



ARTIFICIAL STIMULATION OF RAIN

PROCEEDINGS OF THE FIRST CONFERENCE ON THE
PHYSICS OF CLOUD AND PRECIPITATION PARTICLES

Held at

Woods Hole Oceanographic Institution

Woods Hole, Massachusetts

September 7-10, 1955

*Sponsored by the
Geophysics Research Directorate
Air Force Cambridge Research Center
Air Research and Development Command
and the
Geophysics Branch
Office of Naval Research*

SYMPOSIUM PUBLICATIONS DIVISION
PERGAMON PRESS
LONDON · NEW YORK · PARIS

TABLE OF CONTENTS

	<i>page</i>
Frontispiece Photograph of Conference Participants	
Preface	v
Words of Welcome	
Greetings from the American Geophysical Union .. Helmut Weickmann	xi
A Note of Welcome from the Woods Hole Oceanographic Institution A. H. Woodcock	xiii
Address of Welcome from the Air Force Geophysics Research Directorate Milton Greenberg	xv
 Part 1—Aerosols: their origin, distribution and measurement	
Remarks about the size distribution of natural aerosols	
CHRISTIAN E. JUNGE	3
The question of meteoritic dust in the atmosphere	
VINCENT J. SCHAEFER	18
Some facts about meteoritic dust	
CHRISTIAN E. JUNGE	24
Facts and problems of chemical composition of condensation nuclei in unpolluted and polluted atmospheres	
CHRISTIAN E. JUNGE	31
Electron-microscope studies on the nuclei of sea fog and snow crystals	
UKICHIRO NAKAYA	36
Techniques for the chemical identification of micron and submicron particles	
JAMES P. LODGE, JR. AND BARBARA J. TUFTS	43
Distribution in the atmosphere of certain particles capable of serving as condensation nuclei	
HORACE R. BYERS, JOHN R. SIEVERS AND BARBARA J. TUFTS	47
Some observations of the geographical distribution of giant hygroscopic nuclei	
E. M. FOURNIER D'ALBE	73
Recent measurements of the vertical distribution of Aitken nuclei	
HELMUT WEICKMANN	81
The vertical distribution of aerosols over the ocean	
CHRISTIAN E. JUNGE	89
Time variations of charged atmospheric nuclei	
RITA C. SAGALYN AND GERARD A. FAUCHER	97

	<i>page</i>
Determining the concentration of fogs and other aerosols by a space-charge measuring instrument	
B. VONNEGUT, C. B. MOORE, JOHN EHRENFELD AND C. R. SMALLMAN ..	122
Preliminary investigation of the distribution of space charge in the lower atmosphere	
B. VONNEGUT, C. B. MOORE AND M. BLUME.. .. .	131
Part 2—Condensation and coagulation; measurement of cloud- and rain-drop size; rain from water clouds	
The role of adsorption in water condensation	
S. J. BIRSTEIN	145
Diffusional growth problems in cloud physics	
CHARLES E. ANDERSON	153
A nomogram for the calculation of collision efficiencies	
HELMUT WEICKMANN	161
Laboratory measurements of the growth and of the collection efficiency of raindrops	
GILBERT D. KINZER AND WILLIAM E. COBB	167
The collision efficiency of cloud droplets	
R. M. SCHOTLAND	170
Isokinetic flow and sampling of airborne particulates	
JAMES D. WILCOX	177
Droplet size measurements in convective clouds	
LOUIS J. BATTAN AND CLAYTON H. REITAN	184
Precipitation of convective water clouds	
T. W. R. EAST	192
Atmospheric salt in nuclei and in raindrops	
A. H. WOODCOCK	202
Cloud-seeding trials using common salt	
E. M. FOURNIER D'ALBE	207
Discussion of raindrop distributions made during project shower, Hawaii, 1954	
D. C. BLANCHARD	213
Size distribution generated by a random process	
WALTER HITSCHFELD	224
Discussion of the question of drag by the cloud or rain particles in initiating the downdraft	
HORACE R. BYERS, PRESIDING	229
Part 3—Melting and freezing; studies of snow and ice in the generation of Precipitation	
The supercooling, freezing, and melting of giant waterdrops at terminal velocity in air	
DUNCAN C. BLANCHARD	233

Overseeding of cumulus clouds	
ROSCOE R. BRAHAM, JR. AND JOHN R. SIEVERS	250
A discussion of generating cell observations with respect to the natural existence of freezing or sublimation nuclei	
ROBERT M. CUNNINGHAM	267
Observations of space and time variations in the radar echo intensity of showers	
PAULINE M. AUSTIN AND RAYMOND WEXLER	271
Snow growth and aggregation in generating cells	
R. H. DOUGLAS	277
The melting layer	
RAYMOND WEXLER	306
The snow crystal as aerological sonde	
HELMUT WEICKMANN	315
Physical investigations of snow flakes	
UKICHIRO NAKAYA	327
The growth of ice crystals	
G. A. WOLFF	332
A first experiment on snow-crystal growth	
J. S. MARSHALL AND K. L. S. GUNN	340
Discussion of the growth of ice crystals	
HORACE R. BYERS, PRESIDING	347
Radar measurements of precipitation growth	
DAVID ATLAS	288
Part 4—Crystal growth and nucleation; laboratory and field studies	
Cinema on crystal growth	
DAVID TURNBULL	351
Remarks on the theory of heterogeneous nucleation of crystals	
DAVID TURNBULL	354
Ice nucleation and the structure of nuclei crystal faces	
JAMES E. MANSON	360
The effect of condensation nucleus size and type on the temperature of ice crystal formation in clouds	
C. L. HOSLER AND G. R. SPALDING	369
Studies on the effects of certain chemicals on the inhibition of nucleation	
S. J. BIRSTEIN	376
Surface nature of ice crystals	
UKICHIRO NAKAYA	386
Notes on the structure of ice	
E. J. WORKMAN	390

	<i>page</i>
Observations of freezing nuclei over the southwestern U.S. A. RICHARD KASSANDER, LEE L. SIMS AND JAMES E. McDONALD ..	392
Studies on re-evaporation ice nuclei CHARLES E. ANDERSON	404
Part 5—Thunderstorm Electricity	
Thunderstorm charge generation E. J. WORKMAN	411
Part 6—International Terminology	
The new international definitions of hydrometeors CHARLES F. BROOKS	415
Appendix 1—List of Participants	421
Appendix 2—Agenda of Meeting	425