APPLICATION OF RADAR TO METEOROLOGY

CONFERENCE IN MONTREAL

THE third Radar Weather Conference was held in the Macdonald Physics Laboratory of McGill University, Montreal, during September 15–17. About eighty people actively engaged in research into the application of radar to meteorological problems attended, and some forty papers were read and discussed in seven sessions. A very useful feature of the Conference, which contributed greatly to the value of the discussions that followed each paper, was the provision, before the beginning of the first session, of copies of all the papers scheduled to be read. When it is noted that the time-limit for receipt of authors' manuscripts was only three weeks in advance of the meeting, it is clear that Drs. Marshall, Gunn and Hitschfeld, of the Stormy Weather Research Group, McGill University, who formed the conference committee, accomplished a notable feat of organization.

The subject of Session *A*, under the chairmanship of Mrs. P. M. Austin (Massachusetts Institute of Technology), was "Precipitation Mechanisms". It is now more generally recognized that the Bergeron–Findeisen theory of rain formation—the rapid growth of ice crystals in an atmosphere saturated with respect to water, followed by growth by collision with cloud particles—is not adequate to explain all cases of rain formation, and that growth to raindrop size, without the aid of an ice crystal, by coalescence in the liquid state must also occur. The relative importance of each mechanism in a particular weather situation is, however, still a matter of speculation. That radar may be of great assistance in resolving this problem was shown in papers by Wexler (Massachusetts Institute of Technology), Battan (University of Chicago) and Cunningham (Massachusetts Institute of Technology). From data on the level at which radar echoes from thunderstorms first appear and their subsequent rate of growth, Battan concludes that rain formation in convective clouds, even those extending above the freezing level, may often occur through a process involving only the liquid phase. On the mechanism of this process, East (McGill) suggested that, if by some method—for example, turbulence or steady acceleration of the air—the gravitational field around a cloud droplet is increased, then the rate of growth of that droplet by collision with smaller droplets will also increase. Hence turbulence may play an important part in the generation of rain in cumulus clouds.

Turbulence as it affects aircraft rather than cloud droplets was the subject of a paper by R. F. Jones (Meteorological Office, East Hill). It was shown that the structure of the echo from a cumulus or cumulo-nimbus cloud, as seen on the radar display tubes, particularly in the vertical cross-section, is a useful guide to the severity of the turbulence likely to be encountered by an aircraft traversing the cloud and also indicates the places in the cloud where the turbulence is likely to be the most severe.

Marshall, Langleben and Rigby (McGill), from an examination of the characteristic 'mare's tail' radar echo-pattern (seen in the vertical cross-section) associated with falling snow, suggested that snow is generated continuously in compact generating elements rather than uniformly over a wide area.

Session *B*, under the chairmanship of Prof. H. Byers (University of Chicago), was devoted to "Cloud Observations and Cloud Radar Problems". Whereas radars operating on wave-lengths of 10 cm. and 3 cm.—the only wave-lengths commonly used for weather purposes up to this time—detect only those parts of clouds containing rain or drizzle drops or snowflakes and not the whole clouds, Plank, Atlas and Paulsen (U.S. Air Force Cambridge Research Centre), using a vertically-looking radar of wave-length 1·25 cm., reported that about 47 per cent of all clouds can be detected. Swingle (Signal Corps Engineering Laboratories), with a vertically-looking 0·86-cm. radar, has obtained better results than on 1·25-cm. wave-length on cumulus, cirro-stratus and cirrus clouds, and about the same results on other clouds. The results obtained are in accordance with the Rayleigh scattering theory, so that even these radars of shorter wave-lengths see only the parts of clouds containing the larger elements. Nevertheless, the ability to detect smaller droplets or ice crystals than with wave-lengths of 10 and 3 cm. will add further to the knowledge already gained of precipitation processes.

Session *C* was held in the Council Chamber of the International Aviation Building, with Mr. A. C. Bemis (Massachusetts Institute of Technology) as chairman. The purpose of this session was to bring together the radar meteorologists and those interested in the possibilities of using airborne radar to increase passenger safety and comfort. Carnes (Aeronautical Radio, Inc.) put the airline point of view, and pointed out that economical operation demands that the size and weight of electronic equipment carried must be kept small. He said that 3-cm. airborne radar suffers too much from attenuation in heavy rain, and a wave-length of 6 cm. is being recommended. Tolefson (National Advisory Committee for Aeronautics) showed that the use of radar will enable the pilot of an aircraft significantly to reduce the number of large gusts it encounters with increased passenger comfort, a finding which is supported by the work done in Britain. It is unlikely, however, that radar could assist in reducing the number of small gusts encountered, a factor of importance to structure fatigue.

"Rain Measurements" was the subject of Session *D*, over which Mr. D. Atlas (U.S. Air Force Cambridge Research Centre) presided. 10-cm. or 3-cm. radar has the useful property of indicating over a surrounding area almost instantaneously—in the time taken to sweep the radar beam over the area—the places where precipitation is occurring, and, from the intensity of the received radar signal, an indication of the rainfall intensity can be obtained. In areas where very heavy rainfall over the catchment area of a river leads to dangerous flooding farther down, the warning which radar can give may be of great value in saving lives and property. Research along these lines was reported by Stout and Neill (Illinois State Water Survey), who claimed that rainfall-rates computed from the received signal intensities of a 3-cm. radar were as accurate as those obtained from a rain-gauge network of 1 gauge per 200 square miles.

Similar results using 10-cm. radar, with a pulse integrator device which gives automatically the average signal intensity over an area, were reported by Austin and Richardson (Massachusetts Institute of Technology).

Mr. G. E. Stout (Illinois State Water Survey) presided over Session *E*, which was devoted to "Instruments". As well as the radars of short wave-length already referred to, which it is hoped to use as indicators of cloud base and top, instruments were described which are designed to measure rain-drop sizes and distributions from aircraft and on the ground. A knowledge of liquid water content and drop-size distribution is of importance in assessing quantitatively the radar signal received from a volume of cloud.

Dr. R. A. Smith (Telecommunications Research Establishment, Malvern) was chairman of Session *F*, when "Scattering in the Atmosphere" was discussed. Gunn and East (McGill) and Labrum (Radiophysics Laboratory, Sydney), working independently, have put on a firm quantitative basis the theory of back-scattering of radio energy from ice spheres coated thinly with water and from water spheroids. They have proved (what up to now has been assumed) that a small ice sphere with a thin water coating, as, for example, in the first stage of melting, will scatter nearly as well as a water sphere of the same volume and may absorb better. A water-coated ice spheroid may scatter and absorb very much more strongly than the spherical water drop into which it melts, giving an explanation of the well-known 'bright band' effect of enhanced echo at the freezing-level in conditions of continuous rain.

Gerhardt (University of Texas) said that his refractometer measurements indicated that in subsidence and frontal inversions the refractive index gradient over short distances may be several orders of magnitude greater than the normal, and that isolated patches exist with variations of refractive index adequate to explain 'angel' echoes (radar echoes received from a clear sky). Gordon (Cornell University) explained how scattering from turbulent patches in the atmosphere may increase the field strength beyond the horizon above the theoretical value at frequencies greater than 30 Mc./s., as has often been observed. There was some discussion on 'angel' echoes, which were reported by W. B. Gould (Signal Corps Engineering Laboratory) to have been observed in great numbers using a vertically-looking radar of wave-length 1·25 cm. These echoes are also observed in Britain using wave-lengths of 3 cm. and 10 cm. and are almost certainly associated with inhomogeneities in the atmosphere of the kind described by Gerhardt.

The final session, under the chairmanship of Dr. Gould, discussed "Fluctuating Signals", the object of this topic being to deduce some of the properties of the scattering particles by measurement of the fluctuations from pulse to pulse of a radar signal. In particular, it is hoped that the measurements may yield information on the turbulence within a cloud—for example, the size and duration of turbulent eddies. The subject is clearly complicated by the large distribution of drop sizes within a precipitating cloud and also by the inherent variabilities in the performance of radar sets.

Before finally dispersing, the Conference decided to accept an invitation to hold its fourth meeting during November 1953 in the University of Texas.

R. F. Jones

INTERNATIONAL SCIENTIFIC FILM ASSOCIATION

SIXTH ANNUAL CONGRESS

THE growing strength of the international scientific film movement was well in evidence at the annual congress of the International Scientific Film Association, held in the Maison de la Chimie, Paris, during September 23–October 1. During the congress, the acceptance of three countries as new members was announced—Cuba, East Germany and West Germany—and the reports from all countries showed steady progress and development in the use of the film for scientific education, for research and for popularizing science.

Seventy-two delegates and observers, representing twenty-one countries, the United Nations Educational, Scientific and Cultural Organization, the Federation Internationale des Archives du Film and the Federation Internationale des Ciné-Clubs, attended the congress. During the meeting, a hundred and seventeen films were shown to public and specialized audiences and, of these, the largest number from any one country was from Great Britain, no fewer than twenty-seven British films being shown; among them may be particularly mentioned "Atoms at Work", the Crown Film Unit's ten-minute documentary on Harwell, which attracted wide interest and resulted in a unanimous resolution by the congress urging other countries to give it the widest showing and to make similar films depicting their own development of atomic energy for peaceful ends.

Other films shown included a West German film illustrating, by means of infra-red photography, the remarkable fact that mice will fight savagely in the dark but never in the light; a French film showing the film work by the late Bernard Lyot on astronomy; a quite outstandingly beautiful Hungarian colour film of bird and insect life on the great lakes; an Icelandic film made by Mr. Tutte Lemco on the eruption of Mount Hecla, the dramatic shots of which provoked several bursts of spontaneous applause; and an equally striking Italian colour film of the courtship of the praying mantis.

The Research Section of the Association held several sessions, at one of which there was a demonstration of magnetic strip recording by M. André Didier, which was of particular interest to the British members present in view of its introduction at the present time into Britain. There were also two demonstrations of stereoscopic techniques. The first, by Dr. François Savoye (Paris), dispenses with 'Polaroid' glasses and relies on a synchronized rotating 'grill' in front of the screen to alternate the right- and left-eye images. It was effective, but suffered from the fact that the viewer's head has to be held very still in order to avoid a shifting of the images—a drawback that may possibly be due to the fact that both screen and grill were rather small. The other stereoscopic system was demonstrated by H. Dewhurst, of the Telecommunications Research Establishment, Malvern, using 'Polaroid' glasses and a beam-splitting equipment which is within the scope even of the amateur film-maker. The demonstration was mainly with an amateur colour film, and the results were excellent, although again handicapped perhaps by a small screen.

Among matters discussed by the general assembly of the congress was a proposal to establish a Section