VARIATIONS OF A VERTICAL GRADIENT OF REFRACTIVITY IN POLAR TROPOSPHERE

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Investigation results of a refractivity gradient for the high latitude atmosphere are presented. Parameters of its statistical distribution for different layers of the atmosphere are given. Seasonal variations of the gradient having one maximum in winter are obtained.

As known, the investigation of troposcattering radiowaves is first of all connected with the problem of studying radio meteorological parameters - a refractive index and its vertical gradient. In some detail are investigated the characteristics of radio meteorological parameters in the regions of a temperate climatic zone, where seasonal variations of the refractive index of the atmosphere have one maximum in summer and one minimum in winter [1,2]. Sharply continental regions of middle latitudes are characterised by a seasonal variation of the other type: two maximums - in winter and in summer, two minimums - in spring and in autumn.

This paper gives the results of investigating changeability of a refractivity gradient g_n on five station situated in central Asian regions beyond the Polar circle. The stations of the Chelyuskin cape (1) and Tiksi (2) are situated on the coast line of the Arctic ocean and the stations of Verkhoyansk (3), Igarka (4) and Zhigansk (5) are situated in the continental part of the investigated region.

Table 1 gives the values of the gradient for 1, 10, 50, 90 and 99% of observation time, obtained from statistical distributions of the values of g_n in the layer of 2-300 meters, constructed separately for months on five investigated stations. Table 1 also gives the range of variations of a refractivity gradient g_n(1% - 99%). In winter the median values of g_n in the absolute value are considerably greater than the values of g_n, observed in other seasons of a year.

This is first of all conditioned by properties of high latitude troposphere itself, by intensive inversion of the temperature observed in winter as a result of the effect of a Siberian anticyclone. It should be noted that median of g_n on all stations in the absolute value considerably exceed the value of the gradient, characterising the standard radio atmosphere [1]. The seasonal variation of a refractivity gradient of the air substantially depends on climatic properties of the investigated region. The year variation of g_n on the continental stations beyond Polar circle is different from the analogous variation of g_n on the stations of Arctic coast. On the continental stations beyond Polar circle, seasonal variations of median values of a refractivity gradient of the atmosphere have two maximums /in winter and in summer/ and two minimums /in spring and in autumn/ [3].

The yearly variation with one winter maximum is characteristic of coastal arctic points. Such feature of seasonal variation is the result of composition of specific seasonal changes of temperature and humidity of the air and as well their gradients observed in these regions.

Table

Station	Month	$g_n \cdot 10^8$, m^{-1}					
		1%	10%	50%	90%	99%	1-99%
1	January	-1.7	-4.3	-6.0	-7.4	-10.2	8.5
	April	-1.5	-3.8	-4.4	-5.9	-7.5	6.0
	July	-1.2	-3.1	-4.2	-5.0	-5.5	4.3
	October	-3.1	-3.5	-4.0	-5.1	-5.7	2.6
2	January	-3.5	-3.9	-6.5	-9.3	-10.8	7.3
	April	-2.5	-3.5	-4.4	-6.3	-7.9	5.4
	July	0.0	-2.8	-4.0	-5.1	-5.8	5.8
	October	-2.2	-3.7	-4.1	-6.8	-8.5	6.3
3	January	-4.5	-6.5	-8.9	-11.0	-13.9	9.4
	April	-1.7	-3.4	-4.4	-7.4	-10.1	8.4
	July	0.5	-2.6	-4.0	-6.6	-9.5	10.0
	October	-2.7	-3.1	-3.9	-6.8	-9.0	7.3
4	January	-3.3	-3.8	-5.4	-10.7	-12.5	9.3
	April	-2.2	-3.4	-4.3	-6.3	-8.8	6.6
	July	-0.3	-3.5	-4.8	-7.6	-10.5	10.2
	October	-1.0	-3.4	-4.0	-4.8	-5.7	4.7
5	January	-3.5	-4.5	-7.4	-10.6	-13.0	9.5
	April	-2.8	-3.5	-3.9	-5.0	-6.3	3.5
	July	-1.0	-3.4	-4.6	-6.5	-11.7	10.7
	October	-3.0	-3.6	-4.0	-5.3	-6.7	3.7

The estimation of the contribution of every mentioned parameter is performed by the formula

$$\partial N/\partial H \cdot 10^6 = A \cdot \partial P/\partial H - B \cdot \partial T/\partial H + C\, \partial e/\partial H$$

where $A = 77,6/T$, $B = T^{-2} \cdot (77,6p + 7,46 \cdot 10^5 e/T)$, $C = 3,73 \cdot 10^5 \times T^{-2}$; T - air temperature, K; P - atmospheric pressure, mb; e - water vapour pressure, mb; H - layer altitude, m.

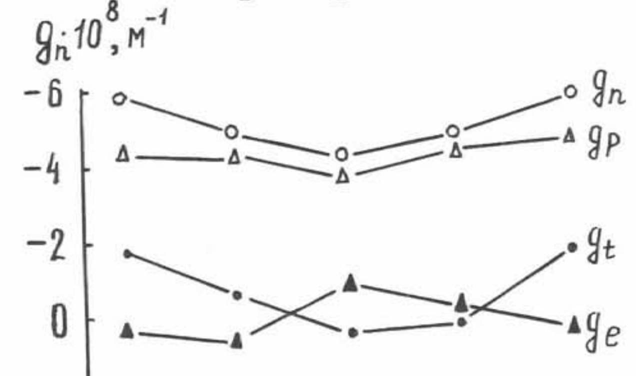

Fig.1

Fig.1 shows the results of the estimation for coastal station I. A refraction depends on cooperative changes of temperature, humidity and atmospheric pressure.

The statistical distributions of g_n in the layer of 2-300 m. on continental station 3 constructed for central months of a seasons are given in fig. 2a. Fig.2b gives the data on coastal station 2. In winter and in summer in-

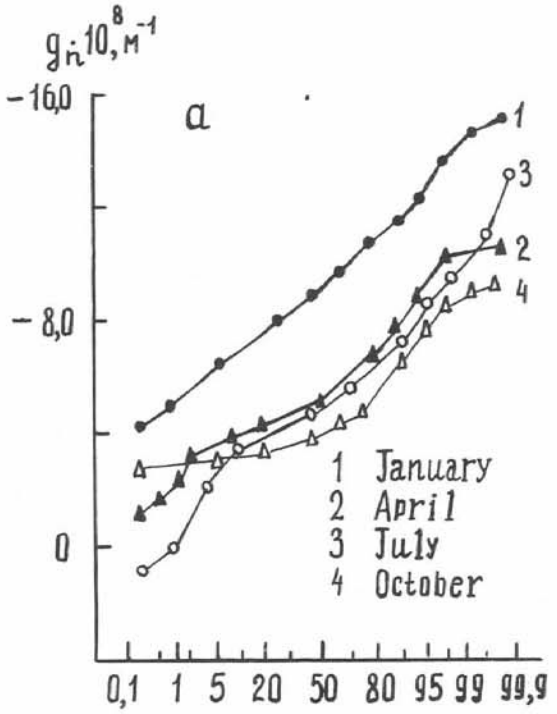

Fig.2a

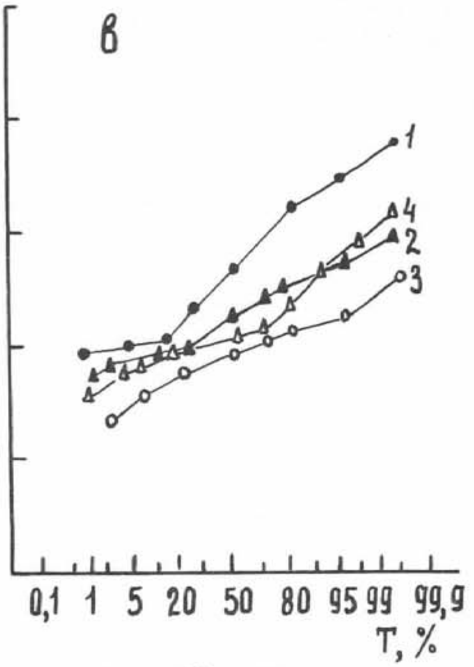

Fig.2b

tegral functions of distribution of g_n on beyond polar circle continental station 3 are satisfactory approximated to the normal law, and deviations from the normal law of distribution are marked in spring and in autumn. Root-mean-square deviations σ , coefficients of asymmetry S_k and excess E_x for real distributions, constructed for spring, make up $\sigma = 1,68 \times 10^{-8}\ \text{m}^{-1}$, $S_k = 1,2$, $E_x = 1,18$ and for autumn - $\sigma = 1,33 \cdot 10^{-8}\ \text{m}^{-1}$ $S_k = 1,06$, $E_x = 0,61$. For station 2, situated on the Arctic coast, integral functions of distribution in all seasons of a year may also be approximated to the normal law.

On all the investigated stations the parameters of integral distribution of g_n in the layer of 2-300 meter are variated depending on the point of observation and on a season of a year in following limits

$$g_n = -(4,0 \div 8,9)\cdot 10^{-8}\ \text{м}^{-1};\quad g_n(1-99\%) = (2,6 \div 10,7)\cdot 10^{-8}\ \text{м}^{-1}.$$

The yearly variation of variability range of $g_n(1 - 99\%)$, analogically median values of g_n hase two maximums /in winter and in summer/ and two minimums /in spring and in autumn/ on continental stations 3, 4 and 5. On more Northern stations I and 2 on the Arctic coast the greatest fluctuations $g_n(1 - 99\%)$ are observed only in winter.

The probability of forming increased conditions of the refraction on the continental stations beyond Polar circle considerably exceeds analogous probability on the coastal Arctic stations. On continental station 3 atmosphere stratification in the layer of 2-300 meters was found, by its refraction properties close to critical ($g_n = -15,7 \cdot 10^{-8}\ \text{m}^{-1}$). The fact allows to suppose that in these regions waveguide conditions are formed in the land layer of the atmosphere with the capacity less than 300 m.

In conclusion we mark the main results.

1. Refractivity gradients of g_n in troposphere in conditions of Asian region beyond Polar circle are characterised by two kinds of seasonal variations: a) one winter maximum of g_n and one summer minimum on the coastal arctic stations; b) two maximums g_n /in winter and in summer/ and two minimums /in autumn and in spring/ on the continental stations.

2. Range of variability g_n(1 - 99%) has a seasonal variation of average monthly values of g_n, judging by the character of a curve.

3. The average conditions of the refraction in winter considerably exceed the conditions of standard refraction. In winter in these regions one can expect the formation of conditions of superrefraction, $g_n < -15,7 \cdot 10^{-8}\ m^{-1}$.

References

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