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# Distinguishing between mainly liquid-drop frontal clouds and clouds giving precipitation from satellite data

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The paper is devoted to the numerical simulation of microphysical and optical characteristics (including the cloud reflectance of the solar radiation) of mixed frontal clouds and the improvement of the procedure of distinguishing between mainly liquid-drop clouds and clouds of highly developed crystallization and precipitation.

The numerical simulation is based on the realistic microphysical model of a mixed stratiform cloud with several forms of crystals (needles, plates, columns).Algorithm of calculations of scattering characteristics for drops is based on the Mie theory, for crystals – on the geometric optics approximation. The Discrete Ordinate Method (DOM) was used for simulation of the solar radiative transfer in a not uniform cloud and calculation of the satellite signal ( cloud reflectance, CR).Computations were realized for the wave lengths 0.55; 1.6 and 3.6 mkm.

Calculations were realized for different variants in which the cloud top temperature T(ct), concentration and type of ice nuclei (IN) are varied.

The simulation depicts that if T(ct)< - 30. . . -35 grad C nearly ice clouds are formed in most cases and high efficiency of precipitation formation is typical for these clouds. If T(ct)> -25 grad C mainly liquid-drop clouds are forms. Calculations demonstrate that rations of the cloud optical thickness (COT) values in satellite radiometer channels 1.6 and 0.55 mkm correlate with the ratio of liquid water content to ice content of a cloud.

Calculations depict that diapasons of CR and COT for mainly liquid-drop and ice clouds with high tops almost do not overlap but these diapasons essentially overlap for clouds with low top. Therefore simultaneously determined values of COT and effective dimensions of cloud particles r(eff) are more effective parameters for distinguishing between

liquid-drop clouds and clouds of highly developed crystallization and precipitation.

Then results of numerical simulation were used for the improvement of COT and r(eff)retrieval from observed CR values in the channels 0.63 and 1.6 mkm and the development the procedure of distinguishing of cloudiness regions with the great liquid water content and regions of highly crystallization and precipitation. Some examples show that this procedure gives results which agree with ground-based precipitation data.