Experimental Study Of Double Frequency Method For Measurements Of Rain Characteristics

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Abstract – **The results of experimental study of rain intensity by double frequency radar are presented which confirm the validity of the method proposed in the previous works.**

Keywords – **Rain intensity, double frequency radar.**

I. Introduction

Study of rain parameters is quite important for scientific research in climatology, atmosphere physics etc. At present, so called *Z-I* relation [1] is widely used which is based on correlation between intensity I (mm/h) and radar reflectivity Z (mm^6/m^3) in the form $Z = AI^B$. However the coefficients A and B essentially differ for various regions and depend on precipitation origin that decreases the reliability of such approach. That is why the use of double frequency radar is of interest to increase reliability of the precipitation measurements. But it is impossible to define three parameters of widely used gamma distribution of drop sizes $N(D)=N_0 \cdot D^a \cdot \exp(-D/b)$, ($D$ – drop diameter, N_0, a and b – distribution parameters) by measurements at two frequencies. So it is necessary to use additional a priori information to fully define inverse task. Particularly the combined double frequency method was proposed [2] based on using correlation dependences between parameters of gamma distribution and rain intensity [3] in the form $a = aI^{-b}$ and $b = cI^d$ (mm), where a = 3.8; b = 0.42; c = 0.148 and d = 0.38. The method permits to measure microstructure rain parameters (N_0, a, b), take into account signal attenuation in rain and eliminate measurement ambiguity for small rain intensity. The goal of the present work is experimental comparison of remote sensing data obtained by double frequency method and contact measurements.

II. Experimental Study

To provide experimental study of the proposed method the double frequency incoherent radar (l_1 = 8.2 mm and l_2 = 3.2 cm) was upgraded. It provides the value of radar constant $C_r = C(l_1)/C(l_2)$ = 7.4 and the range resolution ΔR = 150 m. Output radar signals are digitized and preliminary processed in PC for the further signal processing by developed software on the base of proposed method. Also the high-performance rain gauge was developed on the base of electronic balance to verify the data of remote sensing.

The one example of preliminary results of experimental study is shown in Fig. 1, when the radar antenna was vertically oriented and the first resolution cell is placed at the height H = 750 m. The both dependences in Fig. 1 are plotted in the real time scale so it is possible to estimate the time delay between the radar and rain guage data. During this time the water drops fall from height 750 m to ground surface, where the contact measurements performs. For the case shown in the Fig. 1 the time delay equals approximately to 114 s that corresponds to the falling rate of rain $V_f \cong 6.7$ m/s.

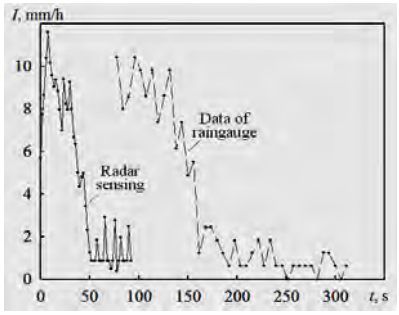

Fig. 1 Comparison of remote sensing and contact measurements of rain intensity

The data obtained do not permit to compare current values of the rain intencity but the average values (at the stationary parts of the curves) are in a good agreement with contact data. Some results of the experiments performed for different rains are presented in the Table I, where I_r is averaged rain intensity measured by radar and I_{rg} – measured by rain gauge.

TABLE 1
Comparison of averaged rain intensity

№	I_r, mm/h,	I_{rg}, mm/h,	Inaccuracy, %
1	8.76	8.34	4.9
2	4.11	4.73	14.1
3	1.39	1.37	1.5
4	3.94	3.79	3.9

It can be seen that remote sensing measurements differ from contact less than 15 %.

II. Conclusion

The preliminary experiments were carried out to verify the proposed double frequency method by comparison of rain gauge and radar sensing data. As it was shown the radar measurements of average intensity are in good agreement with contact measurements – the difference is less than 15 %.

References

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