XXVIIth General Assembly of the
European Geophysical Society
Nice, April 21-26, 2002

Wave like fluctuations of the total neutral density of amplitude increasing with altitude in the upper thermosphere

P. Bencze[1], E. Illés-Almár[2], I. Almár[2]

[1]Geodetic and Geophysical Research Institute, Hungarian Academy of Sciences, H-9401 Sopron, P.O.B. 5, Hungary
[2]Konkoly Observatory, Hungarian Academy of Sciences, H-1525 Budapest, P.O.B. 67, Hungary

Observed phenomenon

Quik look study of data of the DBI accelerometer on board of the low orbital inclination satellite San Marco V (orbital incl: ±3°, perigee: 130 km, apogee: 600 km) revealed some characteristic changes of the total neutral density (sudden decreases, wave-like fluctuations of the density of amplitude increasing with altitude, impulse-like increases of the density in the equatorial upper thermosphere). The finding of these phenomena was enabled by the high time resolution of the measurements, data of which resolution were formerly not available. Wave-like fluctuations of the density of amplitude increasing with altitude appeared in the data set as fluctuations of amplitude beginning to grow at a given altitude and continuously increasing with increasing altitude. In the vicinity of the perigee, amplitude of the fluctuations first increased, then decreased according to the variation of height. 117 such event have been found in the period from April to December 1988.

Results

Statistical analyses, determination of the temporal and spatial variations have shown that this phenomenon is more frequent by night than by day. It is also more frequent in the summer months, than in winter. Considering the spatial variations, the daily variation of the height, where the amplitude of fluctuations begins to increase, indicates a day-time maximum and higher altitudes in summer than in winter. It is interesting that remarkable maxima appear in the longitudinal distritubion of occurrences at longitudes 180° and 240° corresponding to the area of the equatorial Pacific Ocean (El Nino?)

Discussion

On the basis of temporal and spatial distributions of occurrences observed in behaviour of the commencing height of the amplitude increase it may be established that occurrence of this phenomenon depends on the vertical temperature gradient. The height where the vertical temperature gradient attains a critical value - corresponding to indifferent equilibrium - is greater by day than by night, also greater in summer than in winter. Temperature profiles constructed for day-time and night-time conditions indicate that the temperature gradient reaches the indifferent equilibrium state at greater altitude by day than by night, though in case of the seasonal variation there is no significant change.

Thus, small amplitude perturbation is enough to creat convective instability. In this conditions, a possibility of the phenomenon of gravity wave instability might arise. In this case the wave-like fluctuations of the density of amplitude increasing with altitude may be related to the instability of internal atmospheric gravity waves. Condition for development of the instability is according to Johnston (1967)

$$\omega_B > \omega_a$$

ω_B non-isothermal Brunt-Vaisala frequency,

ω_a acoustic cut-off frequency. This would represent the anomalous case occurring above about 120 km (Midgley and Liemohn, 1966), but only to a height of about 300 km. ω_B decreases faster than ω_a because of the decrease of the vertical temperature gradient. However, under non-anomalous conditions as

at commencing heights of the amplitude increase above about 350-400 km, the gravity wave instability might enhance of amplitude of oscillations passing the anomalous regions of the atmosphere below 300 km (Tolstoy and Lau, 1970).

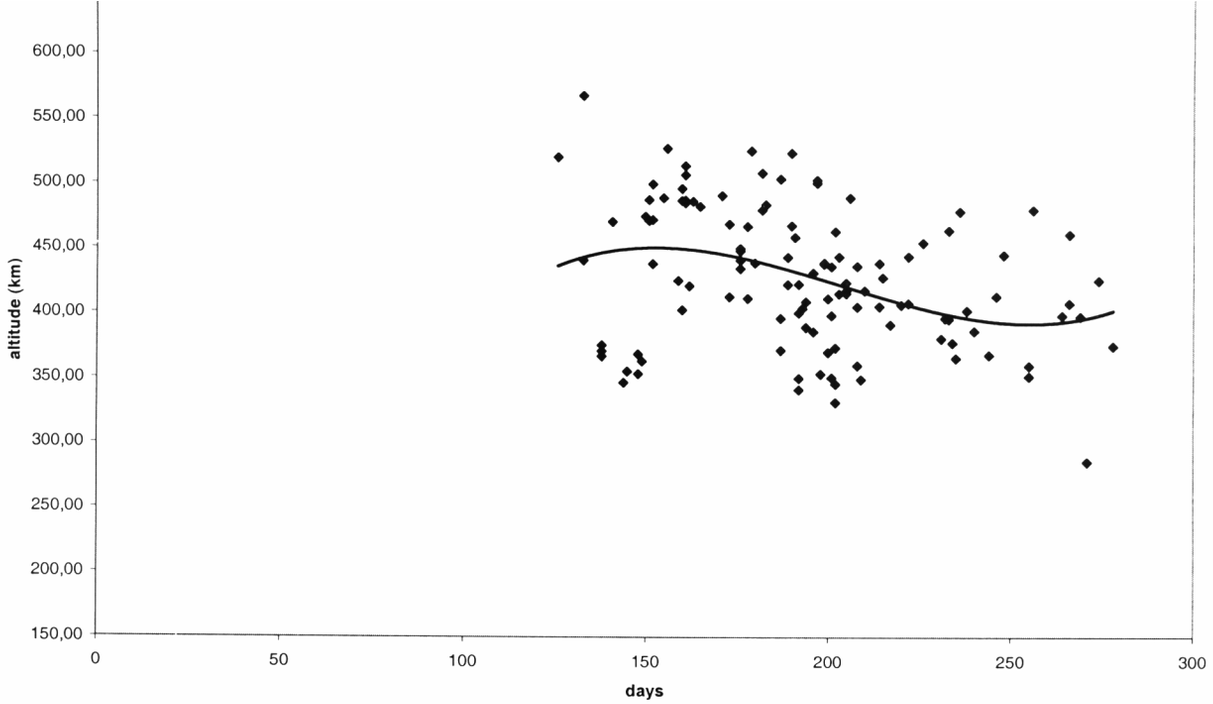
600,00
550,00
500,00
450,00
400,00
350,00
300,00
250,00
200,00
150,00
altitude (km)
0
50
100
150
200
250
300
days

Fig. 4.

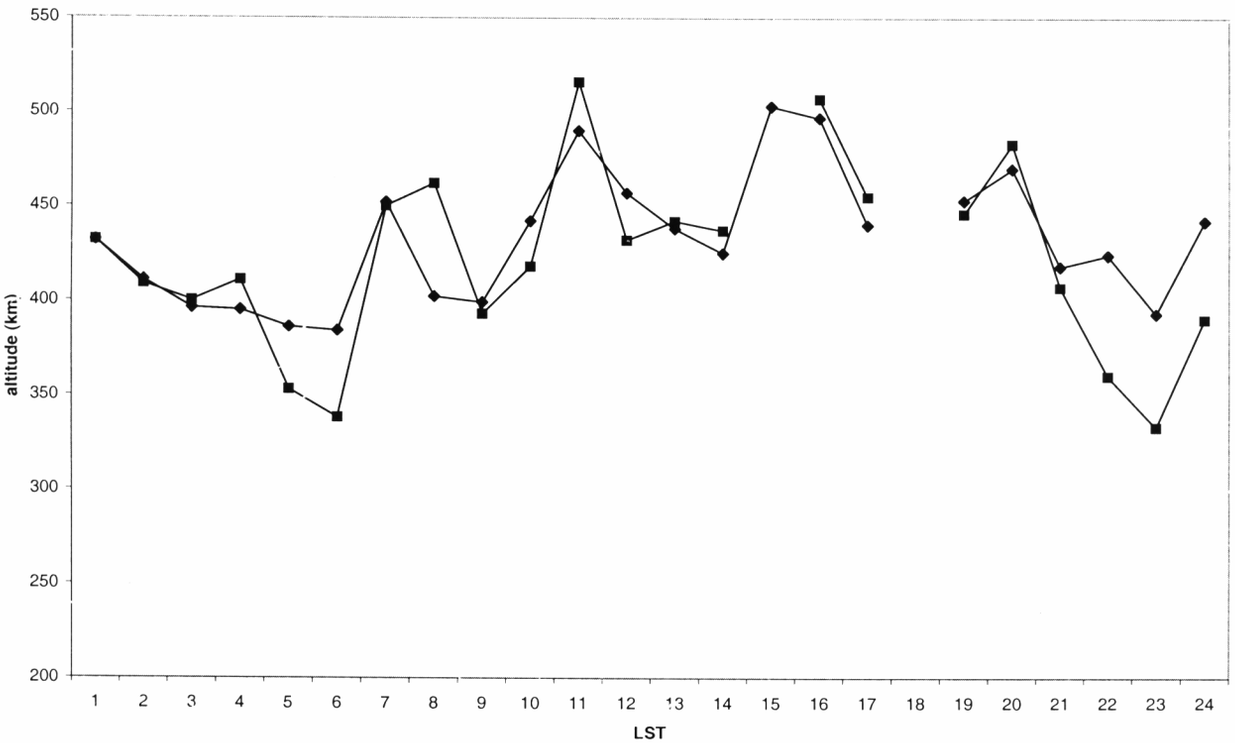
550
500
450
400
350
300
250
200
altitude (km)
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18
19
20
21
22
23
24
LST

Fig. 5.