CENTRAL FORECASTING MONITORING NOTE No.15

A STUDY OF WINDSPEED FOR THE SIX CLASSES OF MARINE SURFACE OBSERVATION

by

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DUPLICATE ALSO

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I Introduction

This study attempts to detect any biases from a background field for different observing practices from marine observations. The background field is a T+6 hour forecast from the global version of the Unified Model valid at the main synoptic hour for assimilation and interpolated to the position of the observation platform.

Surface marine winds are measured from a variety of observing platforms using different techniques. Most observations are made using anemometers located at convenient points on the structure of the observing platform, be it a ship, buoy, rig, etc., not necessarily having the best exposure and probably not at the standard height of 10 m. For observations made at heights other than 10 m the wind speed should be corrected. The winds from buoys are not adjusted for height since the sensors are generally at heights around 6 m and any adjustment would be very small, whereas on some platforms the sensors are often at heights exceeding 100 m and the corrections become more significant (Wills et al, 1986).

Previous studies (Kent, E.C. et al. 1991, Hall et al, 1991) have suggested that readings taken from anemometers are generally spot winds and there is a tendency to report gust and not average winds. Anemometer estimated winds from ships also require a correction for ship motion.

Many wind observations are made using a visual estimate of speed and direction from the character of the sea-surface. Although guidance is often sought from anemometers visual estimates are considered to represent an integration of the windspeed and direction over the past hour or so, rather than a spot wind and do not suffer the problems of the effects of the observing platform structure or motion.

II Observation Types

This study places the observations into 6 categories of observing practice/structure:-

1 - Anemometer (ship)
2 - Automatic
3 - Drifting Buoy
4 - Moored Buoy
5 - Platform/Rig
6 - Visual

The data were extracted from the Observation Processing Database (OPD) (Smith,S.G. and Ashcroft,J.,1992) and categorised by interpreting indicators and identifiers in the records.

Anemometer ship- observation type 12 (SHIP) or 14 (OWS), observing practice bit 10 = 1.

These measurements are made manually using an anemometer attached to an exposed part of the structure of the platform. Inevitably, there will be speed and direction biases imposed on the sensors due to the masking effects of the structure of the ship from most directions.

Automatic	- observation type 13 (SHIPAUTO), identifier all characters and not on UK Platform/Rig list (see below under Platform/Rig). These are automatic observing systems attached to some Platforms/Rigs and a few moored ships such as lightships.
Drifting Buoy	- observation type 13 (SHIPAUTO) or 17 (DRIBU), the identifier is numeric and the last three digits are >=500. These are automatic systems attached to buoys. Except in high seas their exposure will be very good both in terms of wind direction and speed, despite being close to the sea surface.
Moored Buoy	- observation type 13 (SHIPAUTO) or 17 (DRIBU), the identifier is numeric and the last three digits are <500. Similar to drifting buoys, these are automatic systems attached to buoys. Except in high seas their exposure will be very good both in terms of wind direction and speed, despite being close to the sea surface.
Platform/Rig	- observation type 13 (SHIPAUTO), identifier on a UK Platform/Rig list. Similar to ships, these measurements are made manually with the anemometer attached to a convenient structure, usually high up and often close to any helipad. The windspeeds are then 'corrected' to be valid at a height of 10 m. The list of UK Platforms/Rigs consists of 54 identifiers of structures located around the UK.
Visual	- observation type 12 (SHIP) or 14 (OWS), observing practice bit 10 = 0. Wind speed and direction may be estimated visually by observing the sea surface. Poor exposure will not be a degrading factor but the observation will be crude as a result of the relatively large bands used in estimating the wind direction and speed in terms of compass rose and Beaufort force.

The distinction between some of these categories is not always as set out above. For example, there are some moored buoys which have an identifier with the last three digits >= 500 and some drifting buoys which have an identifier whose last three digits are <500. The number of those which do not appear in their correct categories are very few and the effect on the global statistics would be minimal.

Note that winds from drifting buoys were not used by the data assimilation during the period of this study.

III Statistics

To show the different bias characteristics between the observation types, data was extracted from the OPD for three periods of one month. The data was averaged over each month and histograms of various parameters for each observing type were plotted. The months chosen for this study were March, June and October 1992. Generally, data for March will be discussed and comparisons with the other two periods will be made where appropriate. The data used for each plot will be:-

i) no exclusions - all data found in the OPD,

ii) flagged data only - all data in the OPD not used by the model,

iii) only non-flagged data - all data in the OPD used by the model.

The data that has been used will be made clear in the description of each plot.

a) Number of Observations - Global

Figure 1 shows the number of observations returned over the month of March 1992 with no exclusions for each observation type. The data is tabulated in Table 1. The vast majority of observations are of the Anemometer and Visual type.

b) Mean O-B Speed - Global

Figure 2 shows the mean Observation - Background (O-B) windspeed in m s^{-1} over the whole globe with no exclusions. All observation types bar Drifting Buoys over-estimate the windspeed. Moored Buoys over-estimate the speed by just over 0.07 m s^{-1} on this global average.

c) Standard Deviation O-B Speed - Global

Figure 3 shows the global standard deviation for each category with no exclusions. Anemometer ships have the largest global standard deviation possibly due to the motion of the ship not being taken into account and differing draughts resulting in differing anemometer heights not being used to correct the windspeed.

d) Mean O-B Speed - Speed Band

Figure 4 shows the mean Observation - Background windspeed in m s^{-1} split into speed bands. No data has been excluded. The banding has been calculated on the mean of the Observation and the Background windspeeds to avoid skewing of the data.

This figure clearly shows systematic trends for each observing type. Table 2 shows the mean O-B windspeed for each observation type and for each speed band. If there are less than 30 observations the statistic is not shown or plotted as it is regarded as unreliable.

For comparison Figures 5 and 6 show the same as Figure 4 but for June and October 1992.

For all types, bar DRIBUs, the Mean O-B Windspeed bias increases with speed band.

The six observation types may be grouped into pairs in terms of bias characteristics:-

i) anemometer and visual

- have very similar bias characteristics with the anemometer type showing a slightly higher bias at the lower speed bands. The characteristics are evident for all three monthly periods.

ii) automatic and platforms/rigs

- show similar characteristics with negative or near-zero biases in the lowest speed band rising to about 4 m s^{-1} in the 15-20 m s^{-1} band. The slope of the bias increases are less than those found with the anemometer and visual types.

iii) drifting and moored buoys

- both have relatively flat bias characteristics for mean O-B windspeed. For the three months studied drifting buoys have the only consistent negative windspeed bias indicating an under-estimate in the windspeed, although there does not appear to be any trend in the characteristic. Moored buoys have a slightly increasing bias with speed band.

e) Standard Deviation of O-B Speed - Speed Band

Figure 7 shows the standard deviation of O-B windspeed for March with no exclusions split over speed bands. The data is tabulated in Table 2.

The standard deviation rises steadily for each category and each speed band up to the band covering 15-20 m s^{-1} where it reaches ~4 m s^{-1}. Above 20 m s^{-1} the standard deviation rises rapidly to just under 10 m s^{-1} although there are very few observations contributing to the statistics in these higher speed bands. Where a column has not been plotted, there was not enough data to form a statistic.

For comparison the same statistics shown in Figure 7 have been plotted for June and October in Figures 8 and 9.

f) <u>Frequency Distribution of O-B Speed Differences</u>

Figures 10-15 show frequency distributions of O-B windspeed for each observation practice for March for data selected with:-

(a) no exclusions

(b) all flagged data

(c) non-flagged data.

The normal Guassian distribution, which is to be expected of data of this type, given natural deviations from a mean, is also plotted over the histograms with the same mean and standard deviation as the data to emphasise outliers.

Table 1 shows the number of observations used for each data type for the month of March and for each flag status along with the bias and standard deviation in each case.

Figure 10a shows the anemometer observations. Note that the Guassian curve has a poor fit to the histogram. The flagged data in Figure 10b shows a significant number of observations with an O-B value above 30 m s^{-1} which is causing the high standard deviation and positive bias. Figure 10c shows all the unflagged data with a much improved fit of the Guassian curve, a smaller positive bias and standard deviation.

Figures 11a-11c show the same plots for DRIBUs. This is the only data type having a negative bias. DRIBUs are normally rejected from the data assimilation although Table 1 shows that 29 observations do get through probably due to miscoding of observation type (Figure 11b).

Figures 12a-12c show plots for Moored buoys. The unflagged data (Figure 12c) shows the smallest bias and standard deviation of all the observation types in this study apart from the few non-rejected DRIBUs mentioned above.

Platform/Rig data in Figures 13a-13c shows the bias and standard deviation to be similar to visually estimated winds.

Automatics in Figures 14a-14c show the same low bias as with moored buoys but with a higher standard deviation.

Figures 15a-15c show the same sequence of graphs for visually estimated windspeed.

Note the large number of outliers in Figure 15b (flagged data) and the improvement gained using non-flagged data (Figure 15c).

IV **Conclusion**

This study has shown that each of the marine observing types should be treated separately. If the windspeed data is to be used in assimilations, certain corrections could be applied to improve the use of the data, although this may have to be done selectively, even down to call-sign if the minority of already 'good' observations are not to be contaminated.

Despite the data presented being global there is a seasonal trend in the mean and standard deviation of O-B windspeed due to the majority of data being received from the northern hemisphere.

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TABLE 1 - Mean and Standard Deviation O-B Windspeed by flag status for March 1992

	No Exclusions			Flagged data			Non-flagged data		
Ob. type	No. of Obs	Mean m s^{-1}	S.D. m s^{-1}	No. of Obs	Mean m s^{-1}	S.D. m s^{-1}	No. of Obs	Mean m s^{-1}	S.D. m s^{-1}
Anemometer	35054	2.0	5.1	2764	6.7	13.6	32290	1.6	3.1
DRIBU	2388	-1.4	2.8	2359	-1.4	2.8	29	0.8	2.0
MORBU	11723	0.3	3.3	2654	-1.7	5.1	9069	0.7	2.5
Platform/Rig	2466	1.2	3.2	54	5.3	8.0	2412	1.1	2.9
Automatic	856	0.8	3.6	41	2.5	9.2	815	0.7	3.0
Visual	27956	1.3	3.6	1410	4.9	9.0	26546	1.1	3.0

TABLE 2 - Mean and Standard Deviation O-B Windspeed by speed band for March 1992

	0-5 m s^{-1}			5-10 m s^{-1}			10-15 m s^{-1}			15-20 m s^{-1}			20-25 m s^{-1}		
Ob. type	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.	N	Mean	S.D.
Anemometer	9008	0.38	2.41	17091	1.66	3.05	6928	2.98	3.84	1654	5.07	5.33	178	11.90	9.87
DRIBU	823	-1.59	2.14	1125	-1.38	2.43	376	-1.03	2.85	57	-3.32	3.24	0	*	*
MORBU	4327	-0.22	2.67	5810	0.11	3.55	1391	0.54	3.38	181	1.79	4.45	4	*	*
Platform/Rig	241	-0.64	1.94	1098	0.31	2.65	919	1.95	2.93	194	4.06	3.55	12	*	*
Automatic	175	-0.66	2.51	428	0.57	3.34	218	1.54	3.10	31	3.74	3.62	2	*	*
Visual	8061	0.00	2.23	14202	1.05	2.81	4445	3.00	3.61	1049	5.58	5.08	131	10.10	8.36

* = insufficient data to form statistic

Figures

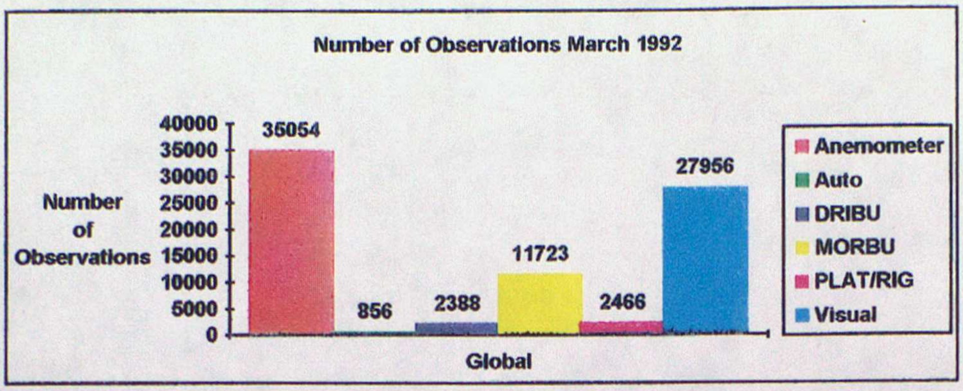
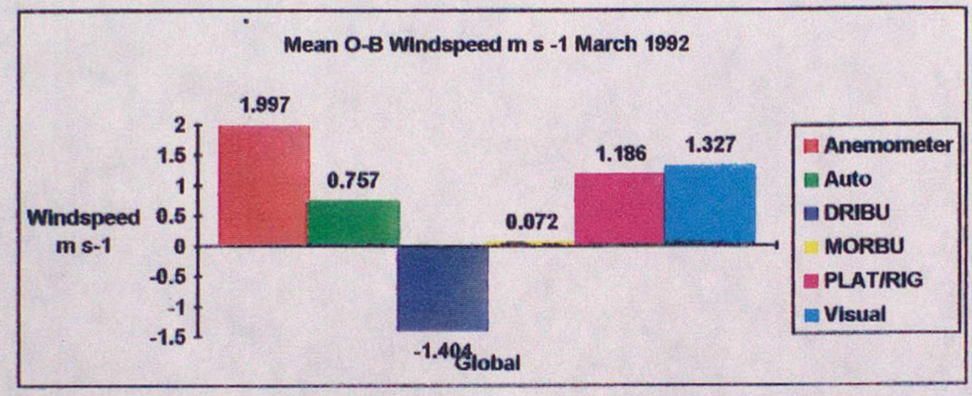


Figure 1



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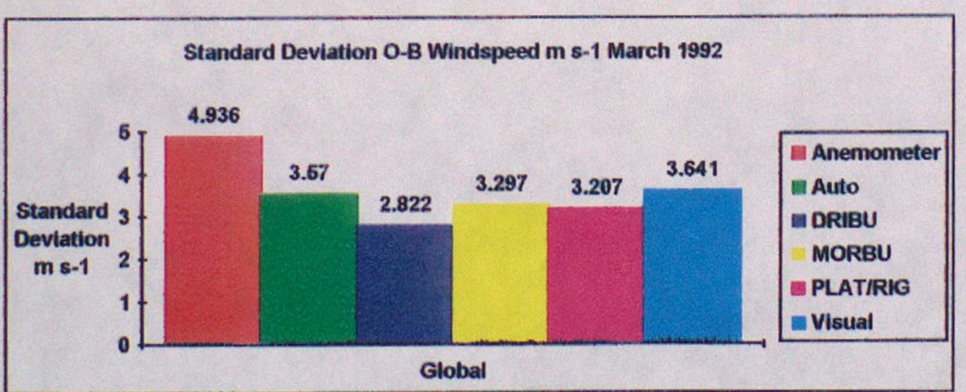

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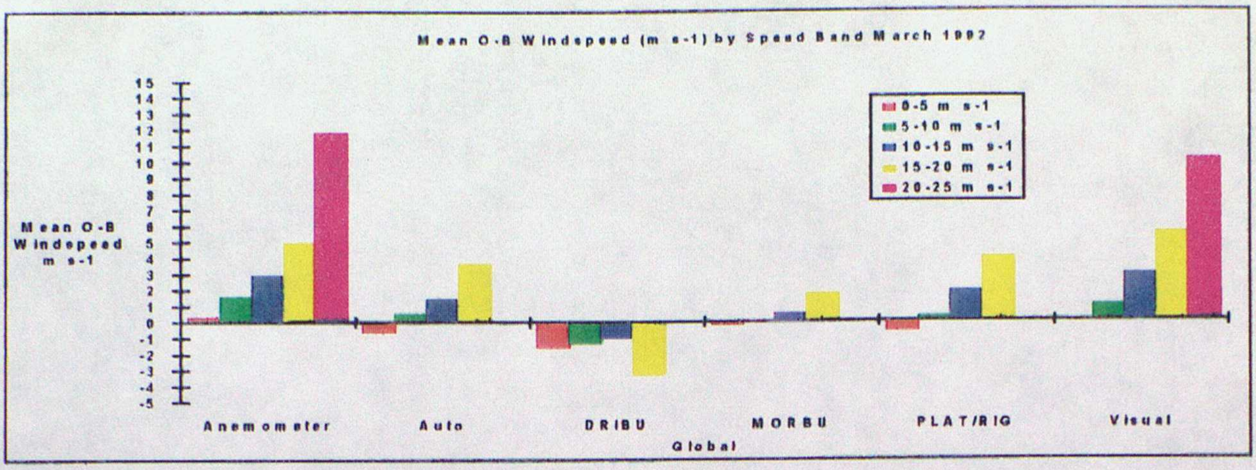

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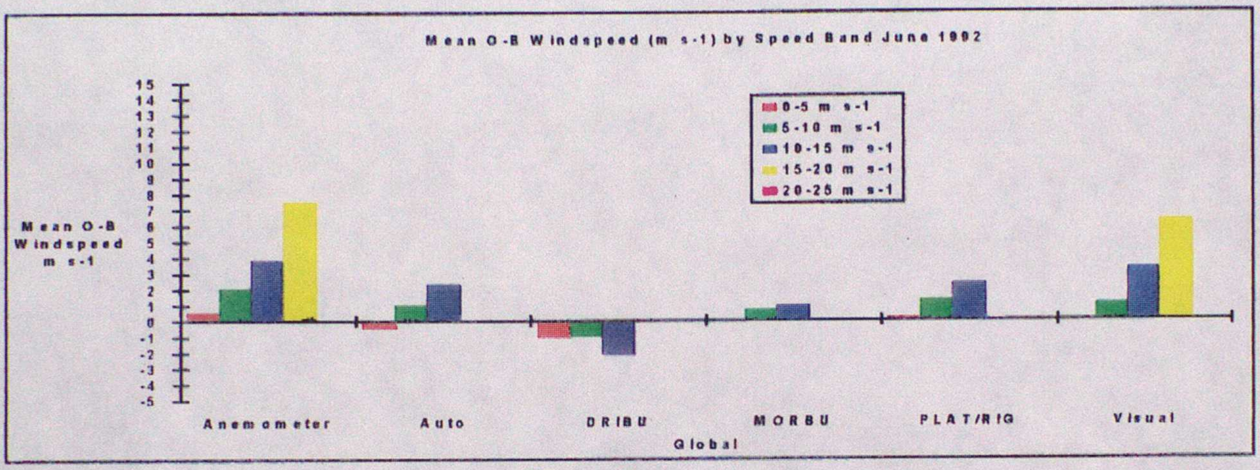

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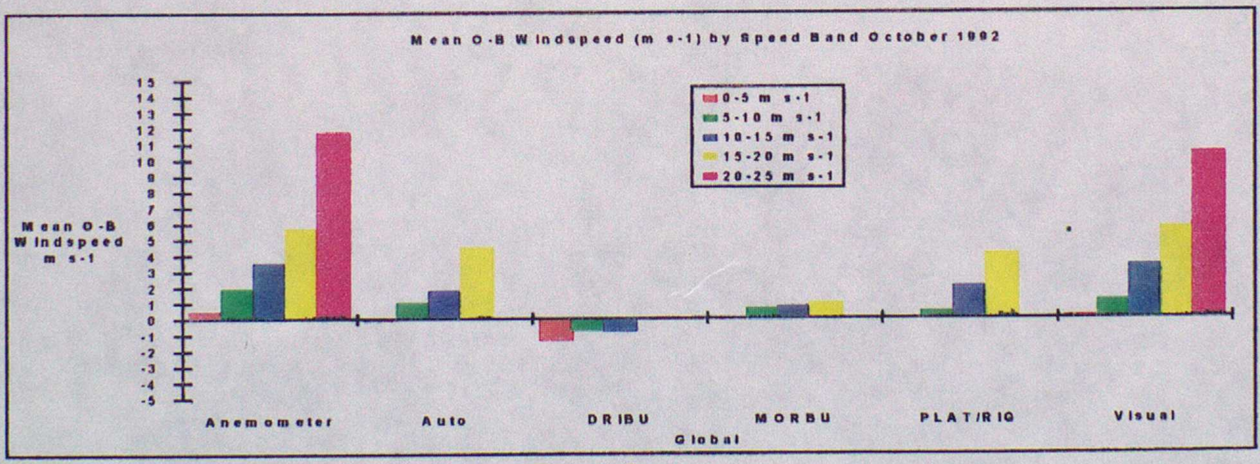

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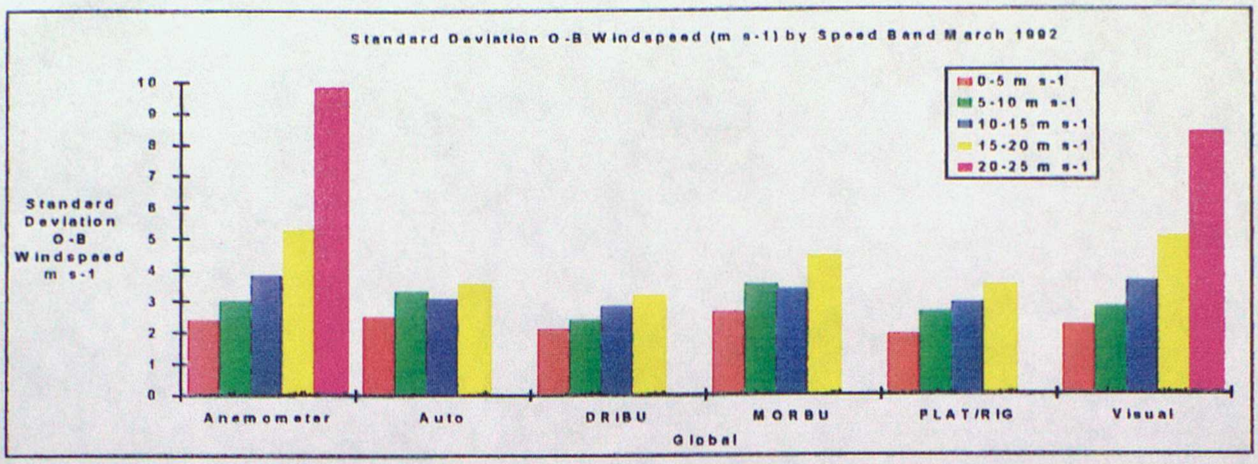

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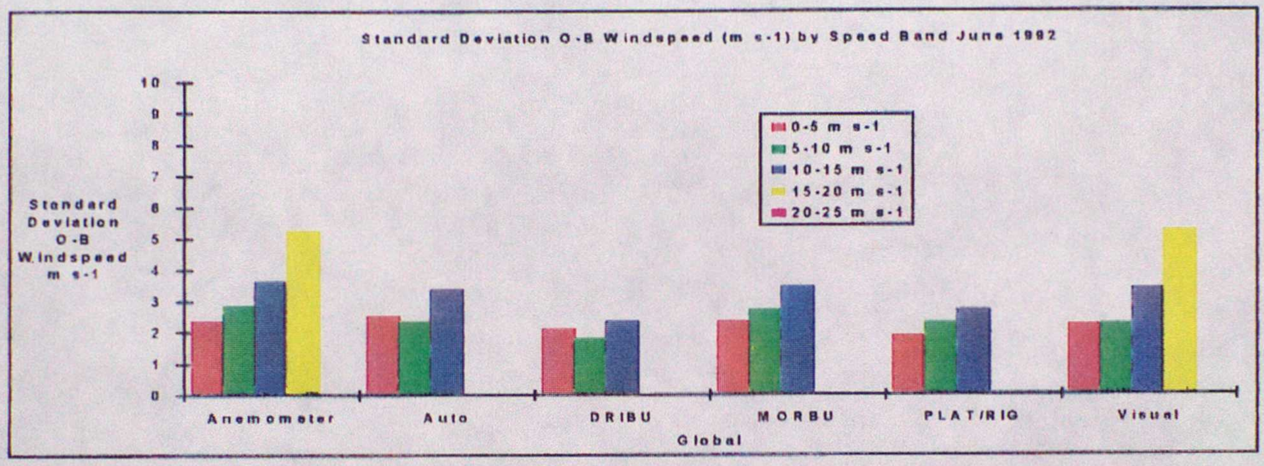

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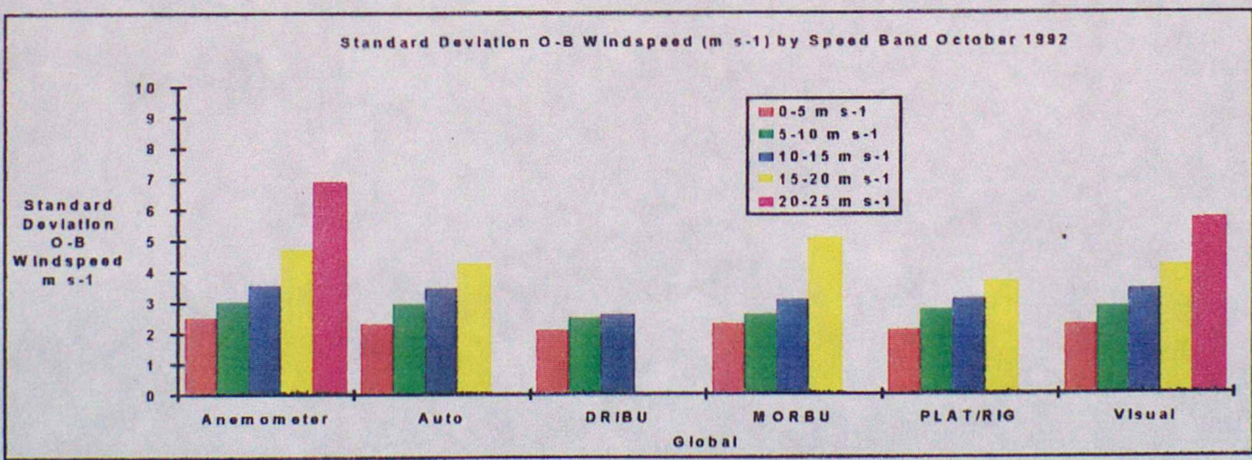

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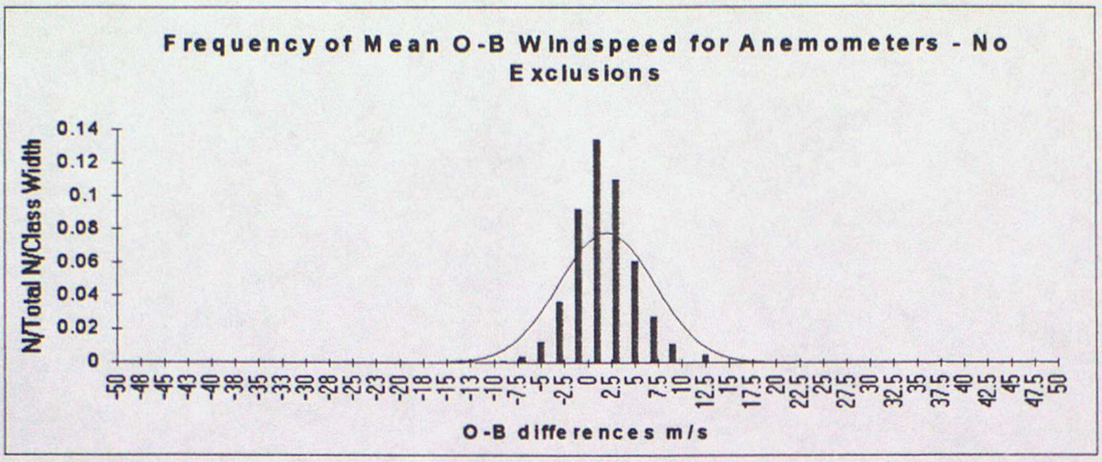
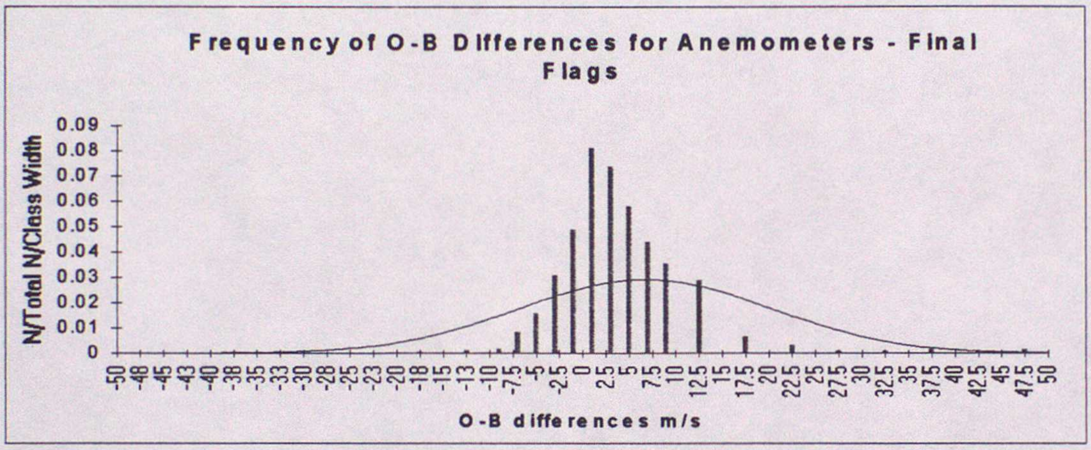


Figure 10a



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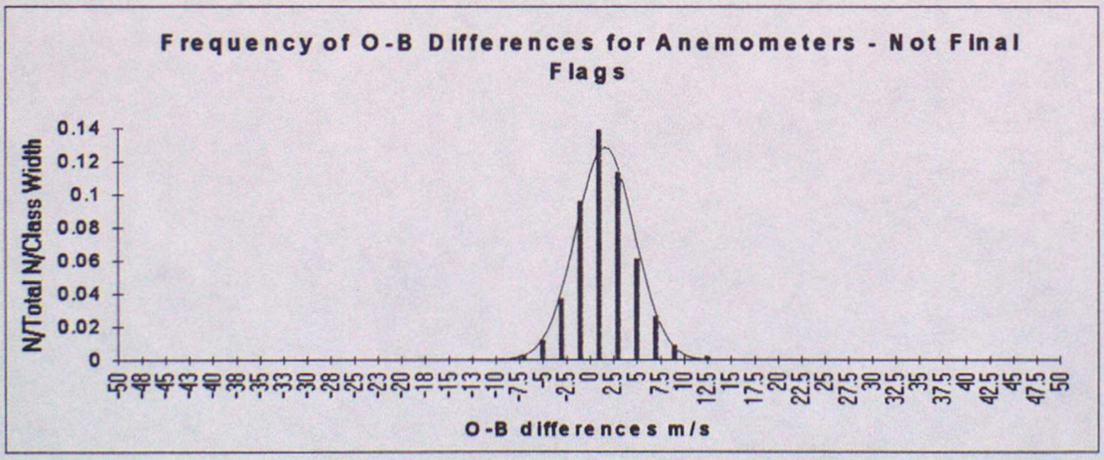

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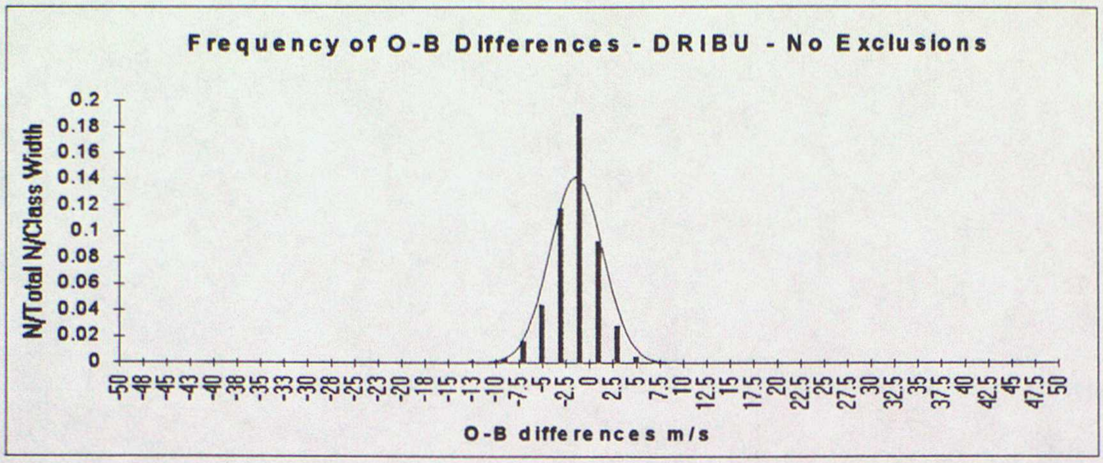

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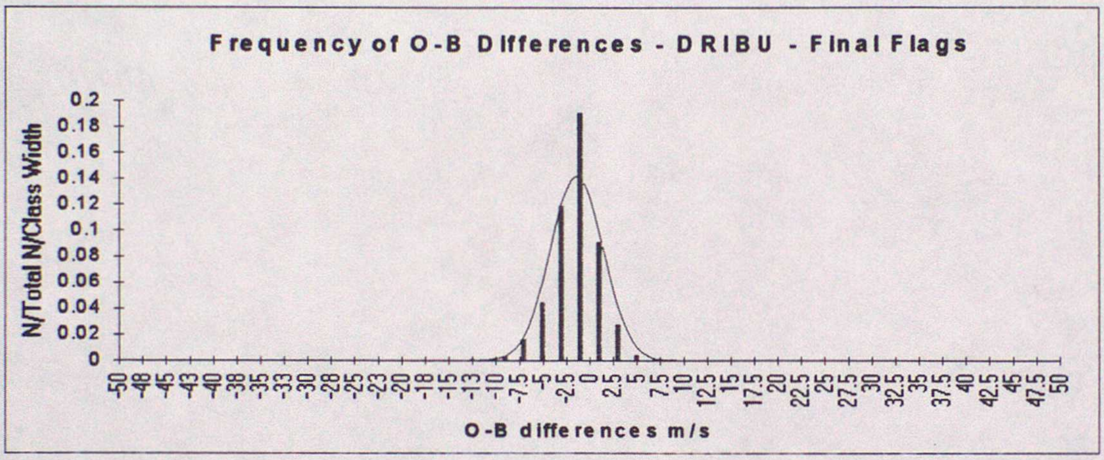

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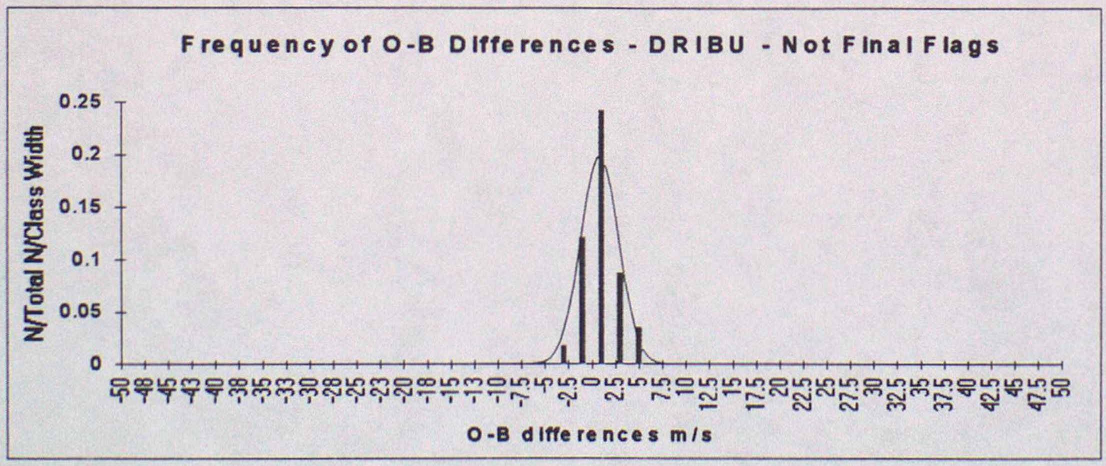

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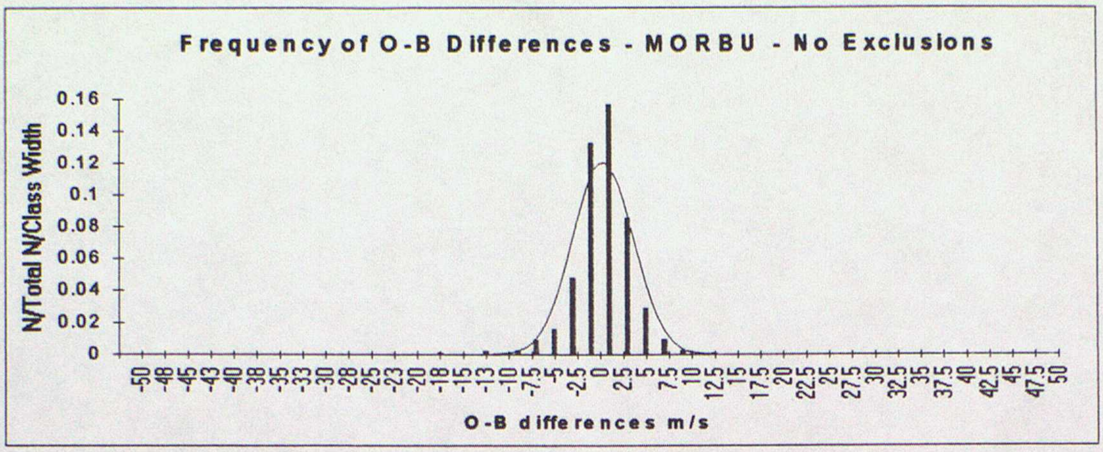

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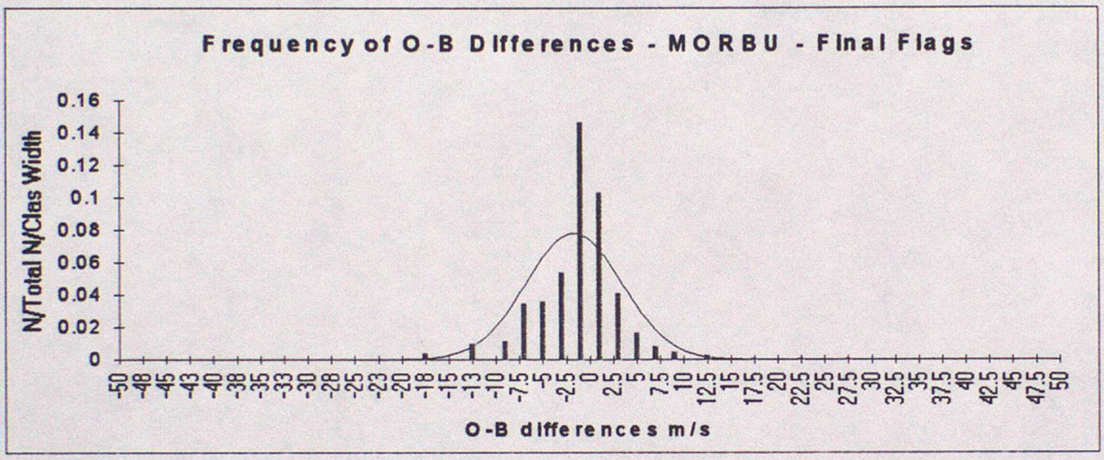

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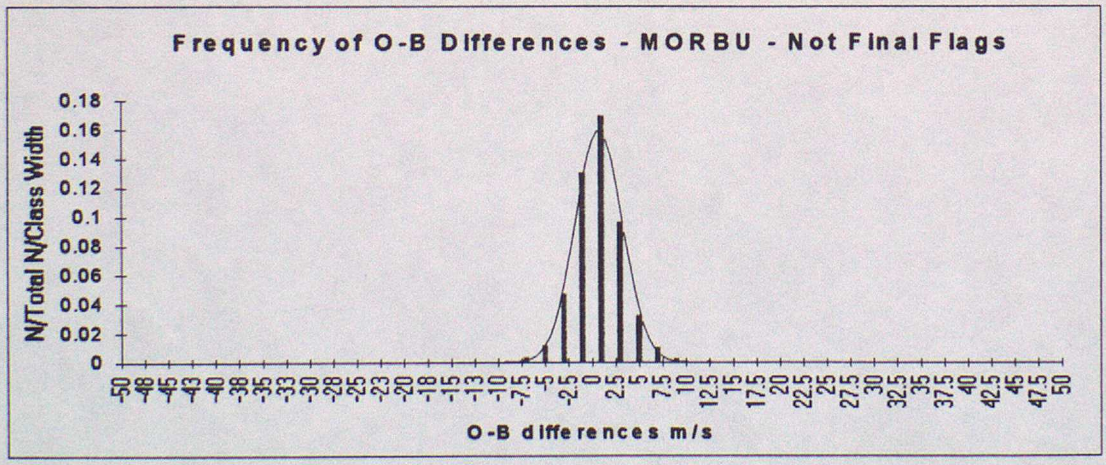

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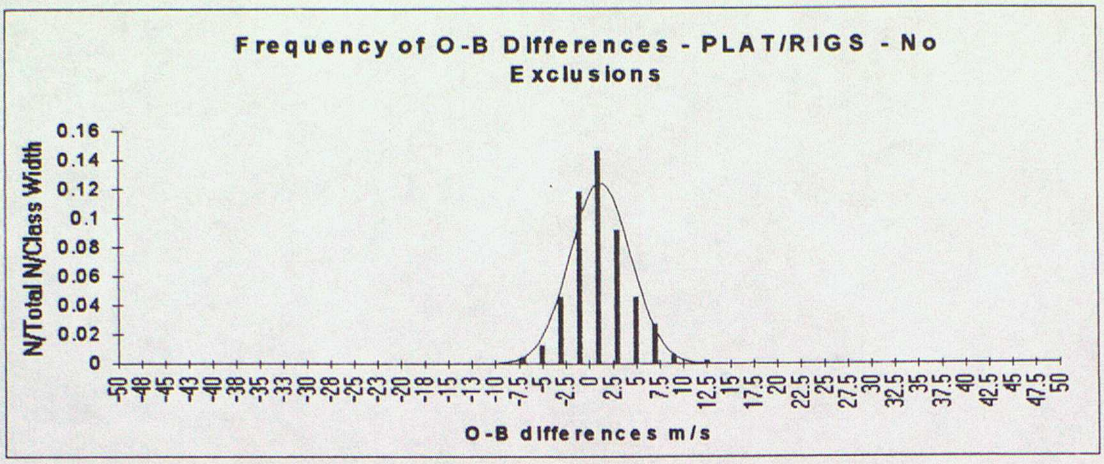

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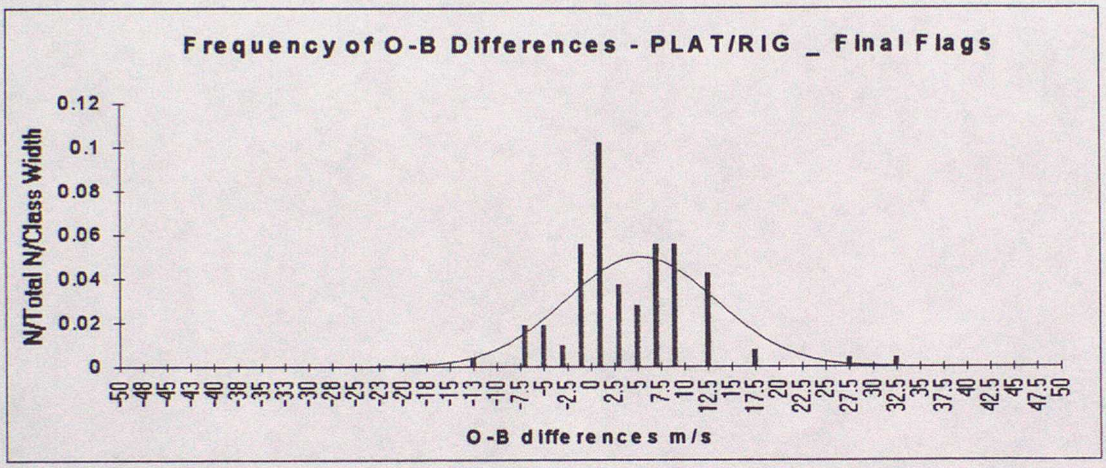

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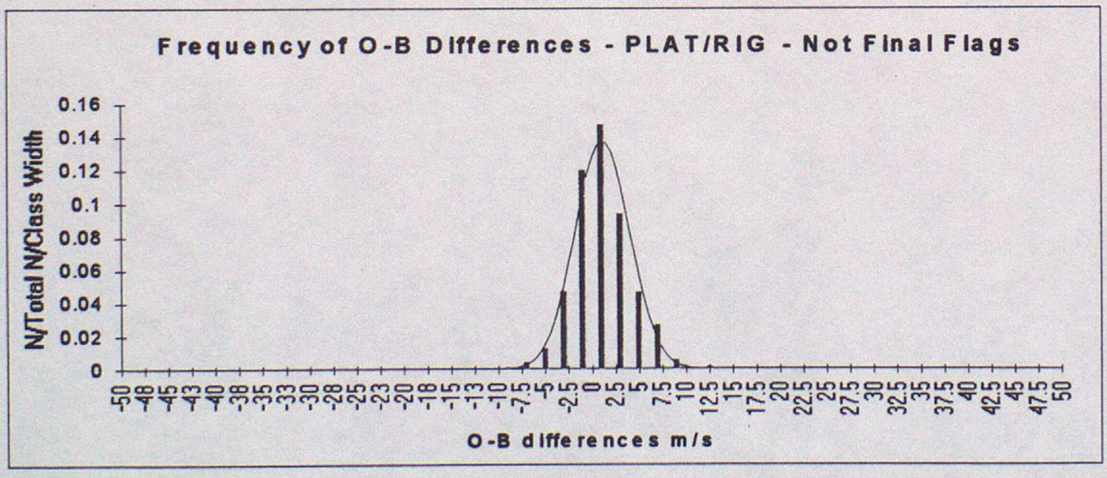

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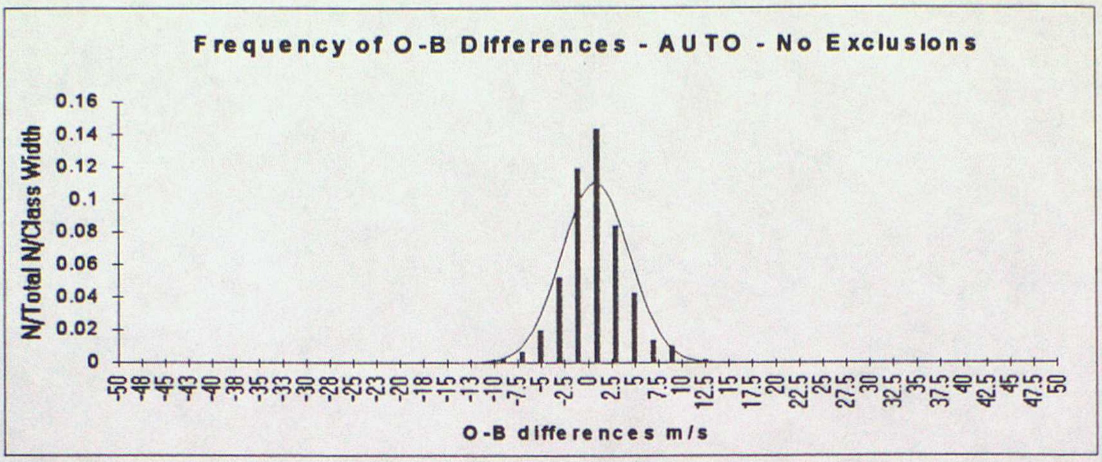

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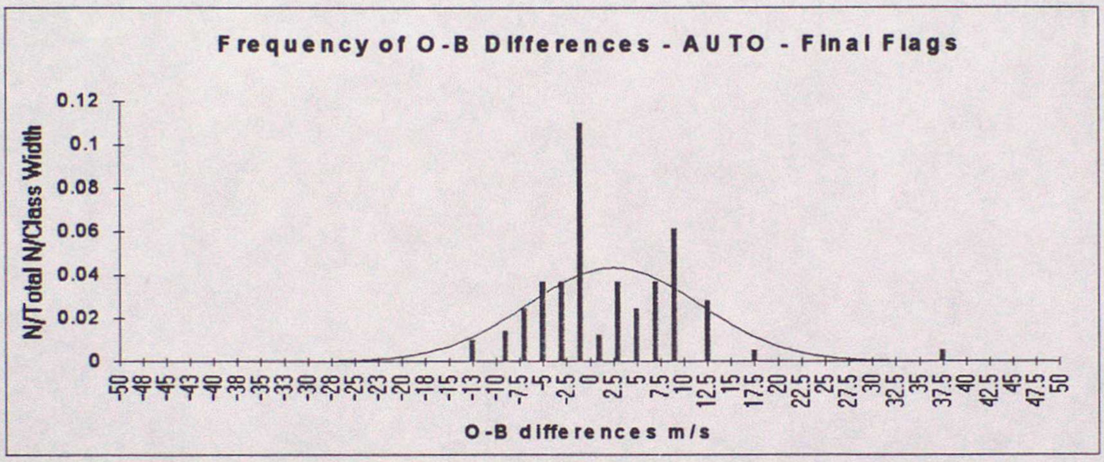

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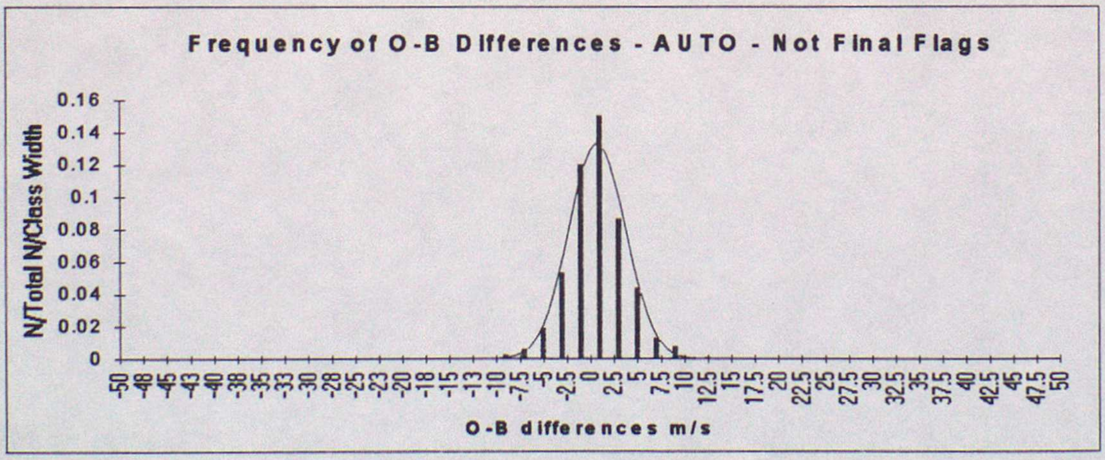

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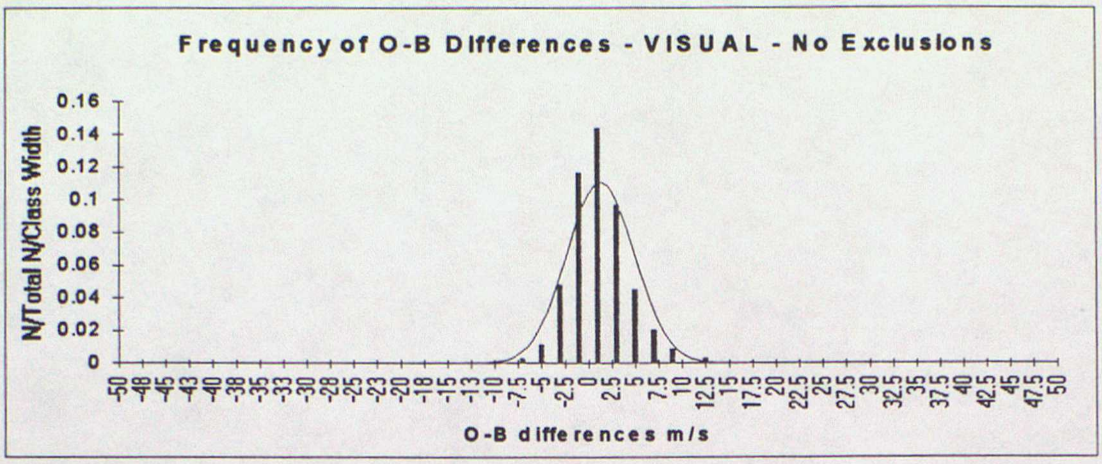

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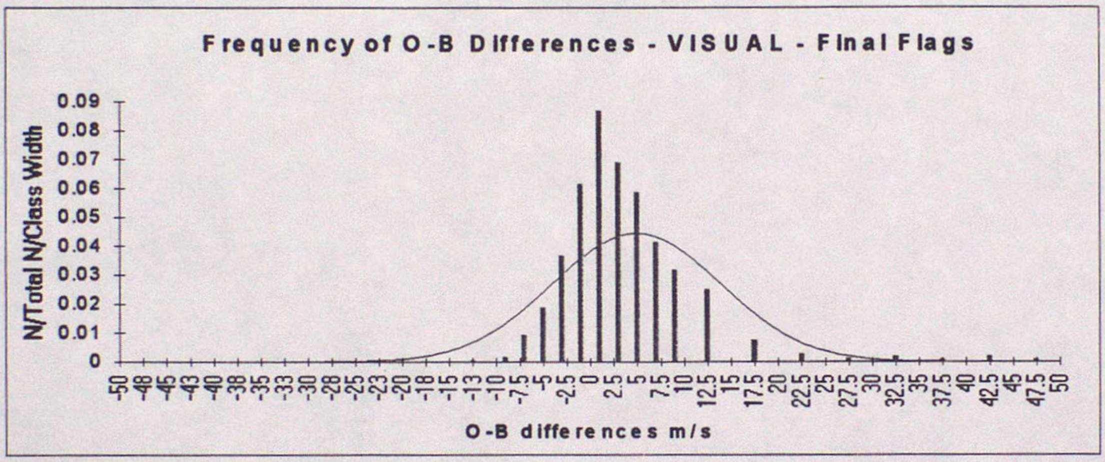

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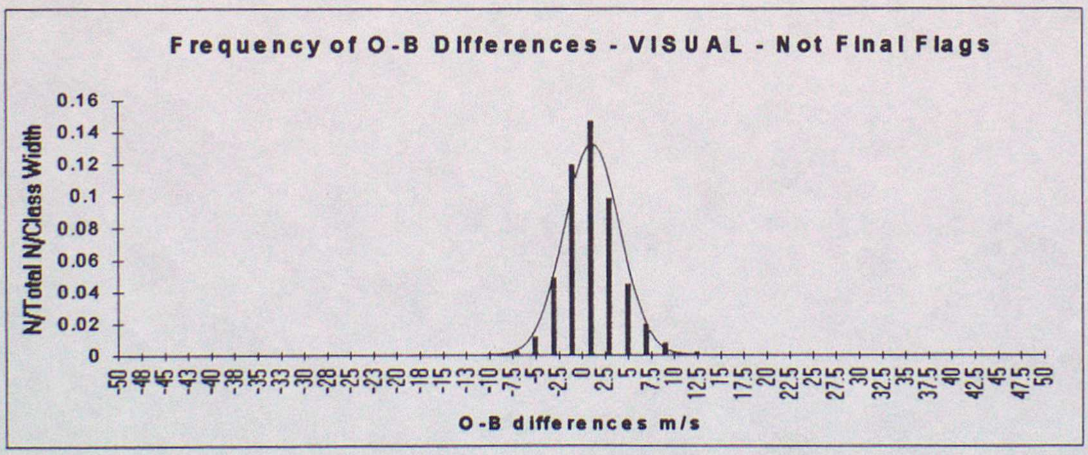

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