Measurement of rain intensity by means of active-passive remote sensing

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Measurement of rain intensity is of great interest for municipal services and agriculture, particularly because of increasing number of floods and landslides. At that monitoring of amount of liquid precipitation allows to schedule work of hydrological services to inform the relevant public authorities about violent weather in time. That is why development of remote sensing methods for monitoring of rains is quite important task.

The inverse problem solution of rain remote sensing is based on the measurements of scattering or radiation characteristics of rain drops. However liquid precipitation has a difficult structure which depends on many parameters. So using only scattering or radiation characteristics obtained by active and passive sensing at a single frequency does not allow to solve the inverse problem. Therefore double frequency sensing is widely used now for precipitation monitoring. Measurement of reflected power at two frequencies allows to find two parameters of drop size distribution of rain drops. However three-parameter distributions (for example gamma distribution) are the most prevalent now as a rain model, so in this case solution of the inverse problem requires the measurement of at least three uncorrelated variables. That is why a priori statistical meteorological data obtained by contact methods are used additionally to the double frequency sensing to solve the inverse problem.

In particular, authors proposed and studied the combined method of double frequency sensing of rains based on dependence of the parameters of gamma distribution on rain intensity. The numerical simulation and experimental study shown that the proposed method allows to retrieve the profile of microstructure and integral parameters of rain with accuracy less than 15%. However, the effectiveness of the proposed method essentially depends on the reliability of the used statistical data which are tend to have a strong seasonal and regional variability led to significant measurement errors. That is why the complex using of double frequency radar (active sensing) and radiometer (passive sensing) for measurement of rain parameters is proposed in the paper. The sufficiency of this approach is based on the different physical nature of the scattering and radiation of electromagnetic waves by rain drops, that improves informativity of the remote sensing data by increasing the number of statistically independent parameters. At that small cost of radiometer and its simple construction permit it to be easy embedded in practical usage as add-on to radar.

Model of uniform rain (drop size distribution parameters do not depend on the distance in the rain) are considered in the paper. In this case the inverse problem of active-passive remote sensing is described by system of three integral equations solution of which was done by calculus of approximations.

The numerical simulation of active-passive sensing of rain was performed for rain intensity from 0 till 30 mm/h and such values of wavelengths: 8.2 mm and 3.2 cm for radar, 3.2 cm for radiometer. Because of measurement ambiguity in solution of inverse task it is necessary to use additional criteria (proximity criterion) to choose one solution. It was shown that proposed approach allows to measure rain intensity with accuracy not more than 10%.