

COMMONWEALTH SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

DIVISION OF METEOROLOGICAL PHYSICS

ANNUAL REPORT

FOR THE YEAR

1955-6

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I GENERAL

There are few activities which are not in some way connected with the weather and climate. The work of the Division is directed towards a closer understanding of the behaviour of the atmosphere, with a view not only to improving the prediction of its effects but of utilizing them to the greatest advantage. The details of the research programme are described below.

More than most others, meteorology is an international science, and international aspects of the work have continued to receive attention. The World Meteorological Organization has in recent years set up Working Groups in special subjects, and the Chief of the Division is a member of that on Microclimatology and Chairman of the newly formed Group on Atmospheric Diffusion, and a member of the Executive Committee of the International Meteorological Association, one of the divisions of U.G.G. I., while Mr. W.C. Swinbank has been appointed to the Ozone Commission of that body. The decision of UNESCO to hold a conference on Climatology of the Arid Zone in Australia later this year is a recognition of the country's stake in and contribution to this field.

Professor P.A. Sheppard, professor of meteorology at Imperial College, London, visited the Division for four months under a Nuffield Fellowship and collaborated in the study of interactions between ocean and atmosphere (see below). The F.R.V. Derwent Hunter was kindly made available for this work for one month by the Division of Fisheries.

Work was begun on the extension to the Division's building at Aspendale, Victoria, to provide more space particularly for physical laboratories, instrument workshop, and for an adequate synoptic laboratory. The wind tunnel room was completed and the wind tunnel installed, with the addition of a smaller working section to give airspeeds up to 55 m.p.h.

II GENERAL CIRCULATION

The studies of the general circulation previously reported have been temporarily set aside to allow a greater concentration on problems of more immediate local significance to the Australian region.

III DYNAMIC METEOROLOGY

Large Scale Circulation

Investigation in dynamic meteorology aims at a better understanding of large scale weather processes and provides the necessary background for analysis and forecasting of the weather situation.

The study of interactions between monsoonal and general circulations in the Australian region is being extended to the trade wind regime and the distribution of rainfall over the continent.

Special observations on 'cool changes' from a large number of places in SE Australia have now been taken for two summer seasons. These have been collated with the more routine observational data, and the statistics of the phenomenon over the whole region are being built into a semi-climatological survey. It has been found that the speed of movement varies through the day and this results in the change tending to occur at preferred times of day, which vary comparatively little from place to place. Upper wind observations at the coast show that the sloping frontal surface (shear zone) is distorted, and this bears on the complex problem of the multiple structure of these changes. Intensive field work was carried out in a wide region centred on Mount Gambier in January 1956, in co-operation with the Bureau of Meteorology and voluntary helpers, supported by a temporary increase in the network of local recording stations.

A quite strong vertical circulation has been found to occur near the elevated part of the shear zone. This may well derive much of its energy from surface heating and affect the speed of movement of the changes.

A general method has been developed for calculating

energy changes involved in disturbing a dry atmosphere which has application to the above problem and to that of frost prevention, among others.

Wind and Pressure Surges

Wind surges are a feature of many regions of interest, particularly in Antarctica where their suddenness and violence has hitherto defied explanation. A new dynamical treatment of katabatic (downslope) flow accounts for the discontinuity and associated phenomena, and should prove relevant to the genesis of discontinuities in other regions. A formula has been developed for the position and character of the jump in terms of conditions up- and downstream.

The South Australian field data provided useful information on the behaviour of penetrating sea-breezes and should help to explain late evening wind surges in places such as Renmark and Kalgoorlie.

A sensitive micro-barograph has been constructed for the observations of pressure jumps etc. associated with cool changes. Pulses caused by H-bomb explosions at Bikini Atoll (distance 3500 miles) have been recorded.

IV CONVECTION

The solution for the velocity and temperature field above a continuous source of heat in calm conditions has now been adapted to provide a working solution under conditions of wind. Fair agreement is obtained with measurements on plumes from factory chimneys and smaller sources, and a basis now exists for estimates under quite general conditions in the many problems (atmospheric pollution, frost prevention, flying conditions, rain physics, air conditioning) in which convection plays a part.

This solution is capable of accounting for the quite sudden change in mechanism of heat transfer from ground to air which occurs with decrease in wind speed. Further measurements of heat flux made in extreme conditions of strong heating and light wind confirm a formula suggested previously, and the rate of transfer may

now be predicted from measurements of wind and temperature gradient near the ground. The pattern of motion in the lighter winds ('free convection'), which determines the flight habits of insect pests and, on larger scale, soaring birds and gliders, is becoming better known from these studies.

V MICROMETEOROLOGY

The incoming solar energy passes with little attenuation through the atmosphere and is absorbed at the earth's surface; a large part is thence transferred to the atmosphere by radiation and turbulence and is ultimately the cause of all weather and climate. The physical processes occurring in the layer of air near the ground which cause this transfer are therefore of fundamental importance. The principal aim has been, through detailed observation of the fine structure of temperature, water vapour content and motion, to study the turbulent mechanisms which achieve the interchange of heat, water vapour and momentum between atmosphere and earth. The work has application to the water balance of crops and open water storages, the micro-climate of vegetation, and allied subjects.

Earlier work has been consolidated during the past year. In particular, the transfer coefficients for water vapour and momentum have been found to be approximately equal and, in unstable conditions, both substantially less than that for heat transfer. Further spectral analysis indicates that, in the transition state between free and forced convection, there are air motions with horizontal scale greater than in any other condition, being several times larger than the height above ground.

The question of response time has been under further investigation. While two-second galvanometers have been found adequate for flux measurements at heights above 2 metres in light winds, at lower heights and in stronger winds some decrease in response time is necessary.

There is a pressing need in agricultural research for an accurate, automatic method of measuring evaporation from natural surfaces, including growing crops, over varying time intervals.

Such a method, based on techniques developed for turbulent transfer studies in the Division, has reached an advanced stage of development and field trials with a prototype model have now started.

There is some evidence that, in conditions of strong convection, the strong temperature gradient near the ground changes to approximately zero gradient at an unexpectedly low level at times as low as 10 metres. Further measurements of the temperature profile up to 100 metres are being made from a kite balloon.

Since most of the Earth's surface is water, more fundamental knowledge is required of the sources of atmospheric energy, water vapour and motion from interaction with the ocean; there is a reciprocal interest as a controlling factor in ocean currents and temperatures, and so in fisheries problems. Micrometeorological observations have been made during October, 1955 from the F.R.V. Derwent Hunter operating in Port Phillip Bay and the nearby waters of Bass Strait. A large number of wind profiles up to 45 feet have yielded useful information on the frictional stress between atmosphere and ocean, which will find application in the study of wind driven ocean current systems. Records of the turbulent fluctuations of wind and temperature were also taken, preliminary to the measurement of heat exchange between the sea and atmosphere. It is proposed to continue and extend this work during further trials planned for November of this year.

Over the last few years there has been an increasing awareness of the importance of micrometeorology to a wide range of problems in primary production, in respect of both plants and animals. As far as possible, without detracting from the development of its own research programme, the Division has acted in an advisory capacity in this field to, and undertaken the construction of special apparatus for, a number of other Divisions and institutions outside the CSIRO. A small group has been formed to promote this activity further. The development of instrumentation for a mobile micro-climate station is well advanced. The Division provides for outside bodies a calibration service for anemometers and air meters.

Lysimeter Installation

Work has started on the installation of a battery of twelve large (diameter 5'3") lysimeters, intended primarily for the study of evapotranspiration under controlled soil moisture conditions. Later work envisaged embraces a wide range of problems, mainly of agricultural interest.

VI FROST PREVENTION

The current series of trials on the use of wind machines for frost prevention were completed during the year. The final points to be investigated were the effects of air jet height and of crop type on the area covered.

The coverage has been found to increase with increasing height of the air jet, but the performance of the machines appears to be largely independent of the crop type, provided the mixing action of the jet penetrates adequately to ground level.

A detailed report of the investigations over the last six years is now being prepared. To meet the need for a detailed bibliography of frost prevention methods, a comprehensive review of this subject has been prepared and published.

VII OZONE INVESTIGATIONS

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. The three Dobson spectrophotometers in Australia have now all been adjusted and calibrated in the Division, and regular measurements have been made at Aspendale during the past year. It is proposed to continue these and the other instruments will be installed soon at Macquarie Island (52°S , 159°E) and Brisbane (27°S , 153°E) in collaboration with the

Australian National Antarctic Research Expedition and the Bureau of Meteorology respectively, in preparation for observations during the International Geophysical Year. The data then obtained will be of interest mainly in studies of the general circulation, but is expected also to be of value in local synoptic investigations.

STAFF LIST

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