Geophysical Research Abstracts
Vol. 21, EGU2019-6129, 2019
EGU General Assembly 2019

On the way of searching possibilities of stimulation local atmospheric convection and aid formation of clouds

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The role of atmospheric convection is difficult to overestimate. It is the main factor leading to the development of rain clouds. Convection helps to disperse aerosol smog, fogs, warm and cold islands, etc.

In this regard, the creation of artificial convection of a local scale, capable to penetrate the weak layers of inversion in the near ground atmosphere is a promising direction.

But the greatest scientific and practical interest in such technologies is chained to the problem of creating artificial clouds. Two thirds of the world's population living in regions with arid and semi-arid climate is experiencing an acute shortage of fresh water. According to forecasts of the World Meteorological Organization in the coming decades, this situation will be exacerbated.

This direction is not new. Even in ancient times, people inflamed giant fires with the aim of causing rain. In the middle of the last century, scientists in France, Russia, and other countries conducted experiments called "meteotrons" in which tens and hundreds of gas and oil burners and vertically oriented jets produced by aviation engines were used to heat the air in some layer of atmosphere. In some cases, these methods really led to the formation of powerful clouds. There are cases when intensive military operations also led to the development of heavy rain. In addition, nature itself often demonstrates such a possibility of the formation of such clouds above volcanic eruptions, forest and other wild fires, called as pyro-convective clouds. In some cases thunderstorms, rain, hail and even tornadoes were recorded in such clouds.

Our project supported by the United Arab Emirates Program for Rain Enhancement Science [grant number APP-REP-2017-02120] is aimed at finding more environmentally friendly and energy-efficient ways to heat the lower atmosphere using solar radiation to stimulate artificial convection and cloud formation by a) the creation of an aerosol layer with particles of optimized size, which will effectively absorb visible solar radiation, and b) the raising of a garland containing a set of the black 'toroids' filled with helium. At each tier, the blackened surface is heated directly by the Sun and transfers its heat to the surrounding air by convection.

A set of numerical experiments of the artificial convection was already carried out on the 3D computational fluid dynamics package suites "FlowVision" and "ANSYS" accounting different vertical profiles of wind speed, temperature and humidity of the ambient air.

According to preliminary theoretical modeling, the most favorable atmospheric conditions for creation of artificial convective clouds include the existence of a surface atmospheric layer with relatively low windspeed, high relative humidity, and increased instability above the cloud condensation level. Also important is a shallow surface temperature inversion (which usually constrains the development of natural clouds).

The preparation of a technical base for conducting full-scale experiments on the creation of thermal convection has begun. The measuring complex includes meteorological station, pyranometer, thermograph, aerosols counter, weather drones and other instruments. Experimental field campaigns are planned for 2019 and 2020.