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TAKING INTO ACCOUNT THE VERTICAL DRIFT OF MOLECULAR IONS
WHEN DETERMINING THE KINETIC PARAMETERS
OF IONIZATION-RECOMBINATION PROCESSES
IN THE F₂-LAYER MAXIMUM

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by N. N. Klimov
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SUMMARY

This note establishes that when one applies the method described in ref. [1-3] for the determination of kinetic parameters during the years of high solar activity, it is permitted to disregard the vertical drift of molecular ions due to neutral gas.

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 * *

When determining the kinetic parameters by the method described in [1-3], the system of equations

$$\begin{aligned}\frac{dN}{dt} &= q_0 \phi(t) - \alpha N x \\ \frac{dx}{dt} &= \gamma M(N - x) - \alpha N x,\end{aligned}\tag{1}$$

where q_0 is the maximum rate of ion formation; $\phi(t)$ is the normalized ionization function; α is the weighted mean dissociative recombination coefficient; γ is the weighted mean ion-molecular reaction coefficient; M , N and x are respectively the concentrations of neutral molecules, electrons and molecular ions, was completed by a term taking into account the vertical drift of molecular ions at the expense of the motion of neutral air.

It was assumed for the sake of clarity that only molecular ions are moving. The calculation was conducted in the assumption that near the main electron concentration maximum the molecular ions have a scale height equal to that of the neutral gas, borrowed from the Harris and Priester model [5]. Then the drift term will be written :

$$\text{div}(x_{\text{vert}}) = \frac{\partial x}{\partial z} U_{\text{vert}} + - \frac{\partial U_{\text{vert}}}{\partial z} x.\tag{2}$$

(*) UCHIET VERTIKAL'NOGO DREYFA MOLEKULYARNYKH IONOV PRI OPREDELENIИ KINETICHESKIKH PARAMETROV IONIZATSIONNO REKOMBINATSIONNYKH PROTSESSOV V MAKSIMUME SLOYA F₂.

Because of the smallness of $\partial U_{\text{ver}}/\partial z$ [6], we may neglect the second term and, taking into account the distribution of molecular ions in height, we may write

$$\text{div}(xU_{\text{ver}}) \approx -\frac{x}{H} U_{\text{ver}} \quad (3)$$

When determining the parameters on the analog EVM MH-7 for March 1958 (Irkutsk) no drift effect could be detected.

The elementary calculation for stationary conditions with $\gamma \sim 10^{-13} \text{ mm}^+ \text{ sec}^{-1}$, $\alpha \sim 10^{-9} \text{ cm}^3 \text{ sec}^{-1}$, $M \sim 10^9 \text{ cm}^{-3}$, $x \sim 10^{+5} \text{ cm}^{-3}$, $U_{\text{ver}} \sim 10^2 \text{ cm sec}^{-1}$, $N \sim 10^6 \text{ cm}^{-3}$, shows that in daytime the drift term is smaller by more than one order than the other terms, while in nighttime it is of the same order, but the error of MH-7, which stood at 20%, could not provide the possibility to take this effect into account.

Consequently, when determining the coefficients by the method described in [1-3], the vertical drift on account of neutral gas may not be taken into account for the years with high solar activity.

***** T H E E N D *****

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