MEANING OF THE VERTICAL PROFILE OF ION TEMPERATURE OVER THE ANTARCTIC

Shigeyuki MINAMI, Shiro TSUTSUMI and Yoshio TAKEYA

Faculty of Engineering, Osaka City University, 3–138, Sugimoto 3-chome, Sumiyoshi-ku, Osaka 558

***Abstract*:** The existence of horizontal stratifications of ion temperature has been reported by several workers. In the mid-latitude region we too observed such a wavelike temperature variation using a sounding rocket. These phenomena may be caused by atmospheric oscillations. The observations are thought to be important over the polar region. In this paper we propose an explanation for the observation of the vertical profile of the ion temperature over the Antarctic.

Ion temperature stratification was first measured by KNUDSEN and SHARP (1965), using a sounding rocket at altitudes of 100 to 160 km. The vertical wavelength was about 10 km. Recently these phenomena were also observed using the satellite-borne retarding potential analyzer (RPA) (SPENCER *et al.*, 1976; BREIG, 1976; KAYZER *et al.*, 1979). The results show that these wavelengths are about several tens of kilometers and that the amplitude of the variation increases in the polar region (Fig. 1). We also observed the ion temperature stratification using a sounding rocket at altitudes of 100 to 350 km in the middle latitude region. The experimental result is shown in

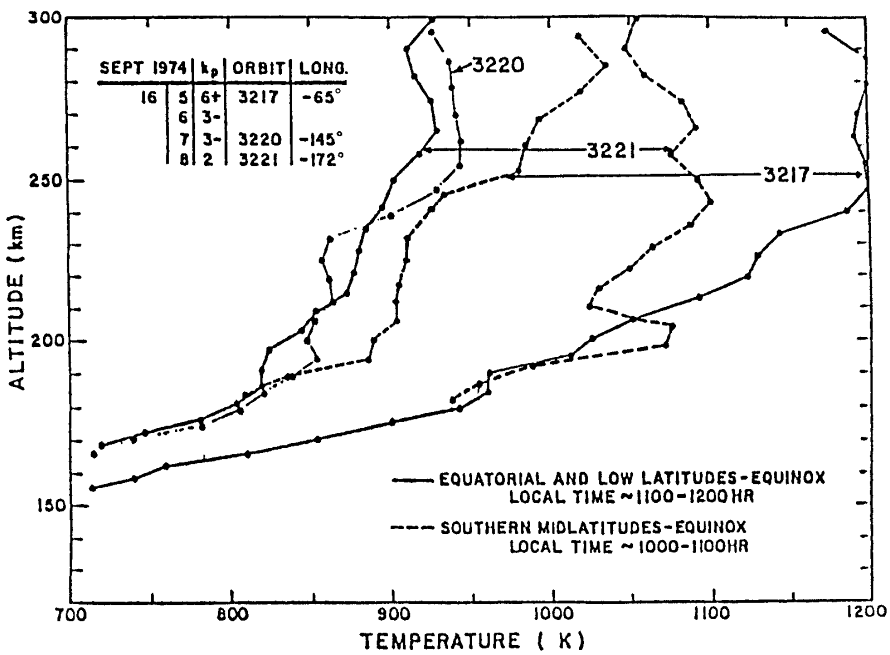

Fig. 1. Measured ion temperature variation from the AE-C satellite (KAYZER et al., 1979)

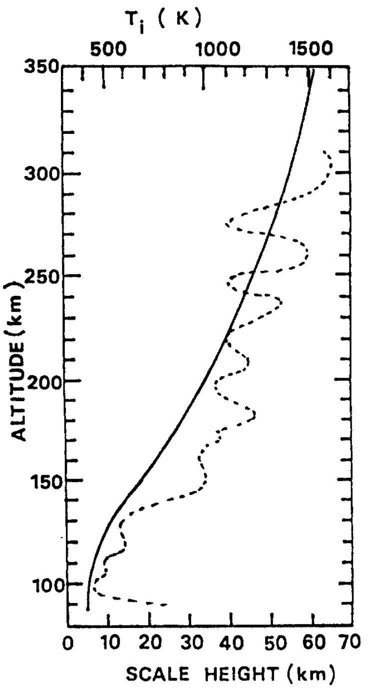

Fig. 2. Evidence of the temperature stratification obtained from a sounding rocket over the mid-latitude region (MINAMI *and* TAKEYA, *1982*).

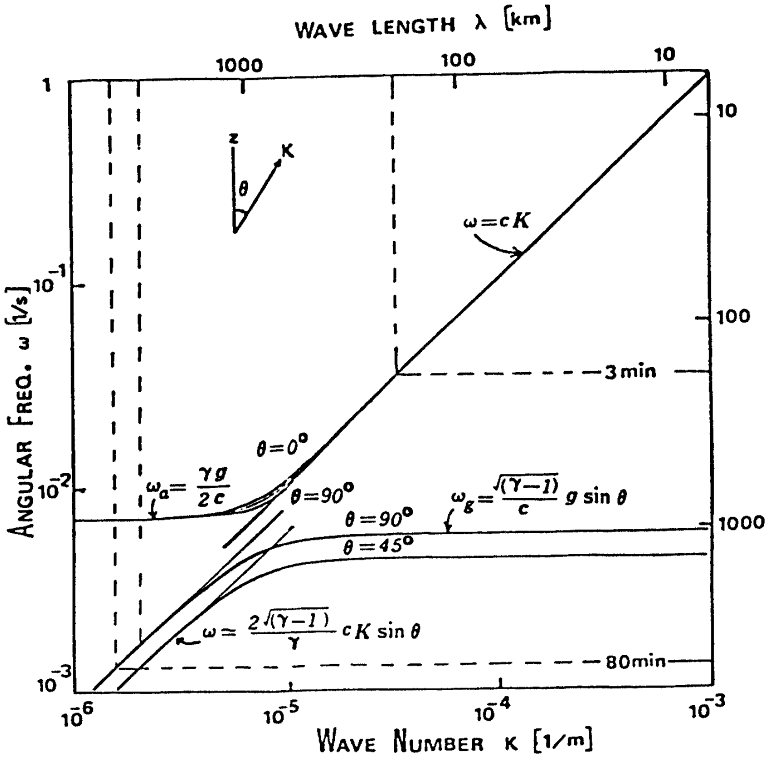

Fig. 3. A dispersion curve of atmospheric wave calculated from the wave equation advocated by HINES *(1960)* (MINAMI *and* TAKEYA, *1982*).

Fig. 2 (MINAMI and TAKEYA, 1982). The vertical wavelength is about 25 km and the amplitude becomes larger at higher altitudes. In this figure the model scale height of the neutral temperature profile is correlated with the amplitude. This wavelike structure may be caused by oscillation of the atmosphere. In Fig. 3 the wave diagram is illustrated using the atmospheric wave functions advocated by HINES (1960). For the measurement of the instantaneous vertical temperature profile a sounding rocket is more useful than a satellite.

To determine the mode of such a wave, spacial multi-point observations are needed. As it is necessary to measure the instantaneous wave pattern, the vertical velocity of vehicles must be fast. A temperature profile measured by a satellite contains the components of the horizontal gradient of the ion temperature variation and the time variation. From the vertical wavelength λ_z can be obtained. In order to decide the wave mode, other parameters such as λ_x (horizontal wavelength) and ω (angular frequency) are needed. By the use of multi-point ground observations it is possible to decide the mode.

In Fig. 4 an example of the time variation of the electron density obtained from the ionosonde at the launching site is shown. A period of about 3 min is found for the periodic oscillation of f_0F_2 in the ionosphere. Another example of the ground

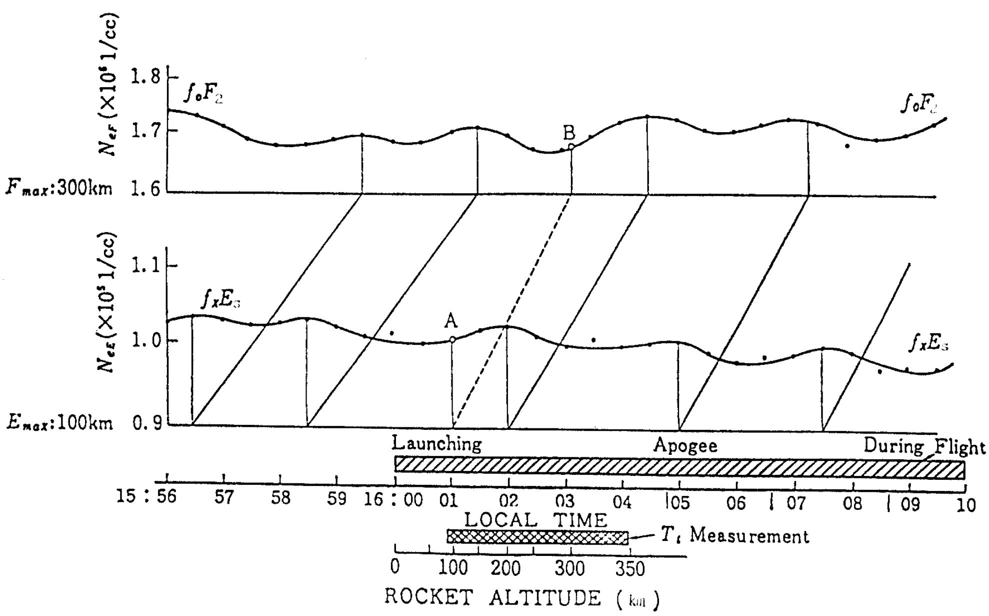

Fig. 4. An example of the short period electron density from the values of f_0F_2 and f_xE_s from ionograms (heights of f_0F_2 and f_xE_s are about 300 and 100 km respectively). (MINAMI and TAKEYA, 1982)

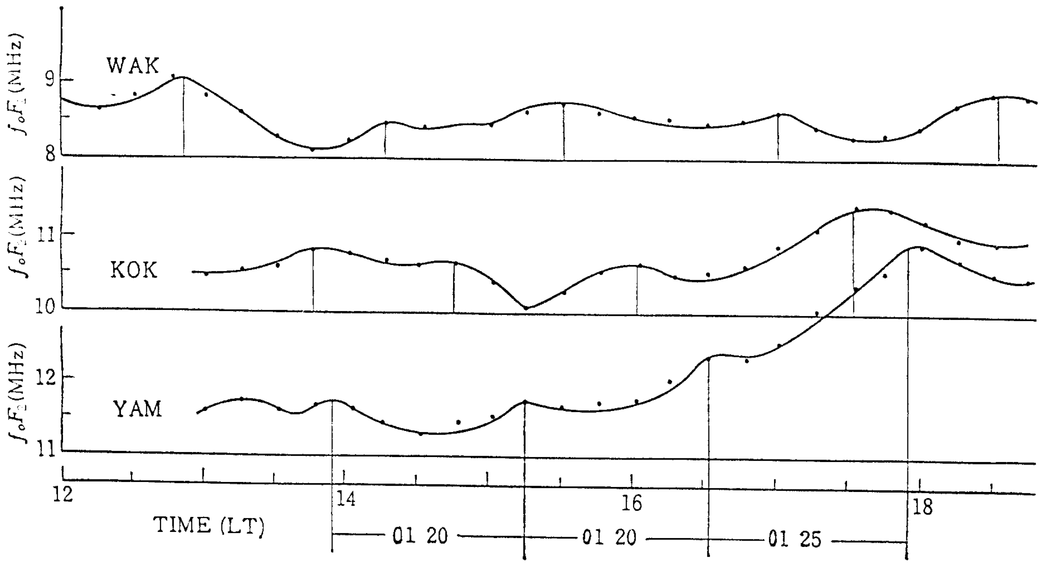

Fig. 5. An example of the electron density variation measured from three different ionosonde stations (WAK, KOK and YAM are the stations Wakkanai, Kokubunji and Yamagawa respectively).

observation which was also measured during the launching time is shown in Fig. 5. From three curves of the f_0F_2, one at each ionosonde station, the horizontal wavelength of the travelling ionospheric oscillation can be calculated. The figure shows that the wave period τ_1 is about 60 min, and from the time delay of the oscillations at each station a reasonable phase velocity v_{p1} can be deduced (MINAMI and TAKEYA, 1982). From the values of τ_1 and v_{p1} the horizontal wavelength λ_x can be calculated. Using

λ_x, λ_z and τ_1 it is decided whether this wave can propagate or not. This is the principle of the method for deciding the atmospheric wave mode. In order to investigate the high time resolution, an ionosonde operating with a fast repetition rate is needed (Fig. 4). The sampling period is 30 s. Another high time resolution method for measuring the wave is the HF doppler technique. This method is easily carried out at different places.

In the polar region an atmospheric oscillation is occasionally produced, probably due to auroral precipitation. The determination of the ion temperature in the polar region using the above mentioned observational methods can give some information not only about the thermal structure, but also about the mode of the atmospheric oscillation. To achieve this entirely, coordination between the RPA experiment aboard a sounding rocket and the ground observations is necessary.

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