WORLD METEOROLOGICAL ORGANIZATION

PROGRAMME ON PHYSICS AND CHEMISTRY OF CLOUDS AND WEATHER MODIFICATION RESEARCH

WMP

REPORT SERIES

No. 34

REGISTER

OF

NATIONAL WEATHER MODIFICATION PROJECTS

1997 and 1998

WMO/TD - No. 1001

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TABLE OF CONTENTS

Page

Annexes

I. INTRODUCTION

As part of the activities which WMO carries out in its Programme on the Physics and Chemistry of Clouds and Weather Modification Research, a Register of National Weather Modification Projects is kept. The Register has existed since 1975 when the Seventh World Meteorological Congress agreed that an inventory of activities within Member countries related to weather modification should be initiated and maintained. Periodic reviews have all recommended that the Register be continued.

This present Register is the twenty first such publication issued. It is based on information obtained from Member countries on experiments and operations sponsored by government agencies or private concerns that took place during 1997 and 1998

To assist the reader in understanding the content of each of the 12 columns used in the tabular presentation found within, detailed explanations are provided in Section II. These columns contain information that was obtained from WMO Member countries in response to questionnaires sent to them in July 1999. The questionnaires are reproduced as Annexes A and B to ensure that the tabular information will be readily understood by readers. Annex A refers to present projects reported in Section IV for the 1997-1998 projects. Annex B refers to completed projects or those where physical and/or statistical evaluation have been carried out that are reported in Section VII.

The names of Member countries who provided the information reported in this Register are listed in Sections III. Section VII provides summaries of completed projects and Section VIII indicates which countries reported that no weather modification activities had taken place in 1997 and 1998.

Requests for further information concerning the projects reported may be addressed to the reporting agency for each country which is indicated in Section V. The WMO Secretariat would be pleased to assist if requested.

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

CANADA											
CAN-1	Op. Hail	26,400 km^2	Alberta Hail Suppression Project	Province of Alberta (Lacombe to High River)	1996 Every Year Yes	Ins. (P)	Cloud-base, in-cloud and cloud-top with acetone burners and pyrotechnic flares from 3 A/C	AgI, Flares: one 20g flare every 5 sec. for in –cloud And 1-2 150g flares/ run at cloud base. 110.9kg used in 1997, 97.7kg in 1998	Convective clouds bases colder than 10°C, tops colder than -20°C. Criteria based on storm cells (defined by radar) with max. 35dBz reflectivity in cloud layer above -5°C level.	15 June-15 Sept 1997/98 - 38 days 1997 - 36 days 1998	
CHILE											
CHI-1	Op. PE(E)	50 km^2	Programa de Estimulacion de Precipitaciones (CHI2)	Areas with precipitation deficit of 80% against normal amount	1990 Inter-rupted Yes	Agr (G)(P) Enr (G) Public works (G)	Throughout clouds with acetone burners and pyrotechnic flares from 1 A/C at cloud temperatures colder than –10°C	AgI, Flares	Both convective and orographic clouds, bases warmer than 10°C, tops colder than -20°C. Criteria in that seeding takes place at or after passage of cold front.	May to Sept 60 days on average	No evaluation for 1997-1998 but evaluation available or planned as is/will be available EIS-No C/B-Yes
FRANCE											
FR-1	Res. Op. Hail	60,000 km^2 420,000 km^2 control	ANELFA	Aguitan and Rhodanian basins and Loire Valley	1952 Every year Yes	Agr. (P)	Ground based seeding with 612 (97) and 622 (98) acetone burners	AgI, 8g/hour per generator. Total consumption 862 kg in 1997, 712 kg in 1998	Convective clouds with bases warmer than 10°C and tops colder than –20°C. Seeding criteria: hailstones with diameter exceeding 15mm predicted	April to Oct. 61 days in 1997 51 days in 1998	Evaluation based on hail pad data. EIS-Yes C/B Yes
FR-2	Res. Dev Hail	8.000km^2 target and control area	Test of modification of hail storm characteristics by seeding hygroscopic nuclei at cloud base	Department of Moyenne Garonne	1993 every year Yes	Agr (P)	Cloud base seeding with pyrotechnic flares from 2 A/C	NaCl, KCl, CaCl at 15 kg per hour. Total consumption about 150 kg each year Convective clouds with bases colder than 10°C and tops colder than –20°C. Seeding criteria based on strong probability of		May to 10 October about 20 days each year	Evaluation based on randomised experiment between 2 salts, hail pads Document available EIS-Yes C/B-Yes

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

								hail, TITAN microstructure of unseeded cloud determined by radar			
FR-3	Res. Dev. Against freezing tempera-tures			Department of Moyenne Garonne		Agr (P)		Using water and ventilation		Feb to May each year	
GERMANY											
GE-1	Res. Op. Hail	4000 km^2	Hagelabwehr/ Hagelforschungs -verein Rosenheim	Northern side of the Alps between 500-1900m	1975 Every year Yes	Municipal	Cloud base seeding with acetone burners from 2 A/C	AgI, 0.5kg/hour Consumption: 62 kg in 1997 30 kg in 1998	Convective clouds with bases warmer than 10°C and tops colder than 0°C but warmer than –20°C. Seeding criteria: based on temp, temp advection, vertical windspeed, humidity, fronts, troposphere height, radar echoes infrared satellites, photos and sferics	May to Sept. 27 days in 1997 21 days in 1998	Estimation based on documented hailfall. Evaluation document available. EIS-No C/B-No
GE-2	Op. Hail	2500 km^2 control 7500 km^2	Hail prevention project – Stuttgart area	48°N, 9°E	1980 Every year Yes	Agr (P)	Cloud base seeding with acetone burner from 1A/C	AgI, 1.4 kg/hr (7% solution) consumption: 31 kg in 1997 20 kg in 1998	Convective clouds with bases warmer than 10°C and tops colder than –20°C. Seeding criteria based on instability index for the day and radar information for the cloud (echo greater than or equal to 25 dBZ and tops greater than or equal to 25,000 feet)	21 April to 15 October. Surveyed days 178 each year	Evaluation document available based on historical records, crop damage and hail pad. Also evaluation based on precipitation information, i.e. frequency of days with 0.1 mm or more per day and the amount in target/control, seeded/unseeded days. EIS-Yes C/B-Yes
GREECE											
GR-1	Res. Op. Hail	2350 km^2	Hellenic National Hail Suppression Project	NW Greece	1984 Inter-rupted Yes	Agr. (G)	Cloud base, in-cloud and cloud top seeding with pyrotechnic flares from 2A/C. In cloud seeding between –8°C to –10°C	AgI, 240 g/min consumption: 31.24 kg in 1997 62.38 kg in 1998	Convective clouds with bases colder than 10°C and tops colder than -20°C.	Apr to Sept. 18 days in 1997 21 days in 1998	Evaluation based on comparison with historical records. Crop damage and hail pads. Final evaluation available in 2000 EIS-Yes C/B-Yes (available in 2000)

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

GR-2	Op. Hail	56km^2		5 different Greek Provinces	1982 Every year Yes	Agr. (G)	G/B Hail canons	Shock waves from canons	Convective clouds	April to October about 25 days each year	Evaluation based on comparison with historical records. No evaluation report EIS-No C/B-No
HUNGARY											
HG-1	Op. Hail	8350 km^2	NEFELA Association	Baranya, Somogy, Tolna	1991 Every year Yes	Agr. (G) (P) Wea. Serv.	G/B seeding with 78 acetone burners	AgI, 8g/hour, consumption: 120 kg each year	Convective clouds with bases warmer than 10°C and tops colder than -20°C.. Seedings criteria: radar reflectivity greater than or equal to 45 Dbz	May to Sept. 40-50 days each year	No evaluation provisions EIS-No C/B-No
ISRAEL											
IS-1	Op. PE	5000 km^2 target 1500 km^2 control	Israel Enhancement Project	Northern Israel	1960-1975 Experimental 1975 Operational Every year Yes	Agr. (G) Hyd (G)	40 G/B acetone burners and 3 A/C with acetone burners seeding at cloud base	AgI G/B at 12 g/hour each. A/C at 500 g/hour each	Convective clouds with bases colder than 10°C, tops both warmer and colder than –20°C. Microstructure of unseeded clouds measured. Seeding criteria cloud tops below –8°C and suitable wind direction.	Nov to April seeding every rainy day during period	Evaluation based on historical records. Document available EIS-No C/B-Yes
JAPAN											
JP-1	Res. PE PR	500 km^2	Study on feasibility of orographic snow cloud modification by seeding	Nigata and Gunma prefectures	1994 Every year Yes	Wea. Serv.	Cloud top seeding with dry ice from 1A/C	Orographic clouds with bases colder than 10°C with tops colder than 0°C but warmer than –20°C. Microstructure of unseeded clouds measured. Seeding criteria: cloud top temp warmer than –25°C.	Dry ice at 30g per second Consumption 200 kg per season	Jan to March in 1997, Dec. 1997 to March in 1998. 30 days in each year	No evaluation Planned EIS-No C/B-No

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

JORDAN											
JOR-1	Op. PE PR Ext. Inc.	14500 km^2	Jordan Precipitation Enhancement Project PEPJ	Marka Airport Amman	1986 Every year Yes	Wea. Serv.	G/B Seeding With 22 acetone burners. Cloud top and in-cloud seeding from 1A/C	Airborne AgI, 240 g/hr Consumption 50 kg per season. G/B 12gr/hr from each acetone burner.	Convective Orographic and stratiform clouds with tops colder than 0°C but warmer than –20°C. Seeding criteria: approach of depressions and/or unstable conditions cloud top temperatures between –12 and –20°C. Jan to May and Oct. to Dec. each year		Evaluation available EIS-No C/B-Yes
LIBYAN ARAB JAMAHIRIYA											
LI-1	Res. Op. PE R	69,000 km^2	Libyan Cloud Seeding and Precipitation Enhancement Programme	Tripoli, Sirt, El-Marje	1980 Every year Yes	Trans (G)	Seeding with pyrotechnic flares from 2A/C at cloud base, in cloud and cloud top. Seeding in cloud at –5°C level		Convective and orographic clouds with bases colder than 10°C and tops colder than 0°C but warmer than –20°C. Seeding criteria based on synoptic situation	Jan to March Oct-Dec Each year	Evaluation based on comparison with historical records, report not available EIS-No C/B-No
MACEDONIA, THE FORMER YUGOSLAV REPUBLIC OF											
MAC-1	Op. Hail	25,000 km^2	Hail Suppression Project	Republic of Macedonia	1971 Every year Yes	Agr. (G) Wea Serv.	In-cloud seeding with rockets and artillery shells at –4 to –10°C level.	G/B seeding with AgI, 400g each rockets/shell, consumption 450 kg total for 1997 and 1998	Convective clouds with bases colder than 10°C and tops colder than –20°C. Seeding criteria based on weather forecast and numerical models	Apr-October Each year	Evaluation based on comparison with historical records, crop damage and statistics. Report available EIS-No C/B-No
MALAYSIA											
MAL-1	Op. PE(E)	Whole country	Drought Operation	Whole country	1997 Yes	Wea. Serv. (G)	In cloud seeding With NaCl liquid spray from 3 A/C	NaCl liquid spray at 150 litres per minute. Consumption 18,000 kg	Convective clouds with bases warmer than 10°C top warmer than –20°C but colder than 0°C. Seeding criteria: Cu cloud with top at least 15,000 ft.	Sept to mid-Nov in 1997 and March to September in 1998 50 days (1997) 110 days	No evaluation provision EIS-No C/B-No

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

MOLDOVA											
MOL-1	Op Hail	21,250 km^2	Prevention of Hail Damage	60 % of the national territory	1964 Every year Yes	Agr. (P)	In-cloud seeding from G/B rockets with pyrotechnic flares at the –4 to –9°C level	AgI at 0.14 kg per hailcell. Total consumption 70 kg each year	Convective clouds with bases warmer than 10°C and tops colder than –20°C. Seeding criteria: top of convection level, wind shift, height of the freezing level, radar reflectivity and mesoscale conditions.	May to Sept. each year. About 30 days per year	Evaluation based on comparison with historical records and crop damage Report available EIS-Yes C/B-Yes
MOROCCO											
MO-1	Op. Res. Dev. PE (E) R Inc.	16,400 km^2 target 6,000 km^2 control	Al Ghait	High Atlas Central basin of Oumer-Bia Basin oued el Abid	1984 Every year Yes	Wea. Serv. (G)	Seeding cloud tops bases and in-cloud with 15G/B acetone burners and pyrotechnic flares from 2 A/C. Seeding performed in region 0°C to –5°C in the presence of both ice crystals and supercooled water as determined by A/C	G/B seeding AgI at 20g/hour NaI at 6g/hour Propane 2kg/hour Airborne seeding: AgI at 375 g/hour NaI at 125 g/hour. Total consumption for the season AgI – 77 kg NaI-25.8kg Propane-7,750 kg	Convective and orographic clouds with bases colder than 10°C and tops colder than 0°C but warmer than –20°C. Seeding criteria LWC>0.1 g/m^3 for 10km, 0.3g/m^3 for less than 10km and from 0.5 –1.0g/m^3 in cumulus	Nov-Dec each year, 25 days each year	Evaluation based on comparison with historical records. Report available EIS-Yes C/B-Yes
PHILIPPINES											
PH-1	Op.PE (E)	3166 km^2 per operation		Nationwide Depending Upon requests	1988 Every year Yes	Agr. (G)	Seeding in-cloud with NaCl by 1A/C per operation Seeding at temp warmer than 0°C with no thunder or lightning activity	NaCl solid dispersal seeding by A/C at rate that varies between 300kg per sortie to 2000 kg depending on type of A/C. Consumption was 31,200 kg in 1997 1,036 800 kg in 1998	Convective clouds with bases warmer than 10°C and tops warmer than 0°C. Seeding performed when clouds are still developing or are mature	Seeding takes place throughout the year, at least 20 days at each site per year.	Evaluation based on comparison with historical records and crop damage Report compiled EIS-No C/B-Yes

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

PH-2	Dev. Op. PE (E)	100km2	Evaluation of chem "101" as seeding agent	Various provinces in Philippines	1995 Inter-rupted (?)	Air Force (G)	Seeding cloud base with 1 A/C with liquid spray	Chem "101" liquid spray throughout smoke generator by A/C	Orographic cloud with base temp colder than 10°C and tops colder than 0°C but warmer than –20°C. Seeding criteria: Rel. Hum >70% and towering cumulus present	Oct to Dec 1997 Jan to May 1998	Evaluation based on comparison with historical records and crop damage Report compiled EIS-No C/B-Yes
RUSSIAN FEDERATION											
RF-1	Op. Hail	20,000 km^2 12,000 km^2	Operational project for hail suppression	Northern Caucasus	1968 every year Yes	Agr. (G)	Seeding in cloud with pyrotechnic flares on rockets	AgI. Total consumption 62 kg in 1997, 41 kg in 1998	Convective clouds with bases colder than 10°C and tops colder than –20°C seeding criteria based on S-band radar images	Apr. to Sept each year. 37 days in 1997 25 days in 1998	Evaluation based on comparison with historical record, crop damage, and hail pads. Report available EIS-Yes C/B-Yes
SOUTH AFRICA											
SA-1	Dev PE R	10,000 km^2	South African Rainfall Enhancement Programme	Northern Province South Africa	1997 Every Year Yes	Agr (G) Hyd. (G) Res. Found. (G) Wea. Serv. (G)	Seeding cloud Base with hygroscopic flares from 2 A/C	NaCl and KCl Hygroscopic flares	Convective clouds with bases warmer than 10°C and tops colder than –20°C. Seeding criteria based on information from A/C and radar	Dec 1997 and Jan to April 1998 20 days during period involving 34 cases	Evaluation based on comparison with historical records and using TITAN the pairing of seeded storms with natural storms. Report available EIS-No C/B-Yes
SPAIN											
SP-1 (1997)	Res. Hail	10,000 km^2	Interprovincial Project on Hail Suppression	Alava, La Rioja and Navarra Provinces	1974 Inter-rupted Yes	Agr. (G) ENESA	G/B Seeding From 108 acetone burners	AgI in acetone at 0.98 l/hour. Consumption (1997)1,180 l with 270 grs AgI/l. Also 30,000 l acetone, 50kg Dichloro - benzene ($C_6H_4CL_2$) and 74 kg of NaI	Convective clouds with bases colder than 10°C and tops colder than –20°C. Seeding criteria based on weather forecast for that day	15 May to Sept. 42 days in 1997	Evaluation based on crop damage. Report available EIS-Yes C/B-Yes
SP-2 (1997)	Op. Hail	2,870 km^2	1997 hail suppression project in Aragon	144 townships (135 in Zarogoza and 9 in Teruel)	1970 Every year Yes	Agr. (G)	G/B Seeding from 130 acetone burners	AgI 8.17 litres per generator Consumption (1997) 1062.1 litres	Convective clouds with tops colder than –20°C. Seeding criteria based on met. forecasts of possible hail	May to Oct. 1997 37 days	Evaluation based on crop damage. No report EIS-No C/B-No

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

SP-3 (1998)	Op. Hail	2500 km^2	1998 Hail suppression project in Aragon	Various township in Zaragoza and Teruel	1970 Every Year Yes	Agr (G)	G/B Seeding from 83 acetone burners	AgI, 4.4 litres per generator consumption (1998) 362.2 litres	As SP-2	May to October 1998	As SP-2
SYRIAN ARAB REPUBLIC											
SY-1	Dev. Op PE, Ext. Inc.	150,000 km^2 Variable control area	Syrian rain enhancement project	Countrywide	1991 Every year Yes	Agr (G)	Cloud top and in-cloud seeding with pyrotechnic flares from 4 A/C	AgI at various consumption rates	Convective and orographic clouds with bases colder than 10°C and tops colder than 0°C but warmer than –20°C	Oct to Dec and Jan to May each year. About 30 days each season. Seeding criteria based on temp of cloud between –10°C and –25°C, clouds must be at least 2000m thick	Evaluation based on comparison with historica records. Report available EIS-No C/B-Yes
UNITED STATES OF AMERICA (1997)											
US-1	PE	1,040 km^2	NOAA 96-917	San Gabriel Mountain California		Muni		AgI. Total Consumption 1.06 kg		Jan to Feb 3 days	Report available
US-2	PE Snow Augmentation	8,294 km^2	NOAA 96-920	Ruby mountains Nevada		State Government		AgI. Total consumption 15.047 kg		Jan to Apr 20 days	Report available
US-3	PE Snow Augmentation	2,834 km^2	NOAA 96-922	Truckee-Tahoe Nevada		State Government		AgI. Total consumption 0.365 kg		April, 2 days	Report available
US-4	PE Snow Augmentation	650 km^2	NOAA 96-924	Northern Utah		Muni		AgI.Total consumption 5.438 kg		Jan to Feb 10 days	Report available
US-5	PE	1,170 km^2	NOAA 96-926	Eastern Sierra California		Muni		AgI. Total consumption 6.420kg		Jan to Dec 9 days	Report available
US-6	PE	1,300 km^2	NOAA 96-927	Kaweah River California		Kaweah Delta Water Conservation District		AgI. Total consumption 0.619 kg		Jan to Dec 2 days	Report available
US-7	PE	3,120 km^2 NOAA 96-928		Kern River California		N. Kern Water Storage District		AgI. Total consumption 6.047 kg		Jan to Dec 19 days	Report available

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

US-8	PE	4,160 km^2	NOAA 96-929	Kings River California		King River Conservation District		Agl. Total consumption 2.585 kg		Jan to Dec 2 days	Report available
US-9	PE	3,120 km^2	NOAA 96-931	San Joaquin River California		(P) Southern California Edison Company		Agl. Total consumption 6.857 kg		Jan to Dec 32 days	Report available
US-10	PE	3,120 km^2	NOAA 96-932	Tuolumne River California		Turlock Irrigation District		Agl. Total Consumption 0.5 kg		Jan to Dec 4 days	Report available
US-11	PE Snow Augmentation		NOAA 96-934	Upper Snake River, Idaho		East Idaho Counties and Irrigation Districts		Agl. Total consumption 0.514 kg		March to April 4 days	Report available
US-12	PE	3,120 km^2	NOAA 96-935	Payette River, Idaho		(P) Idaho Power Company		Agl. Total consumption 18.345 kg		Jan to April 28 days	Report available
US-13	PE Snow Augmentation	78 km^2	NOAA 96-937	Central Southern Utah		Utah Water resources Develop ment Company		Agl.Total consumption 34.28 kg		Jan to March 18 days	Report available
US-14	PE	10,400 km^2	NOAA 96-938	Santa Barbara/Obi spo California		Muni		Agl Total consumption 1.888kg		Jan to March 9 days	Report available
US-15	PE Snow Augmentation	1,235 km^2	NOAA 96-939	Tuscarora Nevada		(G) State of Nevada		Agl Total consumption 3.339 kg		Feb to April 12 days	Report available
US-16	PE Snow Augmentation	1,248 km^2	NOAA 96-940	Toiyabe/Aus tin Nevada		(G) State of Nevada		Agl. Total consumption 0.27kg		April 1 day	Report available
US-17	PE Snow Augmentation	1,300 km^2	NOAA 96-941	Lake Alamnor California		(P) Pacific Gas and Electric Company		Agl. Total consumption 0.55 kg		April 1 day	Report available
US-18	PE	22,100 km^2	NOAA 96-942	Southern Texas		(P) Southern Texas Weather Modification Association		Agl. Total consumption 25.328 kg		May to October 44 days	Report available
US-19	PE	9,100 km^2	NOAA 96-943	Colorado River Texas		Muni		Agl. Total consumption 3.075 kg		May to October 21 days	Report available

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

US-20	PE Fog	6,209 km^2	NOAA 96-944	North Dakota District 1		N. Dakota Atmospheric Research Board		Agl. Total consumption 8.528 kg Dry ice: Total consumption 1,323 kg		June to August 34 days	Report available
US-21	PE Fog	23,278 km^2	NOAA 96-944a	North Dakota District 2		N. Dakota Atmospheric research Board		Agl. Total consumption 1.57 kg Dry ice total consumption 1454 kg		June to August 34 days	Report available
US-22	PE Hail	48,958 km2	NOAA 96-945	Western Kansas		Western Kansas Ground Water Manage ment District		Agl.Total consumption 200.906 kg. Dry ice: total consumption 1585 kg		April to Sept. 68 days	Report available
US-23	PE Snow Augmentation	8,294 km^2	NOAA 97-946	Ruby Mountains Nevada		(G) State of Nevada		Agl. Total consumption 10.268 kg		Nov. to Dec	Report available
US-24	PE Snow Augmentation	8,364 km^2	NOAA 97-947	Carson-Walker Nevada		(G) State of Nevada		Agl. Total consumption 6.077 kg		Nov to Dec 12 days	Report available
US-25	PE Snow Augmentation	2,834 km^2	NOAA 97-948	Truckee Tahoe Nevada		(G) State of Nevada		Agl. Total consumption 12.069 kg		Nov. to Dec 13 days	Report available
US-26	PE Snow Augmentation	1,235 km^2	NOAA 97-949	Tuscarora Nevada		(G) State of Nevada		Agl. Total consumption 1.731 kg		Nov to Dec 6 days	Report available
US-27	PE Snow Augmentation	1,245 km^2	NOAA 97-950	Toiyabe Nevada		(G) State of Nevada		Agl. Total consumption 1.531 kg		Nov to Dec 8 days	Report available
US-28	PE	614 km^2	NOAA 97-951	Sacramento California		Muni		Agl. Total Consumption 4.576 kg		Nov to Dec 6 days	Report available
US-29	PE Snow Augmentation	1,300 km^2	NOAA 97-952	Lake Almanor California		(P) Pacific Gas and Electricity Company		Agl. Total consumption 13.125 kg		Nov to Dec 15 days	Report available
US-30	PE Snow Augmentation	442 km^2	NOAA 97-953	Mokalumne California		(P) Pacific Gas and Electricity Company		Agl. Total consumption 9.933 kg		Nov to Dec 8 days	Report available
US-31	PE Snow Augmentation	260 km^2	NOAA 97-954	Central Colorado		(P) Western Weather Consultants		Agl. Total consumption 17.007 kg		Nov to Dec. 49 days	Report available
US-32	PE Snow Augmentation	156km^2	NOAA 97-955	Telluride San Miguel Colorado		(P) Western Weather Consultants		Agl. Total consumption 0.968kg		Nov to Dec 10 days	Report available

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

US-33	PE Snow Augmentation	52 km^2	NOAA 97-956	Snowbird/Alt a Utah		(P) Snowbird Ski Resort		Agl. Total consumption 1.942 kg		Nov. to Dec 13 days	Report available
US-34	PE Snow Augmentation	390 km^2	NOAA 97-957	Northern Utah		Muni Cache County		Agl. Total consumption 4.012 kg		Dec 5 days	Report available
US-35	PE Snow Augmentation	26,000 km^2	NOAA 97-958	Central and Southern Utah		Utah Water Resource Development Corporation		Agl. Total consumption 16.984 kg		Nov to Dec 14 days	Report available
US-36	PE Snow Augmentation	442 km^2	NOAA 97-959	Grand Mesa Colorado		Water Enhancement Authority				December	Final report not available
US-37	PE Snow Augmentation	468km^2	NOAA 97-960	Wind River Wyoming		Eden Valley Irrigation and Drainage District		Agl. Total consumption 0.075 kg		November 1 day	Report available
US-38	PE	40,625 km^2	NOAA 98-998	Central Southern Texas		High Plains Water Conser vation District		Agl. Total consumption 32.75 kg		June to September 38 days	Report available
US-39	PE Hail	178,506 km^2	NOAA 98-999	Oklahoma		Oklahoma Water Resource Board		Agl.. Total consumption 127.22 kg		March to October 102 days	Report available
UNITED STATES OF AMERICA (1998)											
US-40	PE Snow Augmentation	8,294 km^2	NOAA 97-946 98-983	Ruby Mountains Nevada		(G) State of Nevada		Agl. Total consumption 35.379 kg		Jan to April 33 days Nov to Dec 9 days	Report available
US-41	PE Snow Augmentation	8,364 km^2	NOAA 97-947 98-984	Carson Walker Nevada		(G) State of Nevada		Agl. Total consumption 12.312 kg		Jan to March 36 days Nov. to Dec 4 days	Report available
US-42	PE Snow Augmentation	2,834 km^2	NOAA 97-948 98-985	Truckee Tahoe Nevada		(G) State of Nevada		Agl. Total consumption 8.885 kg		Jan to Feb 17 days Nov to Dec 8 days	Report available
US-43	PE Snow Augmentation	1,235 km^2	NOAA 97-949 98-994	Tuscarora Nevada		(G) State of Nevada		Agl. Total consumption 13.162 kg		Jan to April 33 days Nov to Dec 8 days	Report available
US-44	PE Snow Augmentation	1,248 km^2	NOAA 97-950	Toiyabe Nevada		(G) State of Nevada		Agl. Total consumption 4.364 kg		Jan to April 8 days	Report available
US-45	PE	614 km^2	NOAA 97-951 98-1005	Sacramento California		Muni		Agl. Total consumption 11.163 kg		Jan to Feb 26 days	Report available

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

US-46	PE Snow Augmentation	442 km^2	NOAA 97-952 98-1002	Mokalumne California		(P) Pacific Gas and Electricity Company		Agl. Total consumption 14.07 kg		Jan 7 days Nov to Dec 7 days	Report available
US-47	PE Snow Augmentation	1,300 km^2	NOAA 97-953 98-1001	Lake Almanor California		(P) Pacific Gas and Electricity Company		Ag (I) Total consumption 60.182 kg		Jan to May 36 days Nov to Dec 8 days	Report available
US-48	PE Snow Augmentation	260 km^2	NOAA 97-954	Central Colorado		(P) Western Weather Consultants		Agl total Consumption 12.892 kg		Jan to March 35 days	Report available
US-49	PE Snowugmen tation	390 km^2	NOAA 97-957 98-987	Northern Utah		Muni Cache County		Agl Total consumption 22.938 kg		Jan to Feb 17 days Dec 3 days	Report available
US-50	PE Snow Augmentation	26,000 km^2	NOAA 97-958 98-1000	Central and Southern Utah		Utah Water Resource Development Corporation		Agl Total consumption 53.254 kg		Jan to March 25 days Nov to Dec 5 days	Report available
US-51	PE Snow Augmentation	468 km^2	NOAA 97-960	Wind River Wyoming		Eden Valley Irrigation and Drainage District		Agl. Total consumption 0.036 kg		February 1 day	Report available
US-52	PE		NOAA 98-961	Santa Barbara California		Muni		Agl. Total consumption 4.564 kg		Jan to Dec. 9 days	Report available
US-53	PE Snow Augmentation		NOAA 98-962	Butte, Clarke, and Jefferson City, Idaho		East Idaho Counties and Irrigation District		Agl. Total consumption 5.837kg		Jan to March 26 days	Report available
US-54	PE	75 km^2	NOAA 98-963	District V Idaho		Omeida County				Jan to April	Report available
US-55	PE	9,100 km^2	NOAA 98-964	Colorado River Texas		Colorado River Municipal Water District		Agl. Total consumption 2.2kg		May to September 20 days	Report available
US-56	PE Hail	6,209 km^2	NOAA 98-965	North Dakota District I		N. Dakota Atmospheric research Board		Agl. Total consumption 33.36 kg Dry Ice 1073 kg		June to August 35 days	Report available
US-57	PE Hail	23,278 km^2	NOAA 98-966	North Dakota District II		N. Dakota Atmospheric Research Board		Agl. Total consumption 143.04 kg dry ice 2,034.1 kg		July to August 39 days	Report available
US-58	PE Hail	23,278 km^2	NOAA 98-967	West Kansas		W Kansas Ground- Water Manage ment District		Agl. Total consumption 16775 kg Dry ice 1435 .9 kg		May to Sept. 68 days	Report available

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

US-59	PE	1,170 km^2	NOAA 98-968	Eastern Sierra California		Muni		Agl. Total consumption 20.26 kg		Jan to Dec 26 days	Report available
US-60	PE	1,300 km^2	NOAA 98-969	Kaweah River California		Kaweath Delta Water Conser vation District		Agl. Total consumption 6.821 kg		Jan to Dec 23 days	Report available
US-61	PE	3,120 km^2	NOAA 98-970	Kern River California		North Kern Water Storage district		Agl. Total consumption 10.305 kg		Jan to Feb 20 days	Report available
US-62	PE	4,160 km^2	NOAA 98-971	Kings River California		Kings river Conservation District		Agl. Total consumption 17.734 kg		Jan to Feb 19 days	Report available
US-63	PE	2,080 km^2	NOAA 98-972	Monterey County California		Muni Monterey City Water Resource Agency				Jan to Feb	Report not available
US-64	PE	3,120 km^2	NOAA 98-973	San Joaquin River California		(P) Southern California Edison Company		Agl. Total consumption 24.57kg		Jan to Dec 43 days	Report available
US-65	PE	3,120 km^2	NOAA 98-974	Tuolumne River California		Turlock Irrigation District		Agl. Total consumption 1.6kg		Jan to Dec 15 days	Report available
US-66	PE	22,100 km^2	NOAA 98-975	South Texas		S. Texas Weather Modification Association		Agl. Total consumption 16.795 kg		May to Sept 42 days	Report available
US-67	PE	40,625 km^2	NOAA 98-976	Central and Southern High Plains Texas		High Plains Windgrd Water Conser vation		Agl. Total consumption 40.717kg		May to Sept 48 days	Report available
US-68	PE Hail	178,506 km^2	NOAA 98-977	Oklahoma		Oklahoma Water Resource Board		Agl. Total consumption 399.617 kg		May to October 93 days	Report available
US-69	PE	15,114 km^2	NOAA 98-978	Texas		Texas Border Weather Modification Associa tion		Agl.. Total consumption 2.901 kg		Aug to Sept. 17 days	Report available
US-70	PE Snow Augmentation	260 km^2	NOAA 98-979	Alta/Snowbir d Utah		Snowbird Ski Resort (P)		Agl. Total consumption 2.386 kg		Oct to Dec 15 days	Report available
US-71	PE Snow Augmentation	2600 km^2	NOAA 98-980	Central Colorado		(P) Vail and Beaver Greek Ski Area		Agl. Total consumption 5.31 kg		Nov to Dec 18 days	Report available

IV. REGISTER OF 1997-1998 REPORTED PROJECTS

US-72	PE Snow Augmentation	130km^2	NOAA 98-982	Central Utah		Emery County				Dec	Report not available
US-73	PE Snow Augmentation		NOAA 98-986	Clark Country Utah		Eastern Idaho Counties Irrigation District				Dec	Report not available
US-74	PE Snow Augmentation	156 km^2	NOAA 98-988	Telluride - San Miguel		South western Water Conservation District		AgI.Total consumption 1.823kg		Nov to Dec 10 days	Report available
US-75	PE Snow Augmentation	442 km^2	NOAA 98-998	Grand Mesa Project Colorado		Water Enhancement Authority				December	Report not available
UZBEKISTAN											
UZ-1	Op. Hail	7380 km^2	Hail suppression project	Fergan Valley, Surhardaryn , Kashkadaryn and Samarkand regions	1969 every year Yes	Agr (G)	In-cloud seeding with rockets with pyrotechnic flares. Seeding in layer from −6°C to −10°C.	AgI at a rate of 20g/km^3 Total consumption 40kg-1997 47kg-1998	Convective clouds with bases warmer than 10°C and tops colder than −20°C. Seeding criteria based on strong radar echoes	Apr to Aug each year 31 days-1997 37 days-1998	Evaluation based on comparison with historical records. Report available EIS-No C/B-Yes

V. ADDRESSES OF REPORTING AGENCIES

AUSTRIA	Central Institute of Meteorology and Geodynamics. Department of Climatology Hohe Warte 38 A-1190 VIENNA
BULGARIA	National Institute of Meteorology and Hydrology Bulgarian Academy of Sciences 66 Tsarigradski Chaussee SOFIA 1784
BURKINA FASO	Direction de la Météorologie Nationale, Cellule Scientifique et Technique du Programme SAAGA 01 BP 576 OUAGADOUGOU
CANADA	Atmospheric Environment Service 4905 Dufferin street DOWNSVIEW, Ontario, M3H 5T4
CHILE	Direccion Meteorologica de Chile, Departmento Meteorologia Applicada, Correo Aeropuerto Internacional AMB, Casilla 63 SANTIAGO
FRANCE	Association Nationale d'Etude et de Lutte contre les Fléaux Atmosphériques 52 rue Alfred Duméril 31400 TOULOUSE
GERMANY	University of Hohenheim D-70893 STUTTGART
	Landratsamt REMS, NVRR, D-71338 WAIBLINGEN-PF1419
GREECE	Hellenic Agricultural Insurance Organization 45 Mesogion Street P.O. Box 14103 11510 ATHENS
HUNGARY	NEFELA Association 7602 PECS Pf13

ISRAEL	Israel Meteorological Service Rain Enhancement Division P.O. Box 20 BEN GURION AIRPORT 70100
JAPAN	Japan Meteorological Agency, Meteorological Research Institute, 1-1 Nagamine, 1-2 TSUKUBA, Ibaraki 305-0052
JORDAN	Jordan Meteorological Department Jordan Precipitation Enhancement Programme P.O. Box 341011-Marka AMMAN
LIBYAN ARAB JAMAHIRIYA	Meteorological Department, Weather Modification Research Division P.O. Box 5069 TRIPOLI
MACEDONIA, THE FORMER YUGOSLAV REPUBLIC OF	Republic Hydrometeorological Institute, Skupi bb 91000 SKOPJE
MALAYSIA	Malaysian Meteorological Service Ibu Pejabat Kajicuaca Jalan Sultan 46667 PETALING JAYA
MOLDOVA	Anti Hail Service Ministry of Agriculture and Processing Industry Grenoble str. 193 2043 CHISINAU
MOROCCO	Direction de la Météorologie Nationale BP 8106 Casa Oasis 20203 CASABLANCA
PHILIPPINES	Bureau of Soils and Water Management National Rain Stimulation Office Elliptical Road, Diliman-1104 QUEZON CITY Philippines Air Force, AFROC Fernando Air Base, LIPAR CITY
RUSSIAN FEDERATION	Russian Federal Service for Hydrometeorology and Environmental Monitoring, 12 Novovaganikovsky street 12 MOSCOW 123242

SOUTH AFRICA	South African Weather Bureau Private Bag, X15 BETHLEHEM 9700
SPAIN	Servicio Interprovincial de Defensa, Antigranizo de Alava, La Rioja y Navarra 4 Milicias 4-1 26003 LOGRONO
SYRIAN ARAB REPUBLIC	Meteorological Department of Syria, Rain Enhancement Project, Joul Jammal Street P.O. Box 4211 DAMASCUS
UNITED STATES OF AMERICA	National Oceanic and Atmospheric Administration, National Weather Service, 1325 East-West Highway SILVER SPRING, MD 20910-3283
UZBEKISTAN	Main Administration of Hydrometeorology, 72K, Makhsumov st. 700052 TASHKENT

VI. MEMBER COUNTRIES REPORTING ON COMPLETED PROJECTS

LOCATION AND TERRAIN	PURPOSE AND DURATION	AGENT AND ALTITUDE OF SEEDING	REFERENCES TO PUBLISHED RESULTS	CONTACT FOR INFORMATION
ARMENIA				
Armenia	Hail suppression and precipitation enhancement -began in 1966 and ended in 1991. For the benefit of agriculture	Ground-based and airborne seeding with AgI at temperatures of -6°C + 3°C. Seeding of both convective and orographic clouds at tops and in cloud. Clouds with bases colder than 10°C and tops colder than -20°C. Seeding criteria based on cloud particles between 10^{-10} and 10^{-12} cms at greater than 2 km altitude.	Evaluation done based on crop damage. Report available. Both environmental assessment and cost benefit analysis undertaken	R.S. Ovsepyan Armenhydromet Centre for Weather Modification Leo Str 54 Erevan 375002 Armenia
BULGARIA				
In Northern Danube plain and upper Tracian lowland (22°30' E to 24°40'E and 24°00' E to 26°30'E respectively). Hilly and flat terrain target area 15,000 km^2 (since 1990) control 60,000 km^2. Areas fixed	Hail suppression from 1969 to 1995 during April to September period. A total of 1130 days when seeding occurred.	Ground based seeding with AgI and PbI2 (until 1993) at -5°C to -10°C level in convective clouds. Verification quantities: radar reflectivity, hailpads. Seedability: forecast of hail probability and radar criteria. Statistical test: double mass ratios bevariate test, randomisation t-test, physical statistical method. Result: qualitative-less hail mass, less loss to risk ratio (L/R. Less damaged) crop area to crop area ratio (RDA/DA); quantitative -45% decrease in L/R until 1979 (0.01 significance), 55% decrease in RDA/DA until 1980 (0.05 significance), 71% decrease in RDA/DA until 1994 (comparison target-historical mean at less than 0.01 significance).	Simeonov P. Report of the Meeting of Experts on the Evaluation of Hail Suppression Experiment, Nalchik, Russia, WMO/TD 97, 21-35, 1986 Simeonov P: Preprints, Fifth WMO Scientific Conference on Weather Modification and Applied Cloud Physics, Beijing, China, Vol II, WMO/TD No. 269, 617-620. Simeonov P: Atmospheric Research 28, 1992, 227-235. Simeonov P: Atmospheric Research 28, 1992, 227-235. Simeonov P: J. Appl Meteorology 35 No.9, 1574-1581, 1996. Simeonov P. Preprints Seventh WMO Scientific Conf. on Weather Modification, Chiang Mai, Thailand, Vol II, WMO TD No. 936, 379-382	Hail Suppression Department. Ministry of Agriculture, Forestry and Agrarian Reform, Blvd Hristo Botev 17 1606 SOFIA Bulgaria
CHILE				
Fifty square kilometer target area covering both mountainous and flat terrain. Target only. Variable	Both rain and snow augmentation during specific periods in 1994, 95, 98 and 1999 usually between May and September	Air-based seeding with AgI between 3000 to 6000 m along a 50km track based on severity of drought in each area. Area seeded is supported by 2 raingauges. Seeding verification based on radar reflectivity. Seeding criteria based on forecast models, radar reflectivity, aircraft icing and local forecast knowledge. Unrestricted randomisation. Seeding period 45 hours. Qualitative results: more precipitation. No basis for assessments. extended area effects noted 100km away but not computed. There are no tests or analysis previous to project. There is a lack of expertise necessary for better project preparation.	Final report dated March 1999 by the Centro Privado de Servicios Aereos Ltda for Ministry of Agriculture (available from WMO in Spanish)	Direccion Meteorologica de Chile. Departamento Meteorologia Applicada. Correo Aeroporto International AMB Casilla 63, Santiago, Chile

FRANCE				
Hilly terrain in southwest, centre, centre east and southeast of France. Target 60,000km^2. Fixed	Hail suppression from both convective and frontal clouds. 46 years. 15 April to 15 October	Agent: AgI from more than 600 ground based generators. Verification aided by a network of 1000 hail pads installed in target zone. Experimental unit of 1 day. Decision on seeding based on forecast of hail greater than 15mm diameter (23 days in 1997, 16 days in 1998). seeding period 8 hours per day. Evaluation method correlation between emissions of AgI and hailfall intensity. Quantitative results show 42% decrease of hail with diameters more than 7mm. Statistical significance better than 95% at 0.05 significance.	ANELFA, 1998: rapport sur la campagne 1997-no46, 37pp. ANELFA, 1999: rapport sur la campagne 1998 - No. 47, 46pp. Dessens J. 1998: A physical evaluation of a hail suppression project with silver iodide ground burners in southwestern France. J. Appl. Meteo 37, 1598-1599. Dessens J.J.L. Sanchez and R. Fraile 1999. Response of silver iodide ground seeding on different types of hailstorms as measured with hailpads. Seventh WMO Scientific Conference on Weather Modification, Chiang Mai, Thailand, 17-22 February 1999, WMP report 31, WMO/TD No. 936, 387-390.	Association Nationale d'Etude et de Lutte contre les Fléaux Atmosphériques 52 rue Alfred Duméril 31400 TOULOUSE
GERMANY				
Hilly terrain in Stuttgart area. Target: 2000km^2 Control 7000 km^2 Areas are fixed and crossover each other.	Hail suppression. Since 1980. Targets both convective and frontal clouds. April to October each year.	Airborne seeding of AgI at 1.4 kg/hour along a track about 10km and also back. Altitude about 1500 m at base of cloud. Number of precipitation gauges variable but about 70 and 100 in target and control area, respectively, including about 4 and 2 recording gauges. Seeding based on 00UTC aerological index, radar information and criteria for potential cloud development. Number of units seeded and not seeded: 1997 - 17 days with 19 operations, 1998 - 8 days with 9 operations. Standard seeding period: 15 hours per day. Extended area effects: precipitation frequency and amount on seeded and unseeded days. see WMO register for 1992, 1993/94, 1995, 1996		University of Hohenheim, D-70893 STUTTGART LANDRATSAMT, REMS.NVRR D-71338 WAIBLINGEN PF 1419

JORDAN				
Hilly and flat area. Target area; 14,500km^2. Fixed	Increase precipitation during wet period and extend the wet period from orographic and frontal clouds. 5-7 months over 2 years period (Oct-Dec 1998 and Jan-May 1999)	Ground and air-based seeding, assisted by Doppler radar, with 2% solution of AgI and NaI in acetone. Seeding at a rate of 12g/hr from ground and 120g/hr from aircraft. Seeding at level -8°C to -12°C along 50 km track. 80 precipitation gauges employed. Seeding criteria: cloud top temperatures between -12 and -20°C and their liquid water content and ice particle count. Standard seeding period 70hrs. Statistical test: actual versus horizontal data; analysis precipitation efficiency maps. Results 15-20% increase in annual rainfall. From precipitation efficiency maps effects of seeding extends beyond eastern borders of Jordan. Quantitative results: seed/no seed ratio, 1:17 statistical significance 5%level.	Study on 10 year period of cloud seeding over Jordan by Eng. Inan K. Tahboub, Director of Training and Research Programme, Department of Meteorology	Jordan Meteorological Department PEP J, P.O. Box 341011 marka AMMAN
MOROCCO				
Mountainous terrain in the Central Atlas Mountains. Target area 16,400 km^2 Control area 6,000 km^2. Target and control. Distance 100kms between them. Fixed	Rain and snow augmentation from all types of clouds. Seeding carried at between November and April for the last 15 years.	Ground and air based seeding with AgI and NAI, including 15 generators on the ground. Seeding rate 375 g/hr along a 60km track between 0° and -5°C. Evaluation basis from 20 and 10 gauges in target and control areas, respectively. Conditions on whether to seed or not based on microphysical modelling. Radiosondes, satellite photography and aircraft data. Quantitative results show increased precipitation, statistically significant. Verification quantities: river flows and snowpack.	See register for 1995	Direction de la Météorologie Nationale BP8106 CASABLANCA-OASIS
SYRIAN ARAB REPUBLIC				
All types of terrain. Target area: 150,000km^2. Control area, variable area definition variable	Rain augmentation from orographic, cumulus and frontal clouds. Since 1991 Nov-May period	AgI seeding at altitudes between 3 and 7.5km along various length tracks with a seeding rate of 1 to 5 kg/hr. Standard seeding duration 200h/year. Basin for evaluation from 125 precipitation gauges in target area, including 32 recording gauges. Verification quantities: radar, aircraft measurements, satellite images: Results: see/no-seed ratio 109 to 142%, R=0.95	1. Sixth WMO Scientific Conference on Weather Modification (Paestrum, May/June 1994), WMO/TD No. 596, p.325. 2. Seventh WMO Scientific Conference on Weather Modification (Chiang Mai, February 1999),p.118,p.161 3. Annual Syrian Cloud Seeding Evaluation	Meteorological Department of Syria. Rain Enhancement Project Joul Jammal Str P.O. Box 4211 DAMASCUS

UZBEKISTAN				
Hilly terrain near Tashkent city. Target area 250 km^2. Fixed	Dispersion of cumulus, frontal and stratiform cloud to prevent precipitation. Between 6h and 16h in March. 7 years	Airborne seeding between 4 and 7 km altitude over track 30-40 km long with CO_2 and liquid nitrogen. Seeding rate 180-360 kg/hr. Five precipitation gauges in target area. Verification quantity: radar. Unit 10 hours. Seeding criteria: top of cloud colder than -4°C and more than 400 m thick. Results: absence of precipitation and gaps in the clouds. No analysis prior or after project.		Main Administration of Hydrometeorology 72 Makhsumov street TAKSHKENT 700052
Mountainous terrain. Fixed target, 7380km^2	Hail suppression for protection of crops. April -August	Ground-based AgI seeding using rockets. Fifty eight precipitation guages in target area. Verification quantities: radar reflectivity and visits to target area to determine hail size and damage. Duration of unit: 2-30 minutes, max: 1,5 hours. Seeding criteria: radar reflectivity $R_{10} \geq 10^{-8}$ cm vertical depth of cloud with $R_{10} = 10^{-9}$ cm should be greater than or equal to 2.5km. Units seeded: 100 (prevention of hail) - 1997 33 (interruption of hail) - 1997 130 (prevention of hail) - 1998 64 (interruption of hail - 1998: Results: reduction in radar reflectivity and characteristics of clouds; presence or absence of crop damage.	1. Methodological Instructions for forecasting hail processes in mountains of central Asia by R.G. Shadeeva, Ch.A. Imadjanov, Tashkent 1987, 17pp 2. Ch. A. Imadjanov: Parameterization of hail clouds, proceed. SANII No.100, p.36-40 - Gidrometeo 1984. 3. Kamalov B.A., Sabaev W.W., Usmanov I.U.. Assessing hail prevention activities in the Valley of Fergan, Proceed CANIGMI No.100 p.56-75, 1984. 4. Ch.A. Imadjanov, Hail in NE Uzbekistan, Proceed CANIGMI, No.110, p.87-95, 1990	Main Administration of Hydrometeorology 72 Makhsumov street TAKSHKENT 700052

15. REPORTING AGENCY:

(a) Name of reporting agency:

(b) Official title of responsible office:

(c) Postal address:

. . . .
(Signature) (Date)

Please complete and return this questionnaire as soon as possible, and in any case not later than 1 October 1999

The Secretary-General
World Meteorological Organization
7 bis avenue de la Paix
Case postale 2300
1211 GENEVA 2
Switzerland

NOTES FOR COMPLETING REPORT ON WEATHER MODIFICATION ACTIVITIES

Weather modification activities which should be included in the Register

The seeding or dispersing into clouds or fog of any substance with the object of altering drop-size distribution, producing ice crystals or the coagulation of droplets, altering the development of hail or lightning, or influencing in any way the natural development cycle of clouds or their environment.

Any other activity performed with the intention of producing artificial changes in the composition, behaviour or dynamics of the atmosphere.

For example:

(a) The use of fires or heat sources to influence convective circulation or to evaporate fog;

(b) The modification of the solar radiation exchange of the earth or clouds, through the release of gases, dusts, liquids or aerosols into the atmosphere;

(c) The modification of the characteristics of land or water surfaces by dusting or treating with powders, liquid sprays, dyes, or other materials;

(d) The releasing of electrically charged or radioactive particles, or ions, into the atmosphere;

(e) The application of shock waves, sonic energy sources, or other explosive or acoustic sources to the atmosphere;

(f) The use of aircraft and helicopters to produce downwash for fog dispersal as well as the use of jet engines and other sources of artificial wind generation;

(g) The use of lasers or other sources of electromagnetic radiation.

Weather modification activities which need not be included in the Register

Activities of a purely local nature, such as the use of lightning deflection or static discharge devices in aircraft, boats, or buildings, or the use of small heat sources, fans, fogging devices, aircraft downwash, or sprays to prevent the occurrence of frost in tracts or fields planted with crops susceptible to frost or freeze damage.

Note: One completed copy of this form is requested for each weather modification activity (hereafter referred to as the project).

ADDITIONAL EXPLANATION OF QUESTIONS FOR THE REGISTER OF NATIONAL WEATHER MODIFICATION PROJECTS

ITEM 1 - Mark (X) in the box that corresponds to purpose of activity. By project is meant a related series of weather modification activities having a common objective and conducted at a particular location.

ITEM 2 - Mark (X) in the box corresponding to goal of the activity:

- Research - investigating scientific questions;
- Development - field work to optimize procedures;
- Operational - field work intended directly for economic benefits.

ITEM 3 - The Target Area is the area over which an effect is sought. The Control Area (or Areas) are areas that are chosen so as to be unaffected by the seeding material and used to evaluate results within the Target Area.

ITEM 4 - Enter the name and/or reference of projects used by operator. If the project was reported in the previous Register, please quote the WMO Register number which appears in column 1.

ITEM 5 - Indicate the location of the weather modification project by geographical co-ordinates and name of the region.

ITEM 6 - (a) Enter the year in which the first activities under the present project took place;

(b) Indicate if there were breaks in activities or if activities took place each year since it was started;

(c) Indicate whether the project is expected to continue by marking (X) in the appropriate box.

ITEM 7 - Indicate the principal interests of the organization that funds the project by marking (X) in the appropriate box (use multiple marks if appropriate).

ITEM 8 - During what months did the project operate in the field and on how many days did operations take place? Any other information related to the scope of the activity would be helpful. In some cases projects span two years. It is desirable that the portion conducted only within the reporting year be included in the Register for a particular year. If this is not practical, please indicate the years in which the activities took place, for example, December 1997, January-February 1998.

ITEM 9 - By weather modification apparatus is meant any apparatus used with the intention of producing artificial changes in the composition, behaviour or dynamics of the atmosphere. For example: AgI smoke generators, propane devices, flares, rockets, artillery projectiles, jet engines, etc.

(a) Seeding delivery system. Indicate, by marking (X) in the appropriate box, the nature of the delivery system, ground based, airborne, etc.;

(b) Indicate the way the seeding material is prepared for dispersal (e.g., by burning an acetone solution of silver iodide complex). Solid dispersal refers to the release of pellets (e.g., dry ice), powder (e.g., NaCl), etc.;

(c) Indicate the location at which seeding material is dispersed;

(d) Indicate what seeding material is used and the rate of dissemination (mass per unit of time, mass per cloud, etc.). Indicate total amount of material dispensed during the reporting period in kilograms.

ITEM 10 - (a) Indicate, by marking (X) in the box, the general characteristics of the clouds that are selected for treatment;

(b) Indicate the predominate range of cloud base temperatures;

(c) Indicate the predominate range of cloud top temperatures;

(d) What are the characteristics that distinguish days or clouds that are treated from those that are not treated?

ITEM 11 - This question relates to the evaluation of the effectiveness of the project. More information on the means used to judge the merit of the project are welcomed and can be described under Item 14 or on a separate page.

ITEM 12 - This question relates to any analysis that has been made to predict and/or measure the total change in the environment that is affected by the activity and, separately, the economic benefits expected or achieved.

ITEM 13 - Please supply the name and address of agency to which any request for further information should be directed.

ITEM 14 - This item is to permit the reporting person to include any information not covered by items 1 through 13 but which he feels is significant or of interest such as references to published reports describing results of the weather modification operation or experiment. Any information not previously reported, definite plans for a new project, information that is sought, etc., may be outlined under Item 14.

ITEM 15 - Please supply the name and address of the agency that is transmitting this information to WMO.

ANNEX B

REPORT ON COMPLETED MODIFICATION PROJECT

(Please mark X in box or boxes which apply)

MEMBER OF WMO:

1. DESCRIPTION OF PROJECT

1.1 Project identification (name/location/organization):

1.2 Purpose(s) of project

Precipitation augmentation - rainfall ❑ snow ❑

Hail suppression ❑

Lightning suppression ❑

Other (please specify):

1.3 Major cloud type involved:

Orographic ❑ Cumulus ❑ Stratiform ❑ Frontal ❑

2. DURATION OF PROJECT

2.1 Project duration in years:

2.2 Operational period within each year:

From: . . . . To: . . . . inclusive.

3. SEEDING OPERATION

3.1 Seeding agent: AgI ❑ CO_2 ❑ NaCl ❑

Other (please specify):

3.2 Generator(s): On ground ❑ Airborne ❑

If on ground, please give number of generators:

3.3 Procedure for airborne seeding:

Altitude of seeding (m):

Length of seeding track (m or km):

Seeding rate (kg h^{-1}):

4. PROJECT DESIGN

4.1 Basic design:

Target only ❑ Target + control ❑ Cross-over ❑

4.2 Distance between areas (km):

4.3 Area definition:

Fixed ❑ Variable ❑

If variable, give basis for definition:

4.4 Area subdivisions, if any (give number and nature):

5. PROJECT SITE

5.1 Project terrain:

Mountainous ❑ Hilly ❑ Flat ❑

5.2 Size of target area (km^2):

5.3 Size of control area (km^2):

5.4 Number of precipitation gauges:

5.4.1 All types of precipitation gauges in target area:

All types of precipitation gauges in control area:

5.4.2 Recording precipitation gauges in target area:

Recording precipitation gauges in control area:

5.5 Other verification quantities (e.g. radar reflectivity, aircraft cloud measurements, hailpads)

6. EXPERIMENTAL UNIT

6.1 Duration of unit in hours or days:

6.2 Conditions determining whether unit is seedable or not:

6.3 Total number of units seeded and not seeded (in case of cross-over design this applies to each area):

6.4 Randomization of experimental units:

Unrestricted ❑ Restricted ❑

If restricted, give nature of restriction:

6.5 Standard seeding period (hours):

7. OVERALL PROJECT RESULTS (no stratification or partitioning)

7.1 Name of statistical test(s) and/or analysis (analyses):

7.2 Transformation(s) for each test:

7.3 Results for each test and/or analysis:

7.3.1 Qualitative:

No difference ☐ More precipitation ☐ Less precipitation ☐ Less Hail Mass ☐

Other qualitative results:

7.3.2 Quantitative:

Seed/no-seed ratio: . . . . Statistical significance:

8. BASIS FOR ASSESSMENT OF RESULTS

8.1 Analytical specifications fixed BEFORE the project began

8.1.1 Nature of stratification(s), if any:

8.1.2 Sample size for each stratification (No. of seed/no-seed units):

Seed: . . . . No seed: . . . .

8.1.3 Test(s) and/or analysis (analyses) for each stratification:

8.1.4 Transformation(s) for each stratification and each test:

8.1.5 Results for each stratification, test and transformation:

Qualitative: Quantitative:

8.2 Analytical specifications chosen AFTER the project began

8.2.1 Nature of partitioning(s):

8.2.2 Sample size for each partition (No. of seed/no-seed units):

Seed: . . . . No seed: . . . .

8.2.3 Test(s) and/or analysis (analyses) for each partition:

8.2.4 Transformation(s) for each partition and each test:

8.2.5 Results for each partition, test and transformation:

Qualitative: Quantitative:

9. EXTENDED AREA EFFECTS (i.e. outside the target area)

9.1 Sign of effect:

9.2 Maximum distance observed:

9.3 Statistical significance (size of area and probability):

10. COMMENTS

11. PRINCIPAL REFERENCES TO PUBLISHED RESULTS (where details of above may be found):

WEATHER MODIFICATION PROGRAMME REPORTS

1. Review of Warm Cloud Modification by Bh. V. Ramana Murty (September 1984) (TD No. 5)
2. Papers presented at the Fourth WMO Scientific Conference on Weather Modification (Honolulu, Hawaii, 12-14 August 1985) (TD No. 53)
3. Notes for the International Cloud Modelling Workshop/Conference (Irsee, Federal Republic of Germany, 15-19 July 1985) (out of print) (TD No. 57)
4. Register of National Weather Modification Projects 1983 (November 1985) (TD No. 78)
5. The Evaluation of Hail Suppression Experiments - Report of Meeting of Experts (March 1986) (TD No. 97)
6. Information concerning Weather Modification directed to Government Decision-Makers (June 1986) (TD No. 123)
7. Trends in Weather Modification. 1975-1983 (L.R. Koenig, Geneva, November 1986)
8. Report of the International Cloud Modelling Workshop (Irsee, Germany, 15-19 July 1985) (TD No. 139)
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15. Report of a Meeting of Experts to Review Findings and Make Recommendations on the Saudi Arabia Cloud Physics Experiment (SACPEX) (Geneva, 14-16 November 1990)
16. Report of the Seventeenth Session of the Executive Council Panel of Experts/CAS Working Group on Physics and Chemistry of Clouds and Weather Modification Research (Geneva, 19-23 November 1990)

17. WMO Meeting of Experts on the Role of Clouds in the Chemistry, Transport, Transformation and Deposition of Pollutants (Obninsk, 30 September - 4 October 1991) TD No. 448)

18. Register of National Weather Modification Projects 1990 (TD No. 449)

19. Proceedings - WMO Workshop on Cloud Microphysics and Applications to Global Change (Toronto, Canada, 10-14 August 1992) (TD No. 537)

20. Report of the Third International Cloud Modelling Workshop (Toronto, Canada, 10-14 August 1992) (TD No. 565)

21. Register of National Weather Modification Projects 1991 (TD No. 575)

22. Sixth WMO Scientific Conference on Weather Modification Volumes I and II (Paestrum, Italy, 30 May - 4 June 1994) (TD No. 596)

23. Register of National Weather Modification Projects 1992 (TD No. 686)

24. Eighteenth Session of the Executive Council Panel of Experts/CAS Working Group on Physics and Chemistry of Clouds and Weather Modification Research (Geneva, Switzerland, 30 January - 3 February 1995) (TD No. 687)

25. Register of National Weather Modification Projects 1993 and 1994 (TD No. 745)

26. Expert Meeting to Review the Present Status of Hail Suppression (Golden Gate Highlands National Park, South Africa, 6-10 November 1995) (TD No. 764)

27. Nineteenth Session of the Executive Council Panel of Experts/CAS Working Group on Physics and Chemistry of Clouds and Weather Modification Research (Geneva, Switzerland, 5-9 May 1997) (TD No. 820)

28. Register of National Weather Modification Projects - 1995 (TD No. 851)

29. Report of the Fourth International Cloud Modelling Workshop (Clermont Ferrand, France, 12-16 August 1996) (TD No. 901)

30. Proceedings of the WMO Workshop on Measurements of Cloud Properties for Forecasts of Weather and Climate (Mexico City, 23-27 June 1997) (TD - No. 852)

31. Seventh WMO Scientific Conference on Weather Modification (Chiang Mai, Thailand, 17-22 February 1999) (TD No. 936) (3 volumes)

32. Register of National Weather Modification Projects 1996 (WMO-TD No. 939)

33. Report of the WMO Workshop for the Planning of Precipitation Enhancement Projects in the Mediterranean, S.E. Europe and Middle East Countries (MEDSEEME-PEP) (Monselice, Italy, 8-11 December 1999) (WMO-TD No. 998)

34. Register of National Weather Modification Projects 1997 and 1998 (WMO-TD No. 1001)