საერთაშორისო სამეცნიერო კონფერენცია „კომპლექსური გეოფიზიკური მონიტორინგი საქართველოში: ისტორია, თანამედროვე პრობლემები, ქვეყნის მდგრადი განვითარების ხელშეწყობა“, შრომები, თბილისი, საქართველო, 17-19 ოქტომბერი, 2024 წ.

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EXPERIMENTAL MODELING OF ATMOSPHERIC PROCESSES IN THE LARGE CLOUD CHAMBER OF THE M. NODIA INSTITUTE OF GEOPHYSICS, TSU. PAST, PRESENT, DEVELOPMENT PROSPECTS

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Abstract. *The paper presents a brief overview of studies on modeling atmospheric processes in a large cloud chamber of the M. Nodia Institute of Geophysics of Iv. Javakhishvili Tbilisi State University. Prospective plans for further development of these studies are presented.*

Key Words: *large chamber, experimental modeling, atmospheric processes*.

The ability to predict the evolution of the atmosphere over a wide range of time scales (from hours to decades), as well as active influences on atmospheric processes (hail control, precipitation induction, fog dispersion, forest fire suppression, etc.) bring enormous benefits to society. Atmospheric simulation chambers are among the most advanced tools for studying and quantifying atmospheric processes and are used to determine many parameters included in air quality and climate models, weather modification methodology, etc. In particular, more than 80 chambers with a volume of 0.1 to 270 m^3 are currently used in developed countries to simulate various processes occurring in the atmosphere and cloud environment. At the same time, a significant part of these chambers operate only in warm mode [1,2].

In the mid-seventies of the last century, a unique experimental complex for modeling various physical processes occurring both in a cloudless atmosphere and in clouds was created at the Institute of Geophysics of the Georgian Academy of Sciences. The project for this complex was developed by the Georgian State Institute of Urban Design [3].

In essence, the thermal pressure chamber is a unique giant device built into a laboratory building – a unique architectural monument (Fig. 1).

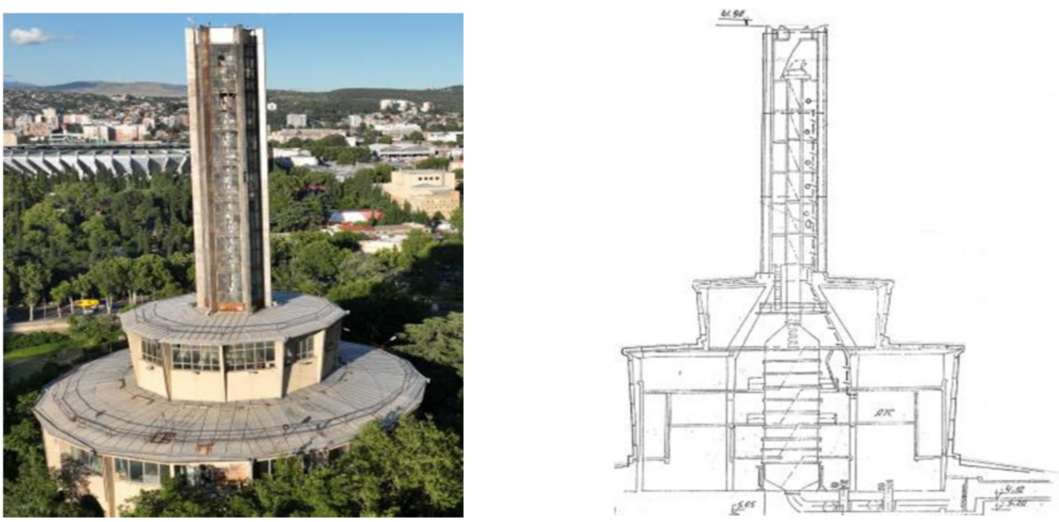

Fig. 1. Large cloud chamber. On the left – general view, on the right – diagram of the layout inside the building.

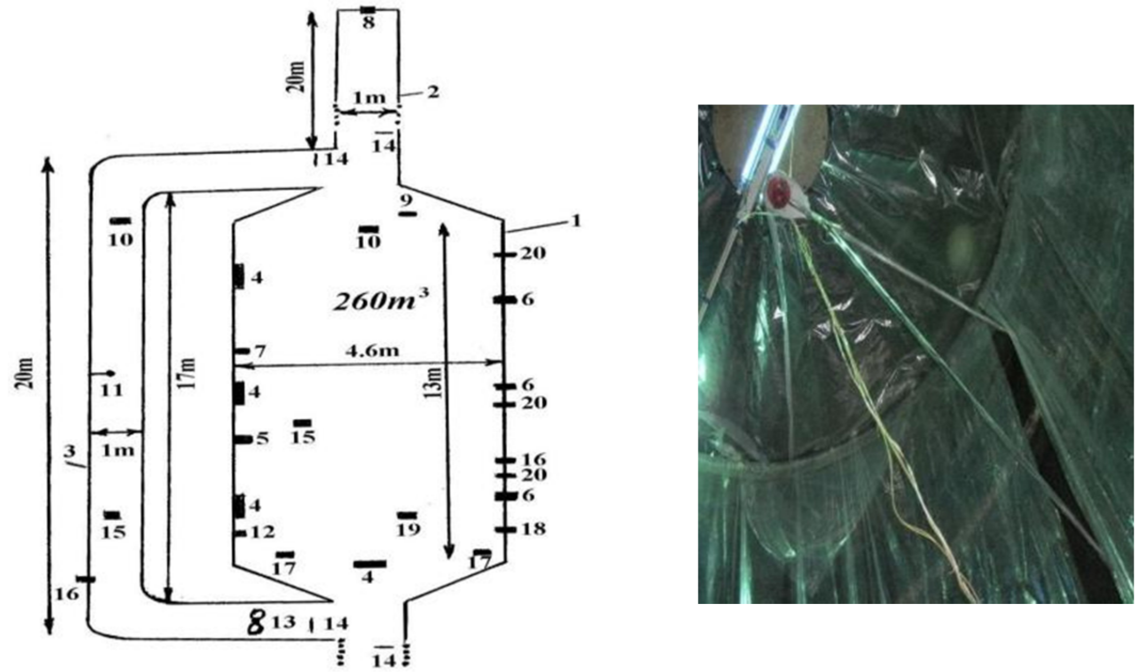

Fig. 2. Large cloud chamber. On the left – diagram of the arrangement of equipment and devices, on the right – example of the arrangement of a source of ultraviolet radiation for ozone generating.

The large cloud chamber (thermo-baric chamber, fog chamber, aerosol chamber, etc.) represents a vertical cylinder with conical bases. The volume of the chamber amounts to 260 m^3, total height – 17 m, the height of the cylindric part – 13 m, diameter – 4.6 m, diameters of two entry hatches – 0.8 m each. In the upper part of the chamber there is a central pipe (2) 20 m heigh and 1m in diameter. On the side of the chamber a vertical aerodynamic pipe (3) is connected to its upper and lower parts, which has the size of the central pipe (2). The velocity of a vertical air flow in this pipe may reach 10 m/sec. Experiments were carried out at temperatures from -20^{O}C to +20^{O}C inside the chamber. Currently the chamber is functioning in the warm mode. The chamber is equipped with various devices for laboratory experiments. In various parts of the chamber electric field measurers (4), transparency registrators (5), aerosol samplers (6), fog aqueosity measurers (7), hydrometeor (8) and large disperse aerosol (9) dropping devices with a current measurers, water dispergators (10), hydrometeor holding device with a current measurer (11), fog introducing device (12), ventilator (13), gates (14), small disperse aerosol, ozone generators (15), aerosol concentration and size spectrum measurers (16), sedimenting particle charge measuring plate (17), aerosol charge and mass measurers (18), air ionizer with a high voltage supply (19), air temperature, humidity, ozone concentration and another measurers (20), etc. are installed (Fig. 2).

In particular, the following important results were obtained based on laboratory experiments [4-19]: the consumption rates of ice-forming reagents required for further improvement of the methods for influencing hail processes were clarified; the aerodynamic characteristics of falling hailstones were clarified, which made it possible to obtain initial data for theoretical calculations of the growth and melting process of hailstones of various shapes, densities and sizes; the role of electric fields and discharges was experimentally revealed both during hailstone growth and in the heterogeneous mechanism of formation and growth of the ice phase on particles of crystallizing reagents; the laws of laser radiation propagation were studied under various conditions characteristic of the earth's atmosphere; the processes of cloud environment electrification during the interaction of droplets with coarse aerosols and ice-forming substances were studied; the properties of various reagents for regulating thunderstorm activity of clouds were studied; the processes of aircraft elements electrification in a simulated cloud environment were studied; tests of disk generators of monodisperse droplets were conducted; the processes of washing out aerosols by artificial raindrops were studied; work has begun on developing methods for creating smog ozone and actively influencing it in order to reduce ozone concentrations

It should be noted that in the eighties of the last century, the thermal pressure chamber had the status of an international laboratory within the framework of the CAPG (Commission for Multilateral Cooperation of the Academies of Sciences of Socialist Countries on the Complex Problem of "Planetary Geophysical Research").

In the future, the following studies are planned:

– Modeling of soil erosion processes;
– Modeling of slanting rains on buildings and structures [the work has begun, 20];
– Development of new and improvement of existing methods for creating various aerodisperse systems (neutral and charged fogs, aerosol formations, etc.);
– Modeling of the processes of formation and evolution of photochemical smog;
– Modeling of the processes of the impact of ionizing radiation (radioactive, cosmic, electromagnetic) on the transformation of microphysical and electrical characteristics of clouds;
– Modeling the influence of a complex of various meteorological and geophysical parameters (electromagnetic fields and radiation, ozone, meteorological elements, etc.) on living organisms and plants;
– Development of new and improvement of existing methods of influencing harmful characteristics of the atmosphere (dispersion of warm fogs; purification of air from aerosol and gas impurities; protection of living organisms and plants from high concentrations of ozone and levels of electromagnetic fields and radiation, including ultraviolet, etc.);
– Improvement of precipitation control methods.

The issue of restoring the previous functions of the pressure chamber for modeling atmospheric processes at negative temperatures using appropriate modern cooling equipment is being considered.

It is also planned to train specialists in the field of experimental atmospheric physics, as well as to improve the qualifications of interested persons in this field of science.

It is also planned to use the resources of this facility to conduct various educational and cognitive activities.

Considering the importance of the above studies, under appropriate conditions of state support, the possibility of participating in international projects and obtaining the status of an international laboratory is not excluded.

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