WIND VARIATIONS IN THE LOWER THERMOSPHERE AT A HIGH-MIDLATITUDE STATION

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ABSTRACT

The meteor-radar-derived winds in the lower thermosphere (90–100 km) over Kuhlungsborn (54° 07′N, 11° 46′ E) are studied. The results relating to monthly mean zonal and meridional components and their diurnal and semidiurnal variations are presented.

INTRODUCTION

For the last several years meteor radars are being used as potent ground-based remote sensing systems for measuring winds in the lower thermosphere (90–100 km) at middle latitudes[1–6]. Recently, these measurements have also been made possible using MST (mesosphere-stratosphere-troposphere) radars[5–7]. The enormous wind data thus obtained have enabled many research workers to pursue studies of the space-time variations of various dynamical processes and associated circulation phenomena prevailing in the upper atmosphere[2, 6, 8]. The seasonal variability of meteor winds at medium latitudes has been studied by several investigators and it exhibits marked intra-latitudinal variations[2, 5, 9]. The present communication deals with the analysis of the meteor wind data recorded at the high-midlatitude of Kuhlungsborn (54° 07′N, 11° 46′ E) during the period 1977–82.

DATA

The Akademie der Wissenschaften der DDR, Zentralinstitut fur solar terrestrische Physik (Heinrich-Hertz-Institut), DDR-1199 Berlin Aldershof, publishes annually the results of radar wind measurements made regularly on every Tuesday and Wednesday at Kuhlungsborn as supplement issues of its Bulletin 'Geophysical Data'. These winds refer mainly to heights between 90 and 100 km. Half hourly mean values of the zonal and meridional components of the horizontal wind along with the results of harmonic analysis of these values for each observational day are published. Information for the six-year period 1977–82 is utilized here to study the changes in wind circulation and tidal characteristics.

MEAN MONTHLY ZONAL AND MERIDIONAL WINDS

Though the raw data are available at weekly intervals, in view of large fluctuations in magnitude and direction of the prevailing wind, the average value for each month is considered for analysis. Figure 1 shows the monthly variation of the mean zonal (EW) and meridional (NS) components of the prevailing wind for the period 1977–82. During the spring transition (April) the EW winds change from westerlies to easterlies in all the years except 1977. During the fall transition (October) the easterlies show a minimum which is conspicuous in the years 1978, 1979, 1980 and 1982. Such a characteristic variation is not noticed for the meridional wind.

The monthly mean of the EW and NS components of the prevailing wind, averaged over the six-year period 1977–82, are shown in figure 2(a). The EW wind shows distinct minima during the equinoxes, one in April and the other in October. The EW wind changes from westerly to easterly during March–April and back to westerly during May. The NS wind reverses from south to north in April and back to south in August. The NS wind is weaker than the EW wind.

The temporal correlation studies between the wind observations in the lower thermosphere (95 km) and the corresponding observations in the stratosphere (30 km) indicate that the spring reversal of EW wind occurs in the lower thermosphere 3–4 weeks prior to that in the stratosphere[8]. Further studies are required to understand the association between the wind changes at these two levels.

RESULTS OF HARMONIC ANALYSIS

(a) Amplitude variations: From the published data monthly mean amplitudes of diurnal and semidiurnal tidal components of EW and NS winds during the period 1977–82 were computed and their variations are represented in figures 2(b) and 2(c). The NS component shows amplitude minima in April and October while the amplitude of the EW component shows no seasonal variation. The semidiurnal com-

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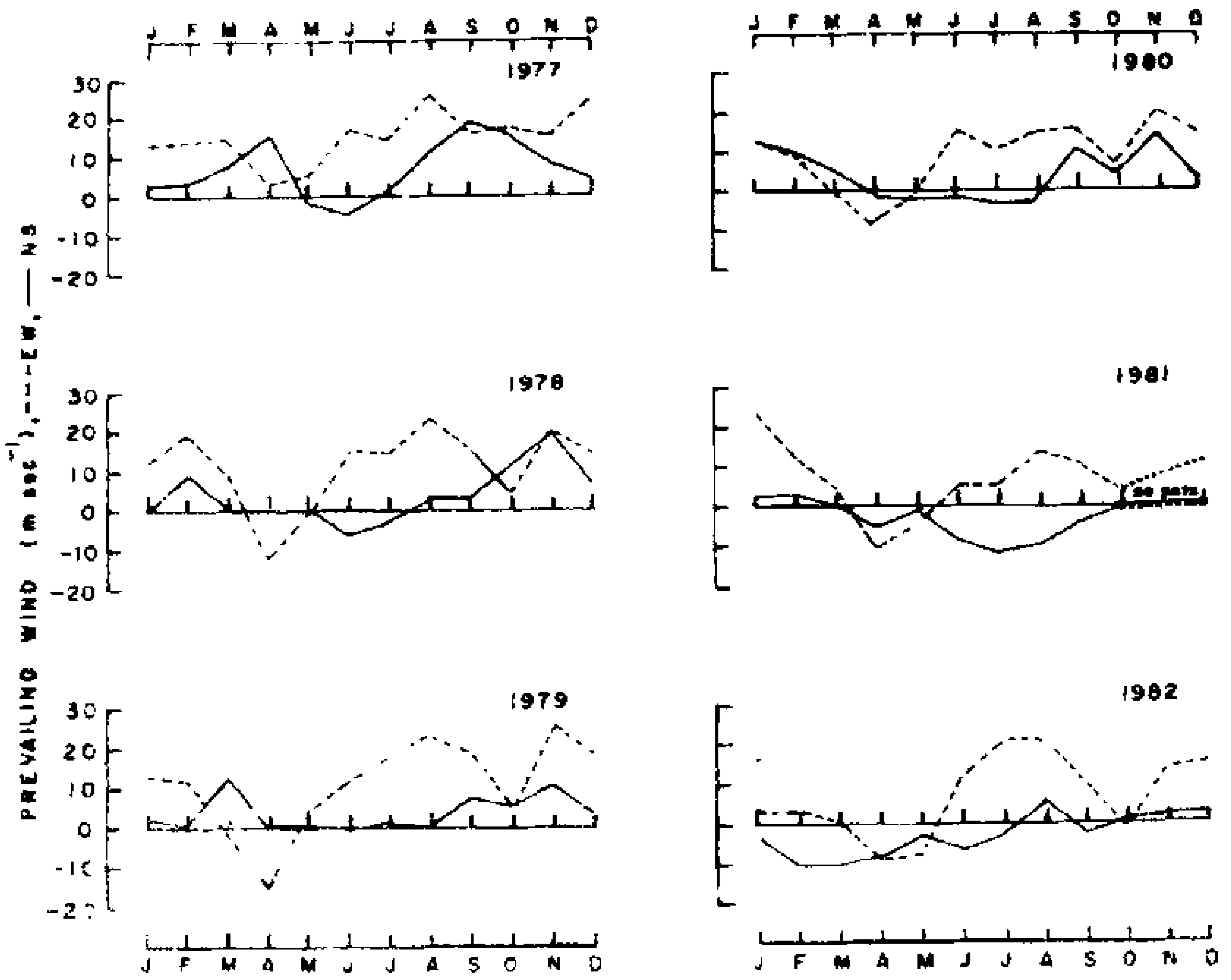

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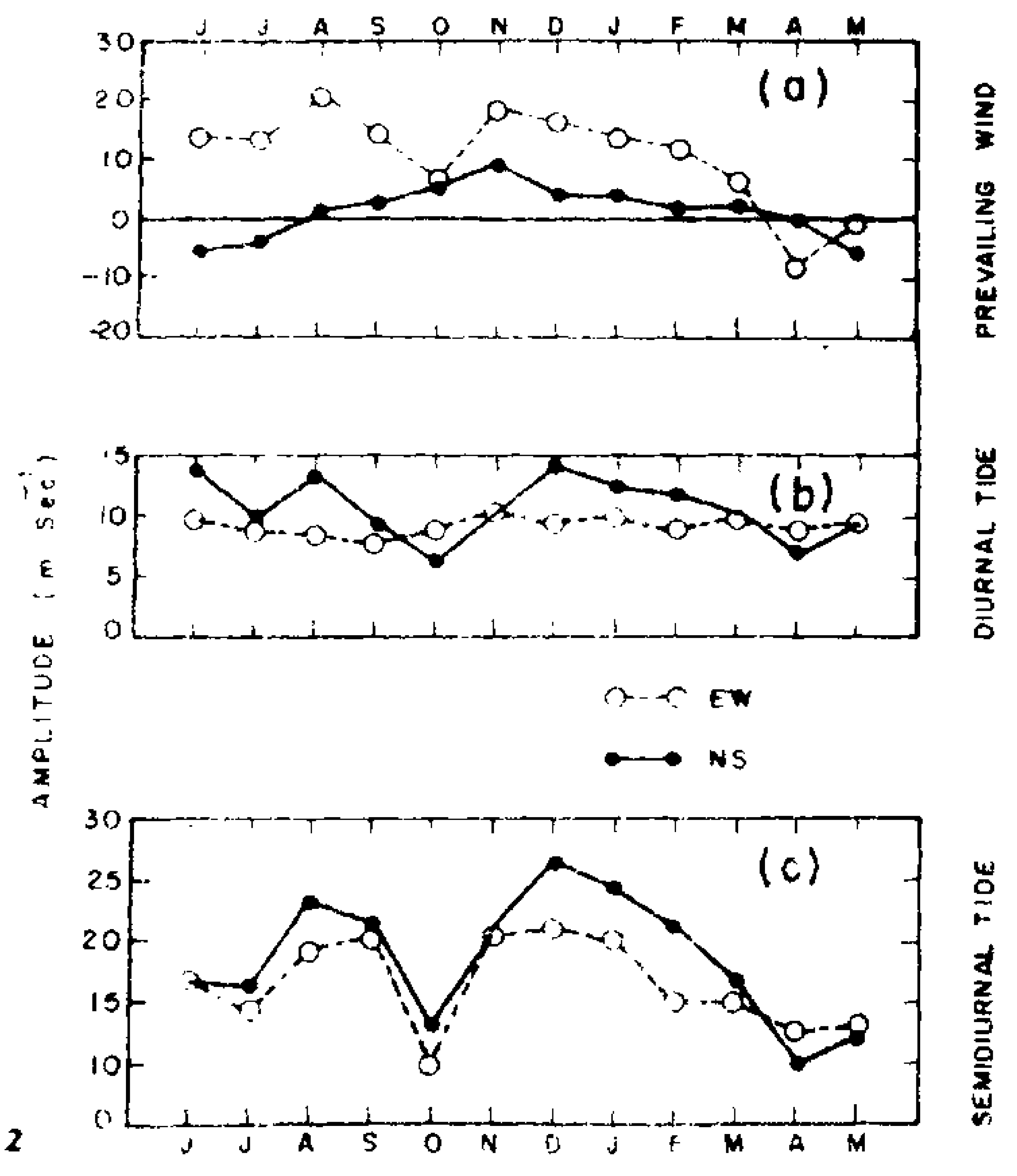

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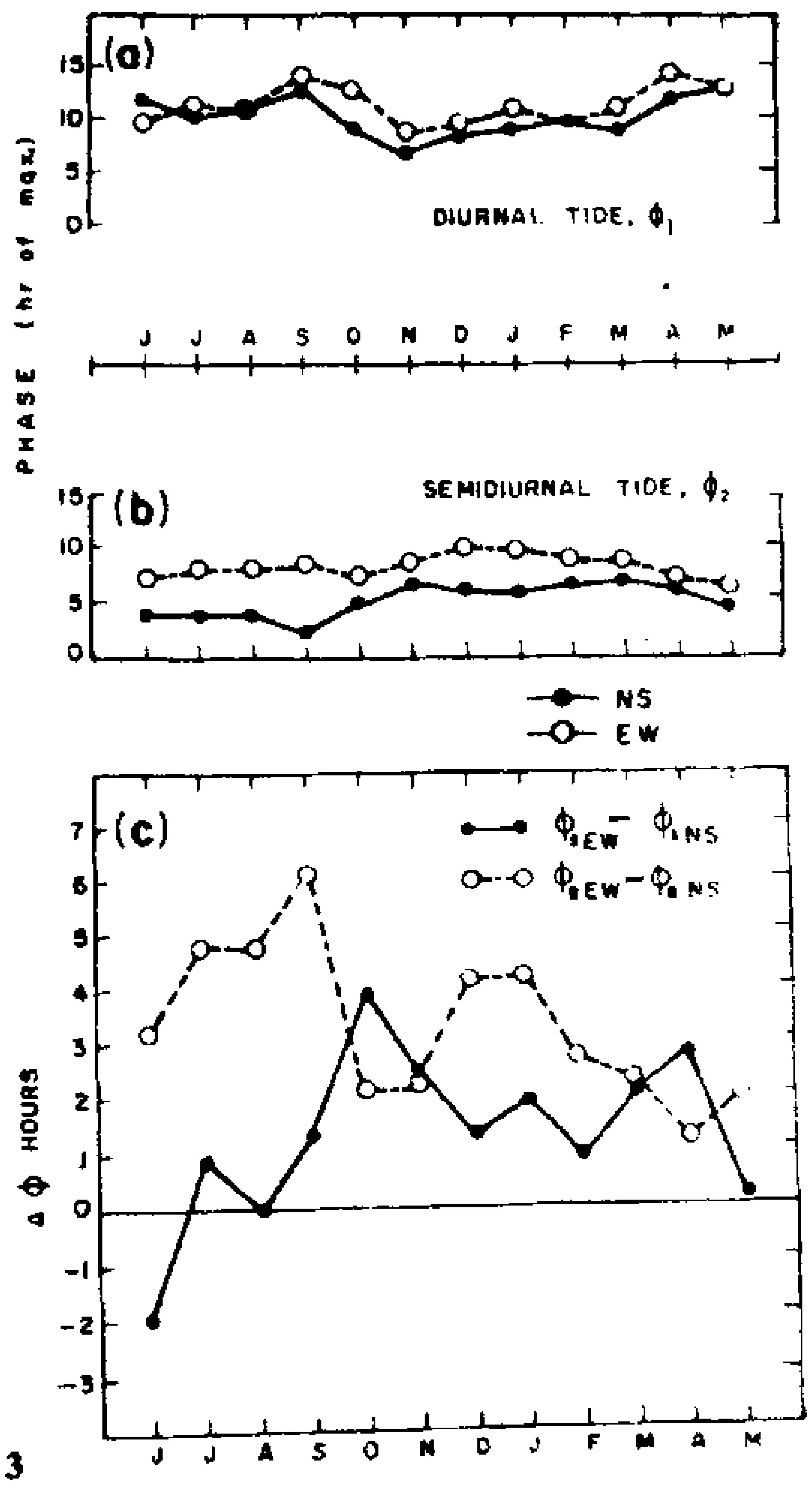

Figures 1–3. 1. Variation of the zonal (EW) and meriodional (NS) components of the prevailing wind during the period 1977–82. **2.** Month-to-month variation of prevailing, diurnal, and semidiurnal winds averaged over the six-year period 1977–82. **3.** Variations of monthly mean phases of diurnal and semidiurnal components of zonal and meridional winds and sense of rotation of wind vector during the period 1977–82.

ponents of both the EW and NS winds show larger amplitudes with minima in April and October.

(b) Phase variations: Variations of the monthly mean phases of the diurnal and semidiurnal components of the EW and NS winds are shown in figures 3(a) and 3(b) respectively. In figure 3(c) are shown the monthly progression of the phase difference between the EW and NS components reckoned in hours ($\Delta\phi = \phi_{EW} - \phi_{NS}$). It shows that the sense of rotation of semidiurnal tidal wind vector is clockwise throughout the year; the phase difference is about six hours in September, which corresponds to a rotation of 180°. The sense of rotation of diurnal tidal wind vector is anti-clockwise in early summer and clockwise during the rest of the year. It shows the maximum phase difference of about four hours in October. The monthly mean phases of semidiurnal component of the EW wind are in agreement with the results reported by Roper and Salah[4] for Atlanta (34°N, 84°W) and Manson *et al*[6] for Saskatoon (52°N, 107°W) whereas the NS wind does not show such agreement

CONCLUSIONS

Analysis of the meteor wind data gathered at Kuhlungsborn, a high-midlatitude station, shows that:

(i) The mean monthly EW and NS wind components have seasonal variations with zonal wind minima in April and October.

(ii) Diurnal and semidiurnal tidal components of the EW and NS winds have minimum amplitudes during equinoctial months (April and October).

(iii) The semidiurnal wind vector rotates in the clockwise direction throughout the year; the diurnal wind vector also rotates likewise during most of the year.

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