 18.4 | -1.4 |
| 30 | 549 | 3.3 | 0.2 | 630 | 7.1 | 0.4 | 533 | 30.2 | -0.1 | 630 | 29.8 | -0.8 |
| 40 | 580 | 3.2 | 0.2 | 588 | 7.3 | 0.5 | 570 | 40.1 | 0.4 | 588 | 38.2 | -0.3 |
| 50 | 645 | 3.3 | 0.2 | 506 | 7.2 | 0.5 | 620 | 50.5 | 0.6 | 497 | 47.8 | 0.4 |
| 60 | 684 | 3.2 | 0.1 | 391 | 6.9 | 0.4 | 660 | 60.0 | 0.9 | 382 | 58.1 | 1.2 |
| 70 | 770 | 3.2 | 0.1 | 291 | 6.6 | 0.3 | 741 | 70.1 | 0.8 | 282 | 66.4 | 1.5 |
| 80 | 793 | 3.1 | 0.0 | 197 | 6.5 | 0.3 | 775 | 79.8 | 0.6 | 197 | 76.3 | 0.8 |
| 90 | 842 | 3.1 | 0.0 | 206 | 6.5 | 0.3 | 827 | 89.4 | 0.1 | 206 | 92.7 | -0.7 |
| 100 | 716 | 3.2 | 0.1 | 265 | 6.6 | 0.3 | 702 | 97.9 | -0.4 | 265 | 102.0 | -1.3 |
| 110 | 531 | 3.3 | 0.1 | 266 | 6.4 | 0.3 | 520 | 105.6 | -1.1 | 266 | 106.8 | -1.6 |
| 120 | 324 | 3.4 | 0.2 | 182 | 6.2 | 0.4 | 313 | 116.5 | -2.1 | 182 | 114.4 | -2.1 |
| 130 | 209 | 3.0 | 0.2 | 78 | 5.6 | 0.4 | 185 | 126.3 | -2.9 | 78 | 123.2 | -3.0 |
| 140 | 173 | 2.4 | 0.2 | 32 | 5.4 | 0.5 | 135 | 136.6 | -2.5 | 32 | 130.4 | -3.6 |
| 150 | 126 | 1.7 | 0.2 | 7 | 5.7 | 0.7 | 79 | 147.5 | -2.5 | 7 | 144.1 | -3.4 |
| 160 | 112 | 1.5 | 0.2 | 2 | 6.2 | 1.6 | 63 | 155.4 | -2.1 | 2 | 158.5 | -3.0 |
| 170 | 93 | 1.2 | 0.2 | 2 | 6.2 | 1.6 | 45 | 168.7 | -3.2 | 2 | 158.5 | -3.0 |
| 180 | 87 | 1.3 | 0.2 | 0 | UNDEFD | UNDEFD | 42 | 178.7 | -1.7 | 0 | UNDEFD | UNDEFD |
| 190 | 81 | 1.4 | 0.2 | 0 | UNDEFD | UNDEFD | 41 | 187.9 | -2.0 | 0 | UNDEFD | UNDEFD |
| 200 | 73 | 1.3 | 0.2 | 2 | 6.5 | 1.6 | 35 | 198.2 | -2.3 | 2 | 213.0 | 2.5 |
| 210 | 89 | 1.5 | 0.3 | 7 | 5.9 | 1.2 | 46 | 212.2 | -0.3 | 7 | 220.0 | -0.4 |
| 220 | 123 | 2.0 | 0.3 | 17 | 6.2 | 1.0 | 80 | 224.5 | -2.0 | 17 | 225.5 | -0.5 |
| 230 | 217 | 2.6 | 0.3 | 26 | 6.4 | 0.9 | 176 | 234.6 | -2.3 | 26 | 232.5 | -0.3 |
| 240 | 324 | 2.8 | 0.3 | 39 | 6.5 | 0.7 | 286 | 242.7 | -2.8 | 39 | 242.1 | -0.4 |
| 250 | 400 | 2.8 | 0.2 | 78 | 6.9 | 0.5 | 367 | 250.0 | -2.3 | 78 | 255.0 | -1.3 |
| 260 | 420 | 2.8 | 0.2 | 168 | 7.7 | 0.5 | 390 | 259.2 | -2.6 | 168 | 264.9 | -2.8 |
| 270 | 413 | 2.9 | 0.2 | 306 | 8.0 | 0.5 | 383 | 269.5 | -3.3 | 306 | 273.4 | -3.9 |
| 280 | 452 | 3.1 | 0.2 | 478 | 8.0 | 0.5 | 424 | 280.5 | -4.3 | 478 | 282.2 | -4.8 |
| 290 | 477 | 3.2 | 0.2 | 594 | 7.8 | 0.5 | 448 | 290.0 | -4.5 | 594 | 290.5 | -5.4 |
| 300 | 484 | 3.2 | 0.2 | 668 | 7.5 | 0.5 | 453 | 298.6 | -4.5 | 668 | 299.5 | -5.6 |
| 310 | 499 | 3.2 | 0.2 | 675 | 7.4 | 0.5 | 461 | 309.8 | -4.5 | 675 | 309.6 | -5.5 |
| 320 | 495 | 3.2 | 0.2 | 658 | 7.4 | 0.5 | 460 | 319.8 | -4.1 | 658 | 319.1 | -5.3 |
| 330 | 493 | 3.3 | 0.2 | 632 | 7.3 | 0.4 | 465 | 328.6 | -3.7 | 632 | 329.2 | -5.0 |
| 340 | 464 | 3.3 | 0.2 | 600 | 7.3 | 0.4 | 445 | 339.6 | -3.0 | 600 | 339.5 | -4.5 |
| 350 | 471 | 3.4 | 0.2 | 741 | 7.2 | 0.3 | 456 | 350.1 | -2.8 | 741 | 351.4 | -3.6 |

## RESEARCHER - PHASE II

| WINDOW | SPEED: LOW WIND SPEEDS NO. OBSER-VATIONS | SPEED: LOW WIND SPEEDS MEAN MAST SPEED | SPEED: LOW WIND SPEEDS MEAN SPEED DIFF. | SPEED: HIGH WIND SPEEDS NO. OBSER-VATIONS | SPEED: HIGH WIND SPEEDS MEAN MAST SPEED | SPEED: HIGH WIND SPEEDS MEAN SPEED DIFF. | DIRECTION: LOW WIND SPEEDS NO. OBSER-VATIONS | DIRECTION: LOW WIND SPEEDS MEAN MAST DIR. | DIRECTION: LOW WIND SPEEDS MEAN DIR. DIFF. | DIRECTION: HIGH WIND SPEEDS NO. OBSER-VATIONS | DIRECTION: HIGH WIND SPEEDS MEAN MAST DIR. | DIRECTION: HIGH WIND SPEEDS MEAN DIR. DIFF. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 643 | 3.9 | 0.1 | 1233 | 7.1 | 0.3 | 643 | 359.1 | -1.5 | 1225 | 357.3 | -1.4 |
| 10 | 565 | 3.8 | 0.1 | 894 | 7.0 | 0.3 | 564 | 7.6 | -0.8 | 890 | 6.4 | -0.8 |
| 20 | 429 | 3.8 | 0.1 | 608 | 6.9 | 0.3 | 426 | 17.0 | -0.2 | 608 | 18.0 | 0.1 |
| 30 | 333 | 3.8 | 0.2 | 468 | 7.0 | 0.4 | 329 | 27.8 | 0.6 | 468 | 28.1 | 0.9 |
| 40 | 272 | 3.7 | 0.2 | 356 | 7.0 | 0.4 | 268 | 38.4 | 1.3 | 356 | 36.6 | 1.5 |
| 50 | 219 | 3.6 | 0.2 | 276 | 7.1 | 0.4 | 215 | 47.2 | 1.8 | 274 | 47.9 | 2.1 |
| 60 | 197 | 3.6 | 0.1 | 203 | 7.0 | 0.4 | 194 | 59.0 | 2.2 | 201 | 57.4 | 2.5 |
| 70 | 144 | 3.7 | 0.1 | 149 | 6.8 | 0.4 | 142 | 68.0 | 2.1 | 147 | 64.3 | 2.5 |
| 80 | 116 | 3.8 | 0.1 | 77 | 6.4 | 0.2 | 112 | 73.7 | 1.7 | 77 | 74.1 | 2.2 |
| 90 | 58 | 3.5 | 0.0 | 46 | 6.3 | 0.2 | 50 | 86.7 | 0.6 | 46 | 87.8 | 1.2 |
| 100 | 43 | 2.8 | 0.0 | 41 | 6.7 | 0.3 | 34 | 99.0 | -0.7 | 41 | 98.6 | -0.1 |
| 110 | 32 | 2.1 | 0.0 | 31 | 7.1 | 0.4 | 26 | 108.4 | -1.1 | 31 | 105.6 | -0.7 |
| 120 | 18 | 1.6 | 0.0 | 20 | 7.8 | 0.5 | 16 | 115.2 | -1.4 | 20 | 113.6 | -2.1 |
| 130 | 10 | 1.9 | 0.0 | 7 | 8.6 | 0.7 | 9 | 124.8 | 0.2 | 7 | 123.1 | -3.1 |
| 140 | 3 | 2.8 | 0.0 | 3 | 9.0 | 0.8 | 3 | 136.0 | -2.0 | 3 | 128.7 | -4.0 |
| 150 | 3 | 2.4 | 0.1 | 0 | UNDEFD | UNDEFD | 2 | 138.5 | -1.5 | 0 | UNDEFD | UNDEFD |
| 160 | 1 | 0.7 | 0.2 | 1 | 6.5 | 0.9 | 0 | UNDEFD | UNDEFD | 1 | 173.0 | -4.0 |
| 170 | 2 | 0.7 | 0.2 | 5 | 6.9 | 0.6 | 0 | UNDEFD | UNDEFD | 5 | 176.8 | -1.6 |
| 180 | 1 | 0.8 | 0.2 | 5 | 6.9 | 0.6 | 0 | UNDEFD | UNDEFD | 5 | 176.8 | -1.6 |
| 190 | 4 | 0.7 | 0.2 | 4 | 6.9 | 0.5 | 0 | UNDEFD | UNDEFD | 4 | 177.7 | -1.0 |
| 200 | 3 | 0.7 | 0.2 | 1 | 6.2 | 0.8 | 0 | UNDEFD | UNDEFD | 1 | 213.0 | 4.0 |
| 210 | 3 | 0.7 | 0.2 | 8 | 7.8 | 1.5 | 0 | UNDEFD | UNDEFD | 8 | 220.9 | 3.9 |
| 220 | 1 | 4.0 | 0.3 | 18 | 8.0 | 1.5 | 1 | 234.0 | -1.0 | 18 | 224.6 | 4.1 |
| 230 | 4 | 2.8 | 0.3 | 24 | 8.3 | 1.4 | 3 | 239.3 | 2.0 | 24 | 229.9 | 3.2 |
| 240 | 26 | 3.4 | 0.2 | 56 | 7.8 | 0.9 | 24 | 249.0 | -0.6 | 56 | 244.7 | 3.2 |
| 250 | 53 | 3.5 | 0.2 | 137 | 7.5 | 0.6 | 48 | 255.4 | -1.1 | 137 | 256.7 | -0.2 |
| 260 | 109 | 3.8 | 0.2 | 219 | 7.3 | 0.5 | 105 | 264.0 | -2.7 | 219 | 262.2 | -1.5 |
| 270 | 149 | 3.9 | 0.2 | 346 | 7.4 | 0.4 | 145 | 272.5 | -3.6 | 346 | 272.3 | -3.4 |
| 280 | 205 | 4.0 | 0.2 | 557 | 7.5 | 0.5 | 201 | 280.8 | -4.5 | 555 | 283.7 | -4.4 |
| 290 | 265 | 4.1 | 0.3 | 814 | 7.4 | 0.5 | 259 | 291.8 | -4.7 | 801 | 292.0 | -4.7 |
| 300 | 409 | 4.1 | 0.3 | 1133 | 7.2 | 0.5 | 403 | 302.8 | -4.5 | 1120 | 301.5 | -4.6 |
| 310 | 538 | 4.1 | 0.3 | 1385 | 7.2 | 0.5 | 534 | 311.4 | -4.0 | 1374 | 311.2 | -4.3 |
| 320 | 643 | 4.1 | 0.3 | 1514 | 7.1 | 0.5 | 641 | 319.9 | -3.7 | 1514 | 319.5 | -3.8 |
| 330 | 694 | 4.1 | 0.2 | 1497 | 7.1 | 0.4 | 692 | 330.2 | -3.2 | 1497 | 328.8 | -3.2 |
| 340 | 698 | 4.0 | 0.2 | 1466 | 7.0 | 0.3 | 697 | 339.5 | -2.7 | 1462 | 339.7 | -2.6 |
| 350 | 709 | 4.0 | 0.2 | 1443 | 7.1 | 0.3 | 708 | 349.3 | -2.1 | 1435 | 349.3 | -1.9 |

RESEARCHER - PHASE III

| WINDOW | SPEED | | | | | | DIRECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | |
| | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. |
| 0 | 947 | 3.2 | 0.1 | 1889 | 7.4 | 0.4 | 938 | 358.8 | 5.8 | 1889 | 359.1 | 5.5 |
| 10 | 907 | 3.1 | 0.1 | 1678 | 7.3 | 0.4 | 891 | 9.1 | 5.7 | 1678 | 8.0 | 5.9 |
| 20 | 845 | 3.0 | 0.1 | 1356 | 7.2 | 0.4 | 820 | 19.6 | 5.7 | 1356 | 17.8 | 6.2 |
| 30 | 786 | 2.9 | 0.1 | 1032 | 7.1 | 0.4 | 755 | 28.3 | 5.6 | 1032 | 27.6 | 6.5 |
| 40 | 688 | 2.8 | 0.1 | 756 | 7.0 | 0.5 | 655 | 38.2 | 5.5 | 756 | 36.7 | 6.5 |
| 50 | 596 | 2.9 | 0.1 | 522 | 6.8 | 0.5 | 532 | 48.1 | 4.9 | 505 | 46.2 | 6.2 |
| 60 | 543 | 2.9 | 0.1 | 344 | 6.7 | 0.4 | 478 | 58.4 | 4.4 | 327 | 56.0 | 5.8 |
| 70 | 461 | 3.0 | 0.1 | 216 | 6.8 | 0.4 | 400 | 68.9 | 3.7 | 199 | 64.9 | 5.3 |
| 80 | 395 | 2.8 | 0.0 | 112 | 6.8 | 0.3 | 367 | 78.7 | 3.0 | 112 | 74.2 | 4.6 |
| 90 | 338 | 2.8 | 0.0 | 71 | 6.7 | 0.3 | 315 | 89.1 | 2.0 | 71 | 88.4 | 2.9 |
| 100 | 287 | 2.7 | 0.0 | 51 | 7.2 | 0.4 | 265 | 97.7 | 1.3 | 51 | 98.3 | 1.6 |
| 110 | 215 | 2.6 | 0.1 | 41 | 7.5 | 0.4 | 198 | 106.4 | 0.5 | 41 | 105.2 | 0.4 |
| 120 | 135 | 2.3 | 0.1 | 26 | 8.1 | 0.5 | 118 | 114.9 | -0.3 | 26 | 120.1 | -1.2 |
| 130 | 77 | 2.1 | 0.1 | 20 | 7.8 | 0.5 | 62 | 123.8 | -1.4 | 20 | 129.8 | -1.9 |
| 140 | 45 | 1.7 | 0.1 | 20 | 7.5 | 0.6 | 30 | 136.7 | -2.3 | 20 | 137.6 | -2.0 |
| 150 | 45 | 1.4 | 0.2 | 11 | 7.1 | 0.5 | 28 | 151.2 | -1.6 | 11 | 146.5 | -1.9 |
| 160 | 49 | 1.4 | 0.2 | 8 | 7.4 | 0.7 | 31 | 159.7 | -0.1 | 8 | 151.6 | -1.5 |
| 170 | 47 | 1.3 | 0.2 | 2 | 7.2 | 0.7 | 31 | 167.3 | 1.7 | 2 | 166.0 | -1.0 |
| 180 | 36 | 1.3 | 0.2 | 1 | 8.2 | 1.1 | 25 | 177.7 | 3.3 | 1 | 169.0 | 0.0 |
| 190 | 28 | 1.2 | 0.2 | 0 | UNDEFD | UNDEFD | 18 | 186.3 | 3.8 | 0 | UNDEFD | UNDEFD |
| 200 | 32 | 1.3 | 0.2 | 0 | UNDEFD | UNDEFD | 20 | 201.6 | 3.2 | 0 | UNDEFD | UNDEFD |
| 210 | 37 | 1.3 | 0.2 | 0 | UNDEFD | UNDEFD | 27 | 214.3 | 2.4 | 0 | UNDEFD | UNDEFD |
| 220 | 48 | 1.6 | 0.2 | 2 | 9.7 | 1.5 | 37 | 220.8 | 3.6 | 2 | 232.0 | 9.5 |
| 230 | 46 | 1.7 | 0.3 | 11 | 7.8 | 1.0 | 34 | 227.7 | 4.3 | 11 | 239.9 | 9.4 |
| 240 | 49 | 2.0 | 0.3 | 26 | 7.6 | 0.8 | 37 | 241.4 | 4.6 | 26 | 245.3 | 5.2 |
| 250 | 67 | 2.4 | 0.2 | 43 | 7.2 | 0.6 | 55 | 255.1 | 3.2 | 43 | 253.1 | 5.5 |
| 260 | 107 | 2.9 | 0.2 | 108 | 7.6 | 0.5 | 99 | 263.8 | 1.7 | 108 | 265.7 | 6.3 |
| 270 | 185 | 3.1 | 0.2 | 189 | 7.3 | 0.4 | 176 | 273.5 | 1.7 | 189 | 274.2 | 6.1 |
| 280 | 233 | 3.2 | 0.2 | 315 | 7.5 | 0.4 | 229 | 281.3 | 1.9 | 315 | 282.3 | 6.4 |
| 290 | 296 | 3.1 | 0.1 | 441 | 7.5 | 0.4 | 288 | 290.4 | 2.6 | 441 | 292.2 | 5.6 |
| 300 | 347 | 3.1 | 0.1 | 588 | 7.7 | 0.5 | 337 | 301.7 | 3.9 | 588 | 301.5 | 5.1 |
| 310 | 426 | 3.2 | 0.2 | 855 | 7.6 | 0.5 | 415 | 310.8 | 5.1 | 855 | 312.3 | 4.9 |
| 320 | 510 | 3.2 | 0.2 | 1111 | 7.6 | 0.5 | 497 | 320.6 | 5.9 | 1111 | 321.6 | 4.9 |
| 330 | 646 | 3.3 | 0.2 | 1347 | 7.5 | 0.5 | 636 | 331.5 | 6.0 | 1347 | 330.2 | 4.8 |
| 340 | 823 | 3.4 | 0.2 | 1580 | 7.4 | 0.4 | 812 | 341.6 | 5.9 | 1580 | 340.8 | 4.9 |
| 350 | 960 | 3.3 | 0.1 | 1800 | 7.4 | 0.4 | 954 | 350.1 | 5.8 | 1800 | 350.7 | 5.2 |

## GILLISS - PHASE I

| WINDOW | SPEED – LOW WIND SPEEDS – NO. OBSER-VATIONS | SPEED – LOW WIND SPEEDS – MEAN MAST SPEED | SPEED – LOW WIND SPEEDS – MEAN SPEED DIFF. | SPEED – HIGH WIND SPEEDS – NO. OBSER-VATIONS | SPEED – HIGH WIND SPEEDS – MEAN MAST SPEED | SPEED – HIGH WIND SPEEDS – MEAN SPEED DIFF. | DIRECTION – LOW WIND SPEEDS – NO. OBSER-VATIONS | DIRECTION – LOW WIND SPEEDS – MEAN MAST DIR. | DIRECTION – LOW WIND SPEEDS – MEAN DIR. DIFF. | DIRECTION – HIGH WIND SPEEDS – NO. OBSER-VATIONS | DIRECTION – HIGH WIND SPEEDS – MEAN MAST DIR. | DIRECTION – HIGH WIND SPEEDS – MEAN DIR. DIFF. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 511 | 3.2 | 0.1 | 246 | 6.1 | 0.2 | 502 | 0.9 | -1.0 | 246 | 1.4 | -0.5 |
| 10 | 608 | 3.3 | 0.2 | 277 | 6.4 | 0.4 | 601 | 11.6 | -1.1 | 277 | 9.5 | -0.6 |
| 20 | 700 | 3.3 | 0.2 | 288 | 6.4 | 0.5 | 691 | 19.8 | -1.4 | 288 | 19.2 | -1.1 |
| 30 | 746 | 3.1 | 0.2 | 287 | 6.4 | 0.6 | 733 | 29.5 | -2.2 | 287 | 30.0 | -2.0 |
| 40 | 739 | 3.1 | 0.3 | 287 | 6.4 | 0.7 | 726 | 39.7 | -3.1 | 287 | 39.1 | -2.9 |
| 50 | 824 | 3.1 | 0.3 | 243 | 6.3 | 0.7 | 786 | 49.8 | -4.1 | 242 | 47.6 | -3.8 |
| 60 | 851 | 3.0 | 0.3 | 203 | 6.5 | 0.8 | 817 | 59.9 | -4.9 | 202 | 58.3 | -4.6 |
| 70 | 990 | 3.1 | 0.4 | 171 | 6.7 | 1.0 | 957 | 70.6 | -5.7 | 170 | 69.8 | -5.4 |
| 80 | 1152 | 3.2 | 0.4 | 195 | 6.5 | 1.1 | 1143 | 81.5 | -6.7 | 195 | 80.7 | -6.8 |
| 90 | 1715 | 3.3 | -0.1 | 164 | 6.2 | 0.9 | 1700 | 92.4 | -7.9 | 164 | 87.7 | -7.9 |
| 100 | 2266 | 3.3 | -0.4 | 254 | 5.8 | 0.1 | 2247 | 101.6 | -8.1 | 254 | 102.4 | -9.0 |
| 110 | 2217 | 3.3 | -0.5 | 283 | 5.9 | -0.1 | 2194 | 107.4 | -8.2 | 283 | 112.2 | -9.2 |
| 120 | 1535 | 3.3 | -0.4 | 263 | 5.9 | -0.1 | 1516 | 114.0 | -7.8 | 263 | 114.5 | -9.1 |
| 130 | 664 | 3.2 | 0.0 | 134 | 5.9 | 0.2 | 642 | 123.2 | -7.7 | 134 | 121.6 | -8.8 |
| 140 | 301 | 2.9 | 0.0 | 36 | 6.4 | 0.4 | 277 | 135.2 | -6.6 | 36 | 138.4 | -7.5 |
| 150 | 159 | 2.7 | 0.1 | 29 | 6.3 | 0.4 | 132 | 146.1 | -5.1 | 29 | 144.5 | -6.6 |
| 160 | 111 | 2.6 | 0.1 | 17 | 6.3 | 0.4 | 91 | 155.3 | -3.6 | 17 | 155.1 | -3.9 |
| 170 | 64 | 2.1 | 0.1 | 8 | 5.3 | 0.3 | 51 | 169.1 | -1.1 | 8 | 166.6 | -1.4 |
| 180 | 54 | 2.1 | 0.3 | 5 | 5.4 | 0.4 | 47 | 177.6 | -0.2 | 5 | 169.8 | -0.2 |
| 190 | 62 | 2.2 | 0.3 | 2 | 5.3 | 1.1 | 55 | 191.0 | -0.9 | 2 | 187.5 | -6.5 |
| 200 | 84 | 2.4 | 0.3 | 6 | 5.2 | 0.5 | 75 | 202.1 | -2.7 | 6 | 208.0 | -2.8 |
| 210 | 116 | 2.6 | 0.2 | 9 | 5.2 | 0.5 | 108 | 210.8 | -4.0 | 9 | 211.0 | -2.3 |
| 220 | 163 | 2.7 | 0.1 | 15 | 5.8 | 0.5 | 154 | 222.0 | -4.1 | 15 | 220.7 | -2.1 |
| 230 | 211 | 2.7 | 0.0 | 16 | 5.8 | 0.2 | 202 | 231.4 | -4.1 | 16 | 230.6 | -2.9 |
| 240 | 243 | 2.7 | -0.1 | 21 | 5.8 | 0.1 | 233 | 239.8 | -4.3 | 21 | 239.1 | -2.7 |
| 250 | 259 | 2.9 | -0.1 | 24 | 5.5 | 0.1 | 247 | 249.7 | -4.3 | 24 | 251.3 | -2.4 |
| 260 | 382 | 3.2 | 0.0 | 50 | 5.4 | 0.2 | 371 | 263.5 | -4.2 | 50 | 264.2 | -2.4 |
| 270 | 487 | 3.2 | 0.0 | 90 | 5.7 | 0.2 | 477 | 271.5 | -4.2 | 90 | 274.2 | -3.6 |
| 280 | 561 | 3.2 | 0.0 | 114 | 5.6 | 0.1 | 552 | 278.6 | -4.4 | 114 | 279.7 | -4.0 |
| 290 | 442 | 3.2 | 0.0 | 135 | 5.6 | 0.1 | 433 | 287.0 | -4.6 | 135 | 290.1 | -4.3 |
| 300 | 413 | 3.4 | 0.0 | 113 | 5.4 | 0.1 | 405 | 299.1 | -4.2 | 113 | 298.6 | -4.1 |
| 310 | 418 | 3.7 | 0.1 | 105 | 5.3 | 0.1 | 409 | 311.4 | -3.3 | 105 | 306.8 | -3.5 |
| 320 | 572 | 3.6 | 0.0 | 83 | 5.5 | 0.1 | 566 | 321.0 | -2.5 | 83 | 319.6 | -2.4 |
| 330 | 575 | 3.5 | 0.0 | 88 | 5.6 | 0.0 | 567 | 329.2 | -1.9 | 88 | 329.9 | -1.8 |
| 340 | 564 | 3.3 | 0.0 | 118 | 5.8 | 0.1 | 556 | 337.7 | -1.6 | 118 | 341.5 | -1.2 |
| 350 | 456 | 3.1 | 0.0 | 175 | 6.0 | 0.1 | 448 | 349.3 | -1.3 | 175 | 352.9 | -0.6 |

# GILLISS - PHASE II

| | SPEED | | | | | | DIRECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | |
| WINDOW | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. |
| 0 | 492 | 3.5 | 0.1 | 476 | 6.6 | 0.2 | 487 | 0.9 | -6.5 | 476 | 1.7 | -5.6 |
| 10 | 598 | 3.6 | 0.1 | 552 | 6.4 | 0.3 | 594 | 11.4 | -6.3 | 552 | 9.9 | -5.5 |
| 20 | 652 | 3.6 | 0.2 | 510 | 6.1 | 0.3 | 648 | 19.3 | -6.6 | 510 | 17.8 | -5.8 |
| 30 | 636 | 3.6 | 0.2 | 351 | 5.9 | 0.4 | 633 | 28.1 | -7.2 | 351 | 25.2 | -6.3 |
| 40 | 515 | 3.5 | 0.3 | 194 | 6.0 | 0.5 | 508 | 37.5 | -8.0 | 194 | 33.8 | -7.4 |
| 50 | 403 | 3.5 | 0.3 | 736 | 7.0 | 0.2 | 388 | 46.3 | -8.8 | 86 | 45.2 | -8.9 |
| 60 | 263 | 3.4 | 0.3 | 715 | 7.0 | 0.2 | 242 | 55.5 | -9.6 | 65 | 59.1 | -9.8 |
| 70 | 169 | 3.2 | 0.3 | 700 | 7.0 | 0.2 | 147 | 66.3 | -10.8 | 50 | 69.4 | -10.5 |
| 80 | 110 | 2.8 | 0.3 | 43 | 7.3 | 1.1 | 95 | 78.6 | -12.0 | 43 | 76.8 | -11.0 |
| 90 | 89 | 2.5 | 0.3 | 28 | 7.2 | 0.8 | 72 | 87.7 | -13.3 | 28 | 88.6 | -12.1 |
| 100 | 73 | 2.2 | 0.1 | 21 | 6.5 | 0.0 | 55 | 96.9 | -13.1 | 21 | 98.3 | -12.6 |
| 110 | 66 | 2.0 | -0.1 | 17 | 6.6 | -0.6 | 46 | 109.3 | -11.5 | 17 | 107.8 | -12.9 |
| 120 | 54 | 2.2 | -0.2 | 38 | 7.1 | 0.0 | 39 | 118.6 | -9.3 | 38 | 125.8 | -12.8 |
| 130 | 44 | 2.6 | -0.1 | 42 | 7.2 | 0.2 | 36 | 127.3 | -9.3 | 42 | 130.6 | -12.6 |
| 140 | 27 | 3.2 | 0.0 | 43 | 7.1 | 0.2 | 24 | 137.7 | -8.9 | 43 | 133.3 | -12.3 |
| 150 | 42 | 3.3 | 0.0 | 14 | 7.1 | 0.2 | 41 | 153.9 | -6.2 | 14 | 141.8 | -11.3 |
| 160 | 40 | 3.1 | 0.1 | 5 | 7.6 | 0.3 | 39 | 160.9 | -5.2 | 5 | 148.0 | -10.2 |
| 170 | 38 | 3.2 | 0.2 | 0 | UNDEFD | UNDEFD | 37 | 163.9 | -5.8 | 0 | UNDEFD | UNDEFD |
| 180 | 24 | 3.0 | 0.8 | 2 | 6.7 | 2.1 | 23 | 182.0 | -6.3 | 2 | 188.5 | -13.0 |
| 190 | 39 | 2.5 | 0.7 | 10 | 6.3 | 1.5 | 31 | 194.2 | -5.5 | 10 | 199.1 | -5.4 |
| 200 | 59 | 2.4 | 0.5 | 27 | 6.5 | 1.5 | 44 | 200.5 | -5.0 | 27 | 205.7 | -3.6 |
| 210 | 68 | 2.3 | 0.3 | 37 | 6.7 | 1.5 | 47 | 209.5 | -5.3 | 37 | 211.1 | -3.2 |
| 220 | 83 | 2.4 | 0.2 | 35 | 6.8 | 1.4 | 58 | 222.0 | -6.2 | 35 | 216.1 | -3.6 |
| 230 | 108 | 2.5 | 0.2 | 21 | 6.8 | 1.2 | 82 | 233.2 | -6.8 | 21 | 224.5 | -4.7 |
| 240 | 148 | 2.7 | 0.2 | 25 | 5.6 | 0.5 | 117 | 241.9 | -7.3 | 25 | 244.2 | -6.0 |
| 250 | 189 | 2.9 | 0.2 | 50 | 5.6 | 0.4 | 156 | 251.6 | -8.0 | 50 | 255.4 | -6.6 |
| 260 | 238 | 3.0 | 0.2 | 67 | 5.7 | 0.4 | 204 | 261.7 | -8.7 | 67 | 260.5 | -7.3 |
| 270 | 262 | 3.0 | 0.1 | 75 | 5.8 | 0.3 | 236 | 270.8 | -9.7 | 75 | 268.1 | -8.1 |
| 280 | 273 | 3.0 | 0.1 | 85 | 5.7 | 0.2 | 254 | 279.7 | -10.4 | 85 | 282.3 | -9.4 |
| 290 | 283 | 3.0 | 0.0 | 148 | 6.0 | 0.1 | 265 | 290.4 | -10.5 | 148 | 293.5 | -9.5 |
| 300 | 298 | 3.1 | 0.0 | 186 | 6.2 | 0.1 | 280 | 299.9 | -10.1 | 186 | 300.5 | -9.2 |
| 310 | 292 | 3.3 | 0.0 | 166 | 6.4 | 0.1 | 273 | 308.8 | -9.2 | 166 | 305.5 | -8.9 |
| 320 | 267 | 3.4 | 0.0 | 164 | 6.6 | 0.1 | 250 | 318.8 | -8.4 | 164 | 320.8 | -7.7 |
| 330 | 258 | 3.5 | 0.0 | 149 | 6.7 | 0.1 | 244 | 330.6 | -7.4 | 149 | 331.8 | -6.9 |
| 340 | 319 | 3.5 | 0.0 | 236 | 6.8 | 0.1 | 310 | 342.0 | -7.1 | 236 | 341.3 | -6.4 |
| 350 | 383 | 3.5 | 0.0 | 320 | 6.7 | 0.1 | 378 | 351.3 | -6.7 | 320 | 353.7 | -5.8 |

GILLISS - PHASE III

| | SPEED | | | | | | DIRECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | |
| WINDOW | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. |
| 0 | 762 | 3.5 | 0.1 | 1143 | 7.0 | 0.2 | 742 | 2.4 | -8.1 | 1143 | 0.2 | -6.8 |
| 10 | 996 | 3.5 | 0.1 | 1180 | 6.9 | 0.3 | 972 | 10.5 | -8.2 | 1180 | 9.5 | -7.0 |
| 20 | 1113 | 3.5 | 0.2 | 1074 | 6.8 | 0.4 | 1082 | 19.7 | -8.9 | 1074 | 18.1 | -7.5 |
| 30 | 1069 | 3.5 | 0.3 | 812 | 6.7 | 0.5 | 1040 | 28.7 | -9.9 | 812 | 26.4 | -8.2 |
| 40 | 999 | 3.2 | 0.3 | 614 | 6.7 | 0.7 | 971 | 38.6 | -11.4 | 614 | 37.8 | -9.6 |
| 50 | 884 | 3.1 | 0.3 | 504 | 6.8 | 0.8 | 829 | 48.8 | -12.9 | 495 | 49.5 | -11.1 |
| 60 | 814 | 3.1 | 0.3 | 495 | 7.5 | 0.8 | 761 | 58.6 | -14.1 | 486 | 58.9 | -12.0 |
| 70 | 738 | 3.2 | 0.4 | 468 | 7.6 | 1.0 | 691 | 69.4 | -14.8 | 459 | 69.5 | -13.1 |
| 80 | 825 | 3.3 | 0.3 | 524 | 6.6 | 0.5 | 811 | 81.1 | -15.9 | 524 | 80.9 | -15.2 |
| 90 | 987 | 3.3 | -0.1 | 532 | 6.5 | -0.2 | 973 | 91.3 | -16.5 | 532 | 89.3 | -16.4 |
| 100 | 1011 | 3.2 | -0.4 | 436 | 6.5 | -0.7 | 995 | 98.2 | -16.6 | 436 | 95.6 | -17.4 |
| 110 | 704 | 3.2 | -0.6 | 238 | 6.4 | -0.9 | 689 | 103.9 | -16.2 | 238 | 103.2 | -17.2 |
| 120 | 326 | 3.3 | -0.3 | 88 | 6.5 | -0.1 | 314 | 111.1 | -15.8 | 88 | 111.6 | -17.0 |
| 130 | 93 | 3.0 | 0.0 | 31 | 6.1 | 0.1 | 84 | 125.7 | -15.0 | 31 | 123.5 | -16.0 |
| 140 | 70 | 2.9 | 0.0 | 9 | 5.6 | 0.2 | 62 | 139.8 | -13.3 | 9 | 133.6 | -15.3 |
| 150 | 76 | 3.0 | 0.0 | 6 | 6.1 | 0.4 | 69 | 149.7 | -10.5 | 6 | 142.3 | -13.8 |
| 160 | 66 | 2.9 | 0.1 | 4 | 7.1 | 1.9 | 60 | 156.2 | -9.8 | 4 | 168.0 | -12.3 |
| 170 | 59 | 2.7 | 0.1 | 13 | 6.6 | 1.8 | 54 | 166.5 | -7.0 | 13 | 174.5 | -10.4 |
| 180 | 41 | 2.2 | 0.2 | 15 | 6.5 | 1.9 | 35 | 176.9 | -6.4 | 15 | 178.1 | -9.5 |
| 190 | 41 | 1.9 | 0.2 | 27 | 6.4 | 1.7 | 29 | 183.2 | -3.7 | 27 | 192.1 | -5.9 |
| 200 | 66 | 2.6 | 0.3 | 48 | 6.2 | 1.4 | 49 | 206.6 | -4.8 | 48 | 206.1 | -2.9 |
| 210 | 117 | 3.2 | 0.4 | 76 | 6.2 | 1.3 | 102 | 216.1 | -3.6 | 76 | 212.2 | -1.9 |
| 220 | 169 | 3.5 | 0.4 | 83 | 6.3 | 1.1 | 160 | 221.6 | -3.7 | 83 | 218.7 | -1.5 |
| 230 | 177 | 3.3 | 0.3 | 77 | 6.4 | 0.8 | 169 | 228.9 | -3.8 | 77 | 228.0 | -1.8 |
| 240 | 146 | 3.0 | 0.2 | 60 | 6.4 | 0.4 | 131 | 236.2 | -4.9 | 60 | 237.5 | -3.0 |
| 250 | 134 | 2.7 | 0.0 | 86 | 6.4 | 0.0 | 116 | 249.8 | -6.7 | 86 | 253.0 | -4.8 |
| 260 | 182 | 3.1 | -0.2 | 140 | 6.3 | -0.3 | 169 | 264.7 | -7.9 | 140 | 265.0 | -5.6 |
| 270 | 298 | 3.4 | -0.1 | 199 | 6.6 | -0.2 | 288 | 273.1 | -8.1 | 199 | 271.3 | -6.1 |
| 280 | 357 | 3.4 | -0.1 | 220 | 6.6 | -0.1 | 344 | 279.8 | -8.2 | 220 | 278.9 | -7.0 |
| 290 | 378 | 3.3 | 0.0 | 219 | 6.7 | 0.1 | 360 | 288.9 | -8.5 | 219 | 289.3 | -8.0 |
| 300 | 362 | 3.3 | 0.1 | 241 | 6.5 | 0.2 | 343 | 300.0 | -8.6 | 241 | 300.1 | -8.5 |
| 310 | 377 | 3.2 | 0.0 | 302 | 6.7 | 0.2 | 357 | 309.2 | -8.2 | 302 | 311.1 | -8.1 |
| 320 | 385 | 3.3 | 0.0 | 368 | 6.7 | 0.1 | 368 | 319.3 | -7.9 | 368 | 320.7 | -7.7 |
| 330 | 412 | 3.2 | 0.0 | 488 | 6.8 | 0.1 | 395 | 330.2 | -7.9 | 488 | 331.4 | -7.4 |
| 340 | 429 | 3.2 | 0.0 | 704 | 6.8 | 0.1 | 414 | 339.9 | -8.2 | 704 | 342.5 | -7.0 |
| 350 | 567 | 3.4 | 0.1 | 941 | 6.9 | 0.1 | 551 | 351.5 | -8.1 | 941 | 351.3 | -6.8 |

<u>DALLAS</u> - PHASE I

| | SPEED | | | | | | DIRECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | |
| WINDOW | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. |
| 0 | 594 | 3.4 | 0.2 | 524 | 7.2 | 0.4 | 561 | 0.0 | 2.5 | 524 | 359.0 | 2.8 |
| 10 | 605 | 3.4 | 0.2 | 477 | 7.2 | 0.4 | 577 | 8.5 | 3.8 | 477 | 8.5 | 4.1 |
| 20 | 527 | 3.4 | 0.2 | 366 | 7.4 | 0.5 | 501 | 18.4 | 4.8 | 366 | 16.5 | 4.8 |
| 30 | 461 | 3.3 | 0.3 | 256 | 7.3 | 0.6 | 436 | 28.4 | 5.7 | 256 | 25.4 | 5.3 |
| 40 | 384 | 3.3 | 0.4 | 136 | 7.1 | 0.8 | 358 | 37.8 | 5.8 | 136 | 35.9 | 5.4 |
| 50 | 850 | 3.5 | 0.5 | 448 | 6.2 | 0.9 | 320 | 48.8 | 5.0 | 94 | 47.0 | 5.3 |
| 60 | 815 | 3.5 | 0.5 | 413 | 6.1 | 0.9 | 290 | 59.5 | 3.6 | 59 | 57.9 | 4.3 |
| 70 | 775 | 3.4 | 0.4 | 397 | 6.1 | 0.9 | 252 | 67.3 | 2.4 | 43 | 64.5 | 3.5 |
| 80 | 215 | 3.0 | 0.3 | 19 | 6.2 | 0.7 | 204 | 77.6 | 1.3 | 19 | 70.9 | 2.8 |
| 90 | 150 | 2.9 | 0.1 | 5 | 5.1 | 0.2 | 138 | 87.5 | 0.2 | 5 | 77.2 | 1.0 |
| 100 | 116 | 2.8 | 0.0 | 1 | 9.8 | 2.4 | 105 | 95.2 | -1.4 | 1 | 106.0 | 1.0 |
| 110 | 66 | 2.9 | 0.0 | 1 | 9.8 | 2.4 | 58 | 105.8 | -5.5 | 1 | 106.0 | 1.0 |
| 120 | 43 | 2.2 | 0.1 | 1 | 9.8 | 2.4 | 33 | 114.2 | -10.2 | 1 | 106.0 | 1.0 |
| 130 | 28 | 1.9 | 0.0 | 0 | UNDEFD | UNDEFD | 19 | 126.0 | -10.2 | 0 | UNDEFD | UNDEFD |
| 140 | 25 | 1.5 | 0.0 | 0 | UNDEFD | UNDEFD | 14 | 141.6 | -7.5 | 0 | UNDEFD | UNDEFD |
| 150 | 25 | 1.7 | 0.0 | 0 | UNDEFD | UNDEFD | 16 | 149.1 | -4.8 | 0 | UNDEFD | UNDEFD |
| 160 | 29 | 1.5 | 0.1 | 0 | UNDEFD | UNDEFD | 15 | 157.7 | -5.3 | 0 | UNDEFD | UNDEFD |
| 170 | 31 | 1.3 | 0.1 | 0 | UNDEFD | UNDEFD | 18 | 171.4 | 0.2 | 0 | UNDEFD | UNDEFD |
| 180 | 31 | 1.4 | 0.2 | 0 | UNDEFD | UNDEFD | 18 | 179.9 | 1.9 | 0 | UNDEFD | UNDEFD |
| 190 | 32 | 1.5 | 0.3 | 0 | UNDEFD | UNDEFD | 22 | 189.6 | 5.0 | 0 | UNDEFD | UNDEFD |
| 200 | 61 | 1.7 | 0.4 | 1 | 9.6 | 1.5 | 46 | 206.2 | 7.7 | 1 | 212.0 | 2.0 |
| 210 | 95 | 1.8 | 0.3 | 1 | 9.6 | 1.5 | 72 | 212.9 | 8.2 | 1 | 212.0 | 2.0 |
| 220 | 151 | 2.0 | 0.3 | 2 | 9.0 | 1.5 | 123 | 222.2 | 5.6 | 2 | 221.5 | 5.5 |
| 230 | 370 | 2.7 | 0.3 | 9 | 7.0 | 0.5 | 336 | 237.2 | 5.1 | 9 | 240.6 | 6.8 |
| 240 | 1009 | 3.1 | 0.3 | 167 | 6.4 | 0.7 | 971 | 246.3 | 3.4 | 167 | 250.6 | 2.8 |
| 250 | 1491 | 3.3 | 0.5 | 546 | 6.7 | 1.4 | 1445 | 251.7 | 1.6 | 546 | 256.9 | 0.6 |
| 260 | 1670 | 3.3 | 0.5 | 800 | 6.6 | 1.4 | 1626 | 257.8 | -1.2 | 800 | 261.0 | -1.7 |
| 270 | 1325 | 3.3 | 0.6 | 773 | 6.7 | 1.4 | 1282 | 267.5 | -4.9 | 773 | 266.1 | -3.6 |
| 280 | 1043 | 3.1 | 0.4 | 468 | 6.6 | 1.1 | 999 | 277.4 | -7.2 | 468 | 275.2 | -6.9 |
| 290 | 820 | 3.0 | 0.3 | 315 | 6.8 | 0.7 | 774 | 287.7 | -7.3 | 315 | 289.0 | -7.7 |
| 300 | 678 | 3.1 | 0.3 | 315 | 7.0 | 0.7 | 640 | 298.3 | -6.5 | 315 | 301.6 | -6.8 |
| 310 | 580 | 3.1 | 0.3 | 391 | 7.2 | 0.7 | 554 | 308.6 | -5.7 | 391 | 310.8 | -6.1 |
| 320 | 541 | 3.0 | 0.2 | 455 | 7.3 | 0.6 | 521 | 319.0 | -4.4 | 455 | 320.5 | -4.8 |
| 330 | 538 | 2.9 | 0.2 | 523 | 7.2 | 0.5 | 518 | 330.1 | -3.0 | 523 | 330.4 | -3.0 |
| 340 | 530 | 3.1 | 0.2 | 560 | 7.3 | 0.5 | 506 | 339.2 | -1.4 | 560 | 339.8 | -1.0 |
| 350 | 588 | 3.2 | 0.2 | 564 | 7.1 | 0.4 | 557 | 350.2 | 0.8 | 564 | 349.2 | 0.9 |

# DALLAS - PHASE II

| WINDOW | SPEED: LOW WIND SPEEDS: NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | SPEED: HIGH WIND SPEEDS: NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | DIRECTION: LOW WIND SPEEDS: NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. | DIRECTION: HIGH WIND SPEEDS: NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 514 | 3.2 | 0.1 | 696 | 6.7 | 0.3 | 480 | 0.4 | 2.8 | 696 | 357.8 | 2.4 |
| 10 | 563 | 3.2 | 0.1 | 554 | 6.7 | 0.3 | 533 | 10.0 | 4.3 | 554 | 8.4 | 4.0 |
| 20 | 530 | 3.3 | 0.1 | 462 | 6.7 | 0.4 | 514 | 18.6 | 5.2 | 462 | 18.2 | 5.1 |
| 30 | 473 | 3.5 | 0.2 | 362 | 6.7 | 0.5 | 466 | 28.3 | 5.8 | 362 | 27.3 | 5.6 |
| 40 | 413 | 3.7 | 0.4 | 258 | 6.8 | 0.7 | 411 | 39.5 | 6.1 | 258 | 36.0 | 5.7 |
| 50 | 687 | 3.8 | 0.4 | 398 | 6.4 | 0.7 | 371 | 48.4 | 5.7 | 159 | 45.5 | 5.6 |
| 60 | 597 | 3.8 | 0.4 | 333 | 6.5 | 0.8 | 283 | 56.0 | 5.1 | 94 | 55.2 | 5.0 |
| 70 | 481 | 3.9 | 0.4 | 292 | 6.3 | 0.7 | 167 | 64.0 | 3.7 | 53 | 64.6 | 3.9 |
| 80 | 96 | 3.5 | 0.5 | 25 | 6.3 | 1.0 | 96 | 76.5 | 1.2 | 25 | 72.5 | 2.3 |
| 90 | 67 | 3.3 | 0.2 | 9 | 5.8 | 0.3 | 67 | 88.2 | -1.0 | 9 | 79.8 | 1.0 |
| 100 | 54 | 3.3 | 0.1 | 1 | 5.5 | 0.8 | 54 | 94.5 | -2.2 | 1 | 86.0 | 2.0 |
| 110 | 29 | 3.1 | 0.1 | 0 | UNDEFD | UNDEFD | 29 | 102.3 | -4.9 | 0 | UNDEFD | UNDEFD |
| 120 | 10 | 2.5 | -0.6 | 0 | UNDEFD | UNDEFD | 10 | 110.7 | -9.6 | 0 | UNDEFD | UNDEFD |
| 130 | 4 | 2.6 | 0.1 | 0 | UNDEFD | UNDEFD | 4 | 121.5 | -14.5 | 0 | UNDEFD | UNDEFD |
| 140 | 1 | 2.5 | 0.3 | 0 | UNDEFD | UNDEFD | 1 | 135.0 | -15.0 | 0 | UNDEFD | UNDEFD |
| 150 | 2 | 2.2 | 0.2 | 0 | UNDEFD | UNDEFD | 2 | 146.0 | -11.5 | 0 | UNDEFD | UNDEFD |
| 160 | 2 | 1.8 | 0.1 | 0 | UNDEFD | UNDEFD | 2 | 164.5 | -4.0 | 0 | UNDEFD | UNDEFD |
| 170 | 5 | 2.1 | 0.3 | 0 | UNDEFD | UNDEFD | 5 | 171.8 | -2.0 | 0 | UNDEFD | UNDEFD |
| 180 | 5 | 2.4 | 0.6 | 0 | UNDEFD | UNDEFD | 5 | 178.8 | 0.4 | 0 | UNDEFD | UNDEFD |
| 190 | 6 | 2.8 | 0.8 | 0 | UNDEFD | UNDEFD | 6 | 187.0 | 0.2 | 0 | UNDEFD | UNDEFD |
| 200 | 4 | 3.3 | 1.1 | 0 | UNDEFD | UNDEFD | 4 | 199.5 | 2.0 | 0 | UNDEFD | UNDEFD |
| 210 | 3 | 3.4 | 1.1 | 0 | UNDEFD | UNDEFD | 3 | 202.0 | 1.3 | 0 | UNDEFD | UNDEFD |
| 220 | 17 | 2.4 | 0.3 | 0 | UNDEFD | UNDEFD | 17 | 229.3 | 6.8 | 0 | UNDEFD | UNDEFD |
| 230 | 66 | 2.5 | 0.1 | 0 | UNDEFD | UNDEFD | 61 | 237.9 | 6.7 | 0 | UNDEFD | UNDEFD |
| 240 | 167 | 3.0 | 0.2 | 70 | 6.6 | 0.7 | 152 | 245.3 | 4.8 | 70 | 251.6 | 3.0 |
| 250 | 463 | 3.5 | 0.6 | 423 | 6.7 | 1.5 | 445 | 256.2 | 0.5 | 423 | 258.6 | -0.2 |
| 260 | 863 | 3.8 | 0.7 | 720 | 6.5 | 1.4 | 847 | 263.9 | -3.7 | 720 | 262.8 | -2.7 |
| 270 | 991 | 3.8 | 0.6 | 838 | 6.5 | 1.3 | 981 | 268.7 | -5.6 | 838 | 267.5 | -4.7 |
| 280 | 892 | 3.8 | 0.5 | 717 | 6.3 | 0.9 | 883 | 276.7 | -7.9 | 717 | 278.4 | -7.8 |
| 290 | 715 | 3.8 | 0.3 | 671 | 6.4 | 0.6 | 705 | 290.1 | -8.6 | 671 | 290.5 | -8.5 |
| 300 | 734 | 3.8 | 0.3 | 777 | 6.6 | 0.6 | 723 | 299.9 | -7.7 | 777 | 300.4 | -7.7 |
| 310 | 762 | 3.7 | 0.2 | 902 | 6.7 | 0.5 | 743 | 308.8 | -6.5 | 902 | 310.8 | -6.6 |
| 320 | 693 | 3.7 | 0.2 | 988 | 6.8 | 0.5 | 665 | 318.5 | -5.0 | 988 | 319.9 | -5.3 |
| 330 | 654 | 3.5 | 0.1 | 1014 | 6.8 | 0.4 | 621 | 328.6 | -3.3 | 1014 | 329.1 | -3.5 |
| 340 | 560 | 3.4 | 0.1 | 952 | 6.9 | 0.4 | 528 | 338.3 | -1.5 | 952 | 338.8 | -1.4 |
| 350 | 528 | 3.3 | 0.1 | 835 | 6.8 | 0.3 | 495 | 348.5 | 0.6 | 835 | 348.3 | 0.6 |

DALLAS - PHASE III

| | SPEED | | | | | | DIRECTION | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | | LOW WIND SPEEDS | | | HIGH WIND SPEEDS | | |
| WINDOW | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST SPEED | MEAN SPEED DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. | NO. OBSER-VATIONS | MEAN MAST DIR. | MEAN DIR. DIFF. |
| 0 | 737 | 3.4 | 0.1 | 698 | 7.2 | 0.9 | 736 | 0.3 | 2.9 | 698 | 358.4 | 2.3 |
| 10 | 760 | 3.4 | 0.1 | 554 | 7.1 | 0.8 | 760 | 9.5 | 4.2 | 554 | 7.6 | 3.6 |
| 20 | 726 | 3.4 | 0.1 | 458 | 7.1 | 0.8 | 726 | 18.3 | 5.0 | 458 | 17.7 | 4.4 |
| 30 | 590 | 3.5 | 0.2 | 328 | 7.0 | 1.0 | 590 | 27.7 | 5.5 | 328 | 27.6 | 4.8 |
| 40 | 472 | 3.5 | 0.3 | 287 | 6.8 | 1.2 | 472 | 37.8 | 5.5 | 287 | 37.8 | 4.6 |
| 50 | 393 | 3.6 | 0.5 | 224 | 6.6 | 1.4 | 378 | 48.6 | 5.2 | 218 | 48.1 | 4.2 |
| 60 | 312 | 3.5 | 0.5 | 167 | 6.6 | 1.5 | 295 | 57.3 | 4.6 | 161 | 54.1 | 3.7 |
| 70 | 245 | 3.3 | 0.5 | 84 | 6.7 | 1.6 | 226 | 66.7 | 3.0 | 78 | 61.6 | 3.1 |
| 80 | 148 | 2.9 | 0.4 | 22 | 6.3 | 1.6 | 143 | 76.6 | 0.6 | 22 | 71.0 | 1.4 |
| 90 | 94 | 2.7 | 0.3 | 7 | 6.7 | 1.7 | 91 | 83.8 | -0.8 | 7 | 82.6 | -0.4 |
| 100 | 48 | 2.1 | 0.2 | 2 | 7.0 | 0.7 | 45 | 94.9 | -2.3 | 2 | 92.0 | -4.5 |
| 110 | 34 | 1.5 | 0.1 | 1 | 8.0 | -0.1 | 30 | 110.7 | -4.9 | 1 | 97.0 | -7.0 |
| 120 | 36 | 1.6 | 0.1 | 3 | 6.1 | -0.8 | 31 | 120.0 | -4.9 | 3 | 131.7 | -10.0 |
| 130 | 35 | 1.6 | 0.0 | 12 | 6.3 | -0.4 | 28 | 127.2 | -4.6 | 12 | 136.4 | -8.8 |
| 140 | 23 | 1.6 | 0.0 | 14 | 6.3 | -0.3 | 17 | 133.3 | -1.6 | 14 | 137.9 | -8.6 |
| 150 | 21 | 1.5 | 0.1 | 11 | 6.3 | -0.2 | 12 | 148.7 | -1.0 | 11 | 139.5 | -8.3 |
| 160 | 16 | 1.4 | 0.2 | 3 | 6.5 | 0.8 | 8 | 161.9 | -1.4 | 3 | 153.7 | -6.0 |
| 170 | 25 | 1.2 | 0.2 | 1 | 6.0 | 1.4 | 12 | 170.4 | -1.3 | 1 | 168.0 | -2.0 |
| 180 | 30 | 1.8 | 0.5 | 10 | 5.7 | 2.0 | 20 | 185.5 | 4.9 | 10 | 190.3 | 8.0 |
| 190 | 41 | 2.1 | 0.5 | 18 | 5.7 | 1.9 | 32 | 192.7 | 7.3 | 18 | 194.5 | 7.0 |
| 200 | 40 | 2.3 | 0.6 | 20 | 5.8 | 1.9 | 34 | 198.4 | 9.0 | 20 | 195.9 | 6.3 |
| 210 | 41 | 2.4 | 0.5 | 15 | 6.2 | 1.6 | 35 | 210.0 | 8.7 | 15 | 204.0 | 5.1 |
| 220 | 51 | 2.7 | 0.4 | 13 | 7.2 | 2.1 | 47 | 224.1 | 9.8 | 13 | 223.5 | 7.3 |
| 230 | 119 | 3.0 | 0.3 | 39 | 6.7 | 1.6 | 117 | 235.4 | 8.7 | 39 | 237.4 | 8.1 |
| 240 | 266 | 3.2 | 0.4 | 252 | 6.7 | 1.3 | 263 | 245.3 | 5.8 | 252 | 248.9 | 4.1 |
| 250 | 488 | 3.4 | 0.6 | 664 | 6.7 | 1.6 | 484 | 253.6 | 2.2 | 664 | 256.0 | 0.9 |
| 260 | 767 | 3.5 | 0.7 | 995 | 6.6 | 1.6 | 762 | 262.5 | -2.5 | 995 | 261.1 | -2.1 |
| 270 | 877 | 3.5 | 0.6 | 1051 | 6.6 | 1.5 | 872 | 269.9 | -5.6 | 1051 | 268.1 | -5.1 |
| 280 | 864 | 3.5 | 0.5 | 914 | 6.5 | 1.3 | 855 | 277.9 | -7.6 | 914 | 278.6 | -8.1 |
| 290 | 801 | 3.4 | 0.3 | 847 | 6.5 | 1.2 | 789 | 289.5 | -7.9 | 847 | 289.8 | -8.3 |
| 300 | 798 | 3.3 | 0.3 | 878 | 6.5 | 1.4 | 786 | 299.8 | -7.0 | 878 | 299.9 | -7.4 |
| 310 | 811 | 3.3 | 0.3 | 949 | 6.5 | 1.4 | 803 | 308.9 | -5.9 | 949 | 310.3 | -6.2 |
| 320 | 754 | 3.3 | 0.3 | 956 | 6.6 | 1.3 | 750 | 319.0 | -4.5 | 956 | 319.5 | -5.0 |
| 330 | 692 | 3.3 | 0.3 | 940 | 6.6 | 1.2 | 690 | 328.8 | -2.9 | 940 | 328.8 | -3.4 |
| 340 | 663 | 3.4 | 0.3 | 860 | 6.8 | 1.1 | 661 | 339.0 | -1.1 | 860 | 339.2 | -1.3 |
| 350 | 664 | 3.4 | 0.2 | 783 | 6.9 | 0.9 | 663 | 349.9 | 1.1 | 783 | 348.6 | 0.6 |

# OCEANOGRAPHER - PHASE I

| WINDOW | SPEED: LOW WIND SPEEDS: NO. OBSERVATIONS | SPEED: LOW WIND SPEEDS: MEAN MAST SPEED | SPEED: LOW WIND SPEEDS: MEAN SPEED DIFF. | SPEED: HIGH WIND SPEEDS: NO. OBSERVATIONS | SPEED: HIGH WIND SPEEDS: MEAN MAST SPEED | SPEED: HIGH WIND SPEEDS: MEAN SPEED DIFF. | DIRECTION: LOW WIND SPEEDS: NO. OBSERVATIONS | DIRECTION: LOW WIND SPEEDS: MEAN MAST DIR. | DIRECTION: LOW WIND SPEEDS: MEAN DIR. DIFF. | DIRECTION: HIGH WIND SPEEDS: NO. OBSERVATIONS | DIRECTION: HIGH WIND SPEEDS: MEAN MAST DIR. | DIRECTION: HIGH WIND SPEEDS: MEAN DIR. DIFF. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 860 | 3.0 | 0.1 | 463 | 7.7 | 0.4 | 825 | 1.1 | -2.2 | 463 | 1.1 | -2.1 |
| 10 | 1021 | 3.0 | 0.1 | 469 | 7.5 | 0.4 | 980 | 10.5 | -3.0 | 469 | 8.9 | -2.8 |
| 20 | 1123 | 3.1 | 0.1 | 445 | 7.2 | 0.4 | 1082 | 20.0 | -3.7 | 445 | 18.6 | -3.6 |
| 30 | 1178 | 3.1 | 0.1 | 401 | 7.0 | 0.4 | 1118 | 29.4 | -4.1 | 401 | 29.7 | -3.9 |
| 40 | 1159 | 3.1 | 0.1 | 384 | 7.0 | 0.4 | 1088 | 39.0 | -3.9 | 384 | 38.8 | -4.0 |
| 50 | 1145 | 3.0 | 0.1 | 350 | 6.9 | 0.4 | 1064 | 49.5 | -2.8 | 350 | 48.3 | -3.2 |
| 60 | 1137 | 3.0 | 0.1 | 311 | 6.7 | 0.4 | 1058 | 59.7 | -1.6 | 311 | 59.1 | -2.3 |
| 70 | 1207 | 2.9 | 0.1 | 287 | 6.5 | 0.5 | 1146 | 70.1 | -0.6 | 287 | 68.9 | -1.3 |
| 80 | 1291 | 3.0 | 0.2 | 284 | 6.5 | 0.8 | 1244 | 80.3 | -0.3 | 284 | 79.4 | -0.8 |
| 90 | 1371 | 3.0 | 0.2 | 323 | 6.5 | 0.7 | 1329 | 89.5 | -0.5 | 323 | 91.0 | -1.0 |
| 100 | 1280 | 3.0 | 0.1 | 386 | 6.7 | 0.4 | 1236 | 98.4 | -1.0 | 386 | 100.8 | -1.6 |
| 110 | 1023 | 3.0 | 0.0 | 409 | 6.8 | 0.1 | 973 | 106.5 | -1.4 | 409 | 108.9 | -1.7 |
| 120 | 645 | 2.8 | -0.1 | 325 | 7.0 | -0.1 | 607 | 114.9 | -1.5 | 325 | 116.3 | -1.3 |
| 130 | 358 | 2.5 | -0.1 | 189 | 7.1 | -0.2 | 321 | 124.1 | -1.2 | 189 | 122.9 | -0.6 |
| 140 | 177 | 2.1 | -0.1 | 71 | 7.5 | -0.5 | 155 | 135.5 | 0.3 | 71 | 131.8 | 0.1 |
| 150 | 126 | 2.0 | 0.2 | 20 | 7.2 | -0.4 | 108 | 143.0 | 2.5 | 20 | 143.3 | 0.3 |
| 160 | 80 | 2.0 | 0.4 | 7 | 7.7 | 0.7 | 73 | 157.4 | 4.6 | 7 | 152.6 | 1.6 |
| 170 | 59 | 1.8 | 0.5 | 3 | 7.2 | 1.1 | 54 | 165.6 | 6.1 | 3 | 158.7 | 2.7 |
| 180 | 34 | 2.0 | 0.7 | 0 | UNDEFD | UNDEFD | 30 | 177.3 | 6.5 | 0 | UNDEFD | UNDEFD |
| 190 | 33 | 2.0 | 0.5 | 4 | 7.1 | -0.4 | 28 | 190.7 | 2.5 | 4 | 201.2 | 1.5 |
| 200 | 34 | 2.0 | 0.4 | 5 | 7.3 | -0.1 | 30 | 201.2 | -1.7 | 5 | 203.2 | 2.0 |
| 210 | 35 | 1.6 | 0.1 | 5 | 7.3 | -0.1 | 31 | 210.0 | -2.0 | 5 | 203.2 | 2.0 |
| 220 | 36 | 1.9 | 0.0 | 7 | 7.9 | 0.2 | 31 | 219.9 | -0.4 | 7 | 227.1 | 7.7 |
| 230 | 33 | 1.8 | -0.1 | 9 | 7.7 | 0.2 | 25 | 228.4 | 2.3 | 9 | 232.7 | 8.3 |
| 240 | 41 | 1.9 | 0.0 | 13 | 7.6 | 0.2 | 30 | 241.5 | 3.1 | 13 | 238.5 | 8.3 |
| 250 | 71 | 2.3 | 0.2 | 42 | 6.8 | 0.5 | 57 | 256.3 | 3.6 | 42 | 259.0 | 8.7 |
| 260 | 132 | 2.6 | 0.2 | 133 | 7.2 | 0.5 | 112 | 263.7 | 4.2 | 133 | 267.5 | 8.5 |
| 270 | 157 | 2.6 | 0.1 | 199 | 7.1 | 0.4 | 139 | 269.8 | 3.6 | 199 | 271.7 | 7.2 |
| 280 | 171 | 2.7 | 0.1 | 204 | 7.2 | 0.4 | 153 | 279.0 | 2.5 | 204 | 277.0 | 5.9 |
| 290 | 160 | 2.6 | 0.1 | 150 | 7.1 | 0.3 | 145 | 290.6 | 0.7 | 150 | 287.3 | 3.3 |
| 300 | 194 | 2.6 | 0.1 | 117 | 7.3 | 0.4 | 169 | 300.7 | 0.6 | 117 | 299.6 | 1.4 |
| 310 | 217 | 2.6 | 0.1 | 148 | 8.2 | 0.5 | 187 | 310.9 | 0.6 | 148 | 311.9 | 0.7 |
| 320 | 268 | 2.7 | 0.1 | 179 | 8.3 | 0.5 | 235 | 321.3 | 0.4 | 179 | 321.7 | 0.0 |
| 330 | 323 | 2.8 | 0.1 | 253 | 8.3 | 0.4 | 291 | 331.4 | -0.2 | 253 | 331.5 | -0.3 |
| 340 | 468 | 2.9 | 0.1 | 303 | 8.0 | 0.3 | 435 | 342.3 | -0.8 | 303 | 341.8 | -0.8 |
| 350 | 656 | 3.0 | 0.1 | 392 | 7.9 | 0.4 | 616 | 352.3 | -1.6 | 392 | 351.2 | -1.3 |

# OCEANOGRAPHER - PHASE II

| WINDOW | SPEED: LOW WIND SPEEDS: NO. OBSERVATIONS | SPEED: LOW WIND SPEEDS: MEAN MAST SPEED | SPEED: LOW WIND SPEEDS: MEAN SPEED DIFF. | SPEED: HIGH WIND SPEEDS: NO. OBSERVATIONS | SPEED: HIGH WIND SPEEDS: MEAN MAST SPEED | SPEED: HIGH WIND SPEEDS: MEAN SPEED DIFF. | DIRECTION: LOW WIND SPEEDS: NO. OBSERVATIONS | DIRECTION: LOW WIND SPEEDS: MEAN MAST DIR. | DIRECTION: LOW WIND SPEEDS: MEAN DIR. DIFF. | DIRECTION: HIGH WIND SPEEDS: NO. OBSERVATIONS | DIRECTION: HIGH WIND SPEEDS: MEAN MAST DIR. | DIRECTION: HIGH WIND SPEEDS: MEAN DIR. DIFF. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1325 | 3.5 | 0.1 | 796 | 6.3 | 0.3 | 1287 | 0.4 | -2.1 | 796 | 359.3 | -1.3 |
| 10 | 1323 | 3.5 | 0.1 | 775 | 6.4 | 0.3 | 1286 | 8.6 | -2.7 | 775 | 8.9 | -2.6 |
| 20 | 1181 | 3.5 | 0.1 | 722 | 6.4 | 0.3 | 1152 | 18.3 | -3.3 | 722 | 19.0 | -3.3 |
| 30 | 921 | 3.5 | 0.1 | 637 | 6.4 | 0.3 | 901 | 27.6 | -3.6 | 637 | 27.9 | -3.5 |
| 40 | 735 | 3.4 | 0.1 | 476 | 6.4 | 0.3 | 720 | 37.1 | -3.3 | 476 | 36.6 | -3.4 |
| 50 | 565 | 3.5 | 0.1 | 464 | 6.4 | 0.3 | 528 | 48.2 | -2.2 | 321 | 46.3 | -2.5 |
| 60 | 472 | 3.6 | 0.1 | 361 | 6.2 | 0.2 | 435 | 57.9 | -0.7 | 218 | 57.9 | -0.8 |
| 70 | 352 | 3.7 | 0.1 | 315 | 6.3 | 0.3 | 322 | 67.0 | 0.7 | 172 | 68.2 | 0.7 |
| 80 | 228 | 3.7 | 0.2 | 142 | 6.6 | 0.6 | 226 | 76.4 | 1.5 | 142 | 77.9 | 1.6 |
| 90 | 128 | 3.7 | 0.2 | 111 | 6.8 | 0.8 | 128 | 85.1 | 1.7 | 111 | 88.1 | 1.6 |
| 100 | 72 | 3.6 | 0.3 | 90 | 6.8 | 0.7 | 71 | 93.4 | 1.8 | 90 | 97.8 | 1.2 |
| 110 | 30 | 3.4 | 0.1 | 62 | 6.7 | 0.4 | 28 | 104.7 | 1.0 | 62 | 106.5 | 0.6 |
| 120 | 19 | 3.1 | 0.0 | 35 | 6.6 | 0.1 | 16 | 115.4 | 0.9 | 35 | 113.2 | 0.3 |
| 130 | 17 | 2.8 | -0.2 | 13 | 6.1 | 0.0 | 13 | 123.3 | 1.3 | 13 | 122.2 | 0.0 |
| 140 | 15 | 2.4 | -0.2 | 3 | 6.1 | -0.3 | 11 | 138.5 | 2.5 | 3 | 131.3 | -1.0 |
| 150 | 14 | 2.1 | -0.2 | 1 | 5.4 | -0.4 | 9 | 144.1 | 2.6 | 1 | 142.0 | -2.0 |
| 160 | 11 | 2.5 | -0.1 | 1 | 5.2 | 1.8 | 8 | 160.9 | 1.6 | 1 | 168.0 | -6.0 |
| 170 | 9 | 3.3 | -0.2 | 2 | 5.2 | 1.8 | 7 | 170.3 | -0.4 | 2 | 173.0 | -4.0 |
| 180 | 6 | 4.3 | -0.3 | 2 | 5.2 | 1.8 | 6 | 171.7 | -1.5 | 2 | 173.0 | -4.0 |
| 190 | 3 | 4.2 | -0.4 | 1 | 5.4 | 1.9 | 3 | 185.0 | -2.0 | 1 | 178.0 | -2.0 |
| 200 | 3 | 3.1 | 0.0 | 5 | 5.7 | -0.3 | 2 | 207.5 | 0.0 | 5 | 209.0 | 2.8 |
| 210 | 4 | 3.5 | -0.1 | 7 | 5.9 | -0.2 | 3 | 212.0 | -1.3 | 7 | 211.9 | 3.3 |
| 220 | 3 | 3.4 | 0.0 | 8 | 6.0 | -0.2 | 2 | 217.0 | -0.5 | 8 | 213.9 | 3.4 |
| 230 | 13 | 4.2 | 0.0 | 4 | 6.2 | 0.1 | 13 | 238.5 | 0.4 | 4 | 227.5 | 4.3 |
| 240 | 18 | 3.7 | 0.0 | 4 | 6.1 | 0.2 | 18 | 244.0 | 1.4 | 4 | 244.5 | 4.0 |
| 250 | 30 | 3.6 | 0.1 | 8 | 6.0 | 0.3 | 30 | 250.0 | 2.2 | 8 | 255.1 | 4.3 |
| 260 | 42 | 3.2 | 0.1 | 18 | 6.4 | 0.2 | 42 | 264.3 | 3.4 | 18 | 264.5 | 4.1 |
| 270 | 77 | 3.6 | 0.2 | 56 | 6.8 | 0.4 | 77 | 273.3 | 3.1 | 56 | 276.3 | 2.5 |
| 280 | 117 | 3.8 | 0.2 | 108 | 6.8 | 0.4 | 117 | 282.4 | 2.6 | 108 | 294.4 | 2.3 |
| 290 | 187 | 3.9 | 0.2 | 175 | 6.6 | 0.4 | 187 | 292.7 | 1.8 | 175 | 292.3 | 1.7 |
| 300 | 299 | 3.8 | 0.2 | 251 | 6.4 | 0.4 | 298 | 303.1 | 0.7 | 251 | 302.3 | 0.9 |
| 310 | 492 | 3.7 | 0.1 | 355 | 6.3 | 0.3 | 487 | 312.8 | 0.2 | 355 | 312.2 | 0.5 |
| 320 | 701 | 3.6 | 0.1 | 492 | 6.4 | 0.3 | 692 | 321.9 | -0.1 | 492 | 321.7 | 0.2 |
| 330 | 912 | 3.6 | 0.1 | 664 | 6.5 | 0.3 | 900 | 331.2 | -0.3 | 664 | 331.5 | 0.0 |
| 340 | 1040 | 3.5 | 0.1 | 775 | 6.4 | 0.2 | 1019 | 340.5 | -0.7 | 775 | 340.4 | -0.4 |
| 350 | 1221 | 3.6 | 0.1 | 836 | 6.3 | 0.2 | 1190 | 350.7 | -1.4 | 836 | 349.6 | -0.9 |

## OCEANOGRAPHER - PHASE III

| WINDOW | SPEED: LOW WIND SPEEDS: NO. OBSER-VATIONS | SPEED: LOW WIND SPEEDS: MEAN MAST SPEED | SPEED: LOW WIND SPEEDS: MEAN SPEED DIFF. | SPEED: HIGH WIND SPEEDS: NO. OBSER-VATIONS | SPEED: HIGH WIND SPEEDS: MEAN MAST SPEED | SPEED: HIGH WIND SPEEDS: MEAN SPEED DIFF. | DIRECTION: LOW WIND SPEEDS: NO. OBSER-VATIONS | DIRECTION: LOW WIND SPEEDS: MEAN MAST DIR. | DIRECTION: LOW WIND SPEEDS: MEAN DIR. DIFF. | DIRECTION: HIGH WIND SPEEDS: NO. OBSER-VATIONS | DIRECTION: HIGH WIND SPEEDS: MEAN MAST DIR. | DIRECTION: HIGH WIND SPEEDS: MEAN DIR. DIFF. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 0 | 1103 | 3.4 | 0.1 | 1728 | 6.9 | 0.4 | 1084 | 359.2 | -2.5 | 1728 | 359.8 | -2.3 |
| 10 | 976 | 3.5 | 0.2 | 1715 | 7.1 | 0.4 | 955 | 7.8 | -3.1 | 1715 | 9.1 | -3.1 |
| 20 | 802 | 3.4 | 0.2 | 1451 | 7.2 | 0.5 | 780 | 17.6 | -3.8 | 1451 | 17.9 | -3.8 |
| 30 | 614 | 3.3 | 0.2 | 1091 | 7.3 | 0.5 | 590 | 28.2 | -4.2 | 1091 | 26.4 | -4.0 |
| 40 | 501 | 3.3 | 0.2 | 705 | 7.2 | 0.5 | 482 | 37.9 | -4.0 | 705 | 36.1 | -3.8 |
| 50 | 426 | 3.3 | 0.2 | 483 | 7.1 | 0.4 | 398 | 48.4 | -2.8 | 483 | 47.4 | -2.9 |
| 60 | 348 | 3.4 | 0.2 | 381 | 6.9 | 0.4 | 327 | 58.6 | -1.5 | 381 | 58.3 | -1.6 |
| 70 | 298 | 3.3 | 0.2 | 339 | 6.9 | 0.5 | 280 | 67.9 | -0.4 | 339 | 68.2 | -0.5 |
| 80 | 228 | 3.4 | 0.3 | 275 | 6.7 | 0.6 | 223 | 78.0 | -0.1 | 275 | 77.7 | 0.4 |
| 90 | 180 | 3.3 | 0.3 | 209 | 6.7 | 0.7 | 177 | 87.2 | 0.5 | 209 | 86.9 | 0.7 |
| 100 | 142 | 3.2 | 0.2 | 146 | 6.8 | 0.7 | 135 | 97.2 | 0.4 | 146 | 97.4 | 0.7 |
| 110 | 116 | 3.1 | 0.0 | 100 | 6.7 | 0.3 | 109 | 108.9 | 0.6 | 100 | 107.5 | 0.4 |
| 120 | 100 | 3.1 | -0.1 | 84 | 6.7 | -0.1 | 92 | 118.4 | -0.3 | 84 | 118.8 | -0.1 |
| 130 | 73 | 3.1 | -0.1 | 57 | 6.6 | -0.2 | 66 | 125.8 | 0.5 | 57 | 127.0 | -0.4 |
| 140 | 48 | 2.8 | -0.1 | 37 | 6.6 | -0.3 | 40 | 135.7 | 0.8 | 37 | 132.4 | -0.5 |
| 150 | 36 | 2.7 | 0.3 | 12 | 6.7 | 0.0 | 29 | 151.5 | 2.1 | 12 | 144.1 | -0.2 |
| 160 | 29 | 2.6 | 0.5 | 4 | 7.3 | 1.2 | 25 | 157.7 | 3.0 | 4 | 156.5 | 1.8 |
| 170 | 18 | 2.7 | 0.6 | 3 | 7.4 | 1.3 | 17 | 161.2 | 4.6 | 3 | 157.7 | 2.0 |
| 180 | 7 | 1.4 | 0.7 | 0 | UNDEFD | UNDEFD | 6 | 175.8 | 22.2 | 0 | UNDEFD | UNDEFD |
| 190 | 6 | 1.7 | 0.8 | 0 | UNDEFD | UNDEFD | 5 | 195.8 | 9.4 | 0 | UNDEFD | UNDEFD |
| 200 | 9 | 1.4 | 0.6 | 0 | UNDEFD | UNDEFD | 5 | 195.8 | 9.4 | 0 | UNDEFD | UNDEFD |
| 210 | 11 | 1.6 | 0.2 | 6 | 6.8 | -0.2 | 5 | 207.2 | -2.2 | 6 | 220.2 | 5.2 |
| 220 | 35 | 3.0 | 0.1 | 16 | 6.8 | -0.1 | 26 | 229.6 | 3.7 | 16 | 225.8 | 5.1 |
| 230 | 60 | 3.0 | 0.1 | 22 | 6.7 | -0.1 | 51 | 234.2 | 4.6 | 22 | 229.6 | 5.5 |
| 240 | 68 | 3.0 | 0.1 | 30 | 6.8 | 0.0 | 61 | 237.8 | 4.6 | 30 | 241.4 | 4.9 |
| 250 | 65 | 2.8 | 0.2 | 52 | 7.2 | 0.1 | 60 | 249.5 | 4.0 | 52 | 255.2 | 4.6 |
| 260 | 68 | 2.7 | 0.2 | 85 | 7.4 | 0.3 | 66 | 263.2 | 2.7 | 85 | 263.0 | 4.3 |
| 270 | 121 | 2.7 | 0.2 | 99 | 7.5 | 0.4 | 119 | 273.8 | 1.5 | 99 | 269.5 | 4.0 |
| 280 | 217 | 2.8 | 0.2 | 120 | 7.6 | 0.5 | 214 | 284.5 | 0.5 | 120 | 281.0 | 2.7 |
| 290 | 338 | 2.9 | 0.2 | 184 | 7.5 | 0.6 | 332 | 292.8 | -0.1 | 184 | 294.0 | 1.1 |
| 300 | 483 | 3.1 | 0.2 | 341 | 7.4 | 0.5 | 472 | 301.7 | -0.6 | 341 | 304.0 | 0.0 |
| 310 | 634 | 3.2 | 0.2 | 551 | 7.3 | 0.5 | 621 | 311.5 | -0.7 | 551 | 312.8 | -0.4 |
| 320 | 754 | 3.3 | 0.2 | 789 | 7.2 | 0.5 | 737 | 320.5 | -0.7 | 789 | 321.6 | -0.6 |
| 330 | 865 | 3.3 | 0.2 | 1141 | 6.9 | 0.4 | 852 | 330.5 | -0.6 | 1141 | 331.9 | -0.6 |
| 340 | 960 | 3.4 | 0.1 | 1417 | 6.8 | 0.3 | 945 | 340.7 | -1.1 | 1417 | 340.9 | -0.8 |
| 350 | 1069 | 3.4 | 0.1 | 1693 | 6.8 | 0.3 | 1056 | 350.0 | -1.7 | 1693 | 350.1 | -1.5 |

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EDS 16 NGSDC 1 - Data Description and Quality Assessment of Ionospheric Electron Density Profiles for ARPA Modeling Project. Raymond O. Conkright, March, 1977. (PB-269-620)

EDS 17 GATE Convection Subprogram Data Center: Analysis of Ship Surface Meteorological Data Obtained During GATE Intercomparison Periods. Fredric A. Godshall, Ward R. Seguin, and Paul Sabol, October 1976. (PB-263-000)

EDS 18 GATE Convection Subprogram Data Center: Shipboard Precipitation Data. Ward R. Seguin and Paul Sabol, November 1976. (PB-263-820)

EDS 19 Separation of Mixed Data Sets into Homogenous Sets. Harold Crutcher and Raymond L. Joiner, January 1977. (PB-264-813)

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EDS 27 U.S. IFYGL Ship System: Description of Archived Data. Robert E. Dennis. February 1978.