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Transformation of ice crystals in frontal clouds. Numerical simulation

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The analysis of particle form composition of precipitation which give frontal mixed and ice clouds shows that the contribution of plate crystals to a total sum of precipitation is comparable with the contribution of columns. At the same time microphysical models of frontal clouds with several forms of crystals give for clouds with a high cloud top height (Z∼5.7 km) a top-heavy value of columns in precipitation. Change of the form of crystals in process of their growth can be one of the reasons of such discrepancy: growth rates of side crystal faces and the axial bases of an ice crystal differently depend on the temperature and humidity.

At numerical simulation of frontal clouds such approach has been used in this paper: columns nucleate in a cloud top at temperature -25 ºC and grow in this area as columns. Transformation of cloud crystals from columnar shapes to the plate shapes can occur below an isotherm -22 ºC depending on supersaturation with respect to ice and density of crystals. Calculations were made with saving of particle numbers and masses in all intervals of the size and saving of particle streams on height.

Calculations with transformation of cloud crystals show that contribution of plates to a total sum of precipitation is almost equal to the contribution of columns. At lowering Z to 3.9 km particles of plate-type are prevail in precipitation. It has been obtained the dependence of the local optical thickness (LOT) on the type of ice crystals in ice clouds: for a cloud with mainly plates LOT in 3 – 4 times more than for a cloud with mainly columns. The same effect is observed for the asymmetry factor (G): G is smaller for clouds with mainly columns than G for clouds with mainly plates. The cloud reflectance (CR) for a cloud with mainly columns more than CR for a cloud with mainly plates (in the channels: = 1.6 and 3.6 mkm). At once maximum values of the COT for a cloud with mainly plates exceed COT values in a cloud with mainly columns nearly in 3 times.

The results of numerical simulating correlate with data of satellite radiometers.