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24-HOUR CHANGES IN THE ELECTRIC CONDUCTIVITY OF THE E-LAYER OF THE DAILY IONOSPHERE

NT

The fact that the geomagnetic field is basically non-homogeneous along the geographic parallels is well known. Due to these causes periodical changes in the tension of the magnetic field -- caused by Earth orbiting -- are experienced near the Earth in any point in a fixed location in relation to the Sun.

Fig. 1 shows these changes as they occur in the midday meridian. The abscissa axis shows here the universal time (UT) while the ordinate axis presents the tension of the geomagnetic field and θ is the geographic co-latitude.

The chart of Fig. 1 has been built along the data in (1) for the sea level, yet they are also characteristic for the low ionosphere altitudes. It is apparent that the tension of the magnetic field in each point of the daily ionosphere undergoes a considerable change; in the Southern Hemisphere the amplitude of changes exceeds the median value of the field. Article (2) - listed at the end - reports that this phenomenon causes UT

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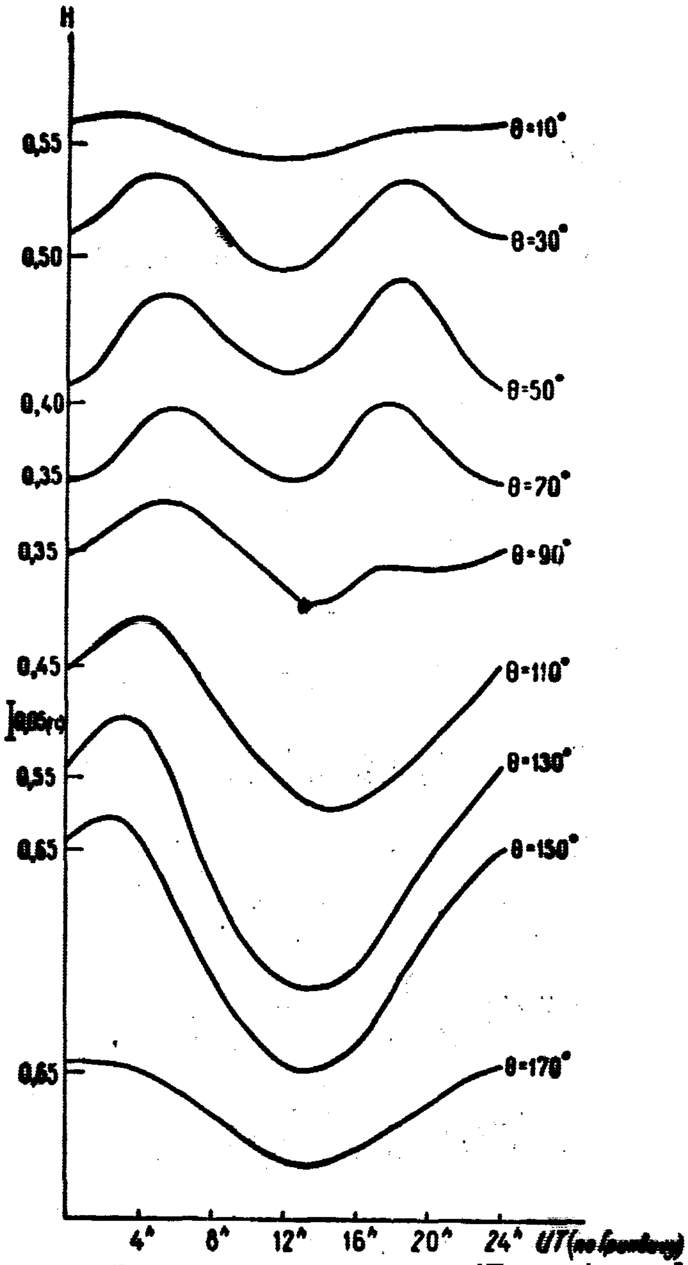
changes in the parameters of ionosphere currents which originate, in particular, the Sq-variations.

In connection with this fact, the present article deals with the evaluation of integral (along the altitude) values of the tensor components of the electric conductivity of the ionosphere for points on the midday meridian in the regions of geographic co-latitudes $10° < \Phi < 170°$.

Formulae determining integral conductivities of Pedersen (Σ_1), Hall (Σ_2) and the effective (actual) (Σ_3): were used in these computations:

$$\Sigma_1 = \int \sigma_1 dz ; \Sigma_2 = \int \sigma_2 dz, \Sigma_3 = \int \sigma_3 dz = \int (\sigma_1 + \frac{\sigma_2^2}{\sigma_1}) dz \quad (1)$$

The last equation takes place under the conditions that $M\nu_i \gg m\nu_e$, which is achieved in the ionosphere. Integrating in (1) was effected in regions at 105 to 180 km altitudes. The collision frequencies were computed using data in (3) with the aid of formulae in (4).



According to Greenwich

UT - мировое время; θ - коширота UT - universal time; Θ co-latitude

Рис. 1. Напряженность геомагнитного поля в полдень.
UT — мировое время, Θ — коширота.

Fig. 1. Tension of the geomagnetic field at noon.
UT - universal time; Θ co-latitude

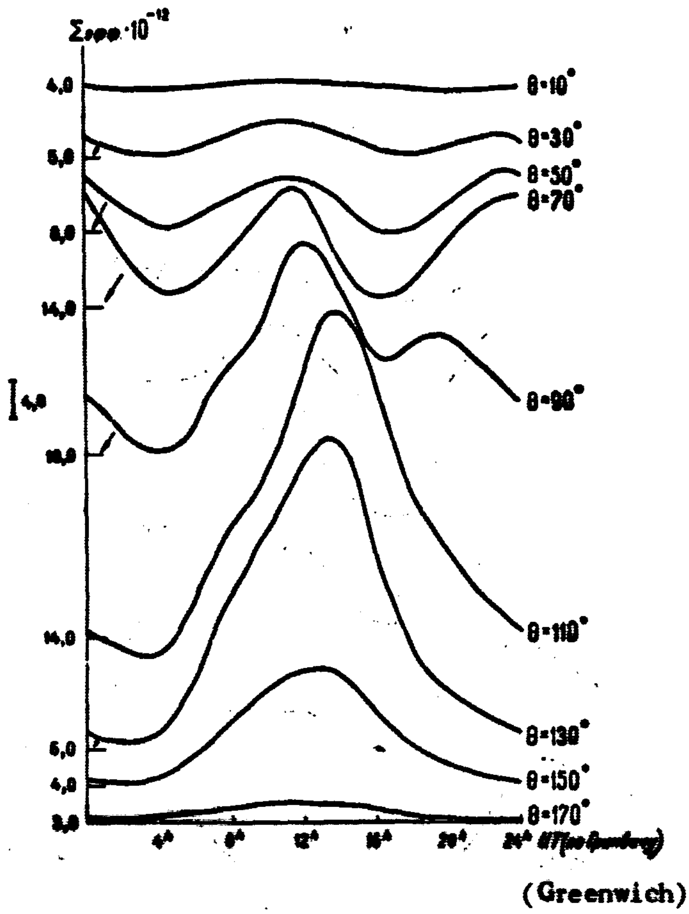


Fig. 2 UT changes in the integral effective conductivity [illegible].

θ— - co-latitude

where

$$\sigma_1 = N_e e^2 \left[\frac{\nu_e}{m(\omega_e^2 + \nu_e^2)} + \frac{\nu_{in}}{M(\omega_i^2 + \nu_{in}^2)} \right],$$

$$\sigma_2 = N_e e^2 \left[\frac{\omega_e}{m(\omega_e^2 + \nu_e^2)} - \frac{\omega_i}{M(\omega_i^2 + \nu_{in}^2)} \right]$$

$$\sigma_3 \approx N_e c^2 \frac{M \nu_{in}}{H^2 + \frac{mc^2 M \nu_{in} \nu_e}{e^2}}$$

$$\nu_e = \nu_{en} + \nu_{ei}$$

$$\nu_{in} = \frac{16\sqrt{2}}{3} \pi a^2 N_n \left\langle \frac{8\kappa T}{\pi M} \right\rangle^{1/2}$$

$$\nu_{en} = \frac{4}{3} \pi a^2 N_n \left\langle \frac{8\kappa T}{\pi m} \right\rangle^{1/2}$$

$$\nu_{en} = \left[34 + 8{,}36 \lg \frac{T^{3/2}}{N_e^{1/2}} \right] T^{-3/2} N_e$$

Latitude changes in electron concentration are calculated using data in (5) on world distribution of critical frequencies of the E and F_1 layers. At that, the N_e distribution with an altitude between the maxima of the E and F_1 layers was taken to be linear.

The results of computations are presented in Figs. 2, 3, and 4. These charts show, along the abscissa axis - the universal time (according to Greenwhich) and the values of integral conductivity (in CGSE units) in the ordinates axis.

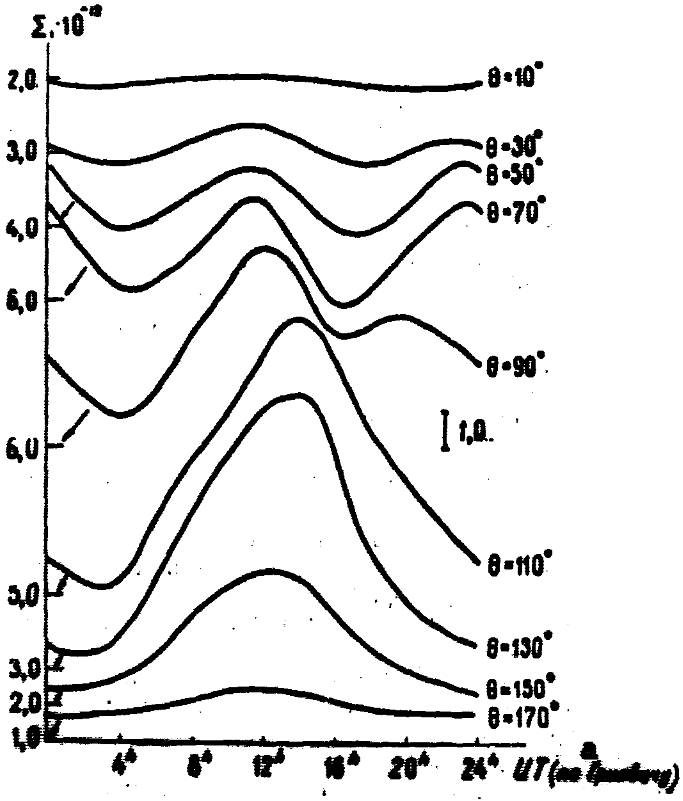


Fig. 3 - UT changes in integral transversal conductivity ($\Sigma_\perp$).

° - co-latitude

a = according to Greenwich

In addition, a harmonic analysis of the 24 hour motion of Σ_1, Σ_2 and Σ_3 has been accomplished. Fig. 5 presents the latitude distribution of the amplitude and phase of the first harmonics of function $\Sigma_3(T)$.

This harmonic which is a 24 hour wave is actually the basic one in the 24 hour motion of Σ_3 everywhere, with the exception of the region of high latitudes. The dotted curve in Fig. 5 also shows the average 24 hour values of

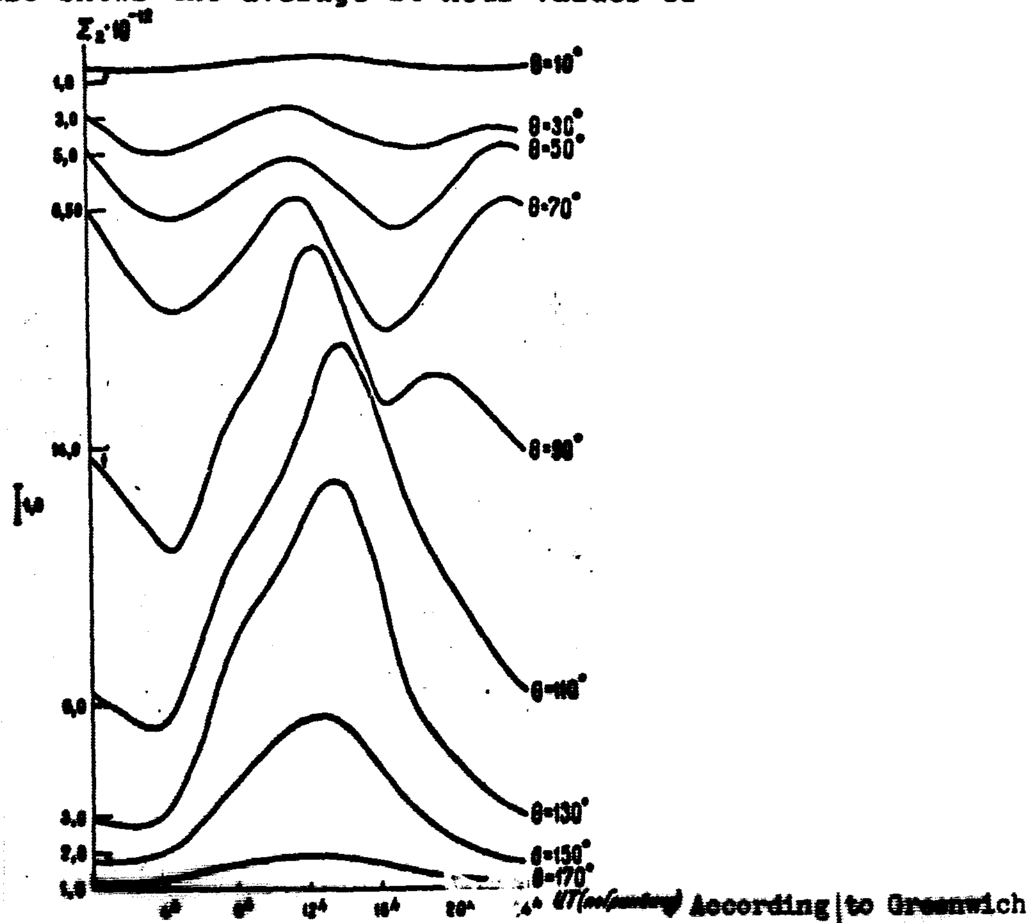


Рис. 4. UT — изменения интегральной проводимости Холла (Σ_2).
Fig. 4. UT changes in the integral conductivity according to Hall (Σ_2)

Figs. 2 - 5 show that electric conductivity of the daily ionosphere does experience considerable changes within the universal time of 24 hours. In the Southern Hemisphere, for instance, the value Σ_3 at the 40° latitude changes during one 24 hour period almost 6 times.

It is interesting to note, at this point, that in median latitudes the phase of the first harmonic of the 24 hour motion of effective conductivity occurs at 4.5 hr UT in the Northern Hemisphere and at 16.5 hours UT in the Southern Hemisphere.

Analogous changes, as reported in (2) are occurring in the density of Sq-currents.

Results of this analysis, notwithstanding the illustrative character of the calculations leve no doubts that the UT changes in electric conductivity in the daily ionosphere are an important factor which determines the regular 24 hour changes of ionosphere currents which originate in the dynamo-region.

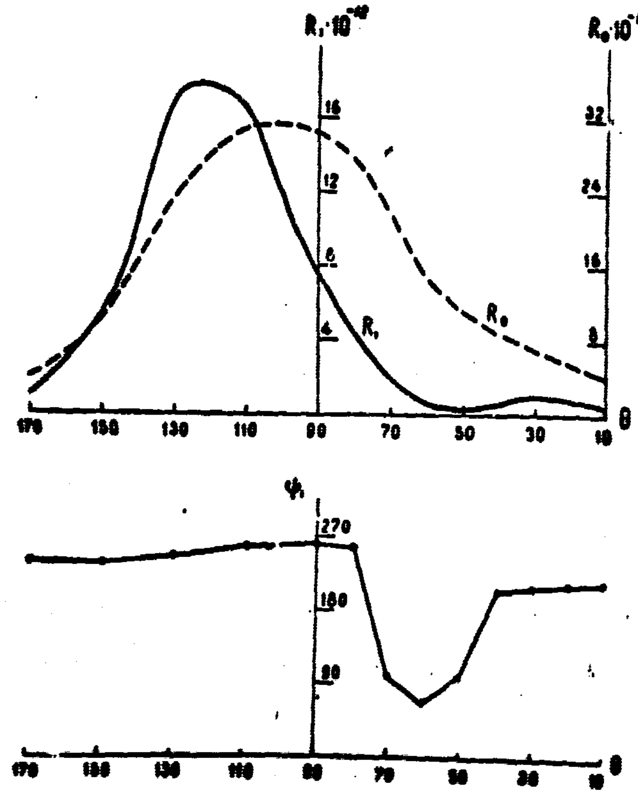


Fig. 5 - Latitudinal motion of parameters of the zero and first harmonics of the 24 hour progress of effective conductivity: φ_1 - phase; R_1 - amplitude; R_0 median 24 hour value.

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