Complex airborne system with combined action on the conditions of risk weather phenomena

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Abstract: *The study of the weather phenomena is one of the main concerns of scientists. Initially, the researches in this area were intended to provide military structures new ways of fighting in wars such as the wars in Korea or Vietnam and then continued with the development of technologies to combat the phenomena that affect the normal conditions of agriculture, the environment, etc. -extreme phenomena- hail, low precipitation regime, etc. Since the last decade of last century also in Romania there were a number of initiatives supported through a national program of research in the fight against hail and stimulation of precipitation. In this context, INCAS proposed in 2008 a research project to implement a complex airborne system, which carry out actions to limit the effects of extreme weather events on crops and objectives of national and strategic interest, on the basis of information received from a system of sensors located on the air platform and intended for measuring the physical characteristics of the atmosphere. Also, as a long-term effect, the action of the complex airborne system may lead to the rainfall regulation and control, with all the implications arising from this (avoiding flooding, providing protection from frost of autumn crop, etc).*
The aerial platform chosen for this research approach is the aircraft for school and training IAR99 SOIM, INCAS being the author of its structural design and also holding the patent for Industrial Design nr.00081 registered with OSIM. Project acronym : COMAEROPREC.

1. INTRODUCTION

In order to combat the effect of extreme weather events on crops and objectives of national and strategic interest the achievement of a complex airborne system was proposed which can

carry out actions of clouds seeding to avoid hail or to stimulate the precipitation, either as rain or as snow. This complex system consists of the following units:

- the air platform IAR99 SOIM;
- sky-rocket multiple-launchers;
- active elements (missile, tracers, weather radar);
- passive elements (sensors for the measurement of physical characteristics of the atmosphere)

Such of concerns stimulate the strong interest of the researchers around the world, due to the increase of the weather phenomena induced by the climate change in the last decades and also to the efforts to improve their effect on the life and food safety of the population.
Among the main characteristics of the complex airborne system we mention:

- action with maximum efficiency and in short time on nuclei of hail in process of formation, environmental monitoring, stimulating the rainfall from clouds when according to the atmospheric conditions analysis it appears that the precipitation would not occur naturally.
- achievement of mechanical-electronic functional interfaces between components of complex airborne system, shaping of the flight paths of the aerial platform and active components (missiles, cartridges containing AGI) along with the possibility of measuring the effect of active substances on cloudy formations (including those of pollutant nature).

As an interdisciplinary project, there will be studies and experimental researches in areas like interior and exterior missile ballistic, (in case of missiles utilization), thermo chemical combustion in cartridges with an active agent of atmosphere influence, atmospheric physics specific data acquisition, electronics, computational methods. The research results will have a significant impact both in the development of scientific knowledge in the field, because of their novelty at the national level but also in producing trade and economic effects on short and medium term, as for instance reduction of losses due to extreme weather events (hail, drought) and, of course, regularization of the medium-term rainfall regime in targeted areas. The project will developed over a period of three years and will be finalized through a technology demonstrator, which will underpin the future development of serial products and also an application for patent will be filed. The project is aligned to European concerns in the field and creates competences leading to its inclusion on the list of the European atmosphere research projects -FP7.

2. MAIN ACTIVITIES OF THE PROJECT

The approached topic is a novelty on the national level. The objectives and the envisaged solutions are not restricted to the fight against hail or to the stimulation of rainfall. Indeed, many of these solutions can be easily adapted for other applications helping to understand the climate changes and leading to a better regional organization of civil defense and disaster prevention. Given the multidisciplinary nature of the project themes, the following contributions to the development of knowledge in the field can be mentioned:

1. Aerial platforms utilization to monitor weather phenomena and to limit the damaging effects
2. Compatibility of an aerial platform with the specific requirements of its utilization to influence the atmosphere and to study the weather phenomena
3. Development of rocket engine design methods and of pyrotechnic means for cloud seeding, along with the development of methods for their testing

4. Development of software intended to calculate the flight trajectories of missiles launched from the air carrying platform
5. Design and implementation of a complex analysis system for cloud physics and anti-hail along with development of prediction computational methods through statistical analysis
6. Development of new operation algorithms intended to discover and influence the areas of potential risk (e.g., hail or heavy rain) and those with optimal conditions for producing artificial rain (in case of drought).

3. GENERAL OBJECTIVES OF THE PROJECT

a) Analysis, development and testing of the operation algorithms for the complex airborne system components in the context of heavy weather, by:

- patterns drawing for the flight of the air platform working on cloudy formations located at different altitudes and atmospheric conditions (temperature, wind); definition of the flight equations for the complex airborne system;
- design and verification of the software for analysis and forecasting of weather fronts evolution on a statistical basis,
- establishing the required procedures to influence actively the cloudy formations.

b) Design and manufacturing of the complex system components, by:

- definition of the complex airborne system architecture and technical specifications for its components;
- design (redesign) of the assemblies and of the mechanical-electronic interfaces air platform- missile launcher- weather-sounding equipment (atmospheric parameter detection system and attached sensors);
- management in case of lack of ground information about the evolution of the atmospheric front;
- achievement of the experimental model for the assemblies of the complex system;

c) Testing the components of the complex airborne system under static and dynamic conditions; acceptance of the experimental model- the technological demonstrator, by:

- developing testing programs for the subassemblies and for the general assembly;
- design and execution of the auxiliary equipment for testing;
- setting the location for testing in dynamic regime, information acquisition, analysis and processing;
- performing testing and issuing the endorsement certificate.

4. SPECIFIC OBJECTIVES OF THE PROJECT ARE THE FOLLOWING:

- achievement of a complex airborne system with combined action on extreme weather phenomena, such as rain or hail;
- cloud data acquisition (before and after using the active elements), transmission and remote processing at ground in order to improve the operation algorithm.
- achievement of the functional mechanical electronic interfaces of the complex system components, by shaping the flight paths of the air platform and other components of the complex system, and also, by modeling the behavior of the cloudy formations (including pollutants) under the action of the active agent of influence;
- application for a patent.

5. CONCLUSIONS

One of the main achievements of researches which is an absolute priority in the field is the utilization of air-air missiles specifically designed to combat the extreme weather. The completion of the research has the following effects:

* Economic effects:
  - Protect the agricultural crops (e.g. vines and fruit trees) that will keep the production unchanged in time;
  - Increase the grain production in areas affected by drought.
* Financial effects:
  - Reduce compensation to be paid to farmers for land damaged by hail;
  - Reduced personnel cost for technical maintenance and missions preparation.
* Scientific effects:
  - Atmosphere control and research;
  - Increase competitiveness of the research team members (which include also young people) and attract final year students of the prophile faculties to the research domain;
  - Create competence- for setting consortiums to participate in auctions of internal research plans (sectorial, national, etc.);
  - Create opportunities for an international collaboration in research projects as for instance the FP-7 program;
  - The project is aligned to the current trends trying to limit the effect of the extreme atmospheric phenomena, as a result of a more general tendency to modify the weather. Therefore, this project can lead to a development of a technological niche in Romania.

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