WMO Expert Committee on Weather Modification Research

To promote scientific practices in weather modification research. This is done through the WMO Expert Team on Weather Modification and through organizing the quadriennial scientific conferences on weather modification.

Report
October 2017
Mission and Functions

- To keep under review, on behalf of OPAG-WWRP and OPAG-EPAC, relevant research, advise CAS on issues requiring attention related to weather modification and suggest mechanisms for addressing such issues;
- To review the criteria for conducting weather modification research to ensure the quality of the science, from the initial design to the final evaluation of field experiments, taking into account advances in supporting fields, including cloud physics, atmospheric chemistry, numerical modelling;
- To serve as a focal point and provide advice and assistance to Members on the manner and means of transferring competence for planning scientific experiments; and
- To assist in the drafting of WMO documents on the status of weather modification and guidelines for providing advice to Members and to propose revisions to these documents where necessary.
Activities since 2016

• Number of countries doing weather modification programs increased from 56 in 2016 to 60 in 2017 and several new programs in individual countries

• Scientific research programs are also increasing (e.g. China, India, USA, Thailand, United Arab Emirates, Japan, Germany, Finland, United Kingdom (the last four through grants from the UAE).

• Meteorological Services are often asked to provide advice and most of the time refer to the Expert Team (Mexico, Peru, etc.)

• Several Expert Team members participated in several international meetings and assessments over the past year. The important meetings were:
  – UAE research grant program for Rainfall Enhancement Science in Arid and Semi-Arid regions of the world
  – ET received funding for the UAE research program to conduct a review of the science of Rainfall Enhancement. One meeting was held in Geneva in June and a first draft will be available at the end of the month.
  – Assessment of Hail mitigation projects were done for Canadian (Insurance industry) and Moldovian (FAO) projects
Activities since 2015

WMO Statement on Weather Modification
Research and Guiding Principles for the Planning
of Weather Modification Activities

- Review the mission of the Expert Team especially through better interactions with other working groups and GAW, WGNE, SPARC. Initial discussion with GAW and other working groups have started.
- Review the purpose of the WMO statement on Weather Modification.
- Continue to provide advice to member countries and participate in research programs by individual countries.
- Planned next meeting of Team in conjunction with Review meeting on rainfall enhancement.
International Research Programs

UAE research grant program for Rainfall Enhancement Science in Arid and Semi-Arid regions of the world

– Competitive grant program with a thorough review process.

– Program annually has US$5 million to distribute and operate the program. Approximately 3 awards are made every year since the beginning of 2015 with grants typically in the order of 500k per year for three years for researchers

– Program is widely advertised around the world.
International Research Activities

AA9, AA10, AA17

SNOW

Orographic

– Major US research efforts planned
– Will include two instrumented aircraft, three mobile dual polarization X-band radars and a suite of ground-based instruments
– Large modeling component with aerosol and seeding components
Recent Scientific highlights

UAE Research Program, ICE-T, NASA-SEAC4RS & CampEX, etc.

AA1, AA7, AA8, AA9, AA10, AA12, AA17

Aerosol/Cloud interactions and the effects on droplet size distribution, the onset of coalescence and ice processes in convective clouds.
It all Starts at Cloud Base

Caribbean Maritime
+22 °C 86 cc⁻¹
ICE-T

Gulf Coast Quasi-Maritime
+18 °C 215 cc⁻¹
SEAC⁴RS

Mid-Latitude Continental
+5 °C 636 cc⁻¹
High Plains

Southeast US Quasi-Continental
+18 °C 470 cc⁻¹
SEAC⁴RS
Maritime - 5 °C Updraft (ICE-T)

Quasi-Maritime - 5 °C Updraft (SEAC4RS)

Quasi-Continental - 5 °C Updraft (SEAC4RS)

Mid-Latitude
First Ice Penetration: 2 g m⁻³ LWC, Millimeter Drops, Very Low Concentration of Small Ice

4 min Later: Cloud Nearly Glaciated - Only Small Supercooled Drops Remain.

3 min Later: Rapid Glaciation, Millimeter Drops Frozen.
Variation in Cloud Microphysics with Latitude:

Cloud Base Temperature and Drop Spectra have a Significant Impact on the Development of Drop Size Distribution and Ice Formation.

$T_{\text{ice}} = -40e^{-0.041(T_{\text{CB}} - 38)(DSD_{\text{CBmax}})}$

$R^2 = 0.95$

-12 °C

0 °C

Southeast US (SEAC4RS)

Caribbean (ICE-T)

Great Plains (UAE, NHRE/CCOPE)

Gulf Coast (SEAC4RS)

Increased aerosol concentration also has the same effect.
Recent Scientific highlights

- Alberta Hail Mitigation Program. Funded by the insurance industry and solely focused on the protection of property in the cities.
- Been conducted for more than 20 years.
- Developed radar parameters for hail size and damage.
- Moldova Project assessment funded by FAO. Hail climatology.

![Graph showing precipitation efficiency vs. wind shear.](image)

![Plot showing maxZ vs. time.](image)
Precipitation Formation
Three Aspects

1. Aerosol size distributions and hygroscopicity
2. Thermodynamic structure of atmosphere
3. Effects on ice processes

Large CCN? Capping inversion layers
Interactions with other partners

- GAW, WGNE, SPARC
- SDS - dust mixed with other pollutants
- TMR – Aerosol-Cloud-Precipitation interactions
- HIWEATHER – Role of aerosols, microphysical-dynamical interactions in severe weather
- Others also in different ways
Future Plans

AA1, AA7, AA8, AA9, AA10, AA12, AA17

• Updating the Mission and Functions of the Team to align with WWRP goals and align better with other WWRP working groups.

• Developing a plan for next two years:
  – Drafting a updated scientific review of the current status of weather modifications research related to Rainfall Enhancement
  – Redraft the WMO statements to align better with the mission and simultaneously addressing the common requests that WMO and the Expert Team receives from member countries.
  – Organize regional workshops to inform both NMHS and decision makers on the scientific status of weather modification
  – Two major field efforts next year (UAE and Phillipines)
Science Summit

Overwhelming but Inspiring

- Need to leverage research between WMO groups, public institutions, academic and private sector also related to projects and WWRP
- Need for linkages between different groups and other WMO programs and outside groups. How to do this is challenging and where the linkages are should also be better explored.