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ABOUT THE NUMERICAL MODEL OF CLOUDS BY TAKING INTO ACCOUNT OF SOME ADDITIONAL MOMENTS OF SOLAR RADIATION

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Clouds physics as an indipendent domain was formed in a second part ofthe last centure.It was caused by a rich multiformity of itself object (thermohydrodynamics, water vapour phase transformation, microphysics, electrical and magnetic fields, an artificial influense, an aerosol spreading, ecological problems, aviation meteorology, plane electrisation, atmospherical precipitations, an influence on biological objects and so on.). If we discuss in planetar scale, clouds and fogs are responsible for water and radiation balance on earth. Let's remark that today, in an artificial satellite epoch clouds and fogs are called as cosmic objects and precipitations (rain, snow, hail) - as hydrometeors.

One of important trends of cloud physics is an influence of a solar radiation on a development of already existing clouds and fogs (later on all told about clouds can logically attribute to fogs). When solar rays fall on clouds, we have whole string of interest phenomenons [1,2]:

a) cloud and cloudless environments of an atmosphere are optical different properties having bodies, particularly, a water and an ice being in clouds absorb a solar spectr long-wave part on one order more than a water vapour being in cloudless conditions;

b) clouds water drops also absorb "deep" an ultra-violet part of a spectr (8-12 micron) which a cloudless atmosphere passes without an obstacle;

c) a water and an ice absorb spectr is continuous and one of a water vapour is linear;

d) there is a long-wave radiation scatter on a cloud water and an ice in that time when it is absence in a cloudless atmosphere;

e) there is a short-wave spectr absorbtion on a clouds water is on several orders more than in a cloudless environment;

f) the indicatrix of a light diffusion on water drops has a brightly expressed strethed form.

Taking into account of these all factors significantly complicates the problem of radiation transition in a cloudy atmosphere. In particularly, there is a temperature variation (inversion) on cloud and fog boundaries, especially, on upper and lower ones. It can be both negative and positive.

At the given stage of our study we don't research a mechanism of this inverse formation - we are only interesting in an existence this fact taking into account of which in certain approach will perfect , enrich our mesoboundary layer of an atmosphere (MBLA) numerical model.

The inversion layer stretches about 100 meters thickness inside and outside of cloud borders. We must remark that it is more importance when we hawe negative temperature variation, that is the case of cooling inversion process. As follows from aerometeorological experiments cooling is highly significantly, from 0 about to 15 grade C.

It is remarkably that as a plane fly is not secure into clouds, because experimental researches of this domain significantly is backward from theoretical ones. Naturally, this circumstance some more stipulates an importance of mathematical simulation in considerable problem.

The above-mentioned temperature inversion, in particularly, cooling process, causes an intensification of MBLA thermohydrodynamics, an condensation of water vapour, fast increasing of water mixture ratio (sometimes about in 8 times), creats favourable conditions for forming of a squall phenomenon and abruptly changes a form of clouds upper part because of a superadiabatic temperature gradient. Thus this factor, that is cooling, favours a self-preservation and self-development of clouds. Therefore, in case clouds cooling is more essential, than warming - at warming we haven't got above-mentioned anomal phenomenons.

We work at a problem of a numerical simulation of MBLA and developed clouds in it long ago. In our models clouds mainly forms because of nonhomogeneous warming of a MBLA underlying surface (heat 'islands', breeze and mountain-valley circulations) [3-5].

Naturally, we can present for consideration the above-mentioned (the temperature inversion) factor as a volume thermal source. It has mainly ephemeral character in contrast with an underlying temperature - it sometimes appears, sometimes disappears at all, abruptly changes in a time and a space. At simulating it will be taken from an experimental data.

We must ramark that this temperature inversion has a special meaning in case of fogs: it turns out there is warming process at upper boundary of fogs and cooling process at a lower boundary of one because of different optical properties. As fogs are often forming at an ordinary temperature inversion, therefore the above-mentioned warming process will promote an intensification of an atmosphere inversion. In these cases it is rise different kinds of smogs. Therefore the considered problem has also ecologically importance meaning.

Let's remark once again, in case of clouds we have both cooling and warming but more actual is cooling-process.

We must also add that the considered problem is similar to classic thermohydrodynamic ones about warming or boiling from not lower but middle or upper parts of a liquid [6]. There are some interest analitical solutions in these works, which we can use as tests for our numerical models.

We must also notice, that the given problem is very interesting from the point of view of a turbulent regime, which as a rule smoths a considered by us inversion layer. The study this question is possible by our MBLA numerical models. Most likely the research of this problem is more interesting in case of convective clouds.

Except this radiation factor (cooling and warming at clouds and fogs borders) in a frame of our MBLA numerical model it is possible to consider of second very important radiation moment. As a matter of fact it is taking into account of shades by clouds formed in MBLA: as we remarked, in our model stratus clouds develop because of nonhomogeneously of a MBLA underlying surfase. Naturally, the formed cloud is an obstacle for sun radiation, consequently a temperature of a heat 'island', or dry land (at a breeze circulation) falls down, what causes a decrease of an air convection intensity and, of course, a cloudy diminishes or at all disappears. This causes a sun radiation increase, afterward making of an air additional convection and consequently a cloud forming process. Therefore, it takes place very interesting periodical process, that is an existence of a direct- and back-coupling between of radiation and cloudform processes. Naturally, taking into account this radiation moment enriches our MBLA numerical model.

We can consider this periodical process as auto-oscillation system. Similar systems are existencing in different spheres of science and technique, f. e., the classical biological problem of 'Prey-victim', system of forest fire-rain and so on.

Certainly, it is possible to unite these both above-mentioned radiation factors in frame of our MBLA numerical model.

Now let's consider immediately initial equations described two-dimensional nonstationary problem about MBLA over thermal nonhomogeneous underlying surface taking into account cloud- and fogformation processes [3-5]:

$$
\begin{aligned}
&\frac{\mathrm{du}}{\mathrm{dt}} = -\frac{\partial \pi}{\partial \mathrm{x}} + \Delta' \mathrm{u}, \\
&\frac{\partial \pi}{\partial \mathrm{z}} = \lambda \theta, \\
&\frac{\partial \mathrm{u}}{\partial \mathrm{x}} + \frac{\partial \mathrm{w}}{\partial \mathrm{z}} = 0, \\
&\frac{\mathrm{d}\theta}{\mathrm{dt}} + \mathrm{Sw} = \frac{\mathrm{L}}{\mathrm{c_p}} + \Delta' \theta, \\
&\frac{\mathrm{dq}}{\mathrm{dt}} + \gamma_{\mathrm{q}} \mathrm{w} = - + \Delta' \mathrm{q}, \\
&\frac{\mathrm{dv}}{\mathrm{dt}} = \ + \Delta' \mathrm{v}, \\
&\frac{\mathrm{d}}{\mathrm{dt}} = \frac{\partial}{\partial \mathrm{t}} + \mathrm{u}\frac{\partial}{\partial \mathrm{x}} + \mathrm{w}\frac{\partial}{\partial \mathrm{z}}, \\
&\Delta' = \mu \frac{\partial^2}{\partial \mathrm{x}^2} + \nu \frac{\partial^2}{\partial \mathrm{z}^2},
\end{aligned}
\tag{1}
$$

where u, w are horisontal and vertical components of an air velocity, respectively, π, θ, q - deviations of a pressure analog, a potential temperature and a water-vapor mixing ratio from their undisturbed fields, respectively, v - a liquid-water mixing ratio, λ, S - parameters of an atmospheric flotation and a stratification, respectively, γ_q - a vertical gradient of an undisturbed water-vapor mixing ratio, - a rate of a water-vapor condensation, L -a latent heat of condensation, c_p - a specific heat of a dry air at a constant pressure, μ, ν - horisontal and vertical coefficients of turbulence, respectively.

Boundary and initial conditions may be written as

$$
\begin{aligned}
&\text{at } z = 0 \quad u = 0, \quad w = 0, \quad \theta = F1(x,t), \quad q = 0, \quad v = 0, \\
&\text{at } z = Z \quad u = 0, \quad \pi = 0, \quad \theta = 0, \quad \frac{\partial q}{\partial z} = 0, \quad \frac{\partial v}{\partial z} = 0, \\
&\text{at } x = 0, X \quad \frac{\partial u}{\partial x} = 0, \quad \frac{\partial \theta}{\partial x} = 0, \quad \frac{\partial q}{\partial x} = 0, \quad \frac{\partial v}{\partial x} = 0, \\
&\text{at } t = 0 \quad u = 0, \quad \theta = 0, \quad q = 0, \quad v = 0, \\
&\text{at } t = t1 \quad \theta = F2(x,t),
\end{aligned}
\tag{2}
$$

where X, Z are horizonthal and vertical boundaries of MBLA, F1(x,t) - the temperature of an underlying surface taking into account of a cloud shade, t1 - the moment of time, when an inversion temperature forms at borders of clouds or fogs, F2(x,t) - the temperature of an inversion layer. F1(x,t), F2(x,t) and t1 are the given function from meteorological experiments .

Let's notice once again that the main point of our work consists in functions F1 and F2.

The model (1), (2) is integrated numerically [3-5].

The following input physical constants and parameters, which had been the same values for all numerical experiments, are used: $\lambda = 0.033\frac{m^2}{sec.grad}$, $S = 0.004\frac{grad}{m}$, $L = 600\frac{cal}{g}$, $c_p = 0.24\frac{cal}{g.grad}$, $\mu = 10^4\frac{}{m^2}sec$, $\nu = 10\frac{m^2}{sec}$, relative humidity $f = 0.95$, $X = 80km$, $Z = 2km$.

At present we are at a stage of a numerical realisation of the problem. During simulation of an inversion layer at a cloud upper border we must consider a very strongly stable stratificired atmosphere in order to a cloud was not press to upper boundary of MBLA. In this time it is difficulty giving an inversion layer. Of course in case of fogs this problem doesn't disturb us. Let's also remark we must give an inversion temperature layer in a numerical scheme very slowly both in time and in space in order to an unstability will not arise in a numerical account.

At given stage it were conducted the first, rough numerical experiments, which suggest that at taking into account of cooling inversion near upper border of cloud, one changes its form, a water mixture ratio increases about on 0.1-0.2 g/kg, but we have not got squall phenomenon - most likely it's possible in case of convective clouds.

In respect of taking into account of a cloud shade a water mixture ratio decreases about on 0.2-0.3 g/kg because of a radiation relaxation. Autooscillation system isn't given yet.

In conclusion let's remark the numerical model satisfactorily grasps main features of the considered process. In following works this problem will be researched by further numerical experiments.

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