5.9 A NEW RADAR METHOD FOR DETECTION OF PARAMETERS OF CLOUDS AND PRECIPITATION

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1. INTRODUCTION

The unknown earlier phenomenon of modulation of radar radiation by spatial coherent waves that allowed on a new, more precise basis to develop the detection method of cloud and precipitation parameters. The given method extends the functional capabilities of non-coherent radars not changing their design and allows to solve a set of new problems considered too difficult.

The radar meteorology is rather young, it is no more than 60 years. The radar equation, obtained in the maiden years, is used till now without essential changes. However, recently, number of authoritative specialists in this area has doubts about the reliability of radar equation based on the results of some experiments. The author of this paper being engaged in problems of metrology of radar measurements, experienced such doubts as well. Nevertheless the author, based on his experience, came to the conclusion, that the radar equation, from the quality point of view, correctly describes the physical processes of detection and ranging. The majority of problems and doubts for the users, in author's opinion, arise from an imperfection of measuring process built on the direct usage of the given equation.

2. STATE OF THE PROBLEM

It is known, that the video signal of the non-coherent radar contains a coded information, which one is capable in a full volume to describe not only the object of a detection and ranging, but also of propagation and radar itself as well. The searching of way of decoding of the given information directly from video signal were made by many specialists before, but all of them appeared unsuccessful. As a result the interest to this problem has disappeared. The judgement has become stronger, that during detection and formation of the video signals, the considerable part of the information and first of all the information on frequencies and phases of treated signals, is irretrievable lost. For this reason there was almost generally accepted opinion that in video signals of non-coherent radars the sources of information are only signal delays and their amplitudes.

Apparently therefore, in radar meteorology for the extension of information base at measurements of the microstructural characteristics of meteorological objects the whole arsenal of special-purpose means is used now.

To number of such means it is possible to attribute: the radars working on several wavelengths, the radars with active and passive channels, the radars with active channel and channel working on Doppler effect and also the radars with devices changing the radiation polarization. However the essential advance from usage of listed types of radars was not achieved. Therefore, the author again addressed to the video signals, as to sources possessing exclusive informativeness and undertaken their processing by optical methods.

3. METHOD OF PROBLEM SOLUTION

With the purpose of searching of possible ways of decoding from video signals the information, interdependent with the internal characteristics of cloud environments, the author has conducted a set of special experiments, in which the local volumes of cloud environments with given intensity of radioechoes were selected and in a dynamical regime the degree of deformation of their parameters was estimated. As a result it was established, that the local volumes of cloud environments, having different microstructural constitution, with other things being equal, have miscellaneous reaction on the same covered path. The given fact, the author used as initial argument for transition to an optical processing techniques of the obtained results. In the total the parameter reacting to a microstructure of cloud environments was decoded from the video signal. New parameter was conditionally called as "structural parameter". The subsequent analysis of experimental data showed, that:

- “structural parameter” is a consequent of modulation phenomenon of dissipated back radiation by spatial coherent waves, which are even more sensitive to changes of dielectric properties in elements of volume of cloud environment;
- averaged periods of modulating waves are significantly less than the period of radiated oscillations (lie inside a period of radiation wave) and are proportional to dielectric heterogeneity’s (Fig.1).

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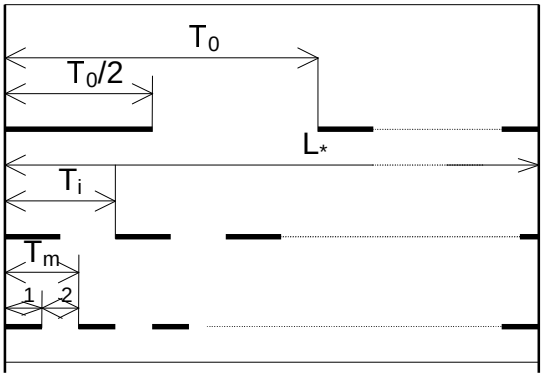

Figure 1

L_* - the path section passed by radiation flux;
T_0 - the period of radiation wave;
T_i - the period of reference wave;
T_m - the period of modulating wave.

In result, the problem of definition of averaged dielectric properties in volume elements was reduced to a problem of obtaining in a point of a data reception (from several directions) about averaged frequencies excited in investigated cloud environment of oscillations.

4. PRACTICAL IMPLEMENTATION OF METHOD

For practical implementation of given method the author, on the basis of present physical concept about location process, created the rebuilt primary standard in the form of virtual homogeneous cloud environment with the given characteristics. The mechanism of rebuilding of the primary standard is correlated to the value of "structural parameter", the parameters of the radar and dielectric properties of volume elements and volume as a whole. As in the primary standard each unit of a volume possesses the known dielectric properties, it provides the representation, through the totality of the hardly phased data, about a wavelength of desired averaged modulating oscillations, about quantity of the semiperiods placing on the measured distance and an expansion of a synthesized projection of echo signal envelope on an axis of distance. Further, on a final stage, the processing is conducted on algorithm of ratio of the corresponding parameters of the reference and operational channel. Generalizing the above-stated it is possible to mark, that the idea of the given method consists in replacement of measurement of the characteristics of cloud environment in different layers of studied volume (impracticable problem) by measurement of decelerated speed of wave propagation of radiation in layers of studied volume of cloud environment (in a place of reception it is the points under envelope of video signal), which one appears to be dependent on the microstructural characteristics of cloud environment. At the same time, the practical implementation of given method can be considered also as the reproduction in the reverse order of averaged pattern of a wave front, that makes a given method alternativeless. The more detailed information on the given method represents “KNOW-HOW” and can be submitted in the order, established for such cases.

5. METHOD CAPABILITIES

The suggested method allows:

- to solve a set of problematic tasks of radar meteorology earlier considered too difficult, for example, to determine in a local volume the liquid water content, phase structure of cloud environment, to measure on a new more precise basis the intensity of precipitation;
- to extend the functional capabilities of nominal radar’s used on ships and aircraft’s without change of their design, that will create a capability to find out the objects masked off by fog or precipitation;
- to control the current value of energy potential of radar, the turbulence of cloud environment etc.

6. REFERENCES

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