TECHNICAL NOTE NO. 29

SOME EFFECTS OF SEA-AIR TEMPERATURE DIFFERENCE, LATITUDE AND OTHER FACTORS ON SURFACE WIND-GEOSTROPHIC WIND RATIO AND DEFLECTION ANGLE

BY

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AB (27) A computer program was written for comparison of reported winds from ships with geostrophic winds obtained from the Fleet Numerical Weather Facility surface pressure analysis. In the comparisons described here, ship reports from 14 synoptic times between 18 January 1967 and 9 February 1967 were used. Thus the results obtained would be representative for the winter season.
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List of Contents

1. Introduction

A computer program was written for comparison of reported winds from ships with geostrophic winds obtained from the Fleet Numerical Weather Facility surface pressure analysis. In the comparisons described here, ship reports from 14 synoptic times between 18 January 1967 and 9 February 1967 were used. Thus the results obtained would be representative for the winter season. The tabulations of the comparison elements were performed by hand. A similar study is contemplated for the summer season.

2. Velocity ratios as a function of $T_a - T_s$

One of the elements computed was the ratio of the magnitude of each reported wind velocity to the geostrophic velocity at that location (V/V_{gs}). This ratio was tabulated for each whole degree of the reported difference between air and sea temperature ($T_a - T_s$) and the median value found for each interval.. These values are shown as x's in Figure 1. The number of cases for each interval is shown in parentheses. For values of $T_a - T_s$ above +1 and below -4 the number of cases appeared to be insufficient to establish stable values.

The o's in Figure 1 are values obtained by Bleeker (from Bijvoet 1957) for a light vessel at 52N 3E.(1)

The horizontal line at $V/V_{gs} = .78$ is the current Fleet Numerical Weather Facility practice in surface pressure analysis.

At the time the analysis is performed, the computer has no information as to the reported air-sea temperature difference.

Thus although the amount of "noise" in the comparison values is large, it does appear that the effect of air-sea temperature differences should be taken account of, both in performing the surface pressure analysis and in extracting winds from the completed analysis.

3. Velocity ratios as a function of latitude

The median values of V/V_{gs} for each 2-1/2 degree of latitude were also computed and are shown as the x's in Figure 2. The o's are values reproduced by Roll, page 214.[4] Again the general behavior of the distributions has correspondence where comparison is possible. No obvious explanation of the maxima near 35°N presented itself. Data and time were not sufficient to attempt to distinguish among various hypotheses such as a failure of the analyses to produce sufficiently intense subtropical highs, a relatively larger part of the wind being non-geostrophic from direct thermal circulation in these latitudes, etc.

4. Velocity ratios as a function of curvature

Relation of the Laplacian of pressure to the ratio V/V_{gs} was investigated to some extent. In common with a number of other studies,[1,2,3,4] it did not appear to be significant. The Naval Oceanographic Office contract study[3] even suggests that the ratio V/V_{gs} is increased in cyclonic motion. Getting first derivatives in the pressure field is "noisy." Getting second derivatives for a trajectory for a suitably small scale which are valid at a point is not yet very meaningful.

The practical result from these studies is that in general the data do not support using curvature as a modifying influence

for the ratio V/V_{gs} at this time. There are obvious exceptions to this as in a hurricane.

5. Velocity ratios as a function of ship call letters

During the processing of these figures it was incidentally noticed that the ratio V/V_{gs} for those ships whose 4-letter call begins with U was very nearly half that of other ships. Clearly the Russian ships are reporting wind velocity in meters per second rather than in knots.

6. Angle between reported wind and geostrophic wind as a function of T_a-T_s

Figure 3 shows the angle α measured positive clockwise from the reported to the geostrophic wind, plotted as a function of T_a-T_s. In this figure the x's are median values from this study and the o's are values from Verploegh (from Bijovet 1957).

From the point of view of vertical variation of wind in the friction layer, it might be expected that the angle α would be small with cold, unstable air, but from the point of view of direct thermal circulation especially in subtropical anticyclones, it could be expected that cold air would have a strong surface component of wind toward lower pressure. At this stage, no more can be done than to speculate on the reasons for the apparent discrepancy between different comparisons.

7. Angle between reported wind and geostrophic wind as a function of latitude

In Figure 4 the median values of α are plotted as x's against latitude for intervals of 5 degrees of latitude. Corresponding

values from Roll (page 214) are plotted as o's. The vertical line at $\alpha = 15^\circ$ represents current Fleet Numerical Weather Facility practice. Here again, evidence from several sources suggests that some improvement in practice is possible.

8. References

(1) H. C. Bijvoet, 1957, 'A new overlay for the determination of the surface wind over sea from surface weather charts," Mededel. en Verh. Kon. Nederl. Met. Inst. No 71, 35 pp.

(2) D. A. Drogaitsev, 1958, "Wind investigation and construction of wind fields above the sea," Mimeo transl. by Natl. Inst. Oceanogr. Engl.

(3) H. U. Roll, 1965, "Physics of the marine atmosphere," Academic Press, N. Y., 426 pp.

(4) Albert Thomasell, Jr. and James G. Welsh, 1963, "Studies of the specification of surface winds over the ocean," Travelers Research Rpt. No. 7049-88 (Mimeo).

List of Figures

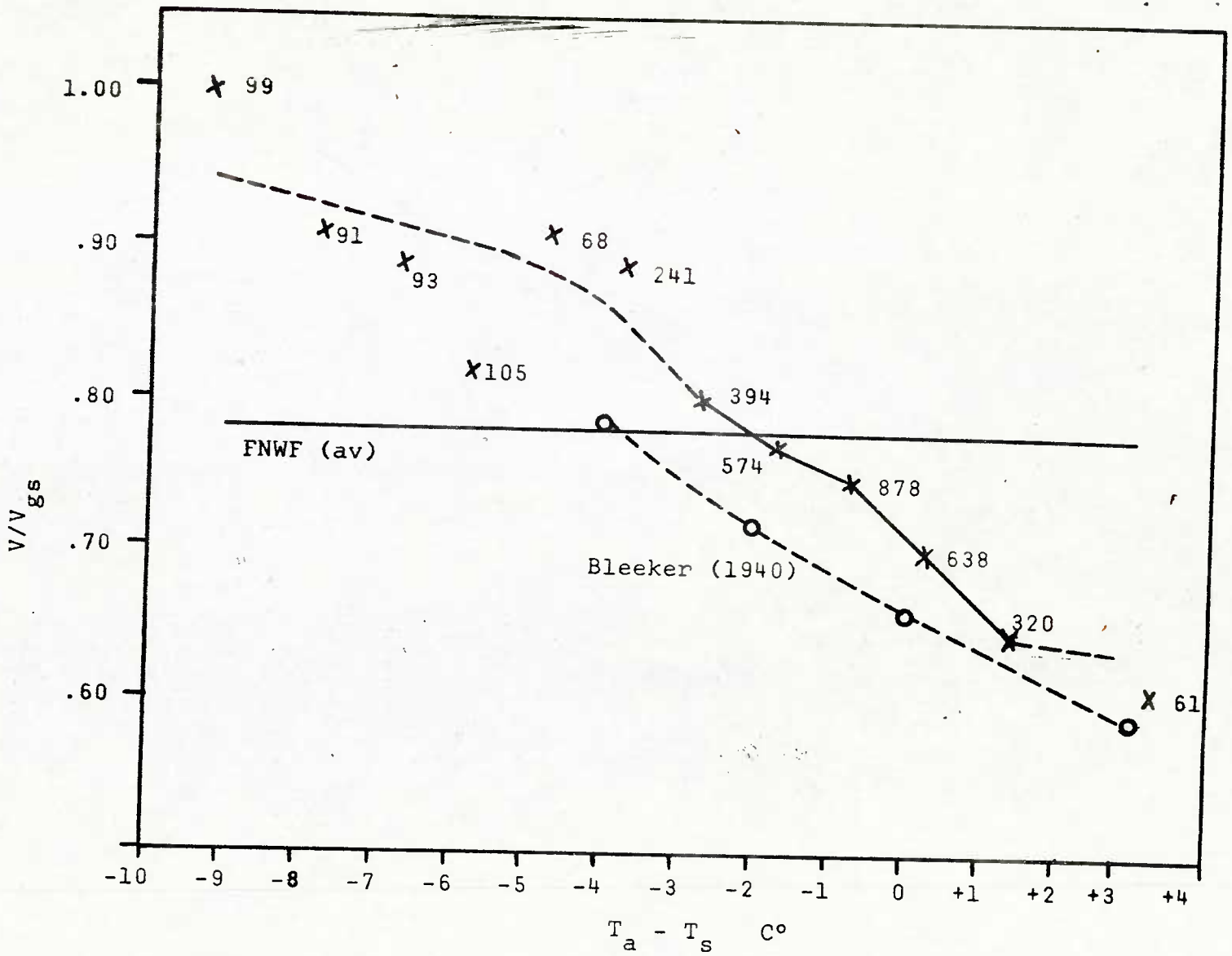

Figure 1 Reported wind-geostrophic wind ratio as a function of air-sea temperature difference.

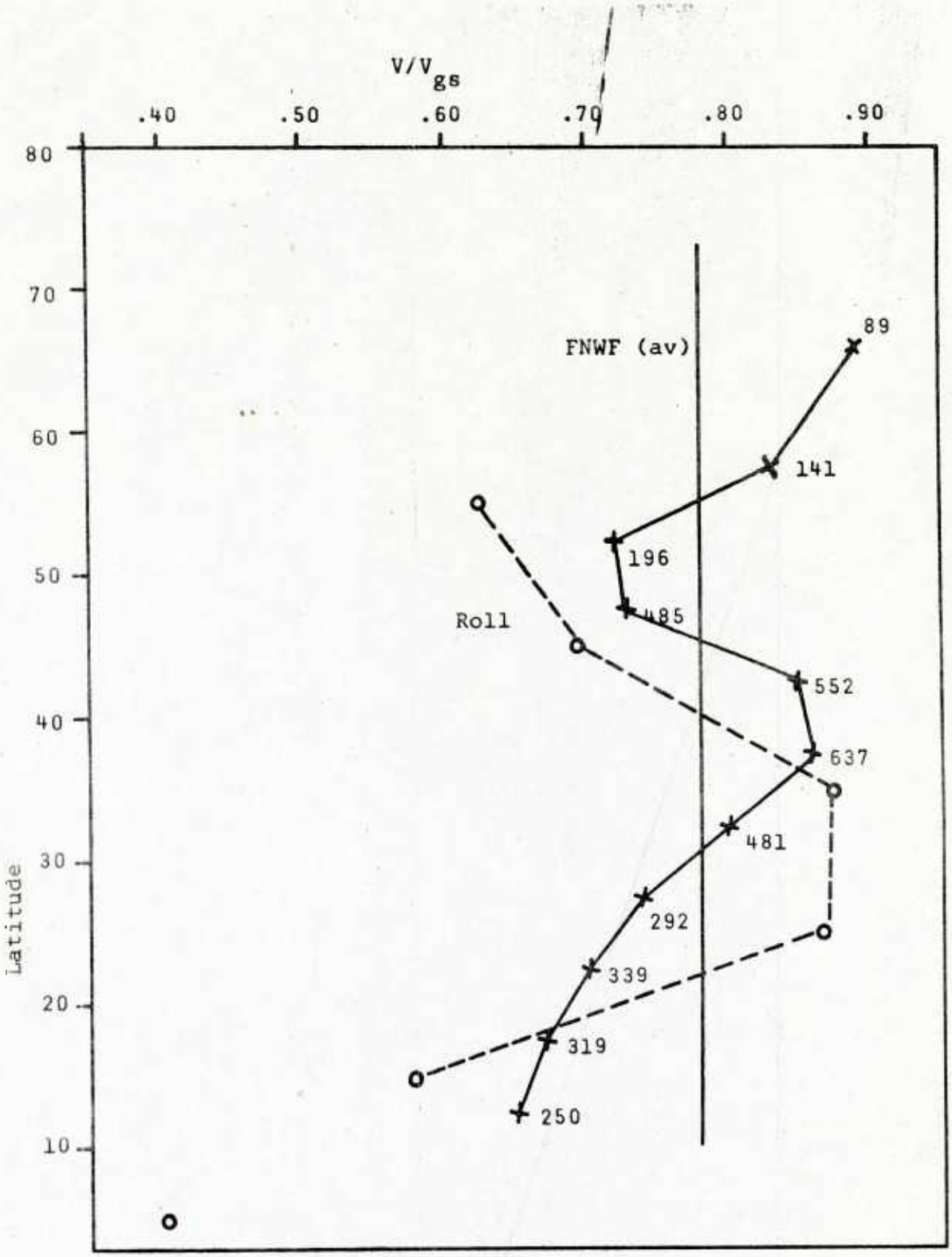

Figure 2 Reported wind-geostrophic wind ratio as a function lf latitude.

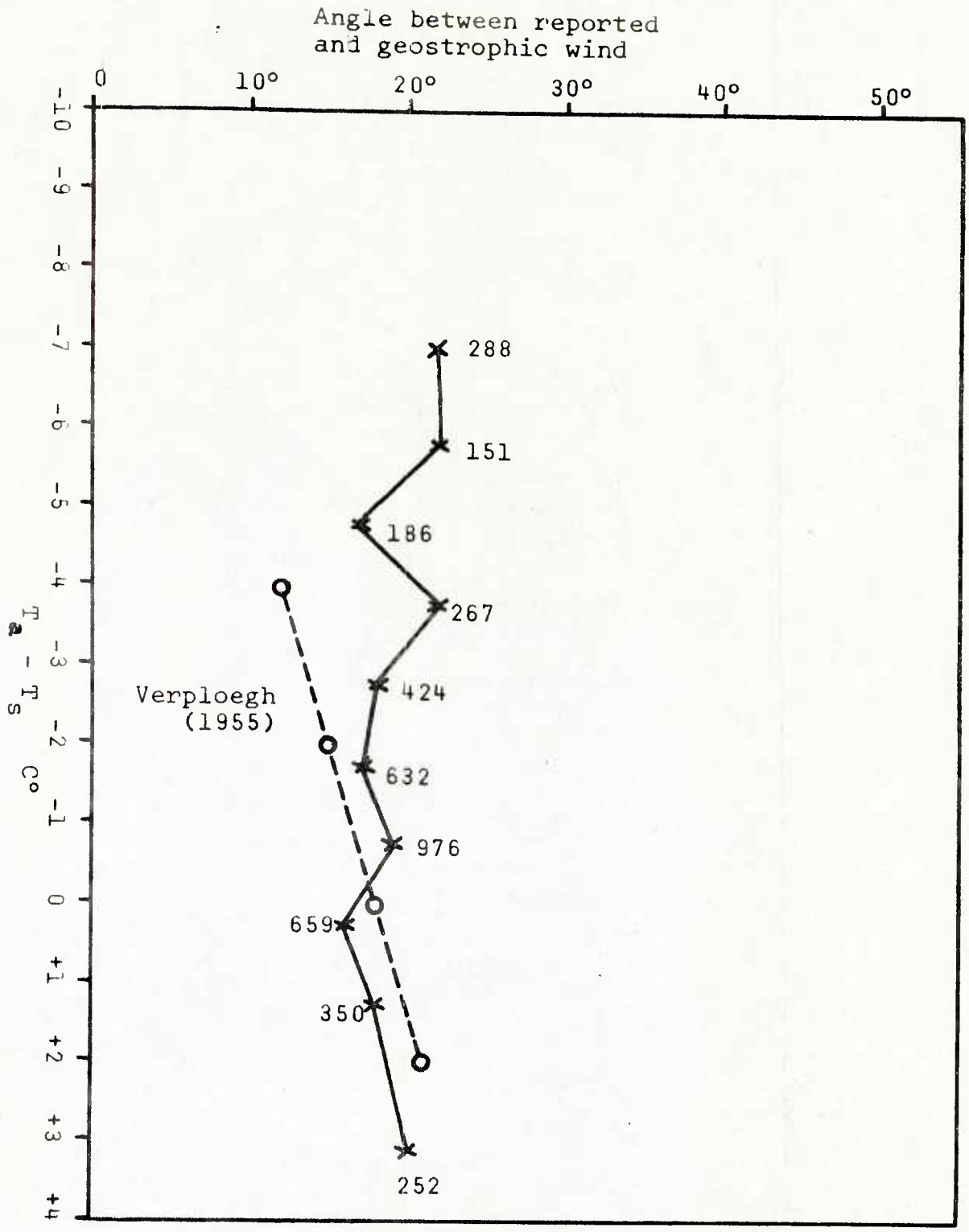

Figure 3 Angle between reported wind and geostrophic wind as a function of air-sea temperature difference.

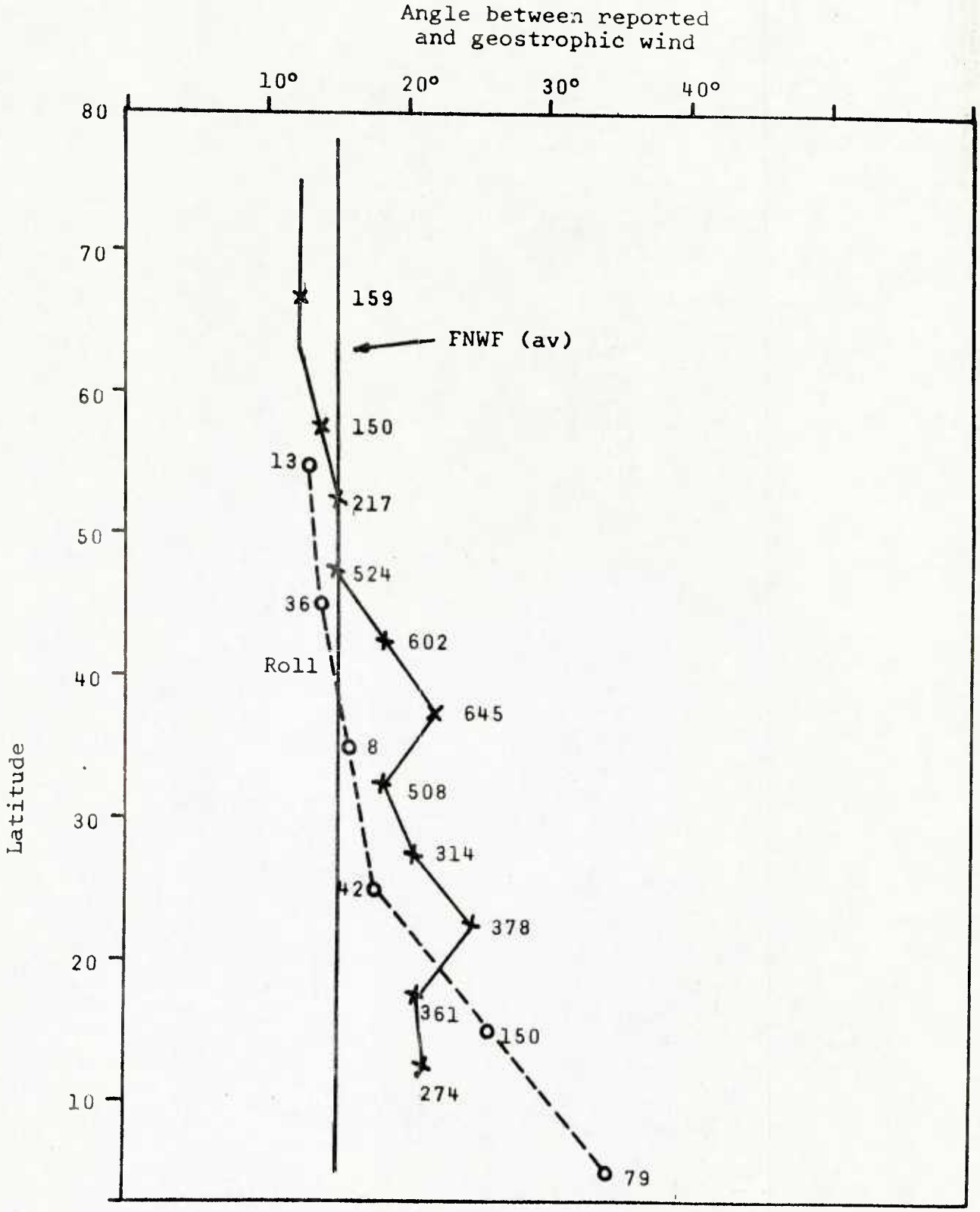

Figure 4 Angle between reported wind and geostrophic wind as a function of latitude.