

Cloud seeding in Libya

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1. Abstract

Weather refers to the state of atmosphere at a certain geographical place and period of time. It is described in terms of many meteorological variables or elements such as dry and wet temperatures, wind speed and direction, precipitation and many others, while meteorology is the science which studies weather conditions and all the atmospheric process and its impacts or influences on our life in general.

Although weather events and phenomena such as precipitations are needed in our life, weather may be considered one of the natural disasters which bring heavy rains, floods and strong winds lead to destroy, death, and economic losses when it occurs in some regions of the world.

In addition, rainfall is one of the most meteorological elements and weather indicators to measure the wet seasons to be used in agriculture to plant a variety of food crops needed for both human and animal.

In dry regions, weather modification could be a practical or operational solution to produce more precipitation to overcome the shortage arises. In this regard "meteorologists have concerned themselves with the development of means for increasing rainfall. Although techniques presently available are not at all likely to lead to a significant change in the water budget of the earth as a whole, there are indications that it may be possible to produce small but important changes in the clouds and precipitation over limited region." (Battan, 1965)

This paper defines weather modification and will highlight some points and stages of the Libyan cloud seeding as a weather modification experiment for increasing rainfall.

2. Weather modification

Weather modification is defined as "any change in weather that is included by human activity. This activity may be either intentional or inadvertent." (Moran & Morgan, 1994, 193)

The concept of weather modification has appeared so far in the past, that human has tried to change weather by different ways, especially the efforts done to bring rainy clouds to drought regions, or increase the rainfall rates in the semi-arid areas.

Although measuring some physical changes in clouds that occur due to the seeding, many questions still need to be answered. Can we move the rain from a place to another? what is the influence on water budget? does the increase of rainfall in a place results a decrease elsewhere? And more in general can the weather modification be controlled? (Wegman & DePriest, 1980)

However, recently, weather modification program referring to the cloud seeding experiments, that are carrying out for different purposes such as :

1 – Precipitation enhancement :

In this program a comprehensive research of cloud physics characteristics and climatology, to examine its ability to be treated by some chemical agent materials such as silver iodide (AgI) to produce more rain than normal.

2 – Hail suppression :

Hail is a kind of precipitation which has been occurred associated with sever thunderstorms in some areas.

Hail suppression operations stop the growth and developing of raindrops in the hail storm, and break it down to fall in liquid form not as a solid precipitation (hail).

3 – Fog dispersion :

Fog is defined as a very low layered cloud, mainly stratus type, which reduced the vertical and horizontal visibility. Cloud seeding operations are carried out to make these clouds disspread and clear the sky. These operations usually conducted in the aviation civil aerodromes and or military air force bases airports where the flight operations do not need to stop anytime especially in the early mornings.

3. Cloud Seeding in Libya

Clouds are the most related meteorological element to precipitation which is the main source of water in the earth, with many other phenomena. Clouds are very important in weather modification programs which study the cloud type, its average age, origin formation and movement.

For example, fog which is very low layered clouds could be studied in a certain area in terms of occurrence days number, intensity and other parameters to launch a fog collection program to develop the scientific research in this field and find the possibility to use it as a source for fresh water.

Mediterranean region is one of the complex cloud formation places in type, age and movement in the world due to the unique Mediterranean cyclogenesis, and that is why there is a need to carry out more research on this subject and the related aspects of cloud formation in this region to find out its effects, ability to be treated and modified to produce more rain than in the normal conditions.

Libya is located at the Mediterranean region with the longest coastal line which is about 1900 km, the place which considered to be very near to the cloud formation and cyclogenesis process affecting all the area. Water resources in Libya is very limited and thus water is very valuable. Due to developing activities in Libya during the last three decades, demand on the water supply has increased dramatically to meet industry, agricultural and population requirements, and once Libya has no rivers, lakes nor heavy precipitation areas, rainfall is considered the main source for ground water, but this rainfall is variable and unreliable in terms of amount, intensity, distribution and time of occurrence as shown in figure (1).

For these reasons department of meteorology in Libya has become very concerned to help in this sense and has decided to conduct a cloud physics study to serve as a guide for weather modification and cloud seeding project, especially when the amounts of moisture and cumuliform clouds pass through the atmosphere over the Libyan coastal line, without producing good amounts of rain were realized and identified.

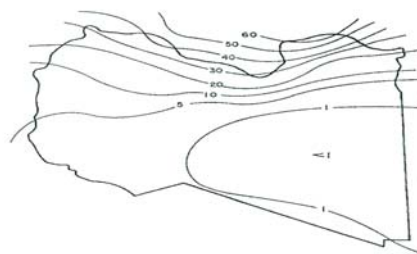


Figure 1 average annual number of days with ≥ 1 mm. Precipitation for Libya

4. Objectives and goals of cloud physics studies in Libya

The scientific committee which was nominated by the Libyan meteorological department and the related national institutions to set the objectives and goals of the cloud physics programme in Libya decided to conduct and stimulate an experiment for more understanding of the physics process of the clouds over the country and encourage Libyan scientists to participate in research relevant to weather modification activities. Also it considered participation in regional and an international work by doing this kind of research especially in an arid and semi arid regions will be very helpful in this field to explore the possibility of obtaining a cheaper and more reliable source of water. In addition of that, it considered cloud seeding programme a further step to transfer the sophisticated technology of weather modification for rain augmentation to this region of the world.

5. Benefits

Rainfall enhancement through cloud seeding in Libya results in direct and indirect benefits. The anticipated benefits of cloud seeding are summarized to be the possible increase in surface water supplies to meet urban, industrial and agricultural demands, the potential increases in the volume of ground water stored due to increased rainfall with the potential increases of economic benefits through increased crop production, employment and improved standard of living, in addition of the possible increases in vegetation resulting from increased rainfall and runoff, leading to improvement in grazing. Another benefits are introduced to be the improvement of forest areas for recreational purposes, and development of variety of new industries as a result of establishing more dependable water resources, with many other socio economic impacts

resulting from increase of rainfall and various impacts resulting from increased economic activities.

6. History of Cloud Seeding in Libya

Libya has a Mediterranean climate which is very hot and dry summers and mid-winter rainfall maximum. This maximum decreases in intensity quite rapidly south toward. Rainfall in this arid area is quite variable and can not support any agriculture activities.

As (Al-Fenadi,1999) has pointed and explained that :

any increase in the frequency and total amount of rainfall, which might result in a widening of the agricultural coastal strip, would be extremely beneficial to the entire Libya. It was for this reason in October 1971, Sierra Research Corporation (USA) signed a contract with the Ministry of Agriculture and Agrarian Reform to conduct seeding experimentation over selected areas of Northern Libya, which begun actually in November 1971. Depending upon this experiment results operations of cloud seeding experiment has conducted and continued since November 19,1980 in Tripoli at the North of Libya, then it was extended in 1981 to Sirt and El-marje sites to cover all the coastal area of the country.

7. Facilities and Equipment

Libyan sites for cloud seeding operations are located along the costal line and equipped with all the required and necessary modern facilities needed to carry out the seasonal operations which start in October till March the year next.

Tripoli site is equipped with a Mitsubishi C-band radar mounted on a 30m tower, complete with Plan Position Indicator (PPI) which displays the horizontal plan view of the precipitation echoes and is used to determine the location of the clouds relative to the radar site, thus their location can be verified relative to the target area. With this display, we can determine the location of the cloud areas as well as their movement through measurement of sequential positions, and with Range Height Indicator (RHI) which displays a vertical cross-section of precipitation echoes at selected azimuth.

Sirt site which is located about midway between Tripoli and El-Marje sites equipped with an Enterprise C-band radar, it is also capable to PPI and RHI displays, the data was logged and displayed using a mini computer. And another Enterprise C-band radar was located at El-Marje site. Concerning the weather radars, it was felt that more study of the available radar data is needed especially processing the digital radar data.

Two aircrafts were utilized for cloud seeding operations : one twin engine Cessna 402 and the second is turbo -charged piper Navajos. The aircrafts were equipped for instrument flight rules (IFR) , including colour weather radar and de-ice boots. They were modified for cloud seeding operations by the addition of two racks of dispensing (Agl) flares mounted on the underside of each aircrafts. Airborne data system to measure and record critical atmospheric and cloud physical parameters such as Ice Particles Concentration (IPC) , liquid water content (LWC) of clouds, air temperature, dew point temperature.

At the three operation sites two VHF transceivers are installed at the radar consoles to provide communications between the aircraft and radar controller in addition to telephone facilities.

8. World Meteorological Organization efforts on weather modification

World Meteorological Organization is the father of meteorology and of course weather modification programs. It announced to establish the Mediterranean regional centre for precipitation enhancement in Italy to encourage the countries in the region to launch their weather modification programs to increase the rainfall.

Libya has supported the establishment of the regional centre and submitted a documented proposal to grant the use of its physical space to carry out a regional weather modification experiment or program, and provide the regional centre with installations and equipment, such as an aircraft with cloud seeding specifications in Libyan operations, cloud seeding pilots, radiosond station, cloud seeding weather forecasters, meteorologists, Agl flares. Also Libya announced to participate in a work team to carry out a regional experiment in Libya or in one of the region member countries, and to host and organise a weather modification workshop or conference for the region member countries.

9. Evaluation and results of cloud seeding

Evaluating weather modification programs and cloud seeding projects which has been carried out in many countries is to answer many questions about the positive results of cloud seeding work, and if it has achieved any physical success or not. In this regard the findings of one of the experiments which has been carried in Florida (USA) were very positive and encouraging. It resulted a 25% increase in rainfall when the clouds were seeded by silver iodide. (Moran&Morgan,1994, p177)

Also in Libya the experiment results has referred to a certain change to the cloud characteristics and a limited increase in rainfall amounts in the selected clouds for that experiment. However, still there is a need to find out if the new generation can provide visual evidence of the experiment results that can be accepted by the scientific community and used as confirmation of the success or failure of cloud seeding.

To answer such question like this, thinking about the visual and statistical evidences is very important. If we look to the matter in the Libyan project particularly, it is clear that weather radar survey and satellite images of the modified clouds that took place afforded enough evidence at times, and were supported by scientific explanations which proves the effectiveness of the cloud seeding experiments carried out.

10. Conclusion

It seems that operational and research systems of weather modification and cloud seeding work effectively in some regions of the world and in Libya as well.

However, a lot of research and modern and advanced evaluation methods are recommended to be taken to improve this scientific effort to bring more better results.

Moreover, weather modification and cloud seeding as has been described above are very big and difficult issues, therefore scientists and experts in this field should be encouraged to modify the rout of this science. This would open the opportunity to discover and apply alternative methodologies which could produce objective evidence of the effects of seeding, and any successful achievements would contribute to the development of cloud seeding technology which could help other semi-arid regions of the world

and that would be a contribution of world wide importance.

Hopefully, the establishment of the Mediterranean centre for cloud seeding for precipitation enhancement will make all governments in the region to pay more attention to the water shortage problem in this region, and consequently give it the required concern to fund all the research and operational programmes applied to use all the different resources to increase any additional amounts of fresh water in the region. Finally any increase in rainfall by cloud seeding may present an opportunity toward meeting the future water demand in the arid regions.

11. Bibliography

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