STUDY OF NEUTRAL WIND GRADIENTS IN THE UPPER ATMOSPHERE

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ABSTRACT

Semidiurnal components of the zonal and meridional neutral wind data observed with meteor radar at Adelaide (35° S, 139° E) during the period 1967–69 over the height interval of 80–100 km is analysed in detail. The variations in height gradients of the amplitudes and phases over the height intervals of 80–90 km and 90–100 km are discussed. A semi-annual variation and oscillations with a period of 3 to 4 months are observed for the gradients in amplitude of both EW and NS components respectively between 90–100 km.

1. INTRODUCTION

RADAR meteor trail returns are well known to yield neutral wind information between 80–100 km region[1–3]. The meteor radar techniques provide the most direct method for the study of various phenomena such as turbulence, tides and diffusion in the upper atmosphere at these heights[4,5]. With the data at Jodrell Bank, Greenhow and Neufeld[6] reported that in December, January and February, the magnitude of the wind gradient was 1·5 m/sec/km falling to 0·4 m/sec/km in June, July and August. By comparing the meteor wind observations at an average height of 95 km and ionospheric drift measurements at an average height of 103 km, Müller[7] arrived at the height gradient in amplitude and phase of 1·06 m/sec/km and 4·7°/km respectively. Glass and Spizzichino[8] have studied the height variation of amplitude and phase of semidiurnal wind component for Adelaide station seasonally, but it is felt worth while that detailed analysis of the observations is necessary to have a clear understanding of the phenomenon involved.

2. DATA AND ANALYSIS

In this paper the day-to-day values of the semidiurnal components of meteor winds at 80, 90 and 100 km for Adelaide station during Jan. 1967–Dec. 1969 are averaged to obtain monthly mean values of amplitude and phase over the three year period. These monthly mean values are used for a detailed study of the behaviour of gradients in amplitude and phase of both the zonal (EW) and meridional (NS) wind components in the height interval of 80–90 km and 90–100 km.

3. RESULTS

3.1. *Height variation of amplitude and phase*:

The mean values of the amplitudes and phase of EW and NS semidiurnal neutral wind components at 80, 90 and 100 km are represented for different months of the year in Figures 1 (A) and 1 (B) and 2 (A) and 2(B) respectively. From Figures 1 (A) and (B), it is clear that the amplitude of EW component decreases from 80–90 km and increases from 90–100 km for all the months. The amplitude of NS component also exhibits nearly similar nature. A large amplitude variation with a height gradient of 2·5 m/sec/km for the EW component is observed between 80–90 km interval during November and nearly same variation with opposite sense is observed for May between 90–100 km interval. For the month of August, a reverse nature of amplitude variation is observed in the height interval of 80–90 km for both the EW and NS components. It is clearly seen from Figures 2(A) and (B), the phase of semidiurnal oscillation has a positive gradient for March, April, May, July, August and October months in the 80–90 km. height interval and the same component has positive gradient for all the months except March and November in the 90–100 km height interval. The phase of semidiurnal oscillation also has an irregular variation from month to month, with a positive gradient between 80 and 90 km for January, February, March, July, and December months and a negative gradients during the rest of the months. Though the EW and NS phase variations are irregular, the trend of variation from 80–90 km is different from and mostly opposite to that of 90–100 km height interval. In this respect there is an agreement between the height variations of amplitude and phase of both the EW and NS semidiurnal components.

3.2. *Variation of the height gradients in amplitude over different months* :

Monthly mean variations of the height gradients of amplitude of the EW and NS semidiurnal components are represented in Figures 3 (A), (B), (C) and (D) for the height intervals of 90–100 km and 80–90 km. The ordinates here represent the gradient multiplied by a constant factor of 10. It can be seen from Figure 3 (A) that the gradient is positive for all months of the year and exhibits a sort of semi-annual variation with maxima of 2·4 m/sec/km and 2·1 m/sec/km in the months May and August respectively, and minima of 0·6 m/sec/km, 1·1 m/sec/km and 0·75 m/sec/km in the months of March, June-July and October. For the same component in the interval between 80–90 km

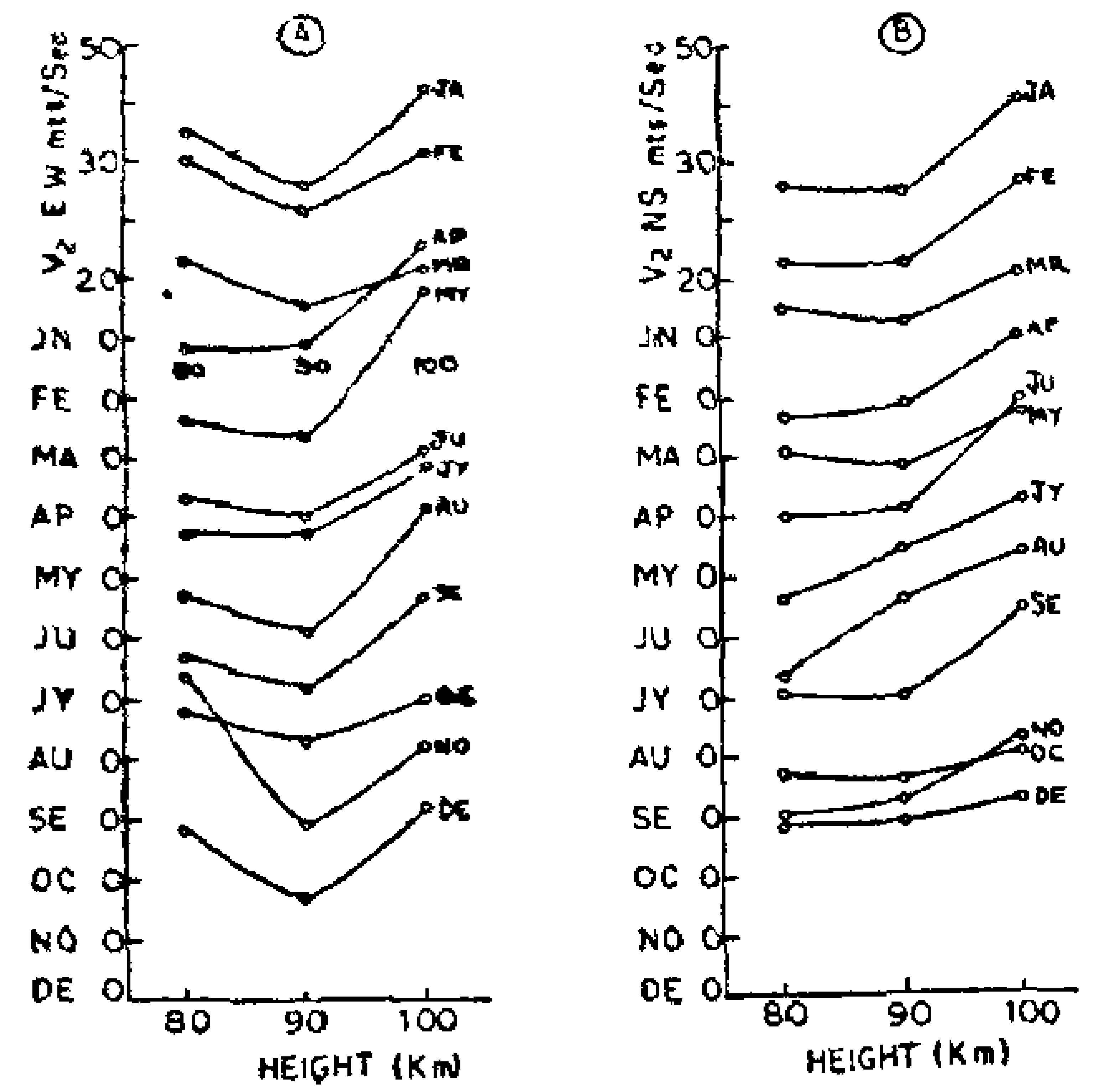

FIG. 1. Height variation of the amplitudes of EW and NS semidiurnal components for different months. (Origin for each month is shifted for clarity).

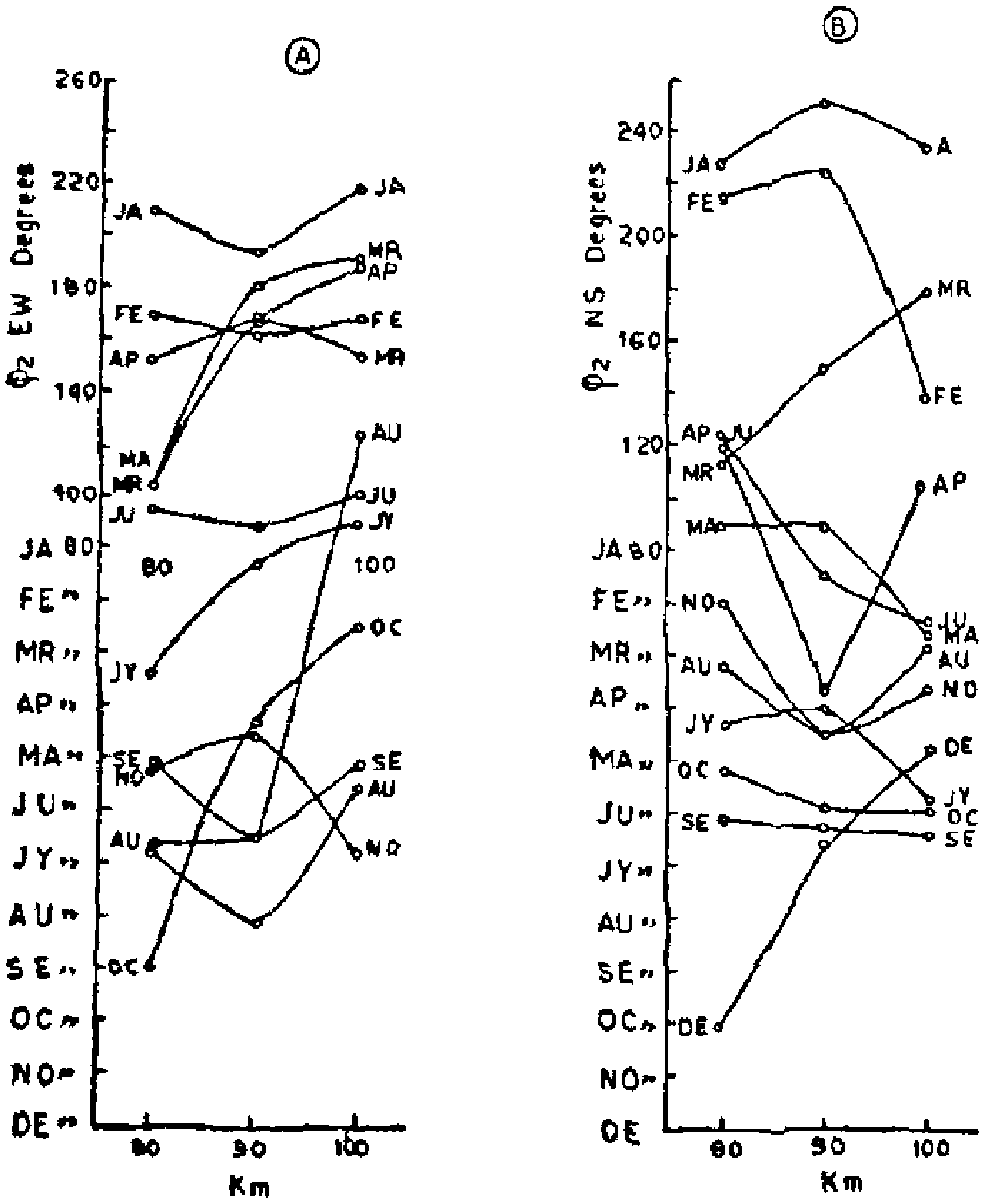

FIG. 2. Height variation of the phases of EW and NS semidiurnal components for different months. (Origin for each month is shifted for clarity).

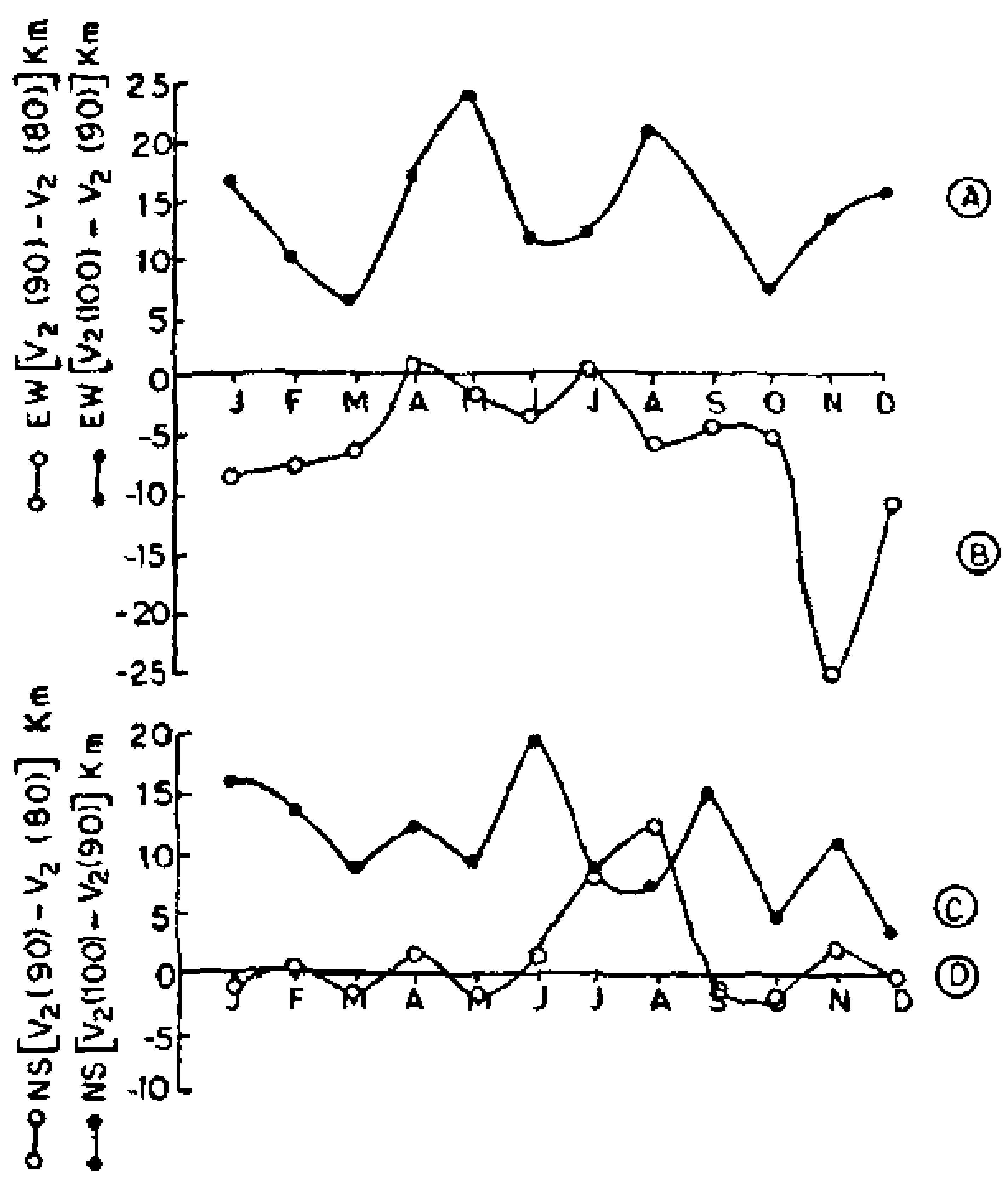

FIG. 3. Monthly variation of gradients in amplitudes of EW and NS semidiurnal components.

the gradient is predominantly negative for most of the months. Though the predominant semi-annual variation observed in Fig. 3 (A) is not perceptible in Fig. 3 (B), the trend of variation is nearly the same in both the regions, with an advancement of one month in the position of peaks. This similarity exists upto August and beyond this, a reversal in the trend of variation is observed with a peak negative gradient of about 2·6 m/sec/km in November.

The gradient of NS semidiurnal component between 90 and 100 km is also positive for all months of the year and it is found to exhibit fluctuation with a period of 3 to 4 months, whereas the EW component fluctuates with a period of nearly 6 months. The magnitude of gradient in amplitude of the NS component between 80 and 90 km is small in all months excepting July and August. Right from May onwards the gradient exhibited a steady increase from a small negative value in May to a large positive value of 1·2m/sec/km in August. Since May, June, July and August months represent winter months for Adelaide station, it appears that the amplitude of the NS semidiurnal components between 80 and 90 km is sensitive to solar heating.

3.3. *Variation of the height gradient in phase over different months* :

Figures 4 and 5 depict the month-to-month variation of the height gradients in phases of NS and EW semidiurnal components in the height intervals of 80–90 km and 90–100 km respectively. The ordinates in these figures represent the gradients multiplied by a constant factor of 10. It is interesting to note from these figures that almost from January to December, the nature of variation of gradient in the height interval of 80–90 km appears to be 180° out of phase with that in the 90–100 km interval. Such an opposite trend of variation in two successive height intervals of 10 km each indi-

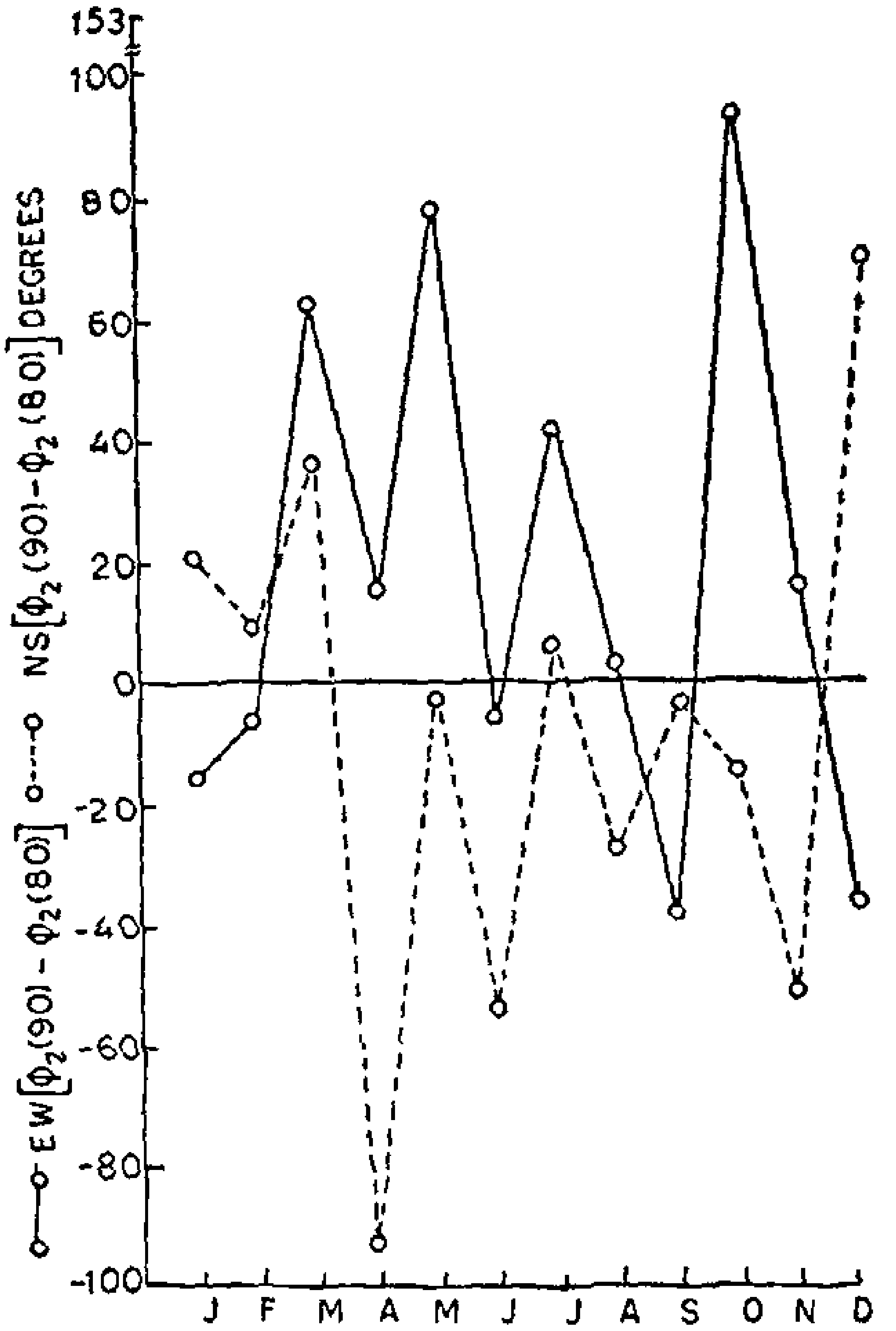

FIG. 4. Monthly variation of gradient in phase of NS and EW semidiurnal components in the height interval of 80–90 km.

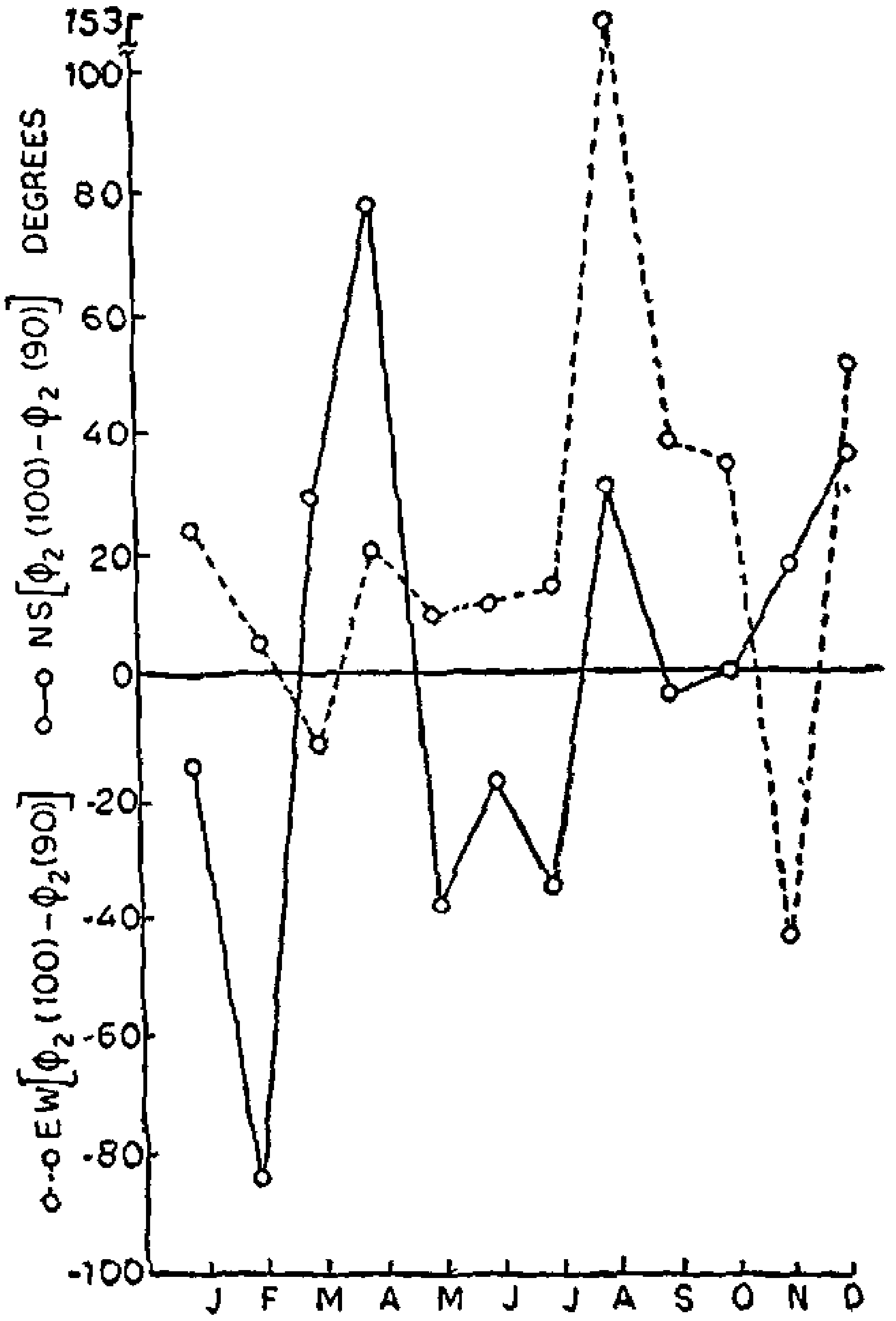

FIG. 5. Monthly variation of gradient in phase of NS and EW semidiurnal components in the height interval of 90–100 km.

cates that the phases of both the EW and NS semidiurnal components differ appreciably over a height difference of 10 km. The trends of variation of the amplitudes of both the EW and NS semidiurnal components also are found to be opposite in the height range of 80–90 km and 90–100 km.

4. DISCUSSION

The observed results can fully be explained by means of tidal phenomenon. The variations in amplitude and phase of the semidiurnal wind components can be described by the propagation of tidal energy from troposphere and its downward reflection in the middle atmosphere. As Greenhow reported, the semidiurnal wind component is caused by a 12 h pressure oscillation of the earth's atmosphere. The irregular and large variations found in Adelaide data can also be explained as due to the presence of two semidiurnal symmetrical modes $S^2_{2,2}$ and $S^4_{2,2}$ with their vertical wavelengths of about 150 km and 55 km respectively. The observed trough at 90 km in the height variation of the amplitude of semidiurnal wind components for almost all the months in the case of zonal and for most of the months in the case of meridional winds probably means that different modes are simultaneously present during the transitional period. Fraser[9] also observed monthly zonal wind height (93 km) reversal for May, June and July months, when he studied the seasonal variation of Southern Hemisphere mid-latitude winds. Elford[10] reported the year-to-year repeatability of seasonal amplitude and phase of the semidiurnal tide over Adelaide and interpreted the summer variation in terms of a standing wave. This standing wave might arise from substantial reflection of a dominant upward propagating mode, or superposition of upward propagating modes forced in different regions or an upward propagating mode superposed on a downward propagating mode forced above the meteor region. As he said, the semi-annual variation in the height gradient in amplitude of the zonal wind component can be interpreted by extrapolating the rocket sonde observations of Belmont and Dartt[11], to higher altitudes. All the observed gradients in amplitude and phase of both zonal and meridional semidiurnal wind components show a better agreement with the results at Christchurch (43° S, 172° E) reported by Wilkinson and Baggaley[12].

5. CONCLUSIONS

The present analysis has shown that the nature of variation of amplitude and phase of the semidiurnal component of neutral wind are predominantly different in the successive height intervals of 80–90 km and 90–100 km.

1. The amplitudes of both EW and NS components have predominantly negative gradients from 80–90 km, the same have positive gradients from 90–100 km.

2. The height gradient in amplitude of the EW component from 90–100 km is found to exhibit a semi-annual variation and the same gradient is found to exhibit a similar nature, to some extent, but with peaks occurring one month in advance between 80–90 km height interval.

3. The height gradient in amplitude of the NS semidiurnal component from 90-100 km is found to exhibit oscillations with a period of 3 to 4 months, and the same component is found to exhibit similar oscillation between 80 and 90 km, but with much smaller amplitude in almost all months of the year.

4. The height gradient and phase of the NS semidiurnal component between 80 and 90 km is found to fluctuate between positive and negative values as the same in 90–100 km interval, but these fluctuations are strikingly out of phase with the fluctuations in the 90–100 km interval.

5. Almost similar behaviour is exhibited by the gradients EW of phase between 80 and 90 km and 90 and 100 km. These fluctuations in phase are expected to be due to the coupling between main semidiurnal mode and higher order modes.

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A COMMON FACTOR IN *IN VIVO* SYNTHESISED POLYPEPTIDES

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FROM early days many workers have looked at the composition of the protein and tried to relate it with the three-dimensional structure[1]. However, it has been well established that the three-dimensional structure is the resultant of amino acid sequence[2]. Furthermore, initial studies have indicated that the oil-drop model proposed by Kauzmann[3] based on hydrophobic interactions can explain folding of polypeptide chain. However, the recent studies of Chothia[4] have indicated that the principle of close packing of different amino acids governs the three-dimensional structure of proteins. Therefore, in order to get some insight into the role of hydrophobic interactions, the importance of which cannot be underrated, the composition of large number of proteins have been analysed.

Our studies on number of proteins, enzymes and polypeptides have shown that the total number of non-hydrophobic residues are directly related to the total number of residues in a given *in vivo* synthesised polypeptide chain indicating that the stability of a protein may be governed by its composition, mainly the number of hydrophobic residues.

The amino acids without any polar side groups, namely, Ala, Ile, Leu, Met, Phe, Pro, Trp and Val are considered to be hydrophobic. Remaining twelve amino acids have been termed as non-hydrophobic[6],