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THE ACCOUNT OF INFLUENCE OF THE ATMOSPHERIC FACTORS ON NEUTRAL WINDS MEASUREMENTS

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1. Introduction

The Doppler shift measurements of a radiating spectral line are among the methods of determination of the neutral gas velocity in the upper atmosphere. The shift of the 557.7 nm emission is determined by the wind in the E-region, and that of the 630.0 nm emission is determined by the wind in the F-region. In the lower thermosphere, at heights of 100-150 km, the horizontal wind velocity, as a rule, does not exceed 400 m/s, and vertical velocity does not exceed 100 m/s. The wind velocity of 100 m/s corresponds to Doppler shift of the 557.7 nm emission of the order of 1.6×10^{-3} Å and, accordingly, the accuracy of wavelength measurement should be higher. Usually the wavelength of emission is measured with Fabry-Perot interferometer [*Hays et al.*, 1979; *Jacka et al.*, 1979; *Batten et al.*, 1988; *Sipler et al.*, 1995]. One of methods to obtain the line profile is changing in interferometer plates separation by piezoelectric ceramics [*Hernandez and Mills*, 1973; *Smith et al.*, 1982]. To register one order of interference it is necessary to move the plate half the wavelength, wich is less than 0.3 microns. The similar shift, however, can be caused by temperature change (because of thermal expansion of ceramics) and can be the change in pressure (because of change of the refractive index). The valuations show, that 1 degree temperature change in 20 mm of length in ceramics results in displacement of a profile maximum at 0.8 of the order, and change in pressure of 27 mb at a distance between plates of 10 mm shifts the picture at 0.2 of the order. The displacement of the interference picture because of atmospheric factors is parasitic, and distorts the measured wind picture and therefore should be eliminated.

2. Technique

In the interferometer, designed in Polar Geophysical Institute [*Bogdanov et al.*, 1990], scanning is created by piezoelectric ceramics, to which the steps - growing voltage is applied. Number of steps, i.e. points of measurement, is 128, the length of ceramics is 20 mm and plate separation is 9.7mm.

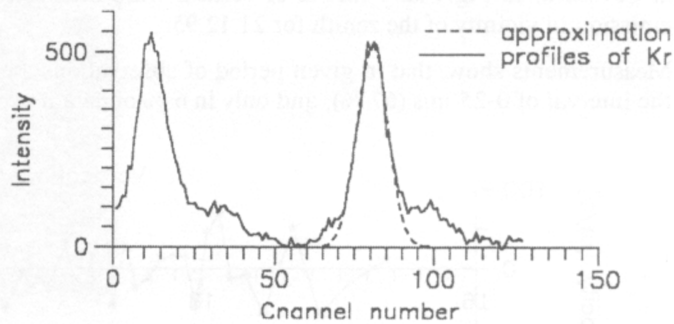

Fig.1. Two orders of interference of the Kr line and approximation through 15 points

Usually [*Hays and Roble*, 1971; *Hernandez and Roble*, 1976] two orders of interference are recorded (Fig.1), and one of profiles is approximated by the Gauss function, which maximum position and halfwidth are determined by the wind velocity and by the neutral gas temperature, respectively. In this case changes in temperature and pressure result in displacement of the interference picture, but always there is one of the profiles, at which measurements are carried out. The behaviour of atmospheric parameters is monitored by the known line, for example Kr (557.0 nm), which is registered after each cycle of measurements and is taken into account at processing. Recording two interference orders of the interference we cannot obtain very high accuracy of profile approximation, since it is possible to use less than 20 points for approximation, and the spectral interval of about 1.5×10^{-3} Å corresponds to each channel.

It is possible to increase the accuracy of approximation by applying the reduced voltage to piezoelectric ceramics and recording one order of the interference. In this case, however, change in atmospheric parameters can shift the interference picture so much that only a part of the profile will be registered or, in general, the profile will be out of the field of view, if not to keep the temperature change within the range of 0.01°C. To solve this problem the following method is offered: one profile is registered, so that the spectral interval of 4×10^{-4} Å corresponds to each channel, and the approximation is possible by 60-70 points (Fig.2). In the beginning and in the end of each measurements cycle the profiles of the Kr line are recorded and their maximum positions are determined . If the Kr maxima do not coincide, then the voltage is applied to ceramics, returning interferometer plates to the initial situation, and the measurements are proceeded. Fig.3 shows the behaviour of the Kr line maximum during different measurement cycles. As it is seen from Fig.3, change in atmospheric parameters can shift the interference picture at 1-3 channels (displacement on 1 channel corresponds to wind velocity of 35 m/s) during one measurements cycle. These changes are automatically corrected and the new cycle of measurements begins at the conditions as those of the previous measurements. It is natural, that change in the atmospheric parameters affects the neutral wind measurements. However, assuming, that the atmospheric parameters vary linearly during a measurements cycle, this influence can be discounted by the expression

$$N = N_0 + (N_2 - N_1)\,(t - t_1)\;/\;(t_2 - t_1)$$

where N and N_0 are the corrected and measured maximum positions of the 557.7 nm line, t is time of measurement of the 557.7 nm line profile, N_1, t_1 and N_2, t_2 are maximum position and time of the Kr line measurement in the beginning and in the end of the measurements cycle, correspondingly.

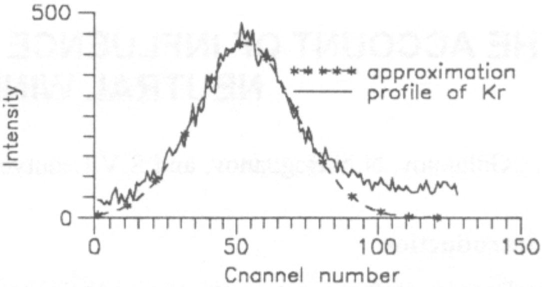

Fig.2. One order of interference of the Kr line and approximation through 60 points. Error is equal to 16 m/s

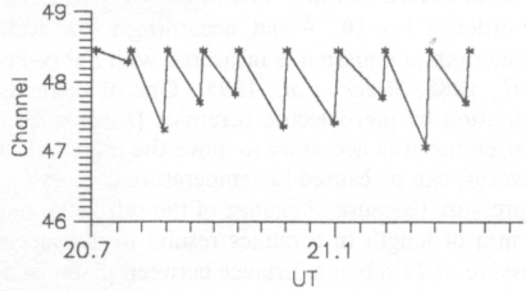

Fig.3. Behaviour of the Kr line maximum in time

3. Results

Thus, the offered technique permits to take into account influence of the atmospheric factors and to fine-tune the interferometer without sharing of an observer. Besides it permits 2-3 times increase in accuracy of measurement of neutral wind velocity and to reduce requirements to interferometer heat setting

In November - December 1995 measurement of wind velocity with use of the given technique were carried out at Lovozero. In Fig.4 an example of vertical wind measurements is shown, together with intensities of the green emission in vicinity of the zenith for 21.12.95.

Measurements show, that in given period of observations the vertical wind velocity basically acquired the value in the interval of 0-25 m/s (67 %), and only in 6 % of data it exceeded the value of 75 m/s.

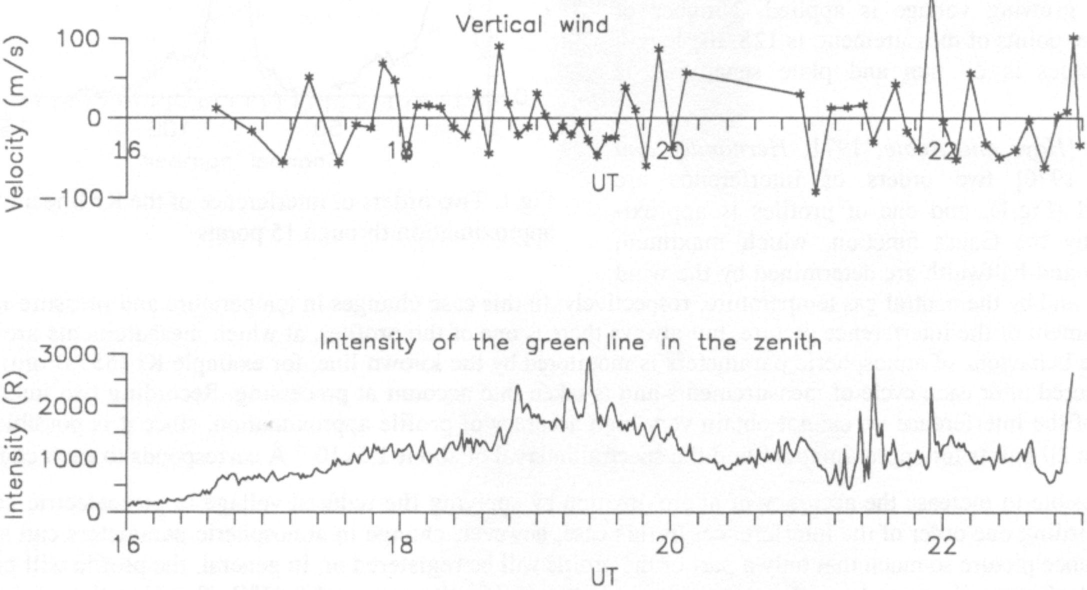

Fig.4. Vertical wind and intensity of the green line on 21.12.95.

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