N88-14528

INTERNAL GRAVITY WAVES IN THE METEOR ZONE IN THE TBILISI REGION

Z. S. Sharadze, G. B. Kikhvilashvili, Z. L. Liadze, and N. V. Mosashvili

Tbilisi State University
Tbilisi, USSR

The study of wave disturbances (WD) in the upper part of the meteor zone (90-110 km) was made in the Tbilisi region. Observations were conducted using three ionospheric vertical sounders located at the corners of a triangle spaced from each other at a distance of 50 km, a four-azimuth electrophotometer by the method of spaced reception with a small distance (method D1) and a recording unit f_D.

Simultaneous round-the-clock observations using the three spaced ionosondes were carried out each season in 1980-83 and in January, 1984, and lasted for as long as 12-14 days. The stations operated in 1- or 5-minute averaging modes. Daily variations of the parameters f_bE_s (blanketing frequency of the layer E_s), f_oE_s (critical frequency of an ordinary ray in the layer E_s), ΔfE_s ($\Delta fE_s = f_oE_s - f_bE_s$ is the semi-transparence of the E_s layer) were analyzed. WD of the layer E_s ionization caused by internal gravity waves (IGW) appear in the form of short-period fluctuations of the mentioned parameters shifted in time over the spaced points of observation.

The most intensive short-period variations of f_oE_s, f_bE_s and ΔfE_s are observed in summer near 90-110 km. Period (T), horizontal velocity (V) and wavelength (λ) of the IGWs were determined by the cross-spectural analysis of daily variations of f_oE_s, f_bE_s and ΔfEs which were recorded simultaneously at the three observation points.

The IGW parameters (T, V, λ) for each season of 1980-1983 determined by quasi-periodic variations of f_oE_s and f_bE_s are shown in the form of histograms in Fig. 1. It is seen that IGW with periods of 10-20 and 70-90 min prevail. In spring and summer the most probable values of IGW periods lie within the intervals of 20-60 and 30-90 min, respectively, In autumn IGW with periods of 50-90 min dominate. In all seasons the prevailing velocities of IGW in the meteor zone are 25-100 mps and their wavelengths (excepting the summer season) are 50-100 km. In summer, IGW of greater wavelength lying in the interval of 50-250 km occur.

With the aim of finding daily variations of the direction of WD propagation for each season, velocity azimuths (ϕ) were grouped by six-hour intervals (00.00-06.00, 06.00-12.00, 12.00-18.00, 18.00-24.00 h LT) which are presented in the form of histogram in Fig. 1. In winter, in the daytime before noon WD propagate in the north-west direction, while in the afternoon they propagate in the southeast direction; at night, until midnight, WD move southwards. In spring, in the daytime until noon disturbances travel in the south-east direction and in the afternoon - in the north-west direction; at night, until midnight, disturbances propagate south-eastwards and, after midnight - south-westwards. In summer, in the daytime until noon disturbances propagate mainly in the south-west direction and, in the afternoon - in the south-east direction; at night,

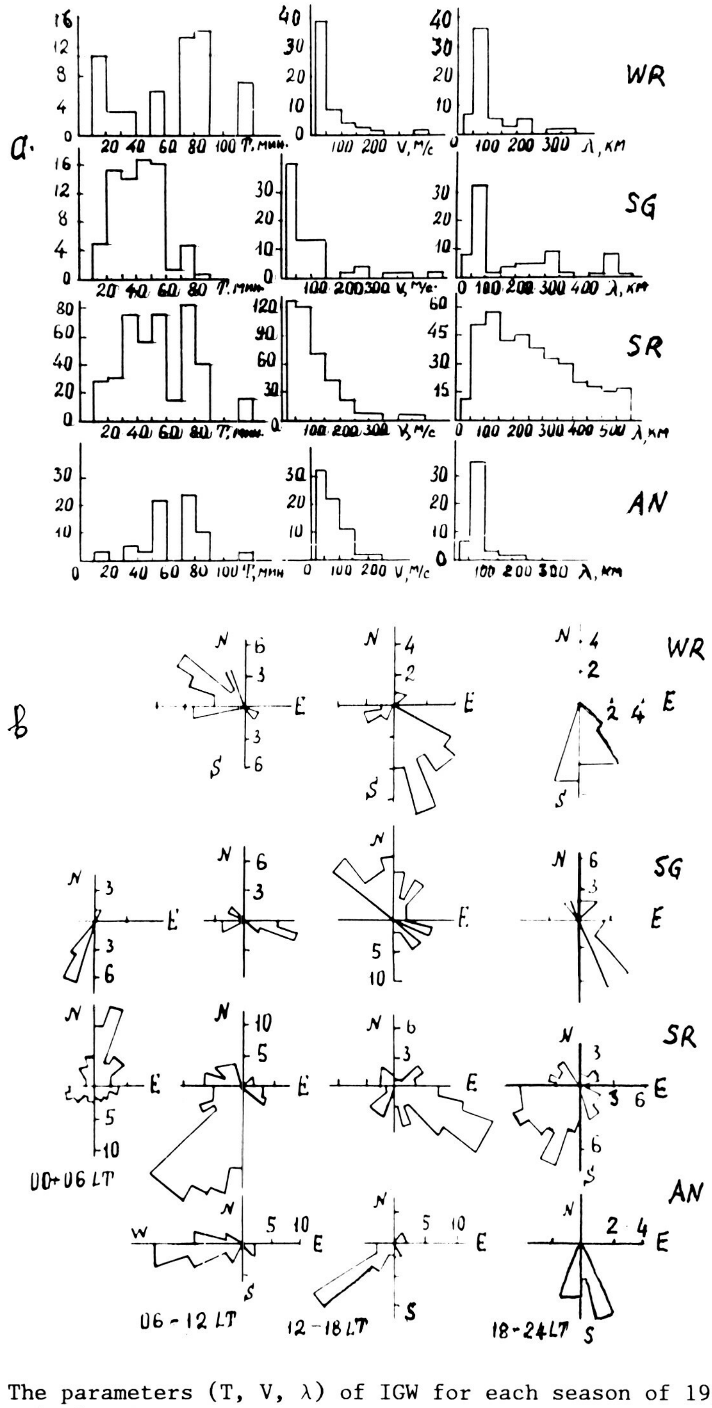

Fig. 1 The parameters (T, V, λ) of IGW for each season of 1980-1983 calculated by quasi-periodic variations of f_oE_s and f_bE_s, (a), and daily variations of WD propagation direction for different seasons of the year, (b). WR-winter, SG-spring, SR-summer, AN-autumn.

until midnight, WD propagation in the south-west direction prevails, and after midnight WD propagating in the north-east direction are mainly observed. In autumn, in the daytime, WD travel westwards and southwestwards; and at night, until midnight, disturbances travel southeastwards.

From variations of ΔfE_s, we find that IGW with periods of 60-90 and 12-17 min occur most frequently. Horizontal velocities and lengths change mainly in the intervals of 12-100 mps and 25-125 km respectively. IGW propagate mainly in the south-west direction in the daytime and in the east-west or north direction at night.

Data obtained by simultaneous observations of WD and wind were used to study the dependence of WD propagation orientation on the background wind. WD propagate mainly crosswise to the wind, though there are cases when they propagate both crosswise and almost down the wind. Velocity values of WD and wind are of the same order while the prevailing directions differ by about 90-120°.

The parameters of medium-scale ($\lambda \leq 1,000$ km) WD in the meteor zone at night, calculated by variations of the emission intensity [01] 5577A, are given in Fig. 2. Measurements by means of a four-azimuth electrophotometer were performed in the winter period of 1980-1983. It is seen that disturbances propagating mainly in the west, south-west and south-east directions and having velocities of 200-400 mps prevail. The spectrum of measured WD has a linear character. The main harmonics have periods of 30-60 min, 7.5-10 min, and about 5 min. Horizontal wavelengths of the most frequently recorded disturbances lie within the interval of 50-200 km.

With a view to finding the role played by IGW in wind velocity variations near 100 km, long continuous (30-90 min and more) sessions of wind measurements were performed using the D_1 method. Wind velocities were determined by the similarity method every 1 or 5 min. In the wind, IGW appear first of all in the form of non-regular, short-period (~ 5-180 min) variations of wind velocity imposed on regular wind velocity variations. The amplitude (root-mean-square deviation of wind velocity) of short-period variations of east-west (Vx(t)) and north-south (Vy(t)) components of wind velocity changes in the interval of 2.5-105 mps, with the most probable values in the interval from 10 to 45 mps. The most intensive variations of V(t) are observed near 100-110 km where the critical value for IGW is expected.

The most intensive variations of the wind are accompanied by the appearance of E_s layers with the parameters f_oE_s, f_bE_s and ΔfE_s changing periodically. The relation between variations of V(t) and the E_s layer ionization confirms the reality of short-period variations of wind velocity in the geophysical sense and points to the fact that IGW disturbances influence the formation and development of Es layers.

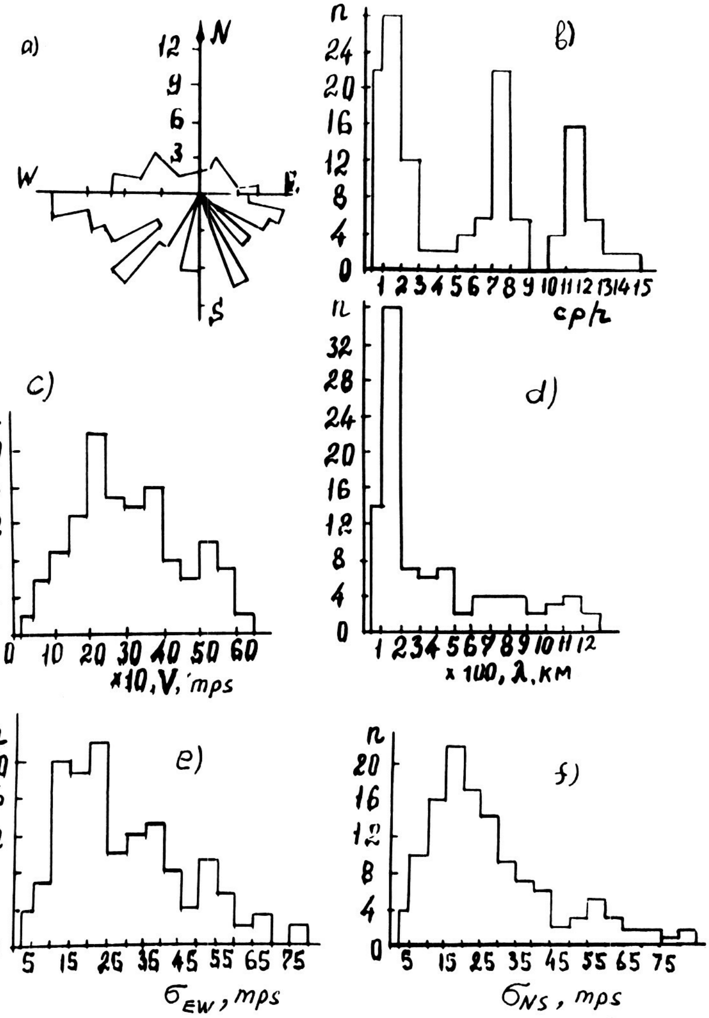

Fig. 2 The parameters of medium-scale WD determined by intensity variations of emission 01 5577 (a-d). Histograms of the distribution of root-mean-square deviations of zonal and meridional winds related to IGW (e.f).