

World Meteorological Organization

EC-LX/Doc. 4.2(2)

EXECUTIVE COUNCIL

Submitted by:

President of CAS

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Agenda Item:

4.2

Expected Result: 7

**ENHANCED CAPABILITIES OF MEMBERS TO PROVIDE AND USE
WEATHER AND CLIMATE, WATER AND ENVIRONMENTAL
APPLICATIONS AND SERVICES**

**Update of WMO Weather Modification
Statement and Guidelines- CAS**

SUMMARY

ISSUES TO BE DISCUSSED:

Update of WMO Statement, Executive Summary of Statement and Guidelines on Weather Modification by CAS

ADDITIONAL FINANCIAL IMPLICATION:

None

DECISION/ACTION REQUIRED:

Adoption of the draft text for inclusion in the general summary of EC-LX given in the Appendix.

REFERENCES:

1. Abridged Final Report with Resolutions of Cg-XV (WMO-No. 1026)
2. WMO Statement on Weather Modification and WMO Guidelines for the Planning of Weather Modification Activities (EC-LX/INF. 12)

CONTENT OF DOCUMENT:

Appendix for inclusion in the final report:

Draft text for inclusion in the general summary of EC-LX

Appendix for information:

EC-LX/Rep. 4.2(2): Progress Activity Report

DRAFT TEXT FOR INCLUSION IN THE GENERAL SUMMARY OF EC-LX

4.2 ENHANCED CAPABILITIES OF MEMBERS TO PROVIDE AND USE WEATHER AND CLIMATE, WATER AND ENVIRONMENTAL APPLICATIONS AND SERVICES (*agenda item 4.2*)

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Update of WMO Weather Modification Statement and Guidelines - CAS

4.2.39 Acting upon the request by Cg-XV (paragraph 3.3.1.6) that CAS present to EC-LX in 2008 its decision on updates to the “WMO Statement on Weather Modification (including an Executive Summary)” and the “WMO Guidelines for the Planning of Weather Modification Activities”, the Executive Council approved the process leading to the revised document given in the annex to this paragraph as proposed by CAS. Considering the rapid advances being made in cloud/precipitation research and observational technology instrumentation, it recommended that CAS implement a regular review of these documents through the Expert Team on Weather Modification. It also requested that the most up-to-date documents are presented at CAS-XV in 2009.

Annex to paragraph 4.2.39 of the general summary

EXECUTIVE SUMMARY OF THE WMO STATEMENT ON WEATHER MODIFICATION

- Purposeful augmentation of precipitation, reduction of hail damage, dispersion of fog and other types of cloud and storm modifications by cloud seeding are developing technologies which are still striving to achieve a sound scientific foundation and which have to be adapted to enormously varied natural conditions.
- Operational programmes in fog dispersion, rain and snow enhancement and hail suppression are taking place in many countries around the world. The primary aim of these projects is to obtain more water, reduce hail damage, eliminate fog, or other similar practical result in response to a recognized need. Accomplishment of the stated goals is often difficult to establish with sufficient confidence. Economic analyses show that rainfall enhancement and hail suppression operations, if successful, could have significant economic benefit, but uncertainties make investments in such efforts subject to considerable risks.
- Research programmes are currently less numerous and are undertaken in only a few countries. The main purposes of research projects are, in general, to elucidate weather modification concepts, to examine some link(s) in the overall modification hypothesis, to test the efficacy and impacts of some modification activity, or to establish proof for some proposed or previously tested methodology. The long-term practical aim of research is to provide a sound basis for the operational implementation of the research results.
- In order to identify and confirm the results of seeding experiments and operations, it is necessary to employ sophisticated statistical designs and analyses. Confidence intervals should be included in the statistical analyses to provide an estimate of the strength of the seeding effect so informed judgments can be made about its cost effectiveness and societal significance.
- Improvements in observational facilities and modelling capabilities now permit more detailed examination of the cloud and precipitation processes and offer new opportunities for advancing the science and practice of weather modification.
- While the outcomes of operational projects in hydrological, economic or other similar terms is usually difficult to ascertain with confidence, it has been shown to be possible under appropriate circumstances such as very long project duration and the existence of highly correlated control areas. Much work is being done to explore additional ways of evaluation. Operational projects, in comparison with research projects, accept a higher degree of uncertainty in the outcome of the intervention and therefore a considerable burden in justifying the investment needed.
- Cloud structure can vary widely from region to region. Seeding results in one geographic area cannot be automatically assumed to apply to another area. Transferability should be carefully considered, since, in addition to meteorological factors, differences in aerosol and trace gas constituents, surface characteristics and other factors may also cause unexpected variations in cloud behaviour and cloud response to intervention.
- Unintended consequences of cloud seeding, such as downwind effects and environmental and ecological impacts, have not been demonstrated but cannot be ruled out.
- There is mounting evidence that human activities modify local and sometimes regional cloud properties and precipitation. Clarification of the existence and processes of such inadvertent weather modification may provide important insights into the possibilities and limitations of deliberate weather modification.

- The activities of the WMO in the area of weather modification are aimed at encouraging research projects, and at providing guidance about best practices for operational projects.

The status of different technologies, and the physical concepts underlying them, is summarized as follows:

Fog dispersal

- In principle, all types of fog can be dispersed by sufficient heating or mechanical mixing, though such methods are often impractical and expensive. It may be economically viable at airports where the cost of aircraft delays and cancellations are very high.
- Dispersal of supercooled fogs using glaciogenic materials or coolants is well established as feasible.
- Seeding with hygroscopic materials has been shown to increase visibility in some types of warm fogs. An environmentally acceptable technology has yet to be demonstrated.

Precipitation enhancement

- There is considerable evidence that cloud microstructure can be modified by seeding with glaciogenic or hygroscopic materials under appropriate conditions. The criteria for those conditions vary widely with cloud type. Evidence for significant and beneficial changes in precipitation on the ground as a result of seeding is controversial and in many cases cannot be established with confidence.
- In our present state of knowledge, it is considered that the glaciogenic seeding of clouds formed by air flowing over mountains offers the best prospects for increasing precipitation in an economically-viable manner. These types of clouds attracted great interest in their modification because of their potential in terms of water management, i.e., the possibility of storing water in reservoirs or in the snowpack at higher elevations. There is statistical evidence that under certain conditions precipitation from supercooled orographic clouds can be increased with existing techniques. Statistical analyses of streamflow records from some long-term projects indicate that cost-effective increases have been realized.
- The use of glaciogenic agents such as silver iodide to seed supercooled cumulus clouds has produced few results of general validity. Observed responses of clouds vary widely. There are competing explanations and the questions are not yet resolved.
- Seeding of convective clouds with hygroscopic materials has been shown to be adaptable to different cloud types and has produced encouraging results but is not yet an established technology.

Hail suppression

- Well-developed glaciogenic seeding technologies have been used operationally in many parts of the world to reduce hail damage. Evaluation of the results has proved difficult and the effectiveness remains controversial.
- Attempts to seed hailstorms with hygroscopic nuclei have been made but have not given demonstrable results.
- Some methods, such as hail cannons or ionization devices, have no physical basis and are not recommended.

Other phenomena

- No confidence can be placed at this time in the use of cloud seeding to reduce the strength of typhoons and tropical storms.
- Attempts to reduce lightning by seeding have not been shown to be effective.

General comments

- The scientific status of weather modification, while steadily improving, still reflects limitations in the detailed understanding of cloud microphysics and precipitation formation, as well as inadequacies in accurate precipitation measurement. Governments and scientific institutions are urged to substantially increase their efforts in basic precipitation research and related programmes in weather modification. Further testing and evaluation of physical concepts and seeding strategies are critically important. The acceptance of weather modification can only be improved by increasing the numbers of well executed experiments and building the base of positive scientific results.
 - Governments and other agencies involved in weather modification activities should invest in relevant education and training.
 - Operational weather modification projects should be reviewed periodically (annually if possible) to assess whether the best practices are being used. Any new project should seek advice from experts regarding the benefits to be expected, the risks involved, the optimum techniques to be used, and the likely impacts. The advisors should be as detached as possible from the project, so their opinions can be viewed as being unbiased. It is recognized that most weather modification projects are motivated by well documented requirements, but they also have associated risks and the results may remain uncertain.
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PROGRESS/ACTIVITY REPORT

SUMMARY

Reference: EC-LX/Doc. 4.2(2)

CONTENT OF DOCUMENT:

Appendix:

- Progress/Activity Report

PROGRESS/ACTIVITY REPORT

In September 2007 at its annual meeting in Oslo, the CAS Management Group (CAS-MG) approved revised versions of the “WMO Statement on Weather Modification (including an Executive Summary)” and the “WMO Guidelines for the Planning of Weather Modification Activities”. As requested by the CAS Management Group, the documents were then posted on the web and made available at the 9th WMO Scientific Conference and Forum on Weather Modification, 22-25 October 2007, Antalya Turkey. The CAS Management Group also requested that approval of these revisions is reported to EC-LX.
