COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF METEOROLOGICAL PHYSICS

ANNUAL REPORT

FOR THE YEAR

1954-5

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I GENERAL

The work of the Division is directed towards a closer understanding of the behaviour of the atmosphere, with a view not only of improving the prediction of its effects but also of utilizing them to the greatest advantage. The details of the research programme are described below.

The subject is essentially an international one and contributions were made during the year at meetings of the International Meteorological Association (UGGI), the Commonwealth Conference on Oceanography, the International Gliding Association, and at the Indian Ocean Science Congress which dealt with problems of more regional significance. Mr. L.P. Smith, Head of the Agricultural Meteorology Branch of the British Meteorological Office, visited Australia for two months as part of a tour to study applications of meteorology to agriculture and observe Australian practice in water conservation and irrigation.

The elevation of the Section to the status of Division took place during the current year.

II GENERAL CIRCULATION

Concentration has recently been on more local problems, but a summary of work on the general circulation was given to a special symposium on this subject at the UGGI Assembly in Rome. The novel features of the approach developed in the Division have played a part in orienting overseas work on this international problem.

Attempts to assess the water balance of the S.E. quarter of the Australian continent by the same techniques, i.e. inflow and outflow from daily soundings of wind and humidity, have so far proved inconclusive, but there are hopes for success if the soundings can be improved in number and accuracy.

III DYNAMIC METEOROLOGY

Work in dynamic meteorology centres on selected problems of a long term nature concerned in the full-scale processes of weather. Selection is decided on basic rather than day-to-day importance, though the work should still lead to improved standards and techniques in analysis and forecasting.

The study of interactions between monsoonal and general circulations in the Australian region is being continued and an investigation of the sequence relations in summer pressure patterns has been completed. An unexpected temporary reversal has been found in January of the continental low pressure system (heat low), which tends to be strongest and furthest South in December and February.

Marked diurnal wind oscillations over the West Australian and Queensland hinterland are being examined as an indication of the daily cycle of convective mixing. Calculations of the relevant transfer coefficient await completion of an analysis of semi-diurnal and diurnal pressure variations in progress in the Bureau of Meteorology.

Investigations into the nature of discontinuities in temperature, moisture and wind, associated with cold fronts and similar phenomena have been continued on an extensive scale. The classification of fronts in Western Australia based on radio soundings has been completed, and related to the behaviour of pressure systems subsequently affecting South-East Australia. Preliminary examinations of 'cool changes' affecting S.E. Australia had emphasised the need for more special observational data. The Division has now enlisted the help of voluntary observers, and has installed recording instruments at key places and on ships and aircraft, while special measurements have been obtained at Aspendale and from the Victorian Country Fire Authority whose operational problems are allied to this study. The multiple structure of the 'cool change' has now been established over a wide region as composed of prefrontal wind shift and/or pressure jump lines, as well as of a cold front in the normal sense. The modification of heated continental air while temporarily over water South of Australia has been found to be an important process. The work, so far exploratory

and selective, should lead to a more systematic study of summer weather changes and a better recognition of the precise processes at work.

IV CONVECTION

Theoretical work has provided a solution for the velocity and temperature fields above a continuous source of heat in calm conditions. Very different behaviour results by day from that by night when a ceiling is formed above which the gas cannot penetrate. Experimental work is on hand to test the theory. Applications may then be made to orchard heating and industrial pollution (which is now under notice in parts of Australia and an urgent health problem overseas), to flying and visibility conditions, and to the physics of rain showers. The theory provides criteria for the proper scaling of heat effects in model (wind tunnel) tests, and there are prospects of quite general extension to the case of a plume bent over by the wind.

V MICROMETEOROLOGY

The principal aim in micrometeorology has been an understanding of the mechanics of turbulent processes in the lower atmosphere by detailed observation of the fine structure of temperature, motion and water vapour content of the air. The exchange of energy between the earth's surface and the atmosphere is a main factor in the production of air masses of different characteristics which originate many weather phenomena. The work relates also to the water balance of crops and reservoirs, the micro-climate of vegetation, and allied subjects. The techniques reported previously have been improved, mainly to extend the range of the study to lighter wind conditions.

The first phase, now largely completed, has greatly clarified the laws of transfer of meteorological properties, and this now allows concentration on more specific aspects. Observations on days of strong heating have disclosed a marked and comparatively sudden change in the heat disposal mechanism with decrease in wind speed. The theoretically derived laws for the heat loss by free convection, which operates at the lighter wind speeds, have been confirmed at the same time.

Spectral analyses of fluctuation records have been carried out to find the intensities associated with different sizes (scales) of eddy. The scale of vertical air movements increases roughly in proportion to height, while the change for horizontal velocity and temperature is less marked. The great change in scale between day and night has for the first time been quantitatively studied. The work also throws light on the adequacy of response time of the recording system and more exact information will come from a current investigation using instruments of varying response simultaneously.

The study of conditions on clear nights has been supplemented by observations of radiative transfer at two levels, to determine the relative importance of this to turbulent heat transfer.

Agricultural research requires a method of measuring evaporation from growing crops over varying time intervals. Progress has been made with an instrument to provide this, adapted from the method employed in the basic micrometeorological work. The vertical velocity meter is almost completed, and a suitable fast-response hygrometer is being evolved based on the principle developed by the Division of Physics.

Measurements of wind speeds up to 500 feet on a radio mast have shown that gustiness increases less rapidly with height than the mean wind speed. This is relevant to the economical design of tall structures and is of some importance in aircraft structural and landing and take-off problems.

Since most of the Earth's surface is water, more fundamental knowledge is required of the source of atmospheric energy derived from interaction with the ocean; this has reciprocal interest as a controlling factor in ocean currents and temperatures, and hence in problems of fisheries. Exploratory studies to extend the work on turbulent transfer to the atmosphere-ocean problem are now well advanced, and it is hoped to carry out some preliminary trials at sea during the coming year.

The Division has continued to advise other organizations on micrometeorological aspects of their work. It has undertaken the construction of a number of fine structure probes, and provides a

calibration service for instruments of this type and for anemometers and air meters for outside bodies.

VI FROST PREVENTION

Trials on the use of wind machines for frost prevention were continued, mainly in grape vines with a ducted fan now available commercially (JETOM). The performance of this machine was generally satisfactory at strong inversions, indicating a favourable mixing pattern with the narrow high-speed air jet, but poor at weak inversions. The effect of increasing the height of the duct outlet will be investigated during the coming season.

In earlier work using large fans attention was focussed on the amount of warm air drawn down, the effect in mixing the inversion layer at a distance being regarded as secondary. Work with fans delivering progressively smaller quantities of air, but with similar amounts of kinetic energy, has reversed the emphasis, much of the temperature increase at low levels being due to mixing at a distance. This conclusion has been confirmed by the lack of substantial improvement when a ducted fan was fitted with a furnace to heat the emerging air.

Accordingly a ducted fan delivering a narrow high-speed air jet is being erected at the main testing site at Griffith. It is hoped that these experiments will round off the basic aspects of the work to the stage at which the effect of all the main factors involved (strength of inversion, tilt of fan, rate of rotation of air jet, power consumption, and type of air jet) can be assessed. Field trials of frost alarms have been transferred to the Commonwealth Research Station at Merbein.

VII OZONE INVESTIGATION

Atmospheric ozone, though small in total amount, makes an important contribution to the radiation balance of the atmosphere and there is a close connection between ozone content and latitude, season, and synoptic situation. Measurements have been made for some years under international auspices, in a number of countries mainly in

the Northern Hemisphere. It is proposed to establish a network of three stations in the S.E. of Australia. The necessary adjustments and calibrations of one of the instruments have been completed and observations started in Melbourne. The data should be of importance in the study of the general circulation and will be an adjunct in routine analysis and forecasting.

STAFF LIST

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Priestley, C.H.B. (1955)	-	Free and forced convection in the atmosphere near the ground. Quart. J. Roy. Met. Soc. Vol.81, No. 348, pp. 139-143.
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