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Simulation of microphysical and optical characteristics of frontal ice clouds

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It has been developed the numerical time-dependent model of frontal mixed, stratiform clouds with detailed microphysics description and with 3 forms of ice crystals: needles, plates, columns. The 4 kinetic equations for dimension distributions for drops and crystals are included in the equation system. The ice nucleation on sublimation nuclei and sorbtion ("condensation - freezing") nuclei as well as the metamorphosis of ice particle shapes has been considered.

In addition to microphysical characteristics we calculated all optical characteristics of cloud particles: the single scattering albedo, the coefficients of scattering and extinction, the phase functions, the cloud optical thickness (COT). Optical characteristic calculations of drops are based on the Mie theory, of crystals - on the geometric optics approximation.

We will give the main attention in this presentation on ice clouds (with the liquid water content under 0,005 g/kg).

Most often ice clouds arise when their cloud top height is above the level of 5 km and cloud top temperature is below of -35...-30 grad C. Columns are the main form in such clouds. The efficiency of precipitation in these cases is very great (the intensity of precipitation formation is equal the thermodynamical condensation rate). These clouds with columns have a not great COT - under 10 - 15.

If the nucleation rate (or concentration of active nuclei) increases, a cloud may crystallize in the case of the more lower cloud top height (cloud top temperature T $>$ - 25

grad C). Plates prevail in these clouds and the COT can rise to values of 40 - 45. The crystal concentration in ice clouds is more than 10 per litre, the modal radius of plates is equal 300 - 400 mkm, the modal dimension of columns 100 - 200 mkm.

The particular feature of optical properties of ice clouds is as follows: COT does not depend on the radiation wave-length. So this property and high values of effective radius of cloud particles form the informative criteria for distinguishing cloudiness regions with highly developed crystallization and precipitation formation.