COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF METEOROLOGICAL PHYSICS

ANNUAL REPORT

FOR THE YEAR

1958-9

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I GENERAL

Aviation, agriculture, and other diverse activities make growing demands on our knowledge of the weather. The Commonwealth Scientific and Industrial Research Organization has established research groups working towards a better understanding of the physics of the atmosphere. This research is aimed not only at improving the forecasting of atmospheric effects, but also at obtaining a more fundamental knowledge of the weather and the processes which control it. In particular, Australia being the driest of the continents, the problem of water supplies is being attacked on a wide front.

The Organization's major meteorological investigations are undertaken in the Division of Meteorological Physics and are directed to an increased understanding and advantageous use of the science of meteorology on the widest possible basis. The Division of Radiophysics is engaged on a series of experiments in cloud physics and artificial rain-making and the Division of Physical Chemistry is conducting research on techniques to retard evaporation from open water surfaces. These latter projects will be described in the composite Annual Report of the Organization.

The main areas of activity of the Division have continued unchanged, though the position of officer in charge of the ozone work has been vacant throughout the year.

Mr. W. C. Swinbank has been on leave of absence for most of the year, working in the University of Chicago and the Argonne National Laboratories, U. S. A. Professor R. B. Montgomery of Johns Hopkins University completed his period of work with the Division as a Fulbright Research Scholar. In the international sphere, two officers by invitation attended the International Symposium on Atmospheric Diffusion and Air Pollution at Oxford in August, 1958, and four attended the International Symposium on Antarctic Meteorology in Melbourne in February, 1959. Members have continued their service on various working groups of the World Meteorological Organization, on Commissions of the International Meteorological Association, and

on National Committees set up by the Australian Academy of Science with their associated international activities including the International Geophysical Year.

II DYNAMIC METEOROLOGY

The I.G.Y. has stimulated further work in meteorological problems of Antarctica. The theory of Antarctic katabatic winds developed in 1956 was extended, indicating that minor topographic features can produce large spatial variations, while the movement of depressions along the coast can cause considerable temporal variations of the katabatic wind strength.

Influences of the elevated cold sourse prevailing in Antarctica, on the climate and circulation patterns in middle southern latitudes, are an important problem for Australia. Controlled experiments were carried out using a removable model "Antarctica" in a rotating vessel containing water heated at the periphery and cooled in the centre. Although complete dynamic similarity was not attainable, results are significant for an understanding of Southern hemisphere temperature regimes.

In conjunction with the Department of Meteorology, University of Melbourne, surges at the rim of Antarctica were studied in relation to seasonal and aperiodic variations in the zonal flow strength in middle latitudes. Lag correlations were found, of possible value in forecasting seasonal anomalies, but the results must await a more complete quantitative treatment of the underlying exchange processes. IGY data should be helpful in extending to the Southern hemisphere a study of periodic mass redistributions based on data covering the whole of the Northern hemisphere, with emphasis on the polar regions.

Further work on the Antarctic cold source is contemplated in conjunction with a longer term program assessing the effects of summertime heating on large scale flow patterns in Australasia. An estimate of the partial heat source below 10,000 feet due to long wave radiation has been completed. Continental heating has considerable effects on synoptic weather sequences. A comprehensive study of cool changes during summer in south-eastern Australia has shown that the changes are markedly influenced by convection and the large-scale seabreeze circulation which penetrates well over 100 miles inland. An expedition to obtain detailed information on

penetration has yielded results from Renmark (S.A.) which should prove illuminating for similar phenomena around the Australian hinterland. Largely because of their bearing on fire control, these phenomena have been treated statistically in a separate publication.

The heat balance and dynamics of the horizontal circulations over and near Australia require a slow transverse drift transporting the energy. Storage of energy in certain forms is of direct importance in assessing spontaneous increases of the circulation, producing monsoonal rains. These processes, which might prove significant in predicting the onset of the monsoonal regime, are being studied theoretically and on data from Australia and Southeast Asia. Related to this problem is the study of a prominent subsidence inversion over Australia which also bears on the density of pollutants and on radio-wave propagation. Theoretical predictions concerning the control of the inversion height by surface heating have been confirmed and in particular a diurnal oscillation of height up to 1.5 km has been found in Central Australia.

The ideas implicit in the paper 'Long waves, lee waves and gravity waves' have been used to derive exact solutions of the barotropic vorticity equation. It is hoped thereby to increase an understanding of certain large-scale features of upper tropospheric flow, e.g. 'split jets' and 'blocks'.

III MICROMETEOROLOGY

Solar energy becomes the motive power of weather phenomena on all scales through the radiative and turbulent energy exchanges between ground and atmosphere: one of these exchanges, i.e. evaporation, is of outstanding importance in its own right. The Division has continued its fundamental studies of these processes and also of the friction between air and ground - the brake on the atmospheric 'engine'.

A major advance has been the completion of development of a prototype instrument to measure directly the turbulent flux, embodying automatic computation from the inputs of suitably responsive anemometers, fine-wire resistance thermometers etc. In field tests the net energy so determined has agreed with the amount available from radiation. If this agreement is maintained, results thenceforward should accrue in far greater number than have been available

anywhere in the past. While primarily aimed at the measurement of daytime evaporation from natural ground surfaces, the instrument will also be most valuable in studies of heat and momentum transfer. Field trials of a simpler, portable, transistor version ('Fvapotron') will begin soon.

The sensitive integrator designed for the above work has been adapted to other applications, notably in the integration of daily solar radiation. Several such instruments have been supplied to other Divisions for various agricultural and pastoral investigations.

A modified form of cup anemometer has been developed which uses transistor circuitry to provide remote recording of wind speed. Unlike existing instruments, it is well suited to record very low speeds.

Temperature and wind speed profiles in the lower atmosphere have been studied in their relationship to the turbulent transport of heat and momentum and a large body of observations, from both this Division and other sources, has been successfully unified. This is a cornerstone investigation on which most meteorological and agricultural applications in some way rest and the latest result, combined with an earlier one on heat transfer, should occasion considerable change in accepted thinking.

For five months of summer a preliminary evaporation survey has been made of Lake Eucumbene, the largest storage of the Snowy Mountains hydro-electric scheme, and from this it has been possible to recommend a routine method for evaluating the evaporation. Knowledge of this loss will be significant in operating the reservoir for best water utilization. More detailed studies may be made in future years. Over land, some further advance has been made in the parallel problem of a practical method of calculating evaporation from measurements of wind speed and humidity at two heights.

In the study of exchanges between sea and atmosphere, analysis of results obtained on cruises of FRV Derwent Hunter is still in hand. A new approach to the measurement of turbulent transfer, via structure functions, has been made theoretically and this should be much more suited to shipboard application than existing methods.

IV AGRICULTURAL METEOROLOGY

Considerable progress has been made with the lysimeter installation

intended for the study of the water losses from bare soils and from different types of crop. Ten of the twelve six-ton soil containers are now in operation and a year's observations have accrued from seven. One lysimeter is now installed on the special recording balance built in the Division. The balance has a resolving power equivalent to an evaporation of 0.001 inch, and has performed satisfactorily over a lengthy test period. This weighing lysimeter also gives the amount of dewfall by night. The next three balances have reached the assembly stage. Auxiliary equipment has been constructed for controlled uniform irrigation and for observing relevant micrometeorological and soil factors.

Observations relating to the infestation of tobacco by blue mould were maintained throughout the summer in collaboration with the Division of Plant Industry and the Victorian Department of Agriculture, and will be continued. Results already indicate the possibility of predicting the occurrence of critical meteorological conditions at the leaf surface from measurements of ambient climate in the crop. The onset of dew on a freely exposed thin lamina is being studied as a related problem.

An instrument has been developed for the estimation of the amount of dew on natural grass. Field trials indicate that the sensitivity of the instrument may depend on the general length of the grass but it is hoped to overcome this difficulty.

Construction of apparatus, instruction, and general assistance with evaporation and other applied micrometeorological problems have been provided for the Divisions of Plant Industry and Land Research and Regional Survey; and to the Victorian Horticultural Research Farm, Scoresby, with reference to humidity and the storage of peaches.

V RADIATION

For the measurement of net radiation at the earth's surface, a new weatherproof and sensitive radiometer has been developed and is to be manufactured commercially under licence.

Instruments have already been supplied to various users, including the Antarctic Division, and one to Dr. F. Loewe for a study of the glaciers of Nanga Parbat.

Measurements at night on the change of radiative flux with height in the lowest few metres above the ground have shown that radiation is considerably more effective in cooling these air layers than had previously been supposed on theoretical grounds.

Co-operation has been maintained with the State Electricity Commission of Victoria in studying the effect of aluminium powder on the heat transfer from a cooling pond.

VI OZONE

The Dobson spectrophotometer at MacQuarie Island was destroyed by fire during the year, but ozone measurements for international collation have continued throughout at Melbourne and Brisbane.

VII MISCELLANEOUS

Practical meteorology in Australia suffers heavily from the scarcity of information from the ocean areas to South and West. An assessment has been made of the feasibility of weather buoys, transmitting pressure in the first instance. The main difficulties are likely to be those of radio transmission and direction finding, and these problems are being kept under investigation.

A recorder has been designed, originally at the request of the Division of Land Research and Regional Survey, which is capable of a year's unattended operation. Depending on the type of transducer coupled to it, it can provide information on water level, rainfall, temperature etc., and should have a wide use particularly for hydrological work in remote regions. Operational tests are in progress under stringent field conditions.

Measurements of the radio-activity in rainfall near Melbourne were commenced in 1958 as a contribution to the I.G.Y. Weekly samples are taken and the total radio-activity is determined, using an ion-exchange resin technique. The radioactive decay of the sample allows estimation of the date of the test explosion responsible, and hence provides information about the transfer processes between equatorial regions (where the explosions have occurred) and higher latitudes.

A radar station, using service types of radar, is being constructed at the Aspendale headquarters as a general meteorological research instrument. Designs are now complete and assembly has begun.

Assistance was given to P.M.G's Department in the estimation of the temperature changes likely to be experienced by the underground co-axial cable to link Melbourne and Sydney.

Data on wind fluctuations at heights from 40 to 500 ft. above ground have been supplied to the Civil Engineering Department of Bristol University. Spectra are to be computed electronically to yield information on wind oscillations of engineering significance.

Calibration services for anemometers and radiation instruments have continued to be provided for outside bodies.

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* U.S. Weather Bureau

* Meteorological Office, Great Britain.

STAFF LIST

Chief	C.H.B. Priestley, M.A., Sc. D., F.A.A.
Senior Principal Research Officer	W.C. Swinbank, M.Sc.
Senior Principal Research Officer	E.L. Deacon, B.Sc.
Principal Research Officer	A.F.A. Berson, Dr. Phil.
Principal Research Officer	R.J. Taylor, B.Sc.
Senior Research Officer	I.C. McIlroy, B.Sc..
Senior Research Officer	E.K. Webb, B.A.(HONS), B.Sc.
Senior Research Officer	R.H. Clarke, B.A., B.Sc.
Senior Research Officer	A.J. Dyer, M.Sc., Ph. D.
Research Officer	F.K. Ball, B.Sc. (HONS)
Research Officer	J.P. Funk, Dr. Phil.
Research Officer	J.E. Humble, B.Sc., M.Sc.
Experimental Officer	D.E. Angus, B.Sc. (Overseas)
Experimental Officer	R.R. McGregor, Dip. Appl. Sc.
Experimental Officer	A.J. Troup, B.Sc.
Experimental Officer	C.J. Sumner, A.M.S.E.,
Experimental Officer	F.J. Maher, A.R.M.T.C., A.M.I.R.E. (AUST)
Experimental Officer	B.G. Collins, B.Sc.
Experimental Officer	N.E. Bacon, B.Sc.
Experimental Officer	Miss S-A. Yeo, B.Sc.
Librarian	I.S. Groodin