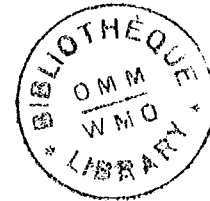


WORLD METEOROLOGICAL ORGANIZATION:

CLOUD PHYSICS
AND
WEATHER MODIFICATION RESEARCH PROGRAMME
(WMP Report No. 9)

REGISTER
OF
NATIONAL WEATHER MODIFICATION PROJECTS
1984 and 1985



Technical Document
WMO/TD - No. 182



GENEVA, July 1987

551.509.61 (05)
WMO

NOTE

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WMP 9
TD 182

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I. INTRODUCTION

As part of the Weather Modification Programme approved by the Seventh World Meteorological Congress (Geneva, 1975), and re-established as the Cloud Physics and Weather Modification Research Programme by the Tenth Congress (1987), the Secretary-General maintains a Register of experiments and operations in weather modification carried out within Member countries.

The present publication is the tenth of its kind and is based on information received from Member countries on experiments and operations sponsored by governmental agencies and private concerns that took place during 1984 and 1985. Data for each year are segregated. For various reasons, the Register does not contain information on all weather modification projects.

The first seven issues of the Register were similar in layout and in the gathered information. The eighth issue (1982) contained substantially different information and format than did the earlier Registers. With the endorsement of the EC Panel of Experts/CAS Working Group on Cloud Physics and Weather Modification (fifteenth session, 1983), the 1983 issue returned to the format and information of the first seven issues (with some modifications). This Register continues that tradition except that, in accordance with Resolution 24 (Cg-IX) data for the two years 1984 and 1985 were gathered at one time and are reported in this publication.

To assist the reader in understanding the contents of each of the 12 columns used in the tabular presentation, detailed explanations are given in Section II. The questionnaire which was sent to all Members in June 1984 is reproduced, in Annex A of Appendix C to the report, in the four official languages of WMO, to ensure that the tabular information will be readily understood by all readers. Information from these questionnaires related to 1984 projects is given in Part IV of the Register and Part VI contains information on 1985 projects. The form to be used in reporting completed programmes or for which a physical and/or statistical evaluation has been carried out is reproduced as Annex B of Appendix C. Reports on completed programmes are found in Section VIII.

The list of Members for which information is included in the Register is given in Section III for 1984 data and Section V for 1985 data. The Members which replied that no weather modification activities had taken place in their country during 1984 are listed in Appendix A and in Appendix B for 1985.

Requests for further information on the projects may be addressed to the reporting agency for each country which is included in Section VII of the Register. The WMO Secretariat will be happy to assist if necessary.

II. DETAILED EXPLANATIONS OF COLUMNS USED IN TABULAR INFORMATION IN THE REGISTER

(The figure in brackets following the column heading title is the similar item in the questionnaire shown in Appendix C).

Column 1: WMO Register No.

This consists of country indicator letters (according to the ISO Standard 3166-1974) and a serial number for each project.

Column 2: Objective of project, type of organization carrying it out (1) and (2)

Dev.	=	Development	PE	=	Precipitation Enhancement
Fog	=	Fog dissipation	(E)	=	Emergency
Hail	=	Hail suppression	(R)	=	Routine
Op.	=	Operational	PR	=	Precipitation Redistribution
			Res.	=	Research

Column 3: Approximate size of project area (3)

Given in square kilometers for target and control (if any) areas.

Column 4: Name of project (4)

Reference numbers are also quoted when supplied.

Column 5: Location of project area (5)

In some cases where co-ordinates of several points delineating the area were given, these have been replaced by a single point at approximately the centre of the area. Towns and islands may be denoted by name; A/P = Airport.

Column 6: Year project commenced and whether or not it will be continued (6)

No = indicates project will not be continued
Yes = indicates project will be continued
(?) = indicates project status is unknown

Column 7: Nature of organization sponsoring project (7)

Indicated by abbreviations as follows:

Agr.	=	Agricultural	(P)	=	Private
Def.	=	Defense	Rec.	=	Recreation
(G)	=	Government	Res.	=	Research
Hyd.	=	Hydrological	Trans.	=	Transportation
Muni.	=	Municipal	Wea. Ser.	=	Meteorological

Column 8: Apparatus, seeding location (8)

Abbreviations are as follows:

Air = Airborne
A/C = Aircraft

G/B = Ground-Based
Temp. = Temperature

Column 9: Agents, dispersal rates (8)

Self-explanatory.

Column 10: Characteristics of clouds treated, seeding criteria (9)

LWC = Liquid water content Temp. = Temperature
Obs. = Observations

Column 11: Active period during reporting year (10)

Months of activity are inclusive.

Jan = January
Feb = February
Mar = March
Apr = April
May = May
June = June

July = July
Aug = August
Sept = September
Oct = October
Nov = November
Dec = December

Column 12: Documentation (12 and 13)

First (Yes or No) applies to analysis of costs and benefits;
Second (Yes or No) applies to provisions for evaluation. The
notation (H) indicates that the evaluation is based on comparison
of historical data.

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(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>ARGENTINA</u>											
AR 1	Res. Dev. Op. Hail	1500 Target	Mendoza Gov. Dirección de Investigación de Lucha Antigranizo	Central San Martín Northern Province of Mendoza	1978 Yes	Agr. (G), (P)	Air & G/B: in-cloud seeding at -6 to -10°C using rockets	16.8 g per rocket 35 kg AgI total	Convective clouds; predominant cloud base temp. +4 to +10°C. Operations alert based on weather service severe storm forecast; seeding criteria based on 10 and 3.2 cm radar reflectivity.	169 days: Oct-Mar	Yes/ Yes (H)
<u>AUSTRIA</u>											
AU 1	Op. Hail	500 Target	Hail Defense Project "Lower Austria"	Districts of Krems-Langenlois	1981 Yes	Agr. (P)	Air: 2 A/C, cloud base seeding with acetone burners	10 l/hr (7% AgI solution), 40 hr burning/yr	Convective clouds; predominant cloud base temp. +12 to +16°C. Operations alert based on thunderstorm forecast from the Vienna Airport; seeding alarm based on radar echo intensity greater than 35 DBZ.	20 days: 15 May to 15 Sept	No/ Yes (H)
AU 2	Op. Hail	1600 Target	Hail Defense Project "Styria"	Districts of Gleisdorf-Weiz	1982 Yes	Agr. (P)	Air: 4 A/C, cloud base seeding with acetone burners	10 l/hr (7% AgI solution), 70 hr burning/yr	Convective clouds; predominant cloud base temp. +12 to +16°C. Operations alert based on thunderstorm forecast from the Vienna Airport; seeding alarm based on radar echo intensity greater than 35 DBZ.	30 days: 15 May to 15 Sept	No/ Yes (H)
<u>BULGARIA</u>											
BG 1	Res. Dev. Op. Hail	14000 Target	BG 1	42°N - 24°E; 43°30'N- 23°30'E	1969 Yes	Agr. (G), Wea. Ser. (G)	Air: in cloud seeding at T = -5 to -10°C using rockets	11500 kg PbI ₂ (total)	Convective clouds; predominant cloud base temp. +13°C. Seeding criteria based on radar reflectivity.	36 Days: May-Sept	Yes/ Yes (H)
<u>CANADA</u>											
CA 1	Res. PE PR	10200 Target	Southern Alberta Cloud Seeding and Plume Study	Southern Alberta - High River - Granum - Vauxall area	1981 Yes	Agr. (G), Res. (G)	G/B: 83 impregnated coke & arc rod generators at 62 locations	0.2 to 30 g/hr/ generator, 29.127 kg AgI total	Convective clouds; predominant cloud base temp. 0° to -5°C. Operations criteria based on upper level synoptic circulation, air mass characteristics & wind flow levels for the AgI plume concentration.	27 Days: 18 June to 13 Aug	Yes/ Yes (H)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>CANADA</u>											
CA 2	Res. PE(E), Hail	20000 Target Control	Alberta Hail Project	130 km radius of Red Deer Industrial Airport	1974 - 1979 operation; 1980-1984 experimental	Agr. (G), Res. (G)	Air: cloud base, top & in-cloud at -8 to 0°C using 5 aircraft 6 acetone burners, (AgI), pyrotechnic flare (AgI) generators, (solid CO ₂) dispensing generator	2250 g/hr wing pyrotechnics; 14400 g/hr droppable pyrotechnics total of 195.18 kg; 130 g/hr AgI, NH ₄ I acetone burners, total consumption 376.8 lt.	Convective clouds; predominant cloud base temp. 0°C. Operations criteria based on radar obs. that cloud growth meets seeding criteria followed by A/C monitoring that confirms that the internal structure of clouds (temp., drafts, particle spectra meet the seeding criteria.	29 Days: 20 June to 31 Aug	Yes/ Yes (H) Randomized experiment
<u>DOMINICAN REPUBLIC</u>											
DM 1	Op. PE	6500 Target Control	Water Augmentation for Hydroelectric Operations of the Dominican Electric Corp.	18°20'N, 70°20'W; 19°20'N, 71°20'W	1984 Yes	Energy (G)	-	Mixture of NaI, NH ₄ I, acetone burned in propane flame	Convective clouds, operations criteria based on sounding and radar echo.	-	-
<u>FRANCE</u>											
FR 1	Op. & Res. Hail	55000 Target Control	Association Nationale d'Etude et de Lutte Contre les Fléaux Atmosphériques (Prévention de la Grêle)	Southwest France, Depts. 09, 11, 16, 17, 31, 33, 40, 64, 65, 66, 81	1952 Yes	Agr. (P) Type 1901 Assoc.	G/B: 448 acetone burners	8 g/hr/generator, 591 kg AgI total	Convective clouds; predominant cloud base temp. 0 to +10°C.	20 to 42 Days: (depending on Dept.) Apr-Oct	Yes/ Yes (H)
<u>GERMANY, FEDERAL REPUBLIC OF</u>											
DE 1	Res. Hail	1700 Target Control	Hail Suppression in Oberschwaben	Southern Federal Republic of Germany Kreis-Ravensburg	1978 Yes	Agr. (G), Agr. (P)	Air: cloud base seeding using 2 A/C and acetone burners	13 kg AgI total	Convective clouds; predominant cloud base temp. +5°C.	30 Days: May-Sept	Yes/ Yes (H)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>GERMANY, FEDERAL REPUBLIC OF (Contd.)</u>											
DE 2	Op. Res. Hail	2700 Target 7000 Control	Hail Suppression Project Stuttgart Area	Stuttgart area	1979 (1980 op- era- tions Yes	Agr. (G), Agr. (P)	Air: cloud base seeding using 1 A/C and pyrotechnic flares	70 g/l solution/ flare (or 2×10^{12} AgI particles/ flare), 194 flares total (AgI)	Convective clouds, predominant cloud base temp. +15°C (highly variable). Operations criteria based on upper air stability, & 24-hr forecast. Seed- ing criteria based on radar echo greater than 25 DBZ above 0°C isotherm & RHI tops above 25000 feet.	May-Oct	Yes/Yes Hail pads, hail cell analysis
DE 3	Ops. Hail	200 Target 400 Control	Hail Suppression Mühlendorf- Altötting	Bavaria, FRG	1983 Yes	Agr. (G- local)	Air: cloud base seeding using 1 A/C and acetone burner	4 l/hr HSEOLL, 100 l total	Convective clouds, predominant cloud base temp. 0 to +30°C. Operations use informa- tion from the Munich Meteorological Office.	31 Days: May-Aug	No/No
DE 4	Ops. Hail	2800 Target 2800 Control	Weather Modification Project - South Bavaria Area Rosenheim Miesbach	Country District Rosenheim Miesbach	1957 Yes	Agr. (G- local)	Air: cloud base seeding using 1 A/C acetone burner	10 kg AgI - acetone solution/ hr (700-800g AgI/ hr), 210 kg solution total	Convective clouds, predominant cloud base temp. +4 to +6°C. Cb with tops above specified threshold level are seeded.	25 Days: 1 May - 15 Sept	Yes/No
<u>HUNGARY</u>											
HU 1	Op. Hail	1500 Target (from 1983 Regis- ter) 2500 total HU 1 & HU 2 report- ed in 1985	Hail Suppression Project of Baranya County	South Hungary 45°55'N, 46°05'N, 18°55'E	1976 Yes	Wea. Ser. (G), Ins. (G)	Air: in-cloud seed- ing between -5 and -10°C using rockets	1508g "Oblako", 66g "PGI-M" and 408g "Alazany" rockets 1200 kg PbI ₂ total (for HU 1 (1984/85) and HU 2 (1985)	Convective clouds, mesoscale bands. Criteria for seeding: height of 40 DBZ radar echo (S band MRL-5) & tendency parameter of cell development.	21 Days: Apr-Oct	Yes/ Yes (H)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>INDIA</u>											
IN 1	Res. PE	1600 Target 1600 Control	Warm Cloud Modification Experiment, Maharashtra State	Maharashtra State, 18°N to 19°06'N, 74°15'E to 74°38'E	1973 Yes	Wea. Ser. (G)	Air: in-cloud seeding 600 m above cloud base using 1 A/C & solid dispensers	600 to 1800 kg/hr, 24000 kg NaCl total	Convective clouds; predominant cloud base temp. +18 to +20°C. Operations criteria based on sounding, low cloud amount, wind velocity & synoptic conditions.	July-Sept	Yes/Yes Randomized, cloud physics obs.
<u>ISRAEL</u>											
IL 1	Res. Op. PE (R)	16000 Target 2300 Control	Rain Enhancement Project (EMS/MEKOROT) Israel	Entire country North of Beer-Sheba, northern part seeded routinely, southern part randomized seeding except in drought years	1961 Yes	Agr. (G) Hyd. (G)	Air and Ground: acetone burners and pyrotechnics	-	Convective, orographic, synoptic scale disturbances & bands organized on the mesoscale. Predominant cloud base temp. +5 to 0°C. Operations criteria: cloud bases <5000 MSL, top >10000 ft cloud top temp. <-8°C.	-	Yes/Yes Randomized
<u>ITALY</u>											
IT 1	Dev. and Op. Hail	2000 Target 6000 Control	Campagna Sperimentale Difensa Anti-grandine "VICENZA"	Province of Venice (NE Italy)	1972 Yes	Agr. (G)	Air and Ground: 12 ground based kerosene + B.T.A. burners, 1 A/C using pyrotechnic flares seeding at cloud base	1.2 kg/hr, 280 kg AgI total from ground; 2 to 3 kg/hr AgI from A/C	Convective clouds; synoptic scale disturbances; predominant cloud base temp. +10 to +20°C. Operations criteria based on synoptic situation & dynamic analysis.	31 Days: May-Sept	Yes/Yes
<u>MEXICO</u>											
MX 1	Op. PE (R) PE (E)	20000 Target	State of Mexico	-	1982 (?)	State Gov.	Air: 1 A/C seeding at cloud base	83 kg AgI total	Convective, stratiform, and orographic clouds. Synoptic scale disturbances, clouds bands organized on mesoscale. Predominant cloud base temp. +20°C.	May-Oct	No/Yes (H)
MX 2	Op. PE (R) PE (E)	20000 Target	Puebla	-	1971 (interrupted in 1976 & 1983)	State Gov.	Air: 1 A/C seeding at cloud base	61 kg AgI total	Convective, stratiform, and orographic clouds. Synoptic scale disturbances, clouds bands organized on mesoscale. Predominant cloud base temp. +20°C.	May-Oct	No/Yes (H)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>MEXICO (contd.)</u>											
MX 3	Op. PE(R) PE(E)	3000 Target	Iguala	-	1984 (?)	State Gov.	Air: 1 A/C seeding at cloud base	40 kg AgI total	Convective, stratiform, & orographic clouds. Synoptic scale disturb- ances, clouds bands organized on mesoscale. Predominant cloud base temp. +20°C.	May-Oct	No/No
<u>MOROCCO</u>											
MA 1	Res. Op. PE(E)	16400 Target, 7000 S Control 3500 N Control	Programme Al-Chait No. 608 - 0190 U.S. AID	Central High Atlas Mountains	1984 Yes	Wea. Ser. (G)	Air: 5 A/C using acetone burners & pyrotechnics seeding at cloud base, summit & in-cloud at -5°C	375 g/h/aircraft, 20.6 kg AgI total plus 4.5 kg AgI using pyrotechnics	Orographic clouds, synoptic scale disturb- ances. Seeding crite- ria requires cloud summit temp. equal to or less than -5°C.	Nov-Apr	Yes/ Yes (H)
<u>NORWAY</u>											
NO 1	Ops. Fog	5-10 Target	-	Oslo Airport, Fornebu; Oslo Airport, Gardermoen	1964 Yes	Trans. (G)	Air: 1 A/C seeding in-cloud at temp. less than -1°C using solid dispensing units	100 to 150 kg dry ice (solid CO ₂) each seeding, approximately 5000 kg CO ₂ total	Stratiform clouds with base temp. between -3°C and -10°C. Criteria for operation depends mainly on temp.	About 40 Days: Jan-Mar, Nov-Dec	No/No
<u>SPAIN</u>											
ES 1	Op. Res. Hail	7 Target	Hail Suppression Actions with Application of Ice- Forming Nuclei	Provinces of Zaragoza, La Rioja, Alava, Navarra	1973 (G/B gen- er- ators) 1984 A/C	Agr. (G) and (P)	G/B and Airborne: A/C in-cloud seeding at about 0°C using acetone burner generators	AgI	Convective clouds. Seeding criteria based on radar reflectivity of 35 DBZ above 0°C isotherm.	June-Sept	Yes/ No
<u>UNION OF SOVIET SOCIALIST REPUBLICS</u>											
SU 1	Op. Hail	6700 Target	Hail Suppression	Uzbek SSR	1967 Yes	Agr. (G), Wea. Serv. (G)	Air: in-cloud seeding between -6 and -9°C using rockets and artillery shells carrying explosive and/or pyrotechnic flare generators	AgI	Convective clouds, predominant cloud base temp. between +10 and +15°C. Operations alert based on prob- ability of hail >0.4; seeding criteria based on radar reflectivity at 3.2 cm being less than that at 10 cm wave length.	42 Days: Apr-Aug	Yes/ Yes (H)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>UNION OF SOVIET SOCIALIST REPUBLICS (Contd.)</u>											
SU 2	Op. Hail	6700 Target	Hail Suppression	Tajik SSR	1964 Yes	Agr. (G), Wea. Serv. (G)	Air: in-cloud seeding between -6 and -10°C using rockets and artillery shells carrying explosive and/or pyrotechnic flare generators	AgI	Convective clouds, predominant cloud base temp. +10 and +15°C. Operations alert based on hail probability >0.4; seeding criteria requires ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length to be <1.	28 Days: Apr-Aug	Yes/ Yes (H)
SU 3	Res. and Dev. PE(R)	10000 Target	Research to Investigate Possibilities for Precipitation Enhancement in the Volga River Basin	Penza Region	1982 Yes	Res. (G), Wea. Serv. (G)	Air: cloud top seeding using pyro- technic flare generators carried by two A/C	AgI and dry ice (solid CO ₂)	Convective clouds, predominant cloud base temp. +10 and +15°C; layer clouds with predominant cloud base temp. between 0 and -5°C; seeding criteria based on temp. condi- tions & presence of supercooled liquid water.	40 Days: May-July; Nov-Mar	No/ Yes (H) For layer clouds radar meas- ure- ment of precip- ita- tion
SU 4	Res. and Op. Fog	3500 x 500 x 100 m Target volume	Artificial Dissipation of Supercooled Fog	Airport at Kishinev, Moldavia	1984 Yes	Res. (G) Wea. Serv. (G)	G/B: liquid propane spray	Propane	Cloud temp. between -5 and -15°C. Seeding criteria based on temp. conditions, wind speed & presence of super- cooled liquid water.	12 Days: Nov-Dec Jan-Mar 1984 and 1985	Yes/ Physical eval- uation based on observa- tions of vis- ibil- ity in the target & sur- round- ing areas
SU 5	Op. Hail	10850 Target	Hail Suppression	Georgian SSR	1964 Yes	Agr. (G), Wea. Serv. (G)	Air: explosive and pyrotechnic flare generators carried by rockets and artillery shells. Seeding at cloud base & in-cloud at temp. between -3 and -9°C	AgI	Convective clouds, predominant cloud base temp. +5 and +10°C. Seeding criteria based on forecast probabilit- ity of hail greater than 0.4; ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	66 Days: Apr-Oct	Yes/ Yes (H)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>UNION OF SOVIET SOCIALIST REPUBLICS (Contd.)</u>											
SU 6	Op. Hail	19700 Target	Hail Suppression	Moldavian SSR	1964 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud between -6 and -15°C and at cloud base using rockets carrying pyrotechnic flare generators	AgI	Convective clouds, predominant cloud base temp. +5 to +10°C. Operation alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	61 Days: May-Sept	Yes/ Yes (H)
SU 7	Op. Hail	2800 Target	Hail Suppression	Ukranian SSR Odessa Region	1980 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud between -6 and -10°C and at cloud base using rockets carrying pyrotechnic flare generators	AgI	Convective clouds, predominant cloud base temp. +10 to +15°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	29 Days: May-Sept	Yes/ Yes (H)
SU 8	Op. Hail	10850 Target	Hail Suppression	Armenian SSR	1964 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud between -4 and -8°C and at cloud base using rockets and artillery shells carrying pyrotechnic flare and explosive generators	AgI	Convective clouds, predominant cloud base temp. 0 to -8°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	68 Days: Apr-Oct	Yes/ Yes (H)
SU 9	Op. Hail	4300 Target	Hail Suppression	Ukranian SSR, Crimea Region	1968 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud at -6 and at cloud base using rockets carrying pyrotechnic flare generators	AgI	Convective clouds, predominant cloud base temp. +15°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	27 Days: May-Sept	Yes/ Yes (H)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>UNION OF SOVIET SOCIALIST REPUBLICS (Contd.)</u>											
SU 10	Op. Hail	7700 Target	Hail Suppression	Krasnodar Region	1967 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud at -6 and at cloud base using rockets and artillery shells carrying pyrotechnic flare and explosive generators	AgI	Convective clouds, predominant cloud base temp. +7 to +14°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	44 Days: May-Sept	Yes/ Yes (H)
SU 11	Op. Hail	12200 Target	Hail Suppression	Azerbaijan SSR	1967 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud between -0 and -12°C and at cloud base using rockets and artillery shells carrying pyrotechnic flare and explosive generators	AgI	Convective clouds, predominant cloud base temp. +3 to +9°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	47 Days: Apr-Oct	Yes/ Yes (H)
SU 12	Op. Hail	7120 Target	Hail Suppression	Northern Caucasus	1967 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud between -3 and -15°C and at cloud base using rockets and artillery shells carrying pyrotechnic flare and explosive generators	AgI	Convective clouds, predominant cloud base temp. +9 to +14°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	45 Days: May-Sept	Yes/ Yes (H)
SU 13	Res. Hail	2500 Target 3000 Control	Complex Hail Experiment	Kabardino- Balkarian ASSR	1983 Yes	Res. (G), Wea. Serv. (G)	Air: seeding in-cloud between -3 and -9°C and at cloud base using rockets and artillery shells carrying pyrotechnic flare and explosive generators	AgI	Convective clouds, predominant cloud base temp. +5 to +10°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	6 Days: May-Aug	Yes/No Physical effects of seeding mon- itor- ed

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>UNITED STATES OF AMERICA</u>											
US 1	Op. PE(R)	1350 Target 988 Control	84-172 KDWOC Project	Kaweah River Watershed, California	1976 Yes	Hyd. (P)	G/B and Air: 5 G/B generators, 1 A/C; G/B and cloud top seeding using acetone burner generators & pyrotechnic flares	2-20 g/min/ pyrotechnic flare generator; 10-20 g/hr/acetone burning generator, 4.349 kg AgI total	Orographic clouds	29 Days: Jan-Apr, Nov-Dec	No/No
US 2	Op. PE(R)	614 Target 2600 Control	Upper American River Project	Sacramento, California	1979 Yes	Hyd., Energy (G- Muni.)	G/B: 8 acetone burning generators	20 g/hr/generator, 2.864 kg AgI total	Orographic clouds	9 Days: Mar, May, Nov, Dec	No/No
US 3	Op. PE(R)	3120 Target 15600 Control	84-491 Kern River Project	Kern River Watershed, California	1982 Yes	Hyd. (P)	Air: 1 A/C carrying pyrotechnic flares seeding AgI at cloud top and in-cloud	60 to 30,000 g/hr, 0.8 kg AgI total	Orographic clouds	4 Days: Mar, Apr	No/No
US 4	Op. PE(R)	2600 Target	84-507 T-18	Texas portion of the water- shed of Red Bluff Lake	1983 Yes	Energy and Hyd. (P)	G/B: 13 arc-type AgI generators	0.5 to 2.0 g AgI/hr/generator, 5.527 kg AgI total	Convective clouds & synoptic scale disturbances.	144 Days: Jan-Dec	No/No
US 5	Op. PE(R)	9100 Target	84-516 Colorado River Municipal Water District Project	Big Springs, Texas	1975 Yes	Agr. (P)	Air: A/C carrying pyrotechnic generators	2.7 to 7.1 g/min, 5.52 kg AgI total	Convective and layer clouds.	20 Days: May-Sept	No/No
US 6	Op. Hail	25474 Target	84-521 Western Kansas Weather Modifi- cation	12 Western Kansas Counties	1975 Yes	Hyd. (G- local)	Air: 1 or 3 A/C acetone burning and solid dispensing generators	0.126 l/min, 26.346 kg AgI total; 0.4536 kg/ min, 1059 kg dry ice (solid CO ₂) total	Convective clouds	52 Days: May-Sept	No/No
US 7	Op. PE(R)	9178 Target	84-522 North Dakota Weather Modification Project District I	West Central North Dakota	1977 Yes	Energy (G- state)	Air: in-cloud seed- ing using acetone burner, solid dispensing & pyrotechnic flares carried by A/C	50.48 kg AgI total; 502.12 dry ice solid CO ₂) total	Convective clouds. Seeding criteria based on cloud base height, cloud base diameter, temp. & liquid water content.	16 Days: Jun-Aug	No/Yes
US 8	Op. PE(R)	22523 Target	84-523 North Dakota Weather Modification Project District II	Northwestern North Dakota	1977 Yes	Agr. (G- state)	Air: cloud base & in-cloud (-2 to -12.5°C) seeding using acetone burn- ing, solid dispensing & pyrotechnic flare generators carried by A/C	68.98 kg AgI total; 441 kg dry ice (solid CO ₂) total	Convective clouds. Seeding criteria based on cloud base height, cloud base diameter, temp., & liquid water content.	40 Days: May-Aug	No/Yes

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<u>UNITED STATES OF AMERICA (Contd.)</u>											
US 9	Op. PE(R) and Hail	6973 Target	84-524 Harding County Weather Modification Program	Harding County South Dakota	1977 Yes	Agr. (G- local)	Air: cloud base, top and in-cloud (-2 to -12.5°C) seeding using acetone burn- ing, solid dispensing & pyrotechnic flare generators carried by A/C	19.02 kg AgI total	Convective clouds. Seeding criteria based on cloud base height, cloud base diameter, temp., & liquid water content.	26 Days: Jun-Aug	No/Yes
US 10	Res.	3484 Target	84-526 - 1984 State Federal Cooperative Field Research Project	Stark County, North Dakota	? Yes	Res. (G- Fed- eral & State)	Air: cloud base and in-cloud (-2 to 12.5°C) seeding using AgI-NH ₄ I-CIO ₄ NaCl ₄ acetone solution burning generator carried by 1 A/C	0.470 kg AgI total	Convective clouds	4 Days: July	No/No
US 11	Op. Fog	26 Target	84-527 Supercooled Fog Dispersal Project	Salt Lake City, Utah	1972 Yes	Trans. (P)	Air: cloud top seed using 1 A/C dispensing dry ice (solid CO ₂)	35295 kg dry ice total	Layer clouds. Seeding criteria based on occurrence of super- cooled fog.	27 Days: Dec-Mar	No/No
US 12	Res.	780 Target	84-525 Utah Water Research Laboratory Balloon Elevated Seeding Technology	Logan, Utah	1982 Yes	Other (G- state)	Air: cloud base and in-cloud seeding using pyrotechnic flares carried by balloons	0.5 g/unit 0.008 kg AgI total	Orographic clouds	1 Day: Feb	No/No
US 13	Op. PE(R)	9100 Target	84-520 Santa Barbara County Cloud Seeding	Santa Barbara County, California	1982 Yes	Agr. (P), Hyd. (P)	G/B. and Air: 1 G/B generator, 1 A/C seeding in-cloud	5 g/min, 3.885 kg AgI total	Bands organized on mesoscale.	5 Days: Mar-Apr	Yes/No
US 14	Ops. PE(R)	468 Target	84-528 Wind River Weather Modification Project	Big Sandy River Drainage, Wyoming	1972 Yes	Agr. (P), Hyd. (P)	G/B: AgI-NH ₄ I propane fueled generators	10 to 15 g/hr; 5.263 kg AgI total	Orographic clouds, predominant cloud base temp. less than 0°C.	17 Days: Nov-Feb	No/No
US 15	Op. PE(R)	9100 Target	84-530 Santa Barbara County Cloud Seeding	Santa Barbara County, California	1982 Yes	Agr. (P), Hyd. (P)	G/B and Air: seeding at ground and in-cloud	25 g/hr; 18.3 kg AgI total	Bands organized on mesoscale.	15 Days: Nov-Apr	Yes/No

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
UNITED STATES OF AMERICA (Contd.)											
US 16	Op. PE(R)	650	84-531 Mokelumne Project	Central Sierra Nevada Mountains, California	1974 Yes	Agr. (P), Energy (P)	G/B: 5 acetone burning generators	25 g/hr, 13.76 kg AgI total	Orographic clouds. Seeding criteria based on height of freezing level, height of -10°C isotherm, cloud type, temp., average wind speed & direction	31 Days: Nov-Apr	No, Random- ized exper- iment with evalua- tion
US 17	Op. PE(R)	1300 Target 364 Control	84-532 Lake Almanor Project	Northern Sierra Nevada Mountains, California	1972 Yes	Agr. (P), Energy (P)	G/B: 5 acetone burning generators	25 g/hr, 24.047 kg AgI total	Orographic clouds & bands organized on mesoscale. Seeding criteria based on height of freezing level, height of -10°C isotherm, cloud top temp., average wind speed & direction.	26 Days: Nov-Mar	No, Random- ized exper- iment with evalua- tion
US 18	Snow enhancement for ski area	260 Target	84-536 Sun Valley Ski Area	Sun Valley, Idaho	1980 Yes	Rec. (P)	G/B and Air: 1 to 2 generators, in- cloud seeding using 1 A/C, acetone & pyrotechnic burning generators	100 to 300 g/hr, 6.57 kg AgI total	Orographic clouds having predominant cloud base temp. <0°C.	18 Days: Nov-Feb	No/No
US 19	Ops. Fog	5.2 Target	84-537 Ground- Based Cold Fog Dissipation System	Elmendorf AFB, Alaska	1971 Yes	Def. (G)	G/B: 24 units to spray liquid propane	12 gal/hr/dispenser, 800 gal propane total	Layer clouds, predom- inant cloud base temp. <0°C. Seeding cri- teria is occurrence of supercooled fog.	6 Days: Nov-Jan	Yes/Yes
US 20	Ops. PE(R)	260 Target 2072 Control	84-534 Central Colorado Project	Vail and Beaver Creek, Colorado	1978 Yes	Agr. (P), For- estry (P), Rec. (P)	G/B: 8 acetone burning generators	5-40 g/hr, 5.686 kg AgI total	Orographic clouds, bands organized in mesoscale.	38 Days: Nov-Mar	No/Yes
US 21	Ops. PE(R)	3900 Target 2072 Control	84-535 San Juan Program	Southwest Colorado	1977 Yes	Agr. (P), Hyd. (P)	G/B: 6 acetone burning generators	5 to 40 g/hr, 4.035 kg AgI total	Orographic clouds	19 Days: Nov-Feb	No/Yes
US 22	Ops. PE(R)	218 Target	84-518 Project OC-4	Hitch Ranch, Oklahoma	1983 Yes	Agr. (P)	G/B: 10 arc type generators	0.5 or 2 g/hr, 2.516 kg AgI total	Convective and layer clouds.	115 Days: Mar-Oct	No/No

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>UNITED STATES OF AMERICA (Contd.)</u>											
US 23	Ops. Fog	26 Target	84-519 Fog Dispersal Project	Medford, Oregon	1980 Yes	Trans (P)	Air: 1 A/C, cloud top seeding using solid dispensing unit	1899 kg dry ice (solid CO ₂) total	Layer clouds. Criteria for seeding is the occurrence of super- cooled fog.	11 Days: Jan-Feb	No/No
US 24	Ops. Fog	130 Target	84-538 Cold Fog Dispersal System	Fairchild AFB, Washington	? Yes	Def. (G)	G/B: 23 units to spray liquid propane	10 gal/hr, 6845 gals propane total	Layer clouds, predominant cloud base temp. <0°C. Seeding criteria is the occurrence of super- cooled fog.	46 Days: Oct-Mar	Yes/Yes
US 25	Ops. PE(R)	3120 Target	84-529 Big Creek Project, San Joaquin River	Upper San Joaquin River, California	1972 Yes	For- estry (P), Hyd. (P)	G/B and Air: acetone burning & pyrotech- nic flare generators. Airborne seeding is in-cloud	4.256 kg AgI total	Orographic clouds	28 Days: Oct-Dec	No/No
US 26	Appl. Res. PE	800 Target	Sierra Co-operation Pilot Project	Central Sierra Nevada, California	1976 Yes	Hyd. (G)	Air: 1 A/C seeding in-cloud (-7 to -13°C) and at cloud top. Seeding region selection based on numerical model incorporating 3-dimensional flow & crystal growth & fallout, pyrotechnic flare & solid dispensing generators	20 g/flare/10 sec flight, 8 kg AgI total; 6 lbs/run or about 0.5 kg/km 250 kg dry ice (solid CO ₂) total	Convective, layer and orographic clouds with predominant cloud base temp. of +5°C. Seeding criteria based on neutrally stable or orographically induced cloud following descent of upper clouds inducing supercooled liquid water. Target- ing model runs to see if winds, liquid water & temp. conditions will allow crystal fallout in target area.	12 Days: Jan-Mar	Yes/Yes Direct observa- tions in cloud and at ground
<u>ZIMBABWE</u>											
ZW 1	Op. PE(R)	390500 Target	National Cloud Seeding Operation (NACSO) Zimbabwe	Zimbabwe	1972 Yes	Wea. Serv. (G)	Air: seeding at cloud top and in-cloud at temp. -10°C or below, using pyrotechnic flares	AgI; 2283 pyrotechnic cartridges type TBZ consumed	Convective clouds, cloud base temp. about +20°C. Seeding criteria: developing Cu with tops at or below -10°C (about 21000 ft AMSL); 1935 clouds seeded.	66 Days: Nov/1984 through Apr/1985	Yes/Yes Random- ized experi- ment

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<u>ARGENTINA</u>											
AR 1	Res. Dev. Op. Hail	1500 Target	Mendoza Gov. Dirección de Investigación de Lucha Antigranizo	Central San Martín Northern Province of Mendoza	1978 Yes	Agr. (G); (P)	Air and G/B: in-cloud seeding at -6 to -10°C using rockets	16.8 g per rocket, 35 kg AgI total	Convective clouds, predominant cloud base temp. +4 to +10°C. Operations alert based on weather service severe storm forecast; seeding criteria based on 10 and 3.2 cm radar reflectivity.	169 days: Oct-Mar	Yes/ Yes (H)
<u>AUSTRIA</u>											
AU 1	Op. Hail	500 Target	Hail Defense Project "Lower Austria"	Districts of Krems-Langenlois	1981 Yes	Agr. (P)	Air: 2 A/C, cloud base seeding with acetone burners	10 l/hr (7% AgI solution), 70 hr burning/yr	Convective clouds, predominant cloud base temp. +12 to +16°C. Operations alert based on thunderstorm forecast from the Vienna Airport; seeding criteria based on radar echo intensity greater than 35 DBZ.	20 days: 15 May to 15 Sept	No/ Yes (H)
AU 2	Op. Hail	1600 Target	Hail Defense Project "Styria"	Districts of Gleisdorf-Weiz	1982 Yes	Agr. (P)	Air: 4 A/C, cloud base seeding with acetone burners	10 l/hr (7% AgI solution), 40 hr burning/yr	Convective clouds, predominant cloud base temp. +12 to +16°C. Operations alert based on thunderstorm forecast from the Vienna Airport; seeding criteria based on radar echo intensity greater than 35 DBZ.	30 days: 15 May to 15 Sept	No/ Yes (H)
<u>BULGARIA</u>											
BG 1	Res., Dev., Op. Hail	14000 Target	BG 1	42°N - 24°E; 43°30'N-23°30'E	1969 Yes	Agr. (G), Wea. Ser. (G)	Air: rockets, in-cloud seeding at T = -5 to -10°C	10600 kg PbI ₂ (total)	Convective clouds, predominant cloud base temp. +13°C. Seeding criteria based on radar reflectivity.	38 Days: May-Sept	Yes/ Yes (H)
<u>CANADA</u>											
CA 1	Res. PE(R)	10200 Target	Southern Alberta Cloud and Seeding Plume Study	Southern Alberta - High River - Taber area	1981 ?	Agr. (G), Res. (G)	G/B: coke and arc rod generators at 80 locations	2 to 30 g/hr/ generator, 21.5 kg AgI total	Convective clouds, predominant cloud base temp. +5°C. Operational criteria based on synoptic situation, upper level winds & prognostic maps for plume.	27 Days: 10 June to 26 July	Yes/ Yes (H)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>CANADA</u>											
CA 2	Res. PE(R), Hail	28200 Target 68000 Control	Alberta Hail Project	130 Km radius of Red Deer Industrial Airport, Alberta	1974 - 1979 operational 1980-1985 Experimental No	Agr. (G), Res. (G)	Air: cloud base and top seeding, in-cloud seeding at -8 to 0°C using 5 acetone AgI burners, pyrotechnic flares (AgI) and CO ₂ solid dispensing generators	2250 g/hr wing pyrotechnics, 10000 g/hr droppable pyrotechnics, 107.5 kg AgI total; 19.9 kg CO ₂ pellets, NH ₄ I (solution) 130 g/hr, 162 l	Convective clouds, predominant cloud base temp. 0°C. Operations criteria based on radar obs. that cloud growth meets seeding criteria followed by aircraft obs. confirming that cloud temp. & structure meet seeding criteria.	3 June to 31 Aug	Yes/ Yes (H) Randomized experiment
<u>DOMINICAN REPUBLIC</u>											
DM 1	Op. PE	6500 Target 6500 Control	-	18°20'N, 70°20'W;; 19°20'N, 71°20'W	1984 Yes	Energy (G)	-	Mixture of NaI, NH ₄ I, acetone burned in propane flame	Convective clouds. Operations criteria based on sounding and radar echo.	108 Days: Mar-July	-
<u>FRANCE</u>											
FR 1	Op. & Res. Hail	55000 Target 470000 Control	Association Nationale d'Etude et de Lutte Contre les Fléaux Atmosphérique (Prévention de la Grêle)	Southwest France, Depts. 09, 11, 16, 17, 31, 33, 40, 64, 65, 66, 81	1952 Yes	Agr. (P)	G/B: 448 acetone burners	8 g/hr/generator, 591 kg AgI total	Convective clouds, predominant cloud base temp. 0 to +10°C.	20 to 42 Days: (depending on Dept.) Apr-Oct	Yes/ Yes (H)
<u>GERMANY, FEDERAL REPUBLIC OF</u>											
DE 1	Res. Hail	1700 Target 4000 Control	Hail Suppression in Oberschwaben	Southern Federal Republic of Germany Kreis-Ravensburg	1978 Yes	Agr. (G), Agr. (P)	Air: cloud base seeding using 2 A/C and acetone burners	13 kg AgI total	Convective clouds, predominant cloud base temp. +5°C.	30 Days: May-Sept	Yes/ Yes (H)
DE 2	Op. & Res. Hail	2700 Target 7000 Control	Hail Suppression Project Stuttgart Area	Stuttgart area	1979 (1980 in field) Yes	Agr. (G), Agr. (P)	Air: cloud base seeding using 1 A/C and pyrotechnic flares	70 g/l solution/flare (or 2x10 ¹² AgI particles/flare), 289 flares total (AgI)	Convective clouds, predominant cloud base temp. +15°C (highly variable): Operations criteria based on upper air stability, & 24-hr forecast. Seeding criteria based on radar echo greater than 25 DBZ above 0°C isotherm & RHI tops above 25000 feet.	May-Oct	Yes/Yes Hail pads cell analysis

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>GERMANY, FEDERAL REPUBLIC OF (Contd.)</u>											
DE 3	Ops. Hail	200 Target 400 Control	Hail Suppression Mühdorf- Altötting	Bavaria, FRG	1983 Yes	Agr. (G- local)	Air: cloud base seeding using 1 A/C, and acetone burner	4 l/hr HSEOLL, 100 l total	Convective clouds; predominant cloud base temp. 0 to +30°C. Operations use the Munich Meteorological Office Information.	31 Days: May-Aug	No/No
DE 4	Ops. Hail	2800 Target 2800 Control	Weather Modification Project - South Bavaria Area Rosenheim - Miesbach	Country District Rosenheim - Miesbach	1957 Yes	Agr. (G- local)	Air: cloud base seeding using 1 A/C, and acetone burner	10 kg/hr AgI solution (700-800 g/hr AgI), 250 kg acetone solution total	Convective clouds, (orographic); predom- inant cloud base temp. +4 to +6°C. Cb with tops above specified threshold level are seeded.	25 Days: 1 May to 15 Sept	Yes/No
<u>HUNGARY</u>											
HU 1	Op. Hail	1500 Target*	Hail Suppression Project of Baranya County	South Hungary 45°55'- 46°05'N, 18°55'E	1976 Yes	Wea. Ser. (G), Ins. (G)	Air: in-cloud seeding between -5° and -10°C using rockets	1508g "Oblako", 66g "PGI-M" and 408g "Alazany" rockets 1200 kg, PbI ₂ total for HU 1 (1984/85) and HU 2 (1985)	Convective clouds, mesoscale bands. Criteria for seeding: height of 40 DBZ echo (S band MRL-5) and tendency parameter of cell development.	42 Days: Apr-Oct (HU 1 and HU 2)	Yes/ Yes (H)
HU 2	Op. Hail	1000 Target*	Hail Suppression Project of Bács-Kiskun County	South Hungary 46°-46°25'N, 18°55'-19°25'E	1985 Yes	Wea. Ser. (G), Ins. (G)	Air: in-cloud seeding between -5° and -10°C using rockets	1508g "Oblako", 66g "PGI-M" and 408g "Alazany" rockets, 1200 kg PbI ₂ total (for HU 1 (1984/85) & HU 2 (1985)	Convective clouds, mesoscale bands. Criteria for seeding height of 40 DBZ radar echo (S band MRL-5) & tendency parameter of cell development.	42 Days: Apr-Oct (HU 1 and HU 2)	Yes/ Yes (H)
<u>INDIA</u>											
IN 1	Res. PE	1600 Target 1600 Control	Warm Cloud Modification Experiment, Maharashtra State	Maharashtra State, 18°N to 19°06'N, 74°15'E to 74°38'E	1973 Yes	Wea. Ser. (G)	Air: in-cloud seeding 600 m above cloud base using 1 A/C, solid dispensers	600 to 1800 kg/hr, 24000 kg NaCl total	Convective clouds; predominant cloud base temp. +18 to +20°C. Operations criteria based on sounding, low cloud amount, wind velocity & synoptic conditions.	July-Sept	Yes/Yes Random- ized cloud physics obs.

* Total target area for HU 1 and HU 2 is reported as 2500 km². 1983 Register reported HU 1 target area of 1500, which is used here.

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<u>ISRAEL</u>											
IL 1	Res. Op. PE(R)	16000 Target 2300 Control	Rain Enhancement Project (EMS/MEKOROT) Israel	Entire country north of Beer-Sheba, northern part seeded routinely, southern part randomized seeding except in drought years	1961 Yes	Agr. (G), Hyd. (G)	Air and Ground: 63 G/B generators, 3 A/C seeding at cloud base. Acetone burners and pyrotechnic flares	A/C 600 g/hr, G/B generators 11 g/hr, 150 kg AgI (total)	Convective, orographic, synoptic scale disturbances & bands organized on the mesoscale. Predominant cloud base temp. +5 to 0°C. Operations criteria: cloud bases <5000 MSL, tops >10000 ft, cloud top temp. <-8°C.	33 Days: Nov-May	Yes/Yes Randomized
<u>ITALY</u>											
IT 1	Dev. and Op. Hail	2000 Target 6000 Control	Campagna Sperimentale Difensa Anti-grandine "VICENZA"	Province of Venice (NE Italy)	1972 Yes	Agr. (G)	Air and Ground: 12 ground based kerosene + B.T.A. burners, 1 A/C using pyrotechnic flares seeding at cloud base	1.2 kg/hr, 350 kg AgI total from ground; 2 to 3 kg/hr AgI from A/C	Convective clouds, synoptic scale disturbances; predominant cloud base temp. +10 to +20°C. Operations criteria based on synoptic situation & dynamic analysis.	38 Days: May-Sept	Yes/Yes
<u>MADAGASCAR</u>											
MG 1	Ops. PE(E)	100 to 250 Target	-	Agricultural regions experiencing high precipitation deficit	1985 Yes	Wea. Ser. (G)	Air: 1 A/C seeding in-cloud within strong ascending drafts using solid dispensing units	15 kg/hr NaCl	Convective clouds, predominant cloud base temp. +15 to +20°C. Seeding in afternoons on days of moderate or strong instability.	30 Days: Oct-Apr	No/No
<u>MEXICO</u>											
MX 1	Op. PE(R) PE(E)	20000 Target	State of Mexico	-	1982 (?)	State Gov.	Air: 1 A/C seeding at cloud base	75 kg AgI total	Convective, stratiform, and orographic clouds, synoptic scale disturbances, clouds bands organized on mesoscale. Predominant cloud base temp. +20°C.	May-Oct	No/No
<u>MOROCCO</u>											
MA 1	Res. Op. PE(E)	16400 Target, 7000 S Control 3500 N Control	Programme Al-Chait	Central High Atlas Mountains	1984 Yes	Wea. Ser. (G)	Air: 5 A/C using acetone burners and pyrotechnics seeding at cloud base, summit and in-cloud at -5°C	375 g/h/aircraft, 20.6 kg AgI total plus 4.5 kg AgI using pyrotechnics	Orographic clouds, synoptic scale disturbances. Seeding criteria requires cloud summit temp. equal to or less than -5°C.	Nov.-Apr	Yes/ Yes (H)

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>NORWAY</u>											
NO 1	Ops. Fog	5-10 Target	-	Oslo Airport, Fornebu; Oslo Airport, Gardermoen	1964 Yes	Trans. (G)	Air: 1 A/C seeding in-cloud at temp. less than -1°C using solid dispensing units.	100 to 150 kg dry ice (solid CO ₂) each seeding, approximately, 5000 kg CO ₂ total	Stratiform clouds, predominant cloud base temp. -3°C and -10°C. Criteria operation depends mainly on temp.	Approx- imately 40 days: Jan-Mar, Nov-Dec	No/No
<u>UNION OF SOVIET SOCIALIST REPUBLICS</u>											
SU 1	Op. Hail	8600 Target	Hail Suppression	Uzbek SSR	1967 Yes	Agr. (G), Wea- Serv. (G)	Air: in-cloud seeding between -6 and -9°C using rockets and artillery shells carrying explosive and/or pyrotechnic flare generators.	AgI	Convective clouds, predominant cloud base temp. +10 and +15°C. Operational alert based on probability of hail >0.4; seeding criteria based on radar reflect- ivity at 3.2 cm being less than that at 10 cm wave length.	55 Days: Apr-Aug	Yes/ Yes (H)
SU 2	Op. Hail	7000 Target	Hail Suppression	Tajik SSR	1964 Yes	Agr. (G), Wea. Serv. (G)	Air: in-cloud seeding between -6 and -10°C using rockets and artillery shells carrying explosive and/or pyrotechnic flare generators	AgI	Convective clouds, predominant cloud base temp. +10 and +15°C. Operations alert based on forecast hail proba- bility >0.4; seeding criteria based on radar reflectivity at 3.2 cm being less than that at 10 cm wave length.	39 Days: Apr-Aug	Yes/ Yes (H)
SU 3	Res. and Dev. PE (R)	10000 Target	Research to Investigate Possibilities for Precipitation Enhancement in the Volga River Basin	Penza Region	1982 Yes	Res. (G), Wea. Serv. (G)	Air: cloud top seeding using pyro- technic flare generators carried by two A/C	AgI and dry ice (solid CO ₂)	Convective clouds, predominant cloud base temp. between +10 and +15°C; layer clouds with predominant base temp. between 0 and -5°C. Seeding criteria based on temp. condi- tions & presence of supercooled liquid water.	40 Days: May-Jul, Nov-Mar	No/ Yes (H) For layer clouds physical asses- ment uses radar measure- ments of precip- ita- tion

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
<u>UNION OF SOVIET SOCIALIST REPUBLICS (Contd.)</u>											
SU 4	Res. and Op. Fog	3500 x 500 x 100 m Target volume	Artificial Dissipation of Supercooled Fog	Airport at Kishinev, Moldavia	1985 Yes	Res. (G), Wea. Serv. (G)	G/B: liquid propane spray	Propane	Predominant cloud base temp. -5 and -15°C. Seeding criteria based on temp. conditions, wind speed & presence of supercooled liquid water.	12 Days: Nov-Dec Jan-Mar	Yes/Physical evaluation based on observations of visibility in the target & surrounding area
SU 5	Op. PE(R)	5000 Target 10000 Control	Seeding of Clouds to Enhance Winter Precipitation	Krivoy Rog, Ukrainian SSR	1985 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud at temperatures less than -4°C using 4 A/C and solid dispensing units	Dry ice (solid CO ₂)	Layer clouds with predominant cloud base temp. of 0°C. Criteria for seeding includes cloud thickness greater than 500 m.	30 Days: Jan-Feb Nov-Dec	Yes/Yes Comparison of precipitation in target & control within 12-hr periods
SU 6	Op. PE (R)	1000 Target 1000 Control	Seeding of Clouds to Enhance Precipitation	Uzbek SSR, Kashkadarinskaya Region	1985 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud between -4 and -18°C using rockets and 1 A/C carrying pyrotechnic flare generators and solid dispensing units	AgI and dry ice (solid CO ₂)	Layer and orographic clouds, synoptic scale disturbances & bands organized on mesoscale. Predominant cloud base temp. -2 and -6°C. Seeding criteria cloud base temp. -4 to -20°C, cloud thickness >300 m, base <1000 m, changes in absolute moisture saturation, speed of cloud glaciation.	15 Days: Feb-Apr	Yes/Yes (H) Instrumental evaluation of part of experiment with use of MRVK "Precipitation"
SU 7	Op. PE(R)	3000 Target	Precipitation Enhancement	Georgian SSR	1985 Yes	Agr. (G), Wea. Serv. (G)	Air: pyrotechnic flare and explosive generators carried by rockets and artillery shells, seeding at cloud base and in-cloud at temp. between -4 and -18°C	AgI	Convective clouds, predominant cloud base temp. between +5 and +10°C. Seeding criteria requires clouds thicker than 2 km.	27 Days: May-Sept	Yes/Yes (H) Hydrological evaluation

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
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SU 8	Op. Hail	10850 Target	Hail Suppression	Georgian SSR	1964 Yes	Agr. (G), Wea. Serv. (G)	Air: explosive and pyrotechnic flare generators carried by rockets & artillery shells. Seeding at cloud base and in-cloud at temp. between -3 and -9°C	AgI	Convective clouds, predominant cloud base temp. +5 and +10°C. Seeding criteria based on forecast probability of hail greater than 0.4 & ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	73 Days: Apr-Oct	Yes/ Yes (H)
SU 9	Op. Hail	22000 Target	Hail Suppression	Moldavian SSR	1964 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud between -6 and -15°C and at cloud base using rockets carrying pyrotechnic flare and explosive generators	AgI	Convective clouds, predominant cloud base temp. +5 to +10°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	44 Days: May-Sept	Yes/ Yes (H)
SU 10	Op. Hail	3050 Target	Hail Suppression	Ukranian SSR Odessa Region	1980 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud between -6 and -10°C and at cloud base using rockets carrying pyrotechnic flare generators	AgI	Convective clouds, predominant cloud base temp. +10 to +15°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.3 cm to that at 10 cm wave length being <1.	29 Days: May-Sept	Yes/ Yes (H)
SU 11	Op. Hail	11220 Target	Hail Suppression	Armenian SSR	1964 Yes	Agr. (G), Wea. Serv. (G)	Air: seeding in-cloud between -4 and -8°C and at cloud base using rockets and artillery shells carrying pyrotechnic flare and explosive generators	AgI	Convective clouds, predominant cloud base temp. 0 to +8°C. Operations alert based on forecast of 0.4 or greater probability of hail; seeding criteria based on ratio of radar reflectivity at 3.2 cm to that at 10 cm wave length being <1.	65 Days: Apr-Oct	Yes/ Yes (H)

