

THERMODYNAMIC AND ENERGY CHARACTERISTICS OF CONVECTIVE CLOUDS ON DIFFERENT STAGE OF THEIR DEVELOPMENT

Shpyg V.

Ukrainian Hydrometeorological Institute, Prospekt Nauki 37, Kiev, 03028, Ukraine, Vilal@rambler.ru

Vertical cross-sections (and distributions) of various convective clouds at different stages of their existence has been constructed with the help 3-D nowcasting model. 11 cases (38 clouds), when intensive convective phenomena were observed over territory of Ukraine, have been considered and made more than 150 vertical cross-section of these clouds.

With the purpose of calculating of height of the top border of a cloud, or convection level, height on which speed of updrafts turn into zero, we shall make an assumption, that above a level on which there is an alignment of temperatures, lifting of a particle is slowed down, but this particle continue to move upwards until the energy saved up to it in the bottom (unstable) layer will be exhausted. Apparently (see fig. 1) such assumption is meaningful and besides enables to use data concerning energy of instability for an estimation of height of the top border of convective cloudiness.

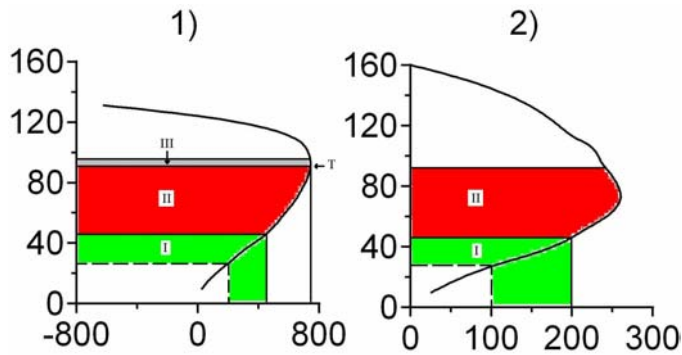


FIG. 1: Vertical distributions [E_{inst} , $J kg^{-1}$ – (1), W , $10^{-2} m s^{-1}$ – (2)] in convective cloud, vertical axis is height, hm.

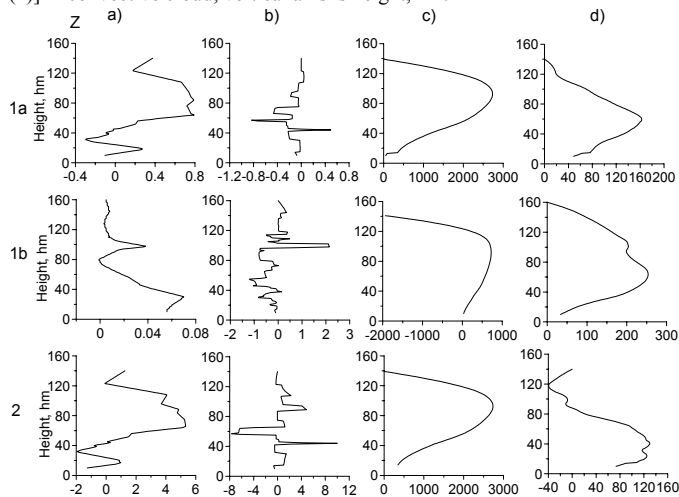


FIG. 2: Vertical distributions [Ω_z , $10^{-3} s^{-1}$ – (a), N_{zs} , $10^{-6} s^{-2}$ – (b), E_{inst} , $J kg^{-1}$ – (c), W , $10^{-2} m s^{-1}$ – (d)] in convective clouds, Z is height, hm. 1a and 1b – cloud on the stage of maximal development; 2 – cloud at the end of the stage of maximal development.

When Ω_z has negative sign and at the same time updrafts have place, N_{zs} has positive value at most of cases.

Stage	E_{inst} , $J kg^{-1}$	Ω_z , $10^{-3} s^{-1}$	w , $m s^{-1}$
initial	500-800	0.01-0.1	1-2.5
maximal development	800-3000	0.01-35.0	>2
decay	400-1000	-4.5...+0.1	≈ 1

TABLE I: Dynamic and energy characteristics of powerful convective clouds (by model calculation).



FIG. 3: Images Crimea and clouds above Crimea at 1322GMT for 22-th July 2007. Case of spouts (tornadoes)

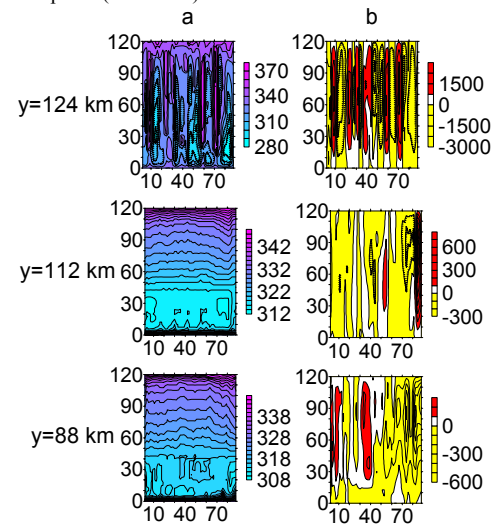


FIG. 4: Vertical cross-sections (the height is specified on a vertical scale, hm) at different Y . X is specified on a horizontal scale, km. (a) Pseudo-potential temperature, K (digits near scale). (b) Vertical motions, cm/s (digits near scale). Case of spouts (tornadoes)

Tornado had place when E_{inst} reached $2000 J kg^{-1}$ and formed in lower 4-th km layer. There was a big reduction of pseudo-potential temperature values (from 370 to 280 K).

CONCLUSIONS

The analysis of results of calculation enables to approve, that height on which there is an alignment of temperature of a particle and an environment temperature, correspond to level of maximal updrafts. Such law is characteristic for clouds at initial stage and at a stage of the maximal development.

Values of vortex velocity decrease with increase of horizontal clouds size and with increase of spatial step in model.