

AEMET on climate manipulation

The issue of rain-stopping planes is a recurring topic. Many people ask for AEMET's opinion. Others accuse AEMET of being behind it all. That is why we believe it is necessary to share our knowledge on this controversial issue.

Does the phenomenon of rain-suppression aircraft really exist? What does the technique involve? What types of compounds are sprayed? At what distance are they sprayed?

AEMET does not have the authority to investigate whether flights are carried out with the aim of seeding clouds to prevent precipitation and make them disappear, so we do not know whether such activities are carried out.

If so, there is no physical basis for the evaporation of water, hundreds of thousands of tons of water for a mediocre cloud system of about 1000 km³ that could generate precipitation. In this regard, artificial weather modification activities in more than 50 countries, on which the World Meteorological Organization (WMO) Committee of Experts reports periodically, aim to modestly increase the amount of precipitation, reduce associated damage and the size of hailstones, and disperse very localized clouds at certain airports or major highways. These measures are based on developing technologies and are still trying to establish a solid scientific basis. Furthermore, it is very difficult to validate the results of the different techniques, as it is impossible to know exactly how much precipitation or hail a cloud system can generate, and the results of seeding would fall within the margins of uncertainty associated with these atmospheric phenomena. Therefore, the WMO recommends being very rigorous in the planning and evaluation of experiments so that the results can be considered valid.

In cloud seeding, microscopic particles measuring 10-3 mm with hygroscopic (high affinity for water) or glaciogenic (allowing the formation of microscopic ice crystals due to their ice-like molecular structure) properties are introduced. These particles are introduced from the ground using rockets or from the air. The basic idea behind this technique is to take advantage of microphysical sensitivities, so that a relatively small, artificially induced disturbance in the system can significantly alter the natural development of atmospheric processes. In short, cloud droplets become unbalanced, which accelerates and promotes their growth within the cloud through various mechanisms.

which promotes the formation of precipitation particles that eventually fall from the cloud. The use of different types and sizes of seeds depends on the type of cloud to be seeded.

Seeding is usually done from below to take advantage of the updrafts that are often present below the base of the clouds.

While the specific quantitative effects of cloud seeding have not been proven, the unintended consequences of artificial weather modification, such as the effects of downdrafts and the impact on the environment and ecology, are unknown.

In the specific case of reducing the size and damage caused by hail, silver iodide is often used as a crystal-forming seed, with the most important physical hypothesis being beneficial competition (the creation of many precursor nuclei for hail particles that compete for submerged water). Although progress has been made, the WMO notes that knowledge of thunderstorms is still insufficient to predict with certainty the effects of seeding on hail suppression or size reduction.

In any case, Spanish legislation, aware of the importance of this issue, has established very clear procedures to regulate any type of measure aimed at artificially modifying the climate.

The idea of artificially modifying the climate with the aim of reducing rainfall is a recurring theme, especially during periods of drought that are so characteristic of the climate in many areas of Spain, particularly in the east and southeast of the peninsula.

If we take the data from several decades of rainfall series, we can see that in an area such as the Region of Murcia, where the presence of small aircraft and the use of other techniques to prevent rainfall are constantly reported, there are no statistically significant trends in annual rainfall, suggesting that interannual variability is very high and that we are within that natural variability. The southeast of the peninsula has always been the least rainy area in Spain and probably the place with the least rainfall in Europe: Cabo de Gata.

The reasons are very natural. On the one hand, it is important to note the general circulation of the atmosphere and the orography, which protect this area from the cloud fronts coming from the Atlantic, which, after crossing the foothills of the mountains, arrive very weakened in the east and southeast of the peninsula.

Is there such a thing as geoengineering?

The term “geoengineering” is used to refer to a wide range of techniques, including those described above that aim to increase rainfall, reduce hail size, and disperse fog. It also includes experiments designed to counteract the rise in temperature associated with climate change. The goal is to manipulate the climate to reduce two main factors: fluctuations in solar radiation and increased CO₂ emissions, in order to mitigate rising temperatures. These techniques suggest theories that aim to reduce solar radiation on the Earth's surface by increasing the albedo or reflectivity of the surface or atmosphere. This second group of techniques would have an impact at the regional or even global level.

Experiments have also been conducted in cities near the poles to provide light during winter nights, using satellites that reflect sunlight toward the Earth's surface using sails.

When and who discovered it?

Humans have always tried to modify the climate to increase water resources and mitigate adverse weather conditions.

Since the late 19th century, scientifically based experiments have been conducted around the world to meet water demand, attempting to increase rainfall by manipulating clouds.

The Dutchman Veraart obtained some positive results in 1930 with solid carbon dioxide (dry ice), so he can be considered the first precursor of artificial rain stimulation, but he was

unable to explain the physical basis of his experiment. In the early 1940s, Findeisen demonstrated the possibility of stimulating rain and combating hail and ice formation on aircraft (icing). Between 1942 and 1944, he conducted several flight tests that earned him the title of father of artificial weather modification. In 1946, Americans Langmuir and Schaefer succeeded in generating rain by inoculating CO₂ and, with their experiments and trials, contributed to the understanding of the mechanisms of precipitation formation. At the end of the same decade, the American Vonnegut discovered that silver iodide or lead iodide are effective ice nuclei, although he also pointed out the difficulties of the practical application of these techniques.

When was it implemented?

In the early 1960s, the US federal government's National Oceanic and Atmospheric Administration (NOAA) began conducting experiments and funded campaigns such as Project Stormfury, which aimed to reduce the intensity of hurricanes through seeding. This project continued for two decades, despite criticism from countries such as Cuba, until it was recognized that seeding had no effect on hurricane behavior.

When did the first phenomena occur in Spain?

In addition to frost protection, which was traditionally achieved through the use of blowers or crop irrigation, the most important project in Spain was carried out in the Duero basin between 1979 and 1981, planned and executed by the WMO under the name "Precipitation Intensification Project" (PIP).

Only the first phase of this experiment was completed, and the results were disappointing and impractical. The most important conclusion was that a deeper understanding of the physical processes of clouds and the structure of cloud systems is necessary before undertaking new research or operational projects.

Which regions are most affected and why?

In all regions where adverse weather events frequently occur that negatively affect certain economic activities, such as prolonged droughts, fog, hail, lack of snow, etc., there are initiatives that, logically, seek to counteract the effects of these weather conditions. There is currently an indisputable link between regions experiencing below-average rainfall and the search for solutions.

What role does the AEMET play and what is the MAGRAMA's position on this issue?

As far as the Ministry of Agriculture, Food, and the Environment is concerned, its position on this issue, through the AEMET, is based on the periodic reports of the WMO, which, through its group of experts in research in this field, summarizes in its latest report the most rigorous scientific conclusions on the subject of artificial climate modification:

It should be noted that the energy associated with weather systems is so great that it is impossible to create cloud systems that produce precipitation, change wind patterns to bring water vapor to a region, or completely eliminate extreme weather events. Artificial climate modification technologies that claim to achieve such broad or extraordinary effects lack a

solid scientific basis (e.g., anti-hail cannons or ionization methods) and are not scientifically credible.

AEMET is also willing to advise interested organizations, participate in forums where the current state of the art is accurately presented, and collect information on these activities, which may be of interest to some users in certain fields of activity.

What types of companies, groups, institutions, or authorities could be behind this phenomenon?

If we ask ourselves what types of associations or organizations are most interested in promoting these activities, they are mainly farmers' associations, chambers of agriculture, water resource managers, etc.

A few years ago, measures were proposed to increase rainfall in the northern mountains of Madrid and, with that, increase water resources. However, these measures were ultimately not implemented.

Which countries are leaders in this technology? You mention China. What level are they at, and does this have anything to do with the Olympic Games?

China is, in fact, one of the most active countries in the field of artificial weather modification, due to the magnitude of the economic and human resources it has devoted to this activity, with the support of the Chinese meteorological service itself. Artificial weather modification projects in China focus on increasing rainfall, suppressing hail, and dispersing fog. Virtually all provinces have an operational or research program on artificial weather modification. In addition to China, the United States, Thailand, and India are the leading countries in terms of investment in artificial weather modification programs.

We do not have specific information on whether artificial climate changes occurred during the Olympic Games, although one of China's leading experts in this field, Professor Xiao Gang of the Institute of Atmospheric Physics at the Chinese Academy of Sciences, states: "We should not rely too much on artificial measures when it rains or snows, because there are too many uncertainties in the sky."

How can the spread of these substances in the atmosphere affect health?

Although some of the substances used, such as silver iodide, are toxic and harmful to the environment, the amounts used in artificial rain enhancement programs are very small. For example, according to WMO reports, one gram of silver iodide, which is supposed to be widely distributed in the cloud, could produce 1 l/m² of precipitation over an area of 1,000 km² in the absence of other nuclei. It is estimated that annual cloud seeding worldwide accounts for 0.1% of the amount of silver iodide released into the atmosphere as a result of human activity in the United States.

However, as mentioned above, the WMO points out in its latest report on the state of artificial climate modification that, although the unintended consequences of artificial climate modification, such as the effects of downdrafts and the impact on the environment and ecology, are unknown, they cannot be ruled out.

We would like to reassure society once again by pointing out that current legislation in Spain, both at the state and community levels, establishes a series of procedures that provide for the necessary controls and authorizations for any type of artificial climate modification that uses products or forms of energy with properties that are potentially harmful to health or have an impact on the environment.