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TÍTULO: TIDAL OSCILLATIONS IN THE MERIDIONAL WIND OVER NATAL.

PROJETO: EXAM

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ABSTRACT

Observations of meridional wind component over Natal taken on March 19-20, 1974 at 3 hrs interval are used to calculate the diurnal and semidiurnal oscillations at rocket levels. A comparison is made with earlier observed and theoretical results. The results of the present calculation confirmed earlier finding that the theoretical maximum in the meridional wind occurred on the average about 3 hrs earlier than the observed maximum.

1. INTRODUCTION

The subject of atmospheric tides is one of the most extensively studied problems of atmospheric sciences. Most of the studies on tides are based on the surface meteorological data, which are readily available. Lack of data in the upper atmosphere prevented an accurate determination of tidal components above 30 Km, where the tidal oscillations attain significant amplitudes. The atmosphere above 30 Km is only accessible to direct measurement by rockets and such measurements are considerably less in number and more widely spaced in time.

Routine rocket measurements have been used by Reed, Mckenzie and Vyverberg (1966) and Reed (1967) to isolate the tidal components. If one uses the soundings which are irregularly distributed over the year then there are problems of trend removal. Thus consistent results could be obtained only for the meridional wind during the summer when the background winds are steadist. Also special tidal experiments have been conducted by making soundings wich are more closely spaced in time for a few days (Miers 1965 and Beyers, Miers and Reed 1966). A review of the above mentioned measurements and others could be seen in Groves (1967) and CIRA (1972). Recently, Groves (1974a) used Rocket Grenade data of 24 launchings during the years 1966-68 over Natal, Brazil to analyse for diurnal components.

Reed, Oard and Marya (1969b) and Groves (1974b) compared the observed tidal components with the theoretical calculation of

Lindzen (1967). It is found that in the SN wind oscillations both in the results of Reed et al. for Ascension Island and Groves for Natal, the theoretical curve of maxima versus height occurred on the average about 3 hrs earlier than the observed ones. Groves (1974b) found that a significant revision of amplitudes and phases of the thermal excitation is required if observations are to be consistent with the theory.

The purpose of the present note is to present the results of a tidal experiment conducted at Natal as a special programme of EXAMETNET in collaboration with NASA and compare the results with earlier calculations. A series of 9 rockets were launched at 3 hrs interval starting from 1600 hrs GMT (1340 Local), March 19, (Schmidlin, Motta, Yamazaki and Brynstien, 1974). It should be mentioned that the 1,00 hr observation was missing and the mean of preceeding and succeeding observation was used to fill the gap. The results are particularly interesting in view of the above mentioned discrepancy between the theory and observation. A comparison of the earlier results for Natal and Ascencion Island is made with the present calculation. Although the present calculation is based on one day's soundings, the general agreement with earlier results is so good that they appear to be meaningful.

2. RESULTS:

Results of harmonic analysis for the meridional wind are presented in Figs. 1 and 2. In Fig. 1(a) and (b) the amplitude and phase of diurnal component are plotted with height. Figs. 2(a) and (b) are for the semi diurnal component. In all the Figures the continuous line represents the line passing through the running average of 3 successive data points put at the central point. The broken line with crosses (X) is the Lindzen's (1967) theoretical calculation. Circles (θ) represent the present calculation for Natal, here after called 'N' values. Triangles (Δ) represent values for Ascencion Island; diurnal from Reed et al. (1969) and semi diurnal from Reed (1967), here after called 'R' values. Squares ⊡ represent Groves (1974) results, here after called 'G' values.

From Fig. 1(a) it could be seen that the amplitudes are less than 3 m sec^{-1} up to 38 Km and the agreement between all the observed values is good, however theoretical values are smaller. Above 38 Km N valuesare higher at almost all levels than both R ang G values and G values are generally smaller than R values. R values are closer to the theoretical values at lower levels. Both N and R values show a maximum at 50 Km. Theoretical values also show a maximum but the value is less.G values show a maximum at 60 Km. N values show another maximum of about 9 m sec^{-1} at 60 Km which agrees well with R values. This is not found in G values and theoretical values.

Regarding the phase, the agreement between N and R values is excellent starting with 46 Km up to 60 Km. At these levels theoretical maxima occurred on the average about 3 hrs earlier comparated to N and R values. Below 42 Km R values deviated very much from both N values and theoretical values. In the G values the maximum phase occurred around 44 Km where the maximum south wind occurred around 14:00 hrs with phase decreasing too rapidly above and below compared to N and R values.Comparing N values with the theory it can be seen that at almost all levels the agreement is good except that the theoretical maximum occured about 3 hrs earlier.

It should be mentioned that the semi diurnal oscillation is less occurately determined than the diurnal oscillation. However, it is felt that a comparison amongN, R and G values might still be useful. In Fig. 2(a) it can be seen that up to 28 Km the semi diurnal oscillation is small and the agreement between the theory and observation is Quite good. Above 38 Km N values are slightly higher at some levels. The amplitude of semi diurnal oscillation reached a maximum of about 8 m sec^{-1} at about 60 Km in N values which is in good agreement with both R and G values. Theoretical value is less at this level being about 4m sec^{-1}. Above 60 Km both N and G values showed a tendency to decrease where as theoretical values continued to increase.

Coming to the semi diurnal phase values, below 40 Km N values differed with R and theoretical values. Above 40 Km the agreement between N and R values is good. In the theoretical values practically there is no phase variation with maximum south wind occurring almost at all levels at about 1200 hrs (or 24 hrs) where as in R and N values the maximum occurred at 12 hrs at about 48 Km and occurred earlier below and above this height.

ACKNOWLEDGEMENTS

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FIGURE CAPTIONS

Figure 1 Amplitude and phase of the diurnal variation.

Figure 2 Amplitude and phase of the semi diurnal variation.

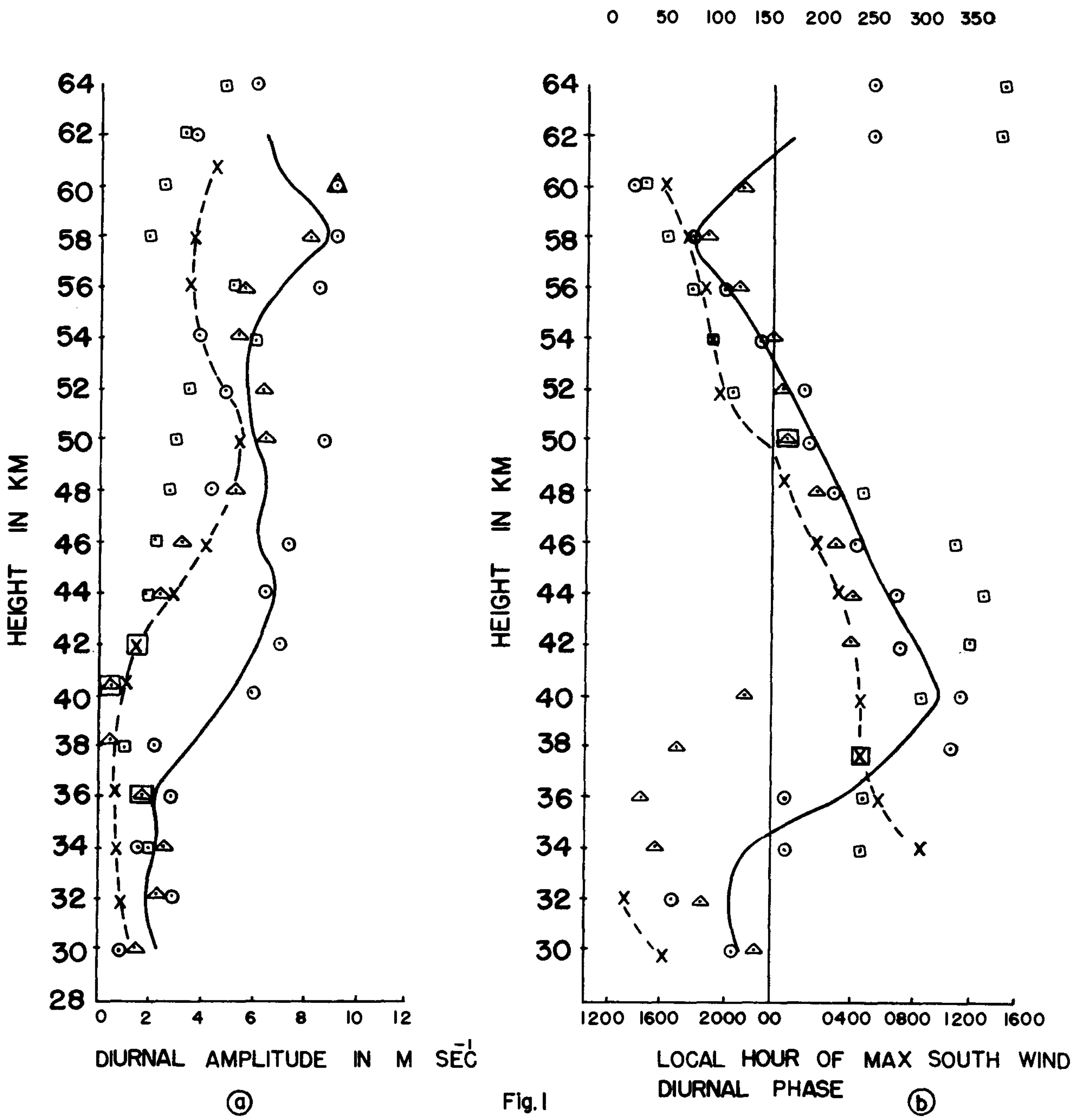

Fig. 1

⊙ NATAL

△ ASCENSION ISLAND. REED ET AL (1969).

× THEORETICAL LINDZEN (1967).

⊡ NATAL, GRENADE DATA, GROVES (1974).

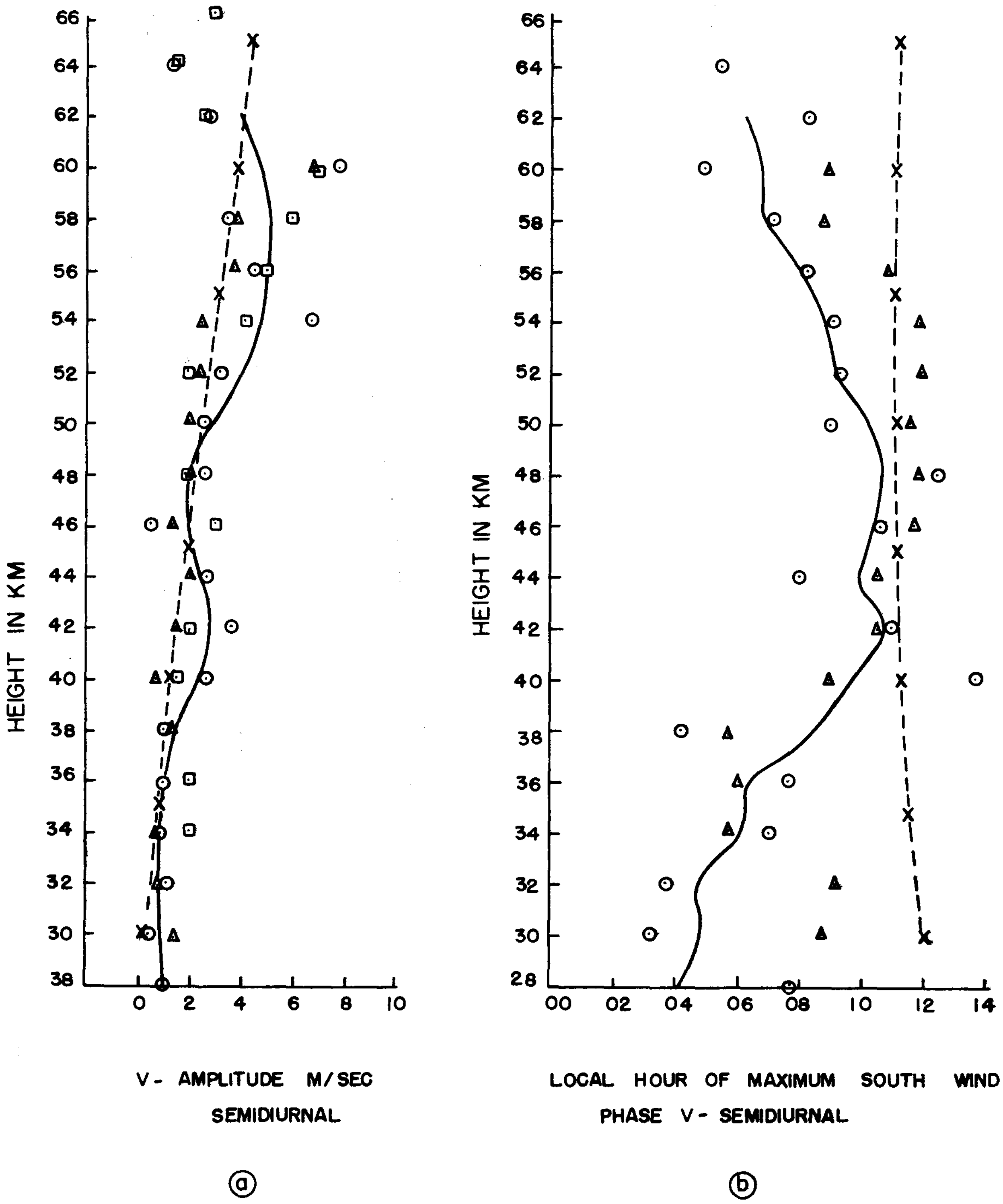

Fig. 2

○ NATAL

Δ ASCENSION ISLAND, REED (1967)

X THEORETICAL, LINDZEN (1967), 10°

▫ NATAL, GROVES (1974)